THE GRADUATE BOOK 2017
PHD STUDENTS GRADUATED FROM THE FACULTY OF SCIENCE 2017
The Graduate Book 2017

PhD students graduated from the Faculty of Science 2017
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Foreword

The PhD school at SCIENCE University of Copenhagen is the second largest PhD school in Denmark with almost 300 new enrolments every year and a total number of enrolled PhD students of 1130. The investment in these PhD studies is in the order of 500 MDKK annually equivalent to about 17% of the faculty’s annual turnover. The PhD students make up around 40% of the total number of scientists and the scientific added value contributed by the PhD students makes up a significant part of the total scientific production made at SCIENCE. Therefore, it is important coherently to document the outcome of this huge investment, and consequently the dean’s office has decided to make this book. The book of graduates includes the abstracts of the PhD thesis from the previous year, and it is meant to facilitate an easy overview of the scientific achievements made by our PhD students every year.

John Renner Hansen
Dean
August 2018
Foreword

The PhD school at SCIENCE University of Copenhagen is the second largest PhD school in Denmark with almost 300 new enrolments every year and a total number of enrolled PhD students of 1130. The investment in these PhD studies is in the order of 500 MDKK annually equivalent to about 17 % of the faculty’s annual turnover. The PhD students makes up around 40 % of the total number of scientists and the scientific added value contributed by the PhD students makes up a significant part of the total scientific production made at SCIENCE. Therefore, it is important coherently to document the outcome of this huge investment, and consequently the dean’s office has decided to make this book. The book of graduates includes the abstracts of the PhD thesis from the previous year, and it is meant to facilitate an easy overview of the scientific achievements made by our PhD students every year.

John Renner Hansen
Dean
August 2018
PHD GRADUATES
FACULTY OF SCIENCE

Abstracts
PHD GRADUATE FROM FACULTY OF SCIENCE
Mads Vendelbo Lind

The Role of Diet in One-carbon Metabolism and Epigenetics - A Metabolic Syndrome Perspective

Supervisor(s):
Associate Professor Lotte Lauritzen, Assistant Professor Alistair Ross, Mette Kristensen

Department: Nutrition, Exercise and Sports

Date of defense: 21 October 2016
Date of awarded PhD degree: 9 January 2017

Summary:
Metabolic syndrome is an increasing public health challenge worldwide. One-carbon metabolism has been implicated in metabolic syndrome, partly because of its role in regulating epigenetics. Altering diet may be one way of altering one-carbon metabolism, affect epigenetics and prevent metabolic syndrome. This PhD thesis investigates the role of diet in one-carbon metabolism regulation and the potential association between one-carbon metabolism, epigenetics and metabolic syndrome. Different dietary components such as fish and whole grain have been investigated in depth.

The present thesis further substantiated the link between one-carbon metabolism and metabolic syndrome. Furthermore, we found associations between fish and whole grain intake and a more favorable one-carbon metabolism. However, increasing whole grain over an 8-week period did not affect one-carbon metabolism compared to consuming refined grain. We also investigated how supplementing 9-month old children with fish oil affected the epigenetic code and found differences even though these were small.

These results are interesting in regard to prevention of metabolic syndrome but further examinations into dietary interventions that can alter one-carbon metabolism and epigenetics are needed.

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Link: www.science.ku.dk/english/research/phd/student/phdtheses
PHD GRADUATE FROM FACULTY OF SCIENCE

Mads Vendelbo Lind
The Role of Diet in One-carbon Metabolism and Epigenetics -
A Metabolic Syndrome Perspective

Supervisor(s):
Associate Professor Lotte Lauritzen, Assistant Professor
Alistair Ross, Mette Kristensen

Department:
Nutrition, Exercise and Sports

Date of defense: 21 October 2016
Date of awarded PhD degree: 9 January 2017

Summary:
Metabolic syndrome is an increasing public health challenge worldwide. One-carbon metabolism has been implicated in metabolic syndrome, partly because of its role in regulating epigenetics. Altering diet may be one way of altering one-carbon metabolism, affect epigenetics and prevent metabolic syndrome. This PhD thesis investigates the role of diet in one-carbon metabolism regulation and the potential association between one-carbon metabolism, epigenetics and metabolic syndrome. Different dietary components such as fish and whole grain have been investigated in depth. The present thesis further substantiated the link between one-carbon metabolism and metabolic syndrome. Furthermore, we found associations between fish and whole grain intake and a more favorable one-carbon metabolism. However, increasing whole grain over an 8-week period did not affect one-carbon metabolism compared to consuming refined grain. We also investigated how supplementing 9-month old children with fish oil affected the epigenetic code and found differences even though these were small. These results are interesting in regard to prevention of metabolic syndrome but further examinations into dietary interventions that can alter one-carbon metabolism and epigenetics are needed.

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Astronomy is at this very moment undergoing a paradigm shift. Transitioning from a time of limited data to a time of data so plentiful that it takes dedicated efforts just to store and access it. As a consequence of this, the field of astroinformatics or astrostatistics is evolving – an interdisciplinary field of astronomers, statisticians, computer scientists and data scientists. Extensive surveys, such as Sloan Digital Sky Survey (SDSS), have made it possible to do science in a way never before seen in astronomy, giving researchers access to information about a billion objects in the sky at the click of a mouse. And SDSS was only the beginning. Many new astronomical observatories are being planned or built as you read this. The Large Synoptic Survey Telescope (LSST), scheduled to be fully operational in 2022, will produce about 30 terabytes (30,000 gigabytes) of images per night, which need to be analysed in near real-time to detect fast changing sources, so-called transients. Another telescope, the Square Kilometre Array (SKA), expected to be operational by the end of the 2020s, will produce a massive 1 exabyte (one billion gigabytes) of raw data per night. Needless to say, manual processing of the data is out of the question. Advanced methods from machine learning and computer vision have slowly entered astronomical research in the past couple of decades, but there is still much to do. Many open questions in astronomy could benefit from the advanced statistical methods available in the computer science field, and many interesting problems in astronomy could spark new ideas and approaches in both computer science and statistics communities. A core hypothesis of this thesis is the idea that there is much more to be learnt from already available data sets, and that advanced statistical methods, such as machine learning and computer vision, can help uncover this information. We investigate this in three different projects covering texture analysis of galaxies, feature selection for redshift estimation, and quality assessment of quasar candidates.
PHD GRADUATE FROM FACULTY OF SCIENCE

Sayma Akhter
Conservation of Mangifera Sylvatica: A Wild Fruit Species for Health and Livelihoods

Supervisor(s):
Professor Morag A. McDonald
Professor Erik Dahl Kjær

Department:
Geoscience and Natural Resource Management

Date of defense: 11 October 2016
Date of awarded PhD degree: 12 January 2017

Summary:
Many wild and underutilised plants contribute to food and nutrition. However, overexploitation due to ever increasing demand for wood products has frequently led to declines in populations of these species. Enhanced knowledge of the status of such species is necessary for livelihood security and conservation of these valuable species. The present study considers an underutilised and threatened species of Bangladesh, namely wild mango (Mangifera sylvatica Roxb.). Although this wild mango is one of the genetically closest species to the common mango (Mangifera indica L.) research is very limited and mostly focused on wood quality and phylogenetic relationships. Therefore, this study investigated the conservation potential of wild mango considering its contribution for food, nutrition and livelihoods. To do so, an assessment was made of the current and future distribution of the species, which is a crucial first step towards mitigation and management of future species losses or habitat shifts. The study characterized fruit quality by profiling morphological, nutritional and medicinal values. Finally, farmers’ preferences, and the agroforestry potential of this unutilized native fruit species were explored. The study conveyed five key messages: 1. Wild mango may become extinct under future climate change scenarios so it is high time to start thinking about conservation initiatives. 2. Wild mango is a small sized mango with a large kernel in relation to other Mangifera species which provides significant nutritional and medicinal advantages, which can contribute to nutrition and health of local people. 3. Wild mango fruit kernels producing a butter which has the potential to be used as a Cocoa Butter Alternative (CBA) thus providing new market potential. 4. Wild mango is a considered as a food for wildlife but local people are also appreciative of the taste and colour of the fruits and consume them. The unripe fruit is also sold to the pickle industry and can generate income during the fruiting season. 5. The crown architecture of wild mango is similar to other popular agroforestry species (M. indica, Artocarpus heterophyllus and Acacia auriculiformis). Therefore, urgent conservation initiatives are required to evaluate its potential as a new native agroforestry tree species. It is concluded that these attractive properties of wild mango could be promoted by a coalition of policy makers, foresters, conservationists, food industries and horticulturists to promote more widespread cultivation of this wild fruit species to realise its full
Amalie Høgenhaven
Real Topological Cyclic Homology

**Supervisor(s):**
Professor Lars Hesselholt
Professor Ib Madsen

**Department:**
Mathematical Sciences

**Date of defense:** 11 January 2017
**Date of awarded PhD degree:** 16 January 2017

**Summary:**
The main topics of this thesis are real topological Hochschild homology and real topological cyclic homology.

Classical topological Hochschild homology is a construction that takes a ring and associates a spectrum, which encodes deep information about the ring. The spectrum comes with a lot of symmetry; it carries a circle action, which means that we can rotate the spectrum. If the ring carries extra structure in the form of an anti-involution, then one can build the anti-involution into the construction and obtain a spectrum with more structure. This time, both the circle and a reflection act in a compatible way, which mean that we rotate and reflect the spectrum. We refer to this more structured spectrum as the real topological Hochschild homology of the ring with anti-involution. The real topological cyclic homology is built from the real topological Hochschild homology and carries an action by the reflection.

The first paper in this thesis computes the homotopy type of the real topological cyclic homology of spherical group rings with anti-involution induced by taking inverses in the group.

The second paper investigates the geometric fixed points of the action by the reflection on the real topological Hochschild homology of a ring with anti-involution. The main theorem of the second paper computes the component group of the geometric fixed points of the reflection.
PHD GRADUATE FROM FACULTY OF SCIENCE

Mikkel Schultz-Johansen
Novel Enzymes for Targeted Hydrolysis of Algal Cell Walls

Supervisor(s):
Associate Professor Peter Stougaard

Department:
Plant and Environmental Sciences

Date of defense: 10 January 2017
Date of awarded PhD degree: 16 January 2017

Summary:
Seaweeds, also known as macroalgae, constitute a rich source of valuable biomolecules which have a potential industrial application in food and pharma products. The use of enzymes can optimize the extraction and separation of these molecules from the seaweed biomass, but most commercial enzymes are incapable of breaking the complex polysaccharides found in seaweed cell walls. Therefore, new enzymes are needed for degradation of seaweed biomass.

Bacteria that colonize the surfaces of seaweed secrete enzymes that allow them to degrade and utilize seaweed polysaccharides as energy. Therefore, we isolated bacteria from seaweed and investigated their enzymatic potential.

One bacterium was found to be a potent degrader of various complex seaweed polysaccharides such as agar, carrageenan and alginate. Examination of hydrolytic genes within this bacterium resulted in the identification and characterization of novel agar- and carrageenan-degrading enzymes, some of which displayed hitherto unknown activities. These enzymes were capable of degrading cell wall polysaccharides present in red macroalgae. In addition, three enzymes were discovered that degraded fucoidan. Fucoidan is a seaweed polysaccharide that is heavily researched due to its wide bioactive properties against e.g. pathogens and cancer cells.

The new enzyme activities discovered in this work may therefore hold a future potential in extraction and production of valuable biomolecules from seaweed.

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Søren Blok van Witteloostuijn
Neoglycolipidation for Modulating Peptide Properties: Towards Better Biopharmaceuticals

Supervisor(s):
Professor Knud Jørgen Jensen
Søren Ljungberg Pedersen

Department:
Chemistry

Date of defense: 13 January 2017
Date of awarded PhD degree: 17 January 2017

Summary:
Excessive body weight is one of the major health care concerns of the 21st century. Worldwide, a staggering 1.9 billion people are overweight, corresponding to almost 40% of the world's adult population. Within this group, 600 million are classified as obese. As a disease, obesity is highly stigmatizing and has a negative impact on health and quality of life. Although life-style modifications seem to be the obvious solution to the problem, dieting and exercise only rarely result in significant and sustained weight loss.

For more than a hundred years, scientists and pharmaceutical companies have been trying to develop anti-obesity drugs that provide substantial weight loss without exposing the patient to serious side-effects. So far, this task has not been solved successfully, and there is currently a huge unmet need for effective and safe obesity drugs.

Today, bariatric surgery is the only medical treatment option for obesity that has curative potential. Gastric bypass surgery can provide a weight loss of up to 40–50 kg in heavily obese subjects, and the weight loss is at least partly sustained for more than 10 years. We have not yet fully understood why gastric bypass surgery is so powerful, but increasing evidence suggests that surgery leads to an increased secretion of the hormones that regulate satiety and food intake within the human body.

This Ph.D. project has explored the possibility of using the peptide hormones neuromedin U (NMU), glucagon-like peptide 1 (GLP-1), and secretin (Sct) as the starting point for novel anti-obesity drugs. We successfully prepared chemically modified versions of these three hormones with improved drug-like properties, and animal experiments revealed that administration of these compounds led to a remarkable decrease in food intake. Our results contribute to emphasize the potential for harnessing hormones of the human body to treat obesity and improve the life of millions of patients.
PHD GRADUATE FROM FACULTY OF SCIENCE

Anier Hernandez Garcia
Numerical Simulations and Mathematical Models of Flows in Complex Geometries: From Laminar to Regimes

Supervisor(s):
Associate Professor Joachim Mathiesen

Department:
Niels Bohr Institute

Date of defense: 20 December 2016
Date of awarded PhD degree: 17 January 2017

Summary:
The research work of the present thesis was mainly aimed at exploiting one of the strengths of the Lattice Boltzmann methods, namely, the ability to handle complicated geometries to accurately simulate flows in complex geometries. In this thesis, we perform a very detailed theoretical analysis of the finite volume unstructured lattice Boltzmann method (ULBM) in three dimensions, considering the Bhatnagar-Gross-Krook (BGK) relaxation time approximation for the collision operator, one of the more commonly used by the community. Regarding this scheme, two time integration methods are considered and through the Chapman-Enskog multi-scale expansion technique the dependence of the kinetic viscosity on each scheme is investigated. Seeking for optimal numerical schemes to efficiently simulate a wide range of complex flows a variant of the finite element, off-lattice Boltzmann method, which uses the characteristic based integration is also implemented. Using the latter scheme, numerical simulations are conducted in flows of different complexities: flow in a (real) porous network and turbulent flows in ducts with wall irregularities.

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Maria Louise Mønster Jørgensen
Structural Analysis of Sumoylated Proteins in Schizosaccharomyces Pombe. With a Special Focus on the DNA Binding Protein Sap1

Supervisor(s):
Professor Karen Skriver

Department:
Biology

Date of defense: 16 January 2017
Date of awarded PhD degree: 17 January 2017

Summary:
The small ubiquitin-related modifier, SUMO, post-translationally modifies a variety of proteins, affecting their interactions, localisation and stability. Sumoylation thereby influences numerous cellular functions, e.g. gene expression, chromosome segregation and the replication and repair of DNA. A mass spectrometry-based approach to identify sumoylated substrates in S. pombe is presented here. The approach provided a global overview of the S. pombe sumoylated proteome and identified sumoylation sites at the residue level in wild-type and mutant S. pombe cells. As expected, groups related to activities in the nucleus were highly represented. It was possible to locate the sumoylated lysines in crystal structures for some of the substrates, thereby revealing the tendency of sumoylation sites to be situated in flexible regions including near DNA binding domains for the structures for which DNA was present.

One of the SUMO-conjugates identified by mass spectrometry was the essential DNA binding protein Sap1. Sap1 is responsible for mating-type switching and for some replication fork blocks in S. pombe. Sap1 was determined to be sumoylated at 6 out of 29 lysines, primarily located in its two dimerization domains. The crystal structure of Sap1 revealed that at least one sumoylation site, K26, is in close proximity to the DNA binding domain. A model of Sap1 bound to DNA located the site in such way that K26 could fit in the DNA minor groove. Sumoylation at this residue might affect DNA structure or Sap1-DNA interactions. In addition, the Sap1 function relationship was investigated in vivo by repeating a search for suppressors of the slow growth phenotype of abp1Δ cbh1Δ mutants.

Autonomously replicating sequence binding protein 1 (Abp1) and cenp-B homologue 1 (Cbh1) co-localise with Sap1 in some genomic regions including retrotransposons LTRs where they have been proposed to exert antagonistic effects on DNA replication. A novel suppressor mutation identified in Sap1 as well as the Sap1-c suppressor reported in the literature are both situated at the dimer interface observed in the crystal, pointing to the mechanistic relevance of the interface in the control of DNA replication by Sap1. Finally, the structure reveals the existence of a deep pocket possibly involved in base-flipping.
Supervisor(s):
Associate Professor Darach Watson

Department:
Niels Bohr Institute

Date of defense: 13 January 2017
Date of awarded PhD degree: 19 January 2017

Summary:
Gravity governs the evolution of the universe on the largest scales, and powers some of the most extreme objects at the centers of galaxies. Determining the masses and kinematics of galaxy clusters provides essential constraints on the large-scale structure of the universe, and act as direct probes of cosmological models, through the cluster mass function. Here, I present the first ever measurement of anisotropic kinematics in clusters of galaxies, providing evidence for anisotropic structure formation, and allowing assessment of systematics in galaxy cluster catalogs. While clusters of galaxies are the largest bound structures, supermassive black holes in active galactic nuclei (AGN) are the most massive compact objects. Probing the structure of AGN through reverberation mapping allows independent measurements of supermassive black hole masses. The masses of black holes in AGN have been shown to correlate with properties of the AGN host galaxy across orders of magnitude. In addition, black hole masses scale with the intrinsic luminosity of the AGN, suggesting that AGN can be used as independent distance probe for cosmology. Improving understanding of the structure of AGN paves the way for improved black hole mass measurements, as well as AGN cosmology. Here, I develop a new method for probing the structure of AGN using reverberation mapping. The method is based on regularized linear inversion with statistical modeling of the light curves. The method is applied to five nearby AGN, yielding velocity-resolved response maps for the Hβ emission line. The results can be compared to physical models of the broad emission line region in AGN, improving our understanding of active galaxies. While useful for studying AGN structure in individual objects, spectroscopic reverberation mapping campaigns require high cadence spectroscopy to isolate broad line emission from the underlying AGN continuum. This makes traditional reverberation mapping prohibitively expensive at higher redshifts $\geq 1$, where the time delays between variations in the continuum and broad line emission is of the order of years. To address this issue, new methods for photometric reverberation mapping have recently been developed. I test the method of photometric reverberation mapping on data obtained from three nearby AGN, and discuss the possibility of using photometric reverberation mapping to constrain scaling relations at high redshift. These results show that photometric reverberation mapping can be a useful and cheap alternative to traditional spectroscopic reverberation mapping campaigns.
PHD GRADUATE FROM FACULTY OF SCIENCE

Birgitte Holtegaard Hartsteen
Using Large-Scale Public Health Data to Explore the Evolutionary Biology of Human Pregnancy and Child Bearing

Supervisor(s):
Professor Jacob Boomsma

Department:
Biology

Date of defense: 17 January 2017
Date of awarded PhD degree: 19 January 2017

Summary:
This thesis focuses on pregnancy, generally perceived as a period of harmonious cooperation between a mother and fetus, when in fact the differences in optimal outcome for the genes of the mother, father and fetus can lead to a series of conflicts. Here, I take an evolutionary perspective to investigate why these conflicts exist, and how they are maintained despite the potentially detrimental effect they can have on the health of the mother and child. The pregnancy induced disease preeclampsia is caused by the mother's blood pressure increasing to a harmful level, but the etiology of the disease has remained unknown. Preeclampsia is detrimental to both the mother and offspring, and should in theory therefore have been removed by natural selection. I looked into evolutionary explanations for this, specifically, whether the paternal genes are able to manipulate maternal blood pressure, thereby increasing resources available to the fetus, and thus benefit its future health. We used the Danish Health Registries to test this hypothesis and as predicted, a fetus exposed to a slightly increased blood pressure had long-term positive health benefits, but if the condition progressed to preeclampsia the health benefits disappeared; this is consistent with evolutionary hypotheses about parental conflicts over resources. Building upon these results, I further investigated the health of offspring up to 30 years after being exposed to either mild or severe preeclampsia. When I examined the impact from duration of exposure, I found that longer exposure during pregnancy increased the future morbidity risks of the child, even when exposed to only mild preeclampsia.

More generally, this thesis demonstrates how taking an evolutionary perspective can help us to better understand important aspects of health and medicine that remain opaque, using the specific example of pregnancy-related conditions. I show how this approach can be complementary to more conventional approaches to medical research, and hope this work will inspire the use of the Danish Health Registries to continue testing evolutionary hypotheses. This is not only important because many interesting questions still remain unanswered, but even more so because this approach could provide novel and important insights into the etiology of diseases, and this in turn could have many clinical benefits for both prophylactic measures and the development of future treatments.

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Rastin Matin
From Pore Scale to Turbulent Flow with the Unstructured Lattice Boltzmann Method

Supervisor(s):
Associate Professor Joachim Mathiesen

Department:
Niels Bohr Institute

Date of defense: 9 January 2017
Date of awarded PhD degree: 19 January 2017

Summary:
The lattice Boltzmann method is a class of methods in computational fluid dynamics for simulating fluid flow. Implementations on unstructured grids are particularly relevant for various engineering applications, where geometric flexibility or high resolution near a body or a wall is required. The main topic of this thesis is to further develop unstructured lattice Boltzmann methods for simulations of Newtonian fluid flow in three dimensions, in particular porous flow. Two methods are considered in this thesis based on the finite volume method and finite element method, respectively. The formulation based on the finite volume method is developed for simulations of laminar single phase flow. The implementation is applied to a real sample of a porous rock and the permeability is numerically determined from the steady state flow field. Detailed analysis of the scheme reveals that the stability region depends on the method of time integration. The formulation based on the finite element method exhibits improved stability and is therefore used for two applications. Firstly, together with a free-energy model two-phase flow is simulated at large density and kinematic viscosity contrasts including surface wettability. Benchmark problems quantify the accuracy of the method and the effects of two different finite element discretizations. Secondly, a direct numerical simulation of single phase turbulent flow is conducted in a square duct with wall imperfections. The imperfections are observed to break the symmetry of the corner vortices. Furthermore, the coherent structures of the flow are examined by decomposing the flow into a set of energetic modes using proper orthogonal decomposition. The transition between structures is characterized by the detachment of an old structure and the initiation of a new at the walls, which corroborates experimental measurements in cylindrical pipes.
Anne Margrethe Wagner

Permitted Exceptions. Authorised Temporary Urban Spaces
Between Vision and Everyday

Supervisor(s):
Associate Professor Bettina Lamm

Department:
Geosciences and Natural Resource Management

Date of defense: 12 January 2017
Date of awarded PhD degree: 23 January 2017

Summary:
This PhD thesis examines the phenomenon of temporary use in a contemporary Northern European planning context. The background for the study is the increasing interest in initiating temporary use projects within urban development by public authorities, such as municipalities, related sub-organisations and partnerships. In this context temporary uses are more than simple short-term appropriations of vacant areas; they become tools for various planning agendas—to establish new collaborative practices, transform spaces, test future facilities in ‘light versions’ and communicate with the public. They embody a wish for ‘different’, exceptional and experimental initiatives to frame city making. While being considered ‘alternative’ urban development tools, there is also a strong desire from the side of the authorities for these initiatives to be well integrated into official planning systems and long-term perspectives. This factor seems to hold some, if not conflicting, then at least challenging aspects.

In this thesis I research the implementation of temporary urban spaces that are authorised, officially launched by public authorities, based on three case studies, two from Denmark and one from the Netherlands: a harbour transformation area in Køge, a vacant urban plot in Valby, Copenhagen and the industrial site of a former sugar factory in Groningen. I explore the assumption that while ‘temporary urban spaces’ contribute to an increasing multiplicity of spatial expressions and practices, they not only challenge established planning procedures, but also understandings and use of space. The study focuses on the various ‘shapers’ which affect the formation and conception of temporary urban spaces in urban planning, in light of the visions expressed for an area—the expectations and motives—and the everyday decisions made and spatial practices carried out. The case studies are informed by different levels of practice involvement and explored through a thematical set of theoretical lenses. The central component of this inquiry is a case-based in-depth study of the temporary use spaces and results in a set of new concepts describing spaces and practices within authorised temporary sites. The study offers a nuanced perspective on the challenges and the potentials of transitional spaces in today’s urban planning culture.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Lars Magnus Torvald Joelsson

Kinetic Isotope Effects in the OH and Cl Reactions of the Clumped Methane Species \(^{13}\)CH\(_3\)D

Supervisor(s):
Professor Matthew Stanley Johnson
Professor Thomas Blunier

Department:
Chemistry

Date of defense: January 20 2017
Date of awarded PhD degree: January 23 2017

Summary:
Methane is a potent greenhouse gas, which atmospheric budget is poorly understood. A promising new tool to restrict the atmospheric methane budget is the concept of “clumped isotopes”. The term clumped isotopes refers to a molecule with the inclusion of two or more rare (usually heavier) isotopes. Since a heavy atom vibrates slower than a light atom, the substitution to heavier isotopes in a molecular bond leads to lower zero-point vibrational energy (ZPE) and thus a more stable molecule. From statistical thermodynamics, the influence of ZPE is larger at low temperatures, therefore clumping of isotopes are temperature dependent. Clumped isotope distributions can be used as a proxy for atmospheric sources of methane and can be a helpful tool in refining its atmospheric budget. The isotopic composition of the atmospheric methane pool is altered by sink mechanisms, especially atmospheric oxidation by hydroxyl (OH) and chlorine (Cl) radicals. The clumped kinetic effect in atmospheric oxidation of methane has been studied experimentally and theoretically in the three current papers: In Paper I the Kinetic Isotope Effect (KIE) of oxidation by the chlorine radical at room temperature (25 °C) was studied, in Paper II the effect of oxidation by the hydroxyl radical over a range of temperatures (5 °C–40 °C) was studied, and in Paper III the effect of both the chlorine and the hydroxyl radical at room temperature was studied. All the experiments were conducted in the smog chamber of the Department of Chemistry, UCPH. Paper I and II used isotopically labeled methane and studied the reactions with Fourier Transform Infrared spectroscopy (FTIR). In Paper III natural abundance methane was used and only the reaction yield was measured with FTIR spectroscopy. The isotopic compositions were measured from smog chamber gas samples by Tunable Infrared Differential Laser Absorption Spectroscopy (TILDAS) at the Department of Earth Atmospheric and Planetary Sciences, Massachusetts Institute of Technology. Quantum chemistry and transition state theory are used study these effects theoretically. The studies show that the clumped KIE is equal to the product of the two KIE in the reactions with the singly substituted isotopologues for OH oxidation, within experimental uncertainties. For the Cl oxidation, there is a significant deviation, however small. The conclusion of the studies is that the clumped isotope signature in the atmosphere reflects the interpolation of the clumped isotope signatures of methane sources.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Noy Rotbart
New Ideas on Labeling Schemes

Summary:
With ever increasing size of graphs, many distributed graph systems emerged to store, preprocess, and analyze them. While such systems ease up congestion on servers, they incur certain penalties compared to centralized data structure. First, the total storage required to store a graph in a distributed fashion increases. Second, attempting to answer queries on vertices of a graph stored in a distributed fashion can be significantly more complicated. In order to lay theoretical foundations to the first penalty mentioned a large body of work concentrated on labeling schemes. A labeling scheme is a method of distributing the information about the structure of a graph among its vertices by assigning short labels, such that a selected function on vertices can be computed using only their labels. Using labeling schemes, specific queries can be determined using little communication and good running times, effectively eliminating the second penalty mentioned. We continue this theoretical study in several ways. First, we dedicate a large part of the thesis to the graph family of trees, for which we provide an overview of labeling schemes supporting several important functions such as ancestry, routing and especially adjacency. The survey is complemented by novel contributions to this study, among which are the first asymptotically optimal adjacency labeling scheme for bounded degree trees, improved bounds on ancestry labeling schemes, dynamic multifunctional labeling schemes and an experimental evaluation of fully dynamic labeling schemes. Due to a connection between adjacency labeling schemes and the graph theoretical study of induced universal graphs, we study these in depth and show novel results for bounded degree graphs and power-law graphs. We also survey and make progress on the related implicit representation conjecture. Finally, we extend the concept of labeling schemes to allow for a better understanding of the space cost incurred by information dissemination.
PHD GRADUATE FROM FACULTY OF SCIENCE

Sofie Vincents Al-Saoudi
Ubiquitin in Signaling and Protein Quality Control

Supervisor(s):
Associate Professor Rasmus Hartmann-Petersen

Department:
Biology

Date of defense: 19 January 2017
Date of awarded PhD degree: 23 January 2017

Summary:
Protein ubiquitylation is an important post-translational modification that holds a variety of cellular functions. This Ph.D. thesis is comprised of two studies, of which one focused on ubiquitylation related to inflammatory signaling, and the other on the role of the ubiquitin-proteasome system in degradation of misfolded proteins.

In the first study, the interaction between a ubiquitin-protein ligase and a deubiquitylating enzyme is described. The linear ubiquitin chain assembly complex (LUBAC) is a ubiquitin-protein ligase complex that exclusively assemble polyubiquitin chains linked by the N-terminal methionine (M1), and recently, the deubiquitylating enzyme, OTULIN, was discovered to counter LUBAC activity by exclusively cleaving M1-linked ubiquitin chains. We provide the molecular detail of the interaction between the LUBAC subunit, HOIP, and OTULIN. The interaction was mapped to the PUB-domain of HOIP and a fragment termed the PUB-interacting motif (PIM) in OTULIN. The crystal structure of the complex was solved and explained the exclusive specificity of the OTULIN PIM for the HOIP PUB domain. Functionally, HOIP mutants inept in OTULIN binding display increased autoubiquitylation to the same degree as is observed when depleting cells of OTULIN. Also, OTULIN-mediated inhibition of NF-κB activation was less pronounced when signaling was induced by a HOIP PUB-mutant compared to wild type HOIP. Thus, the specific interaction that we characterize structurally also appears to be important for the cellular functions of LUBAC and OTULIN.

In the second study, a combined in silico and experimental approach was undertaken to investigate the use of structural stability calculations in predicting the metabolic stability of a protein. As a model protein we selected the human mismatch repair protein MSH2 which is related to the cancer-predisposition disease, Lynch syndrome. Of 24 different MSH2 variants, some of which have been linked to Lynch syndrome, we show that there is a strong correlation between the predicted structural stability and the protein half-life. We show that a predicted destabilization of 3 kcal/mol is sufficient to cause proteasomal degradation of MSH2 variants. Importantly our calculations can, in addition to protein turnover, also predict pathogenicity of MSH2 variants, suggesting that this approach can be applied for Lynch Syndrome diagnosis, and perhaps for other hereditary diseases.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Thomas Holst-Hansen
Inflammation - Modelling Function and Failure of the Innate Immune System

Supervisor(s):
Associate Professor Ala Trusina
Professor Mogens Høgh Jensen

Department:
Niels Bohr Institute

Date of defense: 19 January 2017
Date of awarded PhD degree: 23 January 2017

Summary:
Inflammation is an intricate response relying on the activation and response of both the innate immune system and the infected tissue to remove a threat. The pro-inflammatory NFκB pathway has been studied extensively, among others because of its key role in regulation of inflammation. However, the spatial aspects of the inflammatory response are poorly understood, mainly because of experimental limitations. This thesis consists of three studies of spatial communication through cytokine signalling and one study of bimodal receptor expression.

We showed with a reaction-diffusion model and experiments that the NF-κB pathway can function as a decoder of an external TNF stimulus. This leads to robust signalling which translates a local diffusing stimulus into a well-defined spatial response. We further showed that a macrophage can control the spatial range and severity of the inflammatory response by fine-tuning the amplitude and duration of TNF secretion.

We extended the model analysis to systems where NF-κB activation causes additional secretion of cytokine, creating a self-amplifying feedback loop. Depending on the strength of the positive feedback this model will either respond transiently or persistently to an external stimulus. This reproduces a dual purpose of the pro-inflammatory cytokine IL-1β in pancreatic islets, and the persistent state can be interpreted as part of type 2 diabetes pathogenesis. Because cytokine signalling occurs through diffusion, the geometrical configuration of the cytokine secreting cells will affect the collective dynamical behaviour. By describing cytokine releasing cells as an excitable medium, we related medium size and density to a transition between a collective excitable and bistable state.

Finally, we considered how a single cell model of bistable phenotype expression leads to bimodal expression on a population level and how the distribution of phenotype expression is altered by gene copy number variations. We assumed that a positive feedback is responsible for the bi-stability at the single cell level and show that the position of the feedback relative to gene transcription gives three qualitatively different effects of copy number variations. This can be used to infer the position of a positive feedback based on qualitative differences in the phenotype expression of donors of different zygosity.
PHD GRADUATE FROM FACULTY OF SCIENCE

Morten Ankersen Medici
Search for Dark Matter Annihilation in the Galactic Halo using IceCube

Supervisor(s):
Assistant Professor David Jason Koskinen
Associate Professor Stefania Xella

Department:
Niels Bohr Institute

Date of defense: 19 January 2017
Date of awarded PhD degree: 25 January 2017

Summary:
The evidence for the existence of dark matter is now so strong that this unknown gravitational mass cannot be explained without the introduction of a particle beyond the Standard Model. With the right properties of this hypothesized particle, it is possible to look for a signal of Standard Model particles produced in dark matter annihilation. In this work, the weakly interacting massive particle (WIMP) shall be supposed as a candidate for particle dark matter, and the possibilities of observing its self-annihilation to neutrinos shall be pursued with the IceCube Neutrino Observatory located in the dark clear ice deep underneath the South Pole. An infill to IceCube with a denser instrumentation allows the detection of neutrinos with energies down to 10 GeV, from the center of the Milky Way.

In this thesis, a complete analysis is carried out on data from 1004 days of IceCube data, looking for an excess of neutrinos consistent with the dark matter halo of the Milky Way over a uniform atmospheric background. No significant excess is observed, and constraints are presented for the thermally averaged product of the self-annihilation cross-section and the relative speed $\langle \sigma v \rangle$, which for the annihilation of a 100 GeV WIMP through $W^+W^-$, result in a limit at $\langle \sigma v \rangle = 3.84 \cdot 10^{-23}$cm$^3$s$^{-1}$. The result of the present analysis improves the previous IceCube limits for the $\tau^+\tau^-$ below WIMP masses of 500 GeV and constitute current world leading results of WIMP annihilation to neutrino for masses between 50 and 200 GeV.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Ulrik Terp Rasmussen
Stream Processing Using Grammars and Regular Expressions

Supervisor(s):
Professor Fritz Henglein

Department:
Computer Science

Date of defense: 23 January 2017
Date of awarded PhD degree: 25 January 2017

Summary:
In this dissertation, we focus on programs for processing data represented as strings of symbols. Examples of such include user input, data interchange formats, text files, logging data and sequenced DNA. Before any such string can be processed, however, the structure of the data that it represents must be parsed based on a set of predefined grammatical rules. Parsers are difficult to construct, especially when also taking into account requirements of efficiency and maintainability of the implementations. There is therefore a need for general tools and methods which can reduce the time and complexity associated with the development of string processing programs.

The first part of the dissertation is concerned with regular expressions, a formalism commonly used to express string patterns. Their conciseness and efficiency guarantees have made them popular for expressing string search and input validation programs, and most practical implementations of them also provide primitive data extraction facilities for parsing. However, these facilities have commonly been built as ad-hoc extensions on top of implementations of the classical interpretation of regular expressions as pure string patterns, and as a result the efficiency guarantees have been lost. We instead work from a generalized theory of regular expressions that take parsing into account, and present two new algorithms for efficiently solving the regular expression parsing problem.

In the second part, we focus on formalisms for specifying string processing programs which operate based on the syntactic structure of their inputs, and which must furthermore process large amounts of input at a high rate. Programs of this kind thus have to operate in a streaming fashion where they only store a small part of the input string in memory at any time. We study two formalisms and methods for efficiently running specifications written in them in a streaming fashion. The first of these have been used as the foundation for Kleenex, a high-performance stream processing language.

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PhD Graduate From Faculty of Science

Johannes Fabritius Petersen
pi-Extended Tetrathiafulvalenes

Supervisor(s):
Professor Mogens Brøndsted Nielsen

Department:
Chemistry

Date of defense: 24 January 2017
Date of awarded PhD degree: 26 January 2017

Summary:
This Ph.D.-thesis focuses on the synthesis and properties of various redox-active pi-extended tetrathiafulvalenes. One class of molecules are so-called H-cruciform shaped molecules. In these molecules the formation of a central stilbene double bond is elucidated. Here it was found that the formation of the stilbene bond originates from preformation of a 1, 3-dioxo-2-phospholane, formed by reaction between triethyl phosphate present under the reaction conditions and two aldehydes. Under the reaction conditions this 1, 3-dioxo-2-phospholane can then be converted to the stilbene. These mechanistic studies lead to the improvement of the synthesis of the H-cruciform, making the synthesis reliable and the product easy to purify. A new H-cruciform family with differentially protected acetylenes was also synthesized. These H-Cruciform structures were subsequently employed in polymerization reactions in the attempt to form 2D polymeric sheets with multiple redox sites. These experiments were unfortunately unfruitful. Another class of molecules is based on various indenofluorene scaffolds. Here seven new members of this emerging family of compounds were synthesized and characterized electrochemically. While some of the molecules were found to exhibit extensive aggregation phenomena in their CVs, the inclusion of steric bulk in some of the systems were shown to hamper these aggregation phenomena.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Kang Li
Novel Mathematical Neural Models for Visual Attention

Supervisor(s):
Professor Susanne Ditlevsen
Professor Søren Kyllingsbæk

Department:
Mathematical Sciences

Date of defense: 24 January 2017
Date of awarded PhD degree: 26 January 2017

Summary:
Visual attention has been extensively studied in psychology, but some fundamental questions remain controversial. We focus on two questions in this study. First, we investigate how a neuron in visual cortex responds to multiple stimuli inside the receptive field, described by either a response-averaging or a probability-mixing model. Second, we discuss how stimuli are processed during visual search, explained by either a serial or a parallel mechanism.

Here we present novel mathematical methods to answer the psychology questions from a neural perspective, combining the formulation of neural explanations for the visual attention theories and spiking neuron models for single spike trains. Statistical inference and model selection are performed and various numerical methods are explored. The designed methods also give a framework for neural coding under visual attention theories. We conduct both analysis on real data and theoretical study with simulations.

Our findings are shown in separate projects. First, the probability-mixing model is favored over the response-averaging model, shown by analysis on experimental data from monkeys. Second, both parallel and serial processing exist, with a tendency of being parallel in the beginning and a tendency of being serial later on, shown by another set of experimental data from monkeys. Third, we show that the probability-mixing and response-averaging model can be separated and parameters can be successfully estimated for either model in a more realistic biophysical system, supported by simulation study. Finally, we present the decoding of multiple temporal stimuli under these visual attention theories, also in a realistic biophysical situation with simulations.
Lars Lønsmann Iversen
Spatial Distribution of Aquatic Insects

Supervisor(s):
Professor Kaj Sand-Jensen

Department:
Biology

Date of defense: 25 January 2017
Date of awarded PhD degree: 26 January 2017

Summary:
Species associated with freshwater ecosystems are currently undergoing severe global declines and freshwater ecosystems are regarded as some of the most endangered ecosystems in the world. These declines are a consequence of decades of human overexploitation, pollution and climate change. If adequate conservation actions are to be implemented, there is an urgent need for improving our understanding of the specific habitat requirements and the ecological niches of species in freshwater ecosystems. During my Ph.D. project I have explored current challenges in our understanding of how spatial processes structure and shape the habitat requirements and distribution of one of the most affected groups of freshwater species: aquatic insects. It comprises four chapters each addressing different spatial factors in relation to the occurrence of aquatic insects in Europe.

Collectively the work presented in my thesis highlight the impact off spatial factors when understanding the distribution and ecological niches of aquatic insects. The work supports the notion that the fragmented nature of aquatic habitats enhances environmental disequilibrium states in the species communities associated to these habitats. The thesis documents that environmental history affects current species occurrences both at local and continental scales. The strong link between dispersal ecology and spatial connectivity shown in chapter III underlines the challenges aquatic insects’ faces when tracking environmental and climatic changes.
PHD GRADUATE FROM FACULTY OF SCIENCE

Mats Lundh Gulbrandsen
Quantitative Geological Modeling Based on Probabilistic Integration of Geological and Geophysical Data

Supervisor(s):
Associate Professor Thomas Mejer Hansen

Department:
Niels Bohr Institute

Date of defense: 20 January 2017
Date of awarded PhD degree: 26 January 2017

Summary:
In order to obtain an adequate geological model of any kind, proper integration of geophysical data, borehole logs and geological expert knowledge is important. Geophysical data provide indirect information about geology, borehole logs provide sparse point wise direct information about geology, and the geologist's job is to combine these sources of information with his or her own knowledge about lithology and geological structures and develop geological models. Large and data-rich geophysical surveys make this job extremely difficult. With a manual interpretation approach it is extremely time demanding and practically impossible to develop geological models that are consistent with all available data in an objective fashion. This thesis addresses these issues, and presents new methodologies and workflows, which are developed to assist the geologists in their work on developing plausible and reliable geological models. The work is manifested in two main directions. One direction focuses on how to fast and reliably be able to map geological boundary layers that uses all available geophysical data, treat all data consistently and at the same time treasure geological knowledge. For this purpose a methodology entitled Smart Interpretation is developed. This method learns the relation between the geophysical data and a set of interpretation points of a geological layer that is manually picked by a geological expert. This relation can then be used to predict the interpreted geological layer, throughout the whole geophysical survey. Two applications of this method are presented. In one study, the distribution of permafrost in the Yukon Flats, Alaska is mapped, and in the other study, Smart Interpretation is using well-log data to automatically interpret the base of aquifer in Morrill, Nebraska. The other direction of the thesis is related to seismic inversion. With the focus on how to properly integrate the geological information and how to present the results of the inversion such that they are meaningful in a geological point of view.
Weizhao Yin


Supervisor(s):
Professor Hans Chr. Bruun Hansen

Department:
Plant and Environmental Sciences

Date of defense: 20 January
Date of awarded PhD degree: 26 January 2017

Summary:
In the present PhD project, novel synthesis and modifications of layered Fe(II)-Fe(III) hydroxide (green rusts, GRs) were investigated with focus on improved dehalogenation of carbon tetrachloride by using modified green rusts and/or altered reaction conditions. The Ph.D. project has comprised:

1. New strategy for synthesis of green rusts that enables upscaling. Larger scale application of GRs requires upscaling, including fast and reproducible production of GRs. In this study, we have adopted a homogenous precipitation approach where glycine is used as a buffering and complexing agent during sulphate green rust formation by aerial oxidation of FeII or coprecipitation by adding Fe(III) salt to Fe(II). In comparison with traditional green rust synthesis, pure GRs were synthesized in minutes.

2. Enhanced dehalogenation of CT by GR in presence of selected amino acids. In presence of glycine, chloroform (CF) formation is effectively suppressed: less than 10% of CT is transformed to CF, and more than 90% of dehalogenation products are found to be formic acid and carbon monoxide in presence of 60 mM glycine; while a 80% of CF recovery was obtained without amino acids addition.

3. A “switch” mechanism for GR reactivity. As GR easily become oxidized by oxygen and nitrate in the subsurface it may be useful to be able to block the oxidation. In order to preserve the reactivity of GR for target contaminated zone area, a reactivity control of GR is necessary until these reactive solids disperse in the target area. With this perspective, the concept of a switch for GR reactivity is proposed. The adsorption of silica on GR surface is able to slow down and even stop nitrate reduction and CT dehalogenation by GR since silica bind to the reactive sites, and thus the GR reactivity is switched off. Then, by introducing glycine to turn on the CT dehalogenation by GR.

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Abebe Nigussie Nigatu
Closing the Nutrient Loops in (Peri-)Urban Farming Systems Through Composting

Supervisor(s):
Professor Andreas de Neergaard
Associate Professor Sander Bruun

Department:
Plant and Environmental Sciences

Date of defense: 24 January 2017
Date of awarded PhD degree: 31 January 2017

Summary:
Organic amendments are used to improve soil fertility and maintain agricultural fields in a productive state. Despite these benefits, the use of organic amendments is limited in many developing countries. The overall objective of this thesis is therefore to provide a better understanding of current waste management practices in developing countries and ensure sustainable crop production via biotransformation of urban-waste into a high-quality soil amendment. First, I aimed at determining the causes for the limited use of organic amendments in small-scale urban farming systems. I interviewed 220 urban farmers in Ethiopia and found that competition for agricultural waste between fuel, feed and soil amendment is a major cause for the limited use of organic amendments. Gaseous losses of ammonia and greenhouse gas (GHG) emissions occur during composting of nitrogen-rich urban waste. Several technologies could reduce these losses. However, these technologies are inadequate to fit within the broader farming systems because they are expensive. The second aim of this thesis was to develop low-cost methods to mitigate N losses and GHG emissions from composting, while retaining its fertilising value. Composting by earthworms (vermicomposting) is proposed as a low-cost strategy for minimising N losses and GHG emissions. Using a wide range of substrate qualities (C:N ratio, labile C sources) and other factors (earthworm density, amount of input, and moisture), I showed that vermicomposting reduced N losses and GHG emissions compared with traditional thermophilic composting. Earthworms also change the quantity and composition of dissolved organic carbon during composting. Another low-cost strategy is to delay the addition of N-rich substrates during composting. I demonstrated that addition of nitrogen-rich substrate after the thermophilic phase reduced N losses. Delayed addition resulted in compost that was as stable and effective at completely eradicating weed seeds as traditional composting. In conclusion, urban-waste compost should be considered as alternative source for soil amendment, particularly in developing countries with competition for agricultural waste. Technologies such as vermicomposting and delayed addition of N-rich substrate are recommended to increase or maintain the nitrogen content of compost, reduce N losses and mitigate GHG emissions.
Quantification of Rural Livelihood Dynamics: Environmental Resource Use, Asset Accumulation, Poverty, and Livelihood Strategies

Supervisor(s):
Associate Professor Helle Overgaard Larsen, Professor Carsten Smith-Hall, Professor Bernhard Brümmer

Department:
Food and Resource Economics

Date of defense: 24 January 2017
Date of awarded PhD degree: 31 January 2017

Summary:
Improved understanding of rural livelihoods is required to reduce rural poverty faster. To that end, this PhD study quantified rural livelihood dynamics emphasizing (i) the role of environmental resources use in helping rural households to escape poverty, (ii) development of a new approach for livelihood strategy clustering, (iii) assessment dynamics in rural livelihood strategies, and (iv) the effect of attrition on rural livelihood dynamics assessments. A wide range of quantitative methods were employed using a unique environmentally augmented panel dataset combined with tracking attrite households. Two groups of attrite households were identified: ‘movers’ (households that left their original location) and ‘non-movers’ (households that still resided in the same location but were not interviewed for different reasons). The findings revealed that (i) total environmental income had a limited role in lifting poor out poverty which could be due to restricted access to more remunerative environmental resources, (ii) the developed approach for livelihood clustering (combining household income and asset variables using regression models) outperform both existing income and asset approaches (iii) rural livelihood strategies were found to be highly dynamic: some households move upwards, some move downward, and the remaining persist in any of the livelihood strategies in the livelihood ladder, and (iv) even though attrition did not significantly affect rural livelihood dynamics estimates, ‘non-movers’ were more important than ‘movers’ to rural livelihood studies and the cost of tracking ‘non-movers’ were negligible relative to the cost of tracking ‘movers’. Hence, from the viewpoint of poverty reduction, the study recommends (i) access restrictions should be loosened in order to enhance the role of both forest and non-forest environmental resources towards poverty reduction, (ii) to reduce poverty faster, policies should enable households in low remunerative livelihood strategies to move to medium remunerative livelihood strategies/high remunerative livelihood strategies, while protecting households in high remunerative livelihood strategies and medium remunerative livelihood strategies from slipping into low remunerative livelihood strategies, (iii) the use of more of the livelihood characteristics of households ensure improved livelihood strategy identification and policy interventions and (iv) ‘non-movers’ should always be tracked in rural livelihood studies while the decision on whether to track ‘movers’ depend on the purpose of the study.

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Wenjun Xie
Identification and Characterization of Novel Defence and PCD Signalling Components in Arabidopsis

Supervisor(s):  
Professor Hans Thordal-Christensen  
Associate Professor Carsten Pedersen

Department:  
Plant and Environmental Sciences

Date of defense: 27 January 2017  
Date of awarded PhD degree: 31 January 2017

Summary:
Plants protect themselves from pathogens by activating a defence signalling network. The Arabidopsis double mutant syp121 syp122 is dwarfed and mimics a response as if it was attacked by pathogens. Using EMS as mutagen on syp121 syp122, a suppressor screen was performed. More than 200 partially rescued syp121 syp122 ssdx (suppressor of syntaxin-related death) lines were collected. SSD genes are typically required for pathogen defence. Using this triple mutant library, two novel genes were identified by Mutmap. They are SSD6 and SSD12. SSD6 is a large protein in Arabidopsis with at least six domains with predicted functions, and mutations in five of these showed that they are important for the lesion mimic phenotype of syp121 syp122. Subcellular localization showed that SSD6 functions on the ER. We developed a split-GFP Gateway vector system, and used it to show that SSD6 is an ER membrane anchored cytosolic protein. ssd6 single mutants were inoculated with different pathogens to test SSD6’s involvement in defence. The position of SSD6 in the defence signalling network was studied using syp121 syp122 ssd6 ssdy quadruple mutants, which suggested that SSD6 is not involved in any known signalling pathway. All plant species have homologues of SSD6, but none of these have been formally reported. SSD6 has two homologues in Arabidopsis, SSH1 and SSH2, which are also studied in our work. SSD12 is confirmed to be PRLIP2. PRLIP2 contains a signature pentapeptide motif GXSXG which suggests this protein may have lipase activity. By using site-directed mutagenesis to make substitutions (S162A and S162F) of the serine residue in the GXSXG motif, we confirmed this serine to be essential for the function of PRLIP2. The prlip2 mutant was inoculated with different pathogens to test the involved defence mechanism. The position of PRLIP2 in the defence signalling network was studied like SSD6, which suggests that PRLIP2 is not involved in any known signalling pathway, neither.
Malte Nordmann Winther
Trace Gas Evolution in the Present and Past Atmosphere

Supervisor(s):
Professor Thomas Blunier

Department:
Niels Bohr Institute

Date of defense: 31 January 2017
Date of awarded PhD degree: 3 February 2017

Summary:
Nitrous oxide (N2O) is a very important trace greenhouse gas in the atmosphere. With an increasing atmospheric concentration of 327 ppb at present, and a warming potential 300 times that of CO2, the significance of N2O has been rapidly increasing since the 1950s. It is generally known that N2O primarily originates from microbial production in terrestrial and aquatic ecosystems. In this thesis I present measurements of the intramolecular distribution of 15N in N2O given as site preference (difference in abundance of the isotopomers), d15Nbulk (average abundance of the isotopomers), and measurements of d18O-N2O. The isotopes of N2O are used in investigations of both the specific bacterial reactions pathways influencing N2O emissions and the general evolution of N2O from both the past and the present atmosphere.
Guanchen Liu
Interactions Between Milk Protein Ingredients and Other Milk Components During Processing

Supervisor(s):
Professor Richard Ipsen

Department:
Food Science

Date of defense: 27 January 2017
Date of awarded PhD degree: 8 February 2017

Summary:
Functional milk protein ingredients can be used to improve taste and texture, enhance a natural profile, extend shelf life and reduce production costs. They are manufactured via advanced filtration and separation techniques to extract key proteins from milk. Since these proteins are drawn from natural milk, the addition of artificial ingredients to a product label is avoided, making it more appealing to consumers.

Microparticulated whey protein (MWP) are colloidal particles usually formed by combined heating and shearing of whey protein concentrates, and typically have particle sizes ranging from 1.0 to 10 µm. Nanoparticulated whey protein (NWP) have a smaller particle size (100 to 990 nm). Previous research in our group shown that, both MWP and NWP can give a higher viscosity and denser microstructure compared to WPC when used as fat replacer in low-fat yoghurt.

In the thesis, we investigated how these two types of commercial whey protein particles interact with other milk components and how these interactions affect final acidified milk products. The properties and the interactions of whey protein aggregates with other milk proteins during processing are crucial for final texture and structure of acidified milk gels. The knowledge obtained from these results is expected to provide input for producing tailor-made whey protein aggregates to achieve a desired functionality in dairy products, especially in acidified milk products.

After the literature review in chapter 2 and the project overview in chapter 3, the whey protein aggregates are discussed further in relation to their properties (chapter 4), to interactions in milk model systems during heating (chapter 5) and acidification (chapter 6), and to physical properties of final acidified gels (chapter 7). In chapter 8 and 9, the conclusion and perspective of this study is presented.

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Primary cilia are non-motile, sensory organelles emerging in a single copy from the surface of most quiescent cells in vertebrates. Specific receptors, ion channels and downstream signaling components are localized along the cilium-centrosome axis, enabling the cilium to function as a hot spot for the balanced coordination of multiple signaling pathways to control cell cycle entry, differentiation and migration during embryonic development and in tissue homeostasis. Consequently defects in ciliary assembly and/or sensory function lead to a plethora of diseases and syndromic disorders termed ciliopathies, which include congenital heart defects, blindness, renal disease, brain anomalies, diabetes and tumorigenesis. This dissertation focuses on two specific signaling systems, which are conducted via the primary cilium; the Sonic hedgehog (SHH) and the Transforming growth factor β (TGFβ) signaling pathways. We show that the motor protein, KIF13B is recruited to the ciliary base. The caveolae-enriched protein CAV1 is concentrated at the proximal end of the cilium and depletion of KIF13B dramatically alters this localization. In the absence of this CAV1 microdomain, SHH signaling is impaired. We conclude that KIF13B establishes a CAV1 rich membrane microdomain in primary cilia to regulate SHH signaling. In the second part of this dissertation we show that Tab2, a modulator of TGFβ signaling, localizes to the primary cilium. Previous studies showed that mutations in TAB2 and TGFβ receptors lead to congenital heart disease, and we here demonstrate that Tab2 is required for proper differentiation of mouse stem cells into cardiomyocytes. These results support the conclusion that Tab2 functions at the primary cilium to coordinate specified signaling events, which when defective may lead to congenital heart disease. Collectively, the results presented in this PhD thesis provide new insights into the current understanding of the mechanisms underlying ciliary signal transduction. Further elucidation of this topic may contribute to knowledge leading to prevention and new therapeutic treatment opportunities against ciliopathies.
Muhammad Yasin
Effect of Reduced Light, Low Oxygen and Seed Dormancy on Germination and Growth of Some Plants

Supervisor(s):
Associate Professor Christian Andreasen
Associate Professor Eva Rosenqvist

Department:
Plant and Environmental Sciences

Date of defense: 30 January 2017
Date of awarded PhD degree: 8 February 2017

Summary:
Many abiotic factors affect plants germination, growth, and development. This Ph.D. study elucidates the effect of reduced light, low oxygen and seed dormancy on germination and growth of some weed species, field crops and vegetables. One study describes the growth and developmental responses of some common, invasive and rare weed species to reduced light levels in greenhouse experiments.

The seed germination response of some weed species, field crops, and vegetables to different oxygen concentrations was also quantified in the laboratory experiments. The effect of east-west and north-south row orientations on weed biomass and grain yield of summer barley, oilseed rape, triticale and oat in Denmark was examined. The effect of rolling on biomass production of weeds and grain yield of cereals in Denmark was also investigated in field experiments. It also described that hypoxia improved the germination of the problematic invader Alliaria petiolate of North American forests.
A method was developed to break seed dormancy of the herb garlic mustard using chemicals.
PHD GRADUATE FROM FACULTY OF SCIENCE

Anna Maria Charlotte Kaufmann Lindqvist
Skeletal Muscle Angiogenesis and Its Relation to Insulin Sensitivity

Supervisor(s):
Professor Ylva Hellsten

Department:
Nutrition, Exercise and Sports

Date of defense: 3 February 2017
Date of awarded PhD degree: 9 February 2017

Summary:
One of the major causes of type 2 diabetes is a weakened response to insulin (insulin resistance) in the muscles. Individuals with insulin resistance have fewer small blood vessels (capillaries) and less VEGF (a molecule important to the formation of capillaries) in the muscles. It has been proven that exercise is beneficial to the formation of new capillaries (capillarization) and for increasing insulin sensitivity, however people with insulin resistance are less susceptible to these effects. Studies have shown an association between insulin sensitivity and the amount of capillaries in the musculature, however a possible causal relationship has not previously been established. In this thesis the effect of an increased capillary density in muscles on whole-body insulin sensitivity was examined.
To isolate the exercise effect of capillarization, healthy rats and insulin resistant humans were given a drug known to promote capillarization. In addition, obese Zucker rats (an animal model of insulin resistance) received VEGF augmentation treatment to one muscle in the leg and were subjected to a period of swim training (6 weeks).
In the healthy rats and humans, muscle capillarization was increased and whole-body insulin sensitivity was enhanced. In the obese rats, capillarization was also increased in the muscle subjected to exercise training and VEGF treatment and in this muscle insulin sensitivity was also improved.
In this thesis, a causal relationship between muscle capillarization and insulin sensitivity has been shown. Furthermore, the importance of VEGF to capillarization in response to exercise was displayed. The results point at the importance of the capillary network for prevention and treatment of type 2 diabetes.

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PhD GRADUATE FROM FACULTY OF SCIENCE

Behnoushsadat Ghodsalavi
Hyphae Colonizing Bacteria Associated with Penicillium Bilaii

Supervisor(s):
Associate Professor Ole Nybroe
Mette Haubjerg Nicolaisen, Stefan Olsson

Department:
Plant and Environmental Sciences

Date of defense: 7 February 2017
Date of awarded PhD degree: 13 February 2017

Summary:
Phosphorus (P) is the second most important macronutrient for plant growth after nitrogen. The majority of P in soils is unavailable for plants. Fertilizers are the only way of providing available P for plants. However, only small amount of this P is plant available. In addition, environmental pollution by P fertilizers and increasing price of P fertilizers because of the scarcity of the rock phosphate (as the main source of producing P fertilizer) have created interest in new strategies as substitute or supplement for P fertilizers. One of these strategies is applying phosphate-solubilizing microorganisms (PSM) as an ecofriendly option to make P available for plants. Recently, few different products have been introduced and marketed claiming to increase availability of P for plants. One of them is Jumpstart based on Penicillium bilaii produced by Novozymes A/S. It has been shown that P. bilaii can release P from inorganic phosphate pools through the colonization of the root system and producing organic acid exudates and thereby improve the plant growth. However, the challenges are to obtain robust and reliable performance, to gain low year to year variation, and to limit the influence from environmental conditions.

It has been shown that mycorrhizal Helper Bacteria present in mycorrhizal fungus could stimulate fungal growth and also promote the establishment of the root-fungus symbiosis. Therefore isolation of bacteria present in P. bilaii as a non-mycorrhizal fungus and identification of helper bacteria with positive effect on fungus and then production of inocula containing the selected fungus and helper bacteria could increase the efficiency of inoculation of plant in order to increase availability of P for plants and to stimulate plant growth.

The current PhD thesis aimed to identify and characterize fungal growth-stimulating bacteria associating with the P. bilaii hyphae with the perspective of improving fungal growth and P solubilization in soil – plant systems. Therefore, most of the work within the current project was carried out by development of suitable model systems by mimicking the natural soil habitat to reach to the reliable fungal performance in soil.
Bjarne Larsen
Breeding Potential in Danish Apple Cultivars:
Genetic Diversity and Genome-Wide Association Mapping of
Fruit Quality Traits

Supervisor(s):
Assoc. Prof. Marian Ørgaard, Assoc. Prof. Carsten Pedersen,
Assoc. Prof. Torben Toldam-Andersen

Department:
Plant and Environmental Sciences

Date of defense: 9 February 2017
Date of awarded PhD degree: 13 February 2017

Summary:
The diversity in plant genetic resources is a prerequisite for genetic improvement of cultivated
crop species. Lack of in-depth characterization and evaluation of gene bank accessions is a major
obstacle for their potential utilization. The Danish apple (Malus domestica L.) gene bank
collection represents an ensemble of cultivars that have never previously been genetically
accessed. The aim of this thesis is to study the genetic structure, affiliation and overall diversity
which should facilitate future conservation management strategies. It may also contribute with
new knowledge for better understanding of the link between phenotypes and the underlying gene
tic background which is crucial in plant breeding. We found a considerable genetic diversity in
the collection and no genetic structure. We exposed a high number of accessions in admix and
revealed several putative cultivar parentages, never previously reported. Unique fingerprints wer
obtained for all accessions except for distinctive subclonal sports and synonym accessions. The
cultivar ensemble was shown to hold 22% triploid accessions. We developed a new protocol for
genotyping S-RNase alleles in apple and revealed 25 different alleles, including several rare
alleles. Using historical gene bank records, including aroma volatile analysis, sugar and acid dat;
and other fruit- and tree character records, we established genotype-phenotype relationships,
performing a genome-wide association study. A number of SNP markers are presented that can b
used directly for marker-assisted selection. In addition, we suggest a number of candidate genes
involved in the control of several important fruit quality traits. Future studies and breeding
attempts can therefore benefit from the results, including genetic fingerprints and pedigree
reconstruction. In addition, several of the SNP markers presented can be used directly in
selection for specific traits in breeding lines. However, further characterization and evaluation of
additional important horticultural traits are still needed for upmost utilization of the apple gene
bank collection.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Clarisson Rizzie Canlubo
Non-commutative Covering Spaces and their Symmetries

Supervisor(s):
Professor Ryszard Nest

Department:
Mathematical Sciences

Date of defense: 9 February 2017
Date of awarded PhD degree: 13 February 2017

Summary:
The main goal of this thesis is to propose a notion analogous to covering spaces in classical geometry. This is motivated by the author's long term goal of defining the (‘etale) fundamental group of a non-commutative space and put forth a good notion of monodromy.

We will present a notion of a non-commutative covering space using Galois theory of Hopf algebroids. We will look at basic properties of classical covering spaces that generalize to the non-commutative framework. Afterwards, we will explore a series of examples. We will start with coverings of a point and central coverings of commutative spaces and see how these are closely tied up. Coupled Hopf algebras will be presented to give a general description of coverings of a point. We will give a complete description of the geometry of the central coverings of commutative spaces using the coverings of a point. A topologized version of Hopf categories will be defined and its corresponding Galois theory. Using this and basic concepts from algebraic geometry and spectral theory, we will give a full description of the general structure of non-central coverings. Examples of coverings of the rational and irrational non-commutative tori will also be studied. Using the non-commutative analogue of the hyperelliptic involution, we will show that unlike the classical case, the non-commutative sphere is a covering of the non-commutative torus. There is a purely non-commutative phenomenon happening to non commutative coverings, namely, their symmetry is two-sided. We will explain this and relate it to bi-Galois theory. Using the OZ-transform, we will show that non-commutative covering spaces come in pairs. Several categories of covering spaces will be defined and studied. Appealing to Tannaka duality, we will explain how this lead to a notion of an ‘etale fundamental group. Finally, in the last chapter we will discuss possible future projects.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Maja Gro Rydahl
High-Throughput Antibody Development and Retrospective Epitope Mapping

Supervisor(s):
Associate Professor Bodil Jørgensen, Professor William G. T. Willats, Science Manager Jesper Harholt

Department:
Plant and Environmental Sciences

Date of defense: 13 February 2017
Date of awarded PhD degree: 13 February 2017

Summary:
Plant cell walls are composed of an interlinked network of polysaccharides, glycoproteins and phenolic polymers. When addressing the diverse polysaccharides in green plants, including land plants and the ancestral green algae, there are significant overlaps in the cell wall structures. Yet, there are noteworthy differences in the less evolved species of algae as compared to land plants. The dynamic process orchestrating the deposition of these biopolymers both in algae and higher plants, is complex and highly heterogeneous, yet immensely important for the development and differentiation of the cell. However, our understanding of the evolutionary mechanisms, biosynthesis and remodelling is limited, especially due to a lack of sufficient glycomic tools for studying green plants. This poses a serious hindrance for understanding the fundamental processes behind terrestrialisation and vascularisation of green algae, when they developed into land plants. Hence, there is a pressing need for rethinking the glycomic toolbox, by developing new and high-throughput (HTP) technology, in order to acquire information of the location and relative abundance of diverse cell wall polymers.
In this dissertation, we describe the development and optimization of HTP screening tools, with the specific aim to define the binding profile of novel molecular probes. In addition, we explore the potential in rethinking the way molecular probes are developed. The results presented in this dissertation describe the binding profile - in more or less high resolution - of one small molecular probe, 11 carbohydrate binding modules and 24 monoclonal antibodies. This was made possible by combining the HTP multiplexing capacity of carbohydrate microarrays with diverse glycomic tools, to downstream characterize the specificity of these molecular probes. This reveals an unprecedented expansion of the panel of well-defined molecular probes for cell wall studies. We envisage that this development of novel molecular probes, along with the HTP retrospective mapping of binding profiles could contribute to the evolutionary understanding of green plants, thus aiding their industrial applicability, as well as the fundamental biological understanding.

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Eleftheria Morela  
Sport and Migrants’ Acculturation

**Supervisor(s):**  
Associate Professor Antonis Hatzigeorgiadis  
Associate Professor Anne-Marie Elbe

**Department:**  
Nutrition, Exercise and Sports

**Date of defense:** 25 January 2017  
**Date of awarded PhD degree:** 15 February 2017

**Summary:**  
Sport is considered to be an ideal setting for reinforcing the respect of cultural diversity and overcoming existing prejudices. Recently there has been an increasing policy interest in the use of sport as a venue for promoting social integration and intercultural dialogue. Regardless of its political significance, research on the integrative role of sport is limited and findings seem equivocal. Overall the purpose of the present PhD thesis is to investigate whether participation in organized sport can affect acculturation processes of young adolescents from both minority and majority populations in Greece, and to explore features of the sporting environment that are likely to associate with positive acculturation outcomes. For this purpose quantitative studies were conducted involving both migrant and host populations. Overall, the findings suggest that youth participation in organized sport may be linked to behaviors favoring adaptive intercultural strategies for both the migrant and host population. However, in order to produce socially desired outcomes through sport, the sport environment has to be developed in a way that promotes adaptive social behaviors towards the goal of successful acculturation. In all the studies conducted, the role of the coach and the way he/she structures the sport environment appeared to be associated with both migrant and host adolescent athletes’ intercultural attitudes, thus highlighting his/her influential role on positive youth development. In this regard, an autonomy-supportive coaching environment where the coach targets athletes’ personal improvement, create conditions for athletes to satisfy their basic needs for autonomy, competence, and relatedness, and promotes the development of prosocial skills such as empathy and altruism, may become a promising venue for cultivating intercultural relations and promoting successful acculturation for both migrant and host populations. The present PhD thesis addresses an issue of considerable importance for promoting intergroup relations and facilitating migrants’ integration in host societies. Overall, the findings provide valuable evidence regarding the role of sport as an acculturation agent, with particular emphasis on the importance of an appropriate motivational environment. All the studies conducted within this dissertation substantially enhance our understanding of how sport can be used as an effective socializing context and introduces new directions for further investigating acculturation in a diversifying world.

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Guenevere E.D.K. Prawiroatmodjo  
Attractive Electron-Electron Interactions at the LaAlO$_3$/SrTiO$_3$ Interface

**Summary:**
The conducting interface between the two insulating oxides LaAlO$_3$ and SrTiO$_3$ (LAO/STO) exhibits many intriguing properties such as high mobility, a superconducting phase, ferroelectricity and ferromagnetism. The superconducting phase behaves highly unconventional and exhibits behavior akin to high-Tc superconductors, such as a carrier density dependent critical temperature, a pseudogap phase and striped conductivity. At the single-electron tunneling regime, it was recently shown that LAO/STO hosts a paired ground state that persists above the critical magnetic field $B_c$.

In this thesis, the superconducting phase diagram is explored in terms of critical magnetic field $B_c$, temperature $T_c$ and current $I_c$, and studied for varying carrier densities. Evidence is found for a superconducting phase based on Josephson tunneling of supercurrent, possibly through a network of weak links. Using nanoscale electrostatic gates, a quantum dot is fabricated for which the dot occupation, tunnel coupling to the leads and size can be simultaneously controlled. The excitation spectrum of the paired ground state is explored and compared to calculations based on a single-orbital Anderson model with negative effective charging energy $U$. We find that for strong tunnel coupling, the negative $U$ gives rise to the charge Kondo effect, where an effective ‘charge flip’ resonance at the pair tunneling resonance enhances conductivity at low temperature and magnetic field.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Jakob Herschend
Unravelling the Mechanisms of Bacterial Interactions in Model Communities

Supervisor(s):
Associate Professor Mette Burmølle

Department:
Biology

Date of defense: 10 February 2017
Date of awarded PhD degree: 20 February 2017

Summary:
Microbial communities, such as microbial biofilms, are dynamic structural communities. The architecture and function of these communities is shaped by interaction with the surrounding environment and by the interactions between community members. Microbial biofilms have been associated with everything from human illnesses, food spoilage, climate changes to future energy production. Understanding biofilm development and function is therefore indispensable for our society. However, unravelling the mechanisms influencing community development is not trivial, as a multitude of mechanisms can work in concert on the developing community. By studying simpler model communities these mechanisms can be identified and described individually.

Studying model communities we were able to describe how a range of mechanisms, such as facilitated surface attachment, cross-feeding on amino acids and microbial induced pH stabilization of the local environment, positively affected community development. We also identified a range of mechanisms affecting community development negatively, indicating that community development is a result of both competitive and cooperative interactions. The obtained knowledge can in the future help us predict microbial community development and function, and potentially enable us to modulate community development.

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Raphaël Sura Daveau
Efficient Fiber-Coupled Single-Photon Sources Based on Quantum Dots

Supervisor(s):
Professor Peter Lodahl
Associate Professor Søren Stobbe

Department:
Niels Bohr Institute

Date of defense: 9 February 2017
Date of awarded PhD degree: 20 February 2017

Summary:
This work presents the study of solid-state quantum emitters in two different forms. Single-photon sources based on quantum dots in waveguides are investigated with an emphasis on efficient extraction of the photons into an optical fiber. A coupling efficiency from chip to fiber up to 80 % is demonstrated, thereby making a single-photon source with an efficiency on the order of 10-15 %. This means that the optical preparation of the quantum dot leads to the emission of a photon in the fiber one out of ten times. The source efficiency can be optimized further, which opens a promising future for building a deterministic single-photon source, needed in applications such as boson sampling. The second part of the thesis presents a theoretical study of optical refrigeration with coupled quantum wells. The particular energy levels and lifetimes of carriers confined in coupled quantum wells make them efficient media for removing thermal energy from the system when interacting with laser light. This has potential application for cooling small-scale electronic or photonic circuits without cryogenic fluids.
Miguel R. Carro Temboury

Characterization and Application of DNA-templated Silver Nanoclusters and Polarized Spectroscopy of Self-Assembled Nanostructures

Supervisor(s):
Associate Professor Tom Vosch

Department:
Chemistry

Date of defense: 17 February 2017
Date of awarded PhD degree: 21 February 2017

Summary:
In this thesis two different systems are characterized mainly with light spectroscopy: DNA-templated silver nanoclusters (DNA-AgNCs) and ionic self-assembled (ISA) materials based on azo-dyes.

DNA-AgNCs are few nanometer sized fluorophores formed by a few silver atoms templated by a single stranded DNA (ssDNA) scaffold. By choosing different DNA sequences their emission can be tuned in the visible-NIR range. Their small size, brightness, photostability and good biocompatibility makes them a promising alternative to other commercially available fluorophores. Upon synthesis of the DNA-AgNCs, many emissive species can be formed. In particular, the ssDNA sequence containing 24 cytosines (C24) stabilizes a different range of emitters. Here the spectral heterogeneity and synthesis reproducibility of C24-AgNCs is spectroscopically characterized from the average fluorescence decay time as a function of emission wavelength. This proved to be a robust method to characterize the complexity of the system due to the multi-exponential decay of the emitters. Other studies on DNA-AgNCs photophysics, structural characterization with X-Rays, and work towards potential applications of the DNA-AgNCs in molecular devices are shown in the thesis.

ISA materials formed by surfactant chains and azo-dyes featuring long range order can be easily synthesized, and can form lamellar structures after being spin cast on a transparent substrate. While long range molecular order is linked to the performance of molecular based electronic devices, self-assembled nanostructures are promising for molecular electronics. Here, using polarized absorption spectroscopy, the order of the materials was characterized by probing the absorption transition moment of the azo-dyes. An absorption band in the visible spectrum was measured using the tilted plate method and the stretched polymer-film method. Adapting the theory from the literature and using computational tools, the average angle between the long axis of the azo dyes and the normal of the substrate was calculated. The presence of molecular order in the sample was deduced from the angle between the transition moment and the normal of the substrate.
PHD GRADUATE FROM FACULTY OF SCIENCE

Aghiad Ghazal
Combination of Microfluidics with SAXS for the Investigation of Pharmaceutical Formulations

Supervisor(s):
Professor Kell Mortensen
Associate Professor Anan Yaghmur

Department:
Niels Bohr Institute

Date of defense: 17 February 2017
Date of awarded PhD degree: 22 February 2017

Summary:
Due to the latest advances in both synchrotron X-ray and microfluidics, many research groups became interested in exploiting the advantages of integrating microfluidics on synchrotron X-ray beamlines. Microfluidics makes use of the limited time on the beamline to perform large number of experiments with minimal sample consumption. Thus, this Ph.D. project focused on combining microfluidics with small angle X-ray scattering (SAXS) techniques for monitoring the early dynamic structural changes of samples occurring at the millisecond to few seconds range. Among the samples investigated were lipid-based, drug nanocarriers (cubosomes and multilamellar vesicles), which proved to have great potentials in different pharmaceutical applications due to their ability to change their internal structure from lamellar to non-lamellar liquid crystalline phase by tuning their lipid compositions. Aghiad showed, using the combination of microfluidics and SAXS, that these nanocarriers can also change their internal structure from one non-lamellar cubic phase of symmetry Im3m (P-surface) to another cubic phase of symmetry Pn3m (D-surface) on exposure to buffer containing calcium ions in less than 2s. Moreover, the characterization of in situ formed monodisperse multilamellar vesicles using synchrotron SAXS was also investigated. Aghiad showed that the developed microfluidic systems are also suitable for investigating other samples such as proteins and pharmaceutical solids.
Ivan Iakoupov
Enhancement of Optical Nonlinearities with Stationary Light

Supervisor(s):
Professor Anders S. Sørensen

Department:
Niels Bohr Institute

Date of defense: 3 February 2017
Date of awarded PhD degree: 23 February 2017

Summary:
The topic of this thesis is understanding and application of the phenomenon of stationary light. Stationary light arises in atomic ensembles with certain energy level configurations, when two counter-propagating classical drives (lasers) are applied. Probe light coupled to a different energy level transition than the classical drives can be completely stopped, while still retaining its light character. We will be interested in the regime of stationary light, where the probe light still propagates through the atomic ensemble, but extremely slowly. In other words, probe field has a very low group velocity, which increases its interaction time with any optical nonlinearity. Group velocity can be obtained from the dispersion relation. Therefore, the dispersion relations for various stationary light schemes are studied in detail. The study of the dispersion relations is carried out both in the continuum approximation of atomic ensembles and the discrete model where each atom is assumed to be a linear scatterer.

The enhancement of the effective nonlinear strength by stationary light is then used to propose a two-qubit (controlled-phase) quantum gate for the optical photons, which can in principle work deterministically. We do find, however, that a heralded operation of the proposed gate achieves much higher conditional fidelity (overlap of the ideal state with the actual one), since most of the error in the unconditional fidelity is due to loss of photons, which can be detected.

Before discussing stationary light and its application, we also analyse the different fidelity measures that could be applied to the proposed gate (and related proposals). We show that all of the considered fidelity measures are (approximately) equal due to particular features of the considered physical system. This result allows one to reduce the number of expressions to be evaluated if the performance of the gate is to be analyzed for different applications at the same time.

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Johannes Heiny

Extreme Eigenvalues of Sample Covariance and Correlation Matrices

Summary:
This thesis is concerned with asymptotic properties of the eigenvalues of high-dimensional sample covariance and correlation matrices under an infinite fourth moment of the entries.

In the first part, we study the joint distributional convergence of the largest eigenvalues of the sample covariance matrix of a $p$-dimensional heavy-tailed time series when $p$ converges to infinity together with the sample size $n$. We generalize the growth rates of $p$ existing in the literature. Assuming a regular variation condition with tail index $\alpha<4$, we employ a large deviations approach to show that the extreme eigenvalues are essentially determined by the extreme order statistics from an array of iid random variables. The asymptotic behavior of the extreme eigenvalues is then derived routinely from classical extreme value theory. The resulting approximations are strikingly simple considering the high dimension of the problem at hand.

We develop a theory for the point process of the normalized eigenvalues of the sample covariance matrix in the case where rows and columns of the data are linearly dependent. Based on the weak convergence of this point process we derive the limit laws of various functionals of the eigenvalues.

In the second part, we show that the largest and smallest eigenvalues of a high-dimensional sample correlation matrix possess almost sure non-random limits if the truncated variance of the entry distribution is “almost slowly varying”, a condition we describe via moment properties of self-normalized sums. We compare the behavior of the eigenvalues of the sample covariance and sample correlation matrices and argue that the latter seems more robust, in particular in the case of infinite fourth moment.

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Morten Holm Christensen
Exotic Magnetic Orders and their Interplay with Superconductivity

Supervisor(s):
Associate Professor Brian Møller Andersen

Department:
Niels Bohr Institute

Date of defense: 17 February 2017
Date of awarded PhD degree: 23 February 2017

Summary:
Superconductivity has continued to enthrall researchers since its discovery more than 100 years ago. The ability to conduct electrical current without resistance can lead to the construction of more efficient energy grids and the magnetic properties of superconductors are already applied in MRI machines and high-speed trains.

Conventional superconductivity is a low-temperature phenomenon and typically does not occur above 10K. This makes materials with higher superconducting temperatures very attractive, and while such materials exist their theoretical description has eluded researchers.

In this thesis we consider the interplay between magnetism and superconductivity in such materials and show that a number of exotic magnetic orders occur. A few of these support the formation of so-called topological edge modes, which are 'particles' that are confined to move along the edge of the sample and have a plethora of interesting properties. Additionally we provide theoretical explanations for a range of experimental observations.
PHD GRADUATE FROM FACULTY OF SCIENCE

Simon Holm Stark
Study of forward elastic pp scattering at sqrt(s)=8 TeV with the ALFA detector

Supervisor(s):
Professor Peter Henrik Hansen
Associate Professor Jørgen Beck Hansen

Department:
Niels Bohr Institute

Date of defense: 24 February 2017
Date of awarded PhD degree: 28 February 2017

Summary:
This thesis studies elastic collisions of protons where the protons change momentum but not energy. The protons are collided at the LHC at CERN at almost the speed of light. The ALFA tracking detectors located about 240 m from the collision point measure the proton trajectories from which the scattering angles can be inferred. The angles are so small that the protons are only deflected by 1 mm over the distance of 240 m.

The data is fitted with a simulation where detector effects are included. The fit yields a measure of the total probability for any proton-proton collision. In addition, a parameter specific for elastic collisions were determined which has importance for simulations of cosmic ray interactions in the atmosphere. The results are in agreement with previous measurements. There exists no unique theory for elastic scattering, and different models aim to describe the data. However, the data statistics is too low to exclude any of the models.

In order to perform the fit, a number of detector effects had to be determined. The positions of the detectors were determined with an improved method compared to earlier analyses. The irreducible non-elastic events measured by ALFA were estimated with a new procedure. This is also implemented in the determination of the detector efficiency.

The experience gained in this thesis was used to optimize the experimental setup for a new data taking at the highest human made energy in the world so far. The goal with this data set is to measure elastic scattering at even smaller angles whereby more parameters can be fitted to the data.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Christine M. Ritter
Viscoelastic and Dynamic Properties of Embryonic Stem Cells

Supervisor(s):  
Professor Lene Broeng Oddershede

Department:  
Niels Bohr Institute

Date of defense: 28 February 2017  
Date of awarded PhD degree: 3 March 2017

Summary:  
Stem cells are often referred to as the ‘holy grail’ of regenerative medicine, because they possess the ability to develop into any cell type. The use of stem cells within medicine is currently limited by the effectivity of differentiation and reprogramming protocols, making it therefore imperative to understand stem cells’ differentiation mechanisms better. Studies have shown that mechanical cues can have an influence on stem cells fate decision. However, in order to understand the reaction of stem cells to mechanical input, one should first investigate and understand the mechanical properties of the cells themselves. In this thesis, the viscoelastic properties of mouse embryonic stem cells primed either toward the epiblast (Epi) or the primitive endoderm (PrE) lineage were investigated.

The viscoelastic properties of the cells were investigated by measuring the fluctuations of endogenous lipid granules with optical tweezers. A stem cell line with a sensitive reporter for the primitive endoderm, Hhex, was used, to distinguish between the two cell types. Actin was disrupted and the effect of the disruption on the cells’ viscoelasticity was determined. To assess the effect of actin disruption on gene expression, time-lapse microscopy and qPCR was employed. Furthermore, the underlying diffusive process was determined.

The results showed that PrE-primed cells were significantly more elastic than Epi-primed cells. In both cell types, the nucleus was more elastic than the cytoplasm. After actin disruption, both populations became significantly more viscous. While 24 h time-lapse imaging confirmed a significant drop in Hhex levels of actin disrupted PrE-primed cells, this result could not be confirmed with qPCR. The underlying diffusive process was determined to be continuous time random walk.

Different levels of actin within Epi- and PrE-primed cells caused the differences in viscoelasticity between the two cell types. The diffusion of the lipid granules could be best described by continuous time random walk and active processes dominated the diffusion within the nucleus of PrE-primed cells on longer time scales.
José Alfredo Sameniego Castruita
New Approaches to the Mapping and Assembly of Genomic Data

Summary:
The thesis focuses on exploring bioinformatics methods for assembling and mapping modern and ancient genomes in different contexts. The first chapter consists of a new method to assemble organelle genomes in modern and ancient samples using high throughput sequencing while considering the challenge of organelle derived insertions (ODINs). The method described in this article is able to retrieve the organelle and the nuclear sequence by using a phasing approach. The second chapter consists of investigating the effect on phylogenetic and population genetics analyses when mapping population genomic data against different reference genomes. The dataset in the article consists in different wolf populations around the world that are mapped to the dog reference genome and a new wolf genome. Lastly, the third chapter consists of an exploration of the possibility of using ancestral reconstructed genomes using phylogenetic inference in order to improve the mapping in ancient and modern samples. The dataset in the article consists in 4 different genome species of birds and sequencing reads of an historic sample of great auk.

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Kristian Svennevig
Tectonic Evolution and 3D Modelling of Eastern North Greenland – Structural Geology of Kilen

Supervisor(s):
Professor Lars Stemmerik
Pierpaolo Guarnieri

Department:
Natural History Museum of Denmark

Date of defense: 1 March 2017
Date of awarded PhD degree: 7 March 2017

Summary:
This thesis deals with the tectonic evolution of Kilen in eastern North Greenland studied through application of mapping from oblique photogrammetry and 3D-modelling. During fieldwork in eastern North Greenland in 2012 and 2013, 1300 oblique images were collected from helicopter during flybys over Kilen. Visible geology in the triangulated and georeferenced images were digitized and together with available field data used to construct a 3D model of the area. In this model structural hypothesis could be tested by visually examining the relationships between layers and faults in 3D and by restoring the folded geology to highlight the pre-deformational structures. The 3D-mapping and modelling show that Kilen is dominated by NNW-SSE striking extensional faults, large E-W striking folds and N-S verging thrusts. These structures are formed by post Coniacian ENE-WSW extension followed by N-S compression of presumable Late Palaeocene - Early Eocene age. This is in contrast to previous published works where the structures on Kilen were interpreted to be formed solely by dextral strike-slip. These results are reported in a synopsis, three published papers, two manuscripts and a geological map - all together comprising the PhD thesis.
Yu Zhao

Investigation of the Physiology and Genetics of Lactobacillus Brevis Isolated from Beer

Supervisor(s):
Associate Professor Henrik Siegumfeldt
Susanne Knøchel

Department:
Food Science

Date of defense: 3 March 2017
Date of awarded PhD degree: 7 March 2017

Summary:
Beer is a very harsh environment for bacterial growth due to various inhibitory factors, but a few specialist microorganisms, in particular Lactobacillus brevis, can withstand the harsh conditions. It is therefore important to understand the bacterial stress response and the underlying tolerance mechanisms. The PhD thesis has explored the physiological response of L. brevis towards oxidizing disinfectants and beer-associated stress at the single cell level, as well as the genetic difference between beer tolerant and sensitive strains.

Study I was devoted to developing a rapid colony-based method for investigating the influence of oxidizing disinfectants on L. brevis strains. The method provided comparable results to determination of colony forming units but faster. The results showed that there was no clear relationship between the tolerance to hop compounds and to peracetic acid. A phenotypic heterogeneity was observed with two strains and within one strain. Study II investigated the physiological response of L. brevis to beer-associated stress (mainly hop stress) at the single cell level, using fluorescence microscopy and flow cytometry. The viability results indicated that a large proportion of cells were killed in all the tested strains, but a small subpopulation from the hop tolerant strains eventually recovered, as revealed by pH measurements. Besides, the addition of Mn2+ caused a short-term protection against hop compounds in all strains, but it did not benefit the sensitive strains during long-term incubation. The addition of ethanol resulted in an additional short-term damage, but the subsequent growth pattern indicated a slight cross-resistance toward hop compounds. Study III focused on understanding the phenotypic difference in strains of L. brevis isolated from beer, by investigating the genome of three tolerant strains and three sensitive strains. The genetic difference between the original strain and the plasmid-cured strain confirmed that the plasmid-localized genes play an important role in beer spoilage ability. But further experiments revealed that the beer-spoilage phenotype did not solely depend on the previously described hop-tolerance genes. Furthermore, genes encoding a Clp protease, a replication protein and a manganese transporter other than HitA were identified as novel beer tolerance genes.
Summary:
This PhD project has explored the potentials of Study and Research Paths (SRP) as a design tool for upper secondary mathematics education. SRP is a notion developed within the Anthropological Theory of Didactics (ATD) in didactics of mathematics. The objective of this project was the design and analysis of what students learn from SRP based teaching in a bidisciplinary and an everyday context, and what didactical tools might be needed for students to realise the full learning potential of the designs. The designs cover mathematical modelling, and what is gained with respect to modelling through SRP based teaching, is investigated. Finally, the viability of SRP based teaching is explored. This is explored by analysing the nature of teachers’ collaborations and the relation between SRP based teaching and exam formats. The precise analysis conducted with respect to the content taught in the two design studies proved to be crucial when designing the questions, which the students worked on. In SRP based teaching the sharing of responsibilities amongst teacher and students are changed. The teacher posed open ended questions, explicitly suggested students resources, which the students could choose to study, formed special groups and required all students to share preliminary answers with fellow students. Especially the resources and sharing of preliminary work, made the students engage in inquiry processes in more profound ways than usually. To discuss what could and should be taught in relation to mathematical modelling, more recent historic cases were analysed and compared with official regulations of secondary mathematics. In the historic cases creative approaches were found, which to some extent can be captured by SRP based teaching. The study of teachers’ collaboration point to the need of the creation of structures where teachers can plan, observe and reflect upon their own and colleagues’ teaching practices, if SRP based teaching should be implemented. Finally, the backwash of high stake written exams are needed to be addressed by ATD as a design task, where genuinely new exercises might promote a change of teaching to be more akin to real uses of mathematics.
Markos Tesfaye Woldeyohannes  
Quality of Life Among People Living with HIV in Jimma, Ethiopia: The Role of Mental Health, Food, and Nutrition

Supervisor(s):  
Professor Henrik Friis, Professor Lotte Holm  
Dr. Charlotte Hanlon

Department:  
Nutrition, Exercise and Sports

Date of defense: 7 March 2017  
Date of awarded PhD degree: 9 March 2017

Summary:  
The availability of antiretroviral treatment in Africa has greatly increased the life expectancy of people living with HIV (PLHIV). However, PLHIV who live in Africa face various social, economic, and health-related challenges that affect their quality of life. Food insecurity and mental health problems, both of which are common among PLHIV in Africa, can be detrimental to quality of life.  
This research undertaking aimed to investigate the roles of mental health and food insecurity on quality of life of PLHIV in Ethiopia, and to determine whether supplementation with lipid-based nutrient supplements (LNS) during initiation of antiretroviral medications has effects on quality of life.  
At first, a cross-cultural validation of the World Health Organization's quality of life questionnaire (WHOQOL-HIV Bref) was conducted. This questionnaire was adapted so that aspects relevant to quality of life in the context such as, satisfaction with access to adequate food and nutrition, and relationship with the community were incorporated. Both food insecurity and poor mental health had independent association with lower quality of life among PLHIV. Furthermore, supplementation with LNS during the first three months of initiation of antiretroviral medications improved the quality of life of PLHIV. This finding is robust in terms of scientific methodology as PLHIV were randomized to receive LNS during the three months period or be control group. The fact that our study participants had only mild or no undernutrition at the entry point into the trial means that the beneficial effect of LNS given to PLHIV extends beyond those who have malnutrition. Hence, HIV treatment guidelines for African settings need to consider food security status in addition to undernutrition in their decisions for providing nutritional supplements.
Mikael Kryger Jensen
Engineering Soluble Insect and Plant Cytochromes P450 for Biochemical Characterization

Supervisor(s):
Professor Søren Bak, Mika Zagrobelny & Max Cryle

Department:
Plant and Environmental Sciences

Date of defense: 3 March 2017
Date of awarded PhD degree: 9 March 2017

Summary:
Cyanogenic glucosides (CNglcs) are ancient defence compounds found in certain plant and a few insect species, which releases cyanide upon attack. The biosynthesis of CNglcs in plants and insects is performed by three enzymes converting an amino acid into its corresponding CNglc. The pathways have been shown to have evolved convergently with the enzymes from plants and insects having less than 20 percent sequence identity at the amino acid level. The first enzyme in the pathway is from the cytochrome P450(CYP) 79 and CYP405 family in plants and insects respectively, which convert the amino acid into its corresponding oxime through two sequential (N)-hydroxylation’s followed by a dehydration, decarboxylation and isomerization step. Despite the low sequence identity both families of enzymes display a remarkably high degree of substrate specificity.

The research presented in this thesis demonstrates how to engineer plant and insect microsomal cytochromes P450 to express them in a soluble state in E. coli, using various modifications of the primary sequence as well as optimizing the growth conditions. The modified enzyme CYP79A1 was purified a combined approach of visible-light fluorescence spectroscopy and in silico methods was used to investigate structural features important for determining the specificity in these proteins. We identified residue in the F and I helix as well as the β1-4 and β4-2 strands as likely determinants of substrate specificity, although possibly not the only determinants.
Trine Blædel
The Role of Angiopoietin-like Protein 4 in Obesity and Obesity-Related Diseases

Supervisor(s):
Associate Professor Lesli Hingstrup Larsen
Professor Arne Astrup

Department:
Nutrition, Exercise and Sports

Date of defense: 10 March 2017
Date of awarded PhD degree: 14 March 2017

Summary:
Angiopoietin-like protein 4 (ANGPTL4) is a protein produced in fat, liver, muscle and intestines in humans. The protein inhibits lipoprotein lipase, a protein that cleaves lipid-rich molecules in the blood. Thus, the amount of ANGPTL4 protein in the blood has been associated with regulation of blood lipids and it has been suggested that ANGPTL4 may be modified by changes in diet. Well regulated blood lipids are critical in maintaining health in humans, particularly in obese persons. ANGPTL4 has also been negatively associated with weight and fat deposition. The risk of developing diseases, such as insulin resistance and cardiovascular disease as a consequence of prolonged obesity is related to the state and deposition of fat tissue. The health of expanding fat tissue is dependent on the ability to ensure an adequate flow of oxygen to the fat cells.

This thesis investigates whether ANGPTL4 concentration is modified by a moderate dietary intervention with whole fat milk or with inulin fiber. Furthermore, data from three intervention studies were analyzed in order to investigate the effects of genetic variants, weight loss and weight maintenance.

The main findings from the thesis are that ANGPTL4 in fat is an acute regulator of lipid metabolism; however a moderate dietary intervention did not alter blood concentration of ANGPTL4. ANGPTL4 did not consistently influence blood lipids or weight regulation; however ANGPTL4 seems to influence the fat tissue through interaction with molecules involved in inflammation and in the growth of capillaries that supply fat cells with oxygen.
Amalie Christensen
Stress-driven Pattern Formation in Living and Non-living Matter

Supervisor(s):
Associate Professor Joachim Mathiesen

Department:
Niels Bohr Institute

Date of defense: 7 March 2017
Date of awarded PhD degree: 15 March 2017

Summary:
Spatial pattern formation is abundant in nature and occurs in both living and non-living matter. Familiar examples include sand ripples, river deltas, zebra fur and snail shells. In this thesis, we focus on patterns induced by mechanical stress, and develop continuum theories for three systems undergoing pattern formation on widely different length scales.

On the largest scale of several meters, we model columnar jointing of igneous rock. Using analytical calculations and numerical simulations, we derive a scaling function, which quantitatively relates the column diameter to material parameters and cooling conditions. This scaling function allows us to estimate the cooling rate of historic basalt flows from field measurements of column diameters.

On the scale of micrometers, we model breast cancer tissue as a viscoelastic active fluid. The model captures experimentally observed statistical characteristics as well as the cell division process, and hints at substrate friction being important for cell speed distributions. The model furthermore indicates, that invasive cells exert larger forces on their surroundings during cell division.

On the smallest scale of nanometers, we study thin films of block copolymers, which have potential applications as self-organizing templates for microelectronics. By performing a thin-shell expansion of a well-known model for block copolymers, we develop an effective model for the influence of curvature on pattern formation and ordering kinetics in a thin curved film.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Hasse Christian Knap
The Atmospheric Oxidation of Volatile Organic Compounds Through Hydrogen Shift Reactions

Supervisor(s):
Associate Professor Solvejg Jørgensen
Professor Henrik G. Kjærgaard

Department:
Chemistry

Date of defense: 13 March 2017
Date of awarded PhD degree: 15 March 2017

Summary:
In my PhD thesis I am focusing on the atmospheric oxidation of VOCs to understand the autoxidation processes in the atmosphere. I have used quantum chemical calculations, quantum tunneling, chemical kinetics and global atmospheric modeling tools to describe the gas-phase oxidation reactions connected to the autoxidation of VOCs. I discovered two new reaction mechanisms that have a high impact on the atmospheric oxidation of VOCs. First, I found that the isomerization reaction between a peroxo group and an OOH group is rapid. This is an interesting result, since the rapid reaction mechanism opens up for a large number of new reactions that have not been accounted for in atmospheric models. I have also investigated the isomerization reaction in PAN precursor compounds. PAN molecules are known to transport pollution (NOx) into unpolluted regions. I observed that a similar rapid reaction mechanism is possible in these molecules. This is exciting since the rapid isomerization reaction in these compounds can keep the autoxidation running and thereby produce VOCs with a low volatility.

ORCID No: 0000-0002-8240-9496
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Cardiovascular diseases (CVD) are the main leading cause of death worldwide. A reduction in low density lipoprotein cholesterol (LDL-C) is considered a key target for prevention and treatment of CVDs. Beyond increased LDL-C, low high density lipoprotein cholesterol (HDL-C), high fasting and postprandial insulin and triacylglycerols (TAGs), high blood pressure (BP), and small, dense LDL particles may contribute on their own to increased CVD risk. In several countries, the CVD-related dietary guidelines proposed by health authorities focus on reducing the intake of saturated fatty acids (SFAs), especially from food categories such as dairy. Thus, low-fat dairy products are advocated in most dietary guidelines to reduce the intake of cholesterol-raising SFAs found in regular-fat dairy foods. However, these recommendations remain controversial to many, as evidence from observational data found no detrimental association between dairy intake and CVD-related outcomes. Cheese intake, in particular, has been suggested to have a neutral or even beneficial association with CVD-related outcomes and type 2 diabetes (T2D). Still, there is a key research gap concerning the effect of regular-fat cheese intake compared with reduced-fat cheese.

The overall objective of this PhD thesis was to investigate the effects of regular-fat cheese with an equal amount of reduced-fat cheese and carbohydrate-rich foods on CVD and T2D-related outcomes including fasting blood lipids, LDL particle size distribution, and postprandial insulinemia and lipidemia. The thesis is based on one large 12-week human intervention study (paper I-III). The intervention was designed as a parallel-arm randomized, controlled intervention study.

Overall, the data from the large human intervention study presented in the current thesis do not support the dietary recommendation that consumption of reduced-fat cheese is less atherogenic than consumption of regular-fat cheese. Our results suggest that for most individuals with risk factors of the metabolic syndrome, it is reasonable to include regular-fat cheese as part of a healthy diet.
Cardiovascular diseases (CVD) are the main leading cause of death worldwide. A reduction in total mortality and specific CVD-related mortality is achieved by lowering low density lipoprotein cholesterol (LDL-C), low high density lipoprotein cholesterol (HDL-C), high fasting and postprandial insulin and triacylglycerols (TAGs), high blood pressure (BP), and high small dense LDL particles. Hypertension, dyslipidemia, and diabetes mellitus (type 2 diabetes (T2D)) are major risk factors for CVD. Still, there is a key research gap concerning the effect of regular consumption of reduced-fat cheese compared with reduced-fat dairy products. Our results suggest that for most individuals with risk factors for CVD and T2D-related outcomes, cheese intake, in particular, has been suggested to have a neutral or even beneficial association with CVD-related outcomes and longterm survival.

Insulin resistance is a key feature of the metabolic syndrome (MetS), and high fasting and postprandial insulin are strong predictors of cardiovascular risk. Findings from recent meta-analyses of randomized controlled trials indicate that a low-fat lifestyle is associated with a beneficial effect on insulin resistance. Our results are in line with these findings, as we found evidence of a beneficial effect of reduced-fat cheese consumption compared with regular-fat cheese on CVD and T2D-related outcomes including fasting blood lipids, LDL particle size distribution, and postprandial insulin levels. The overall objective of this study was to investigate the effects of regular-fat cheese with an equal amount of reduced-fat cheese consumption on CVD-related outcomes. Cheese intake, in particular, has been suggested to have a neutral or even beneficial association with CVD-related outcomes and longterm survival. Beyond increased LDL-C, high fasting and postprandial insulin and triacylglycerols (TAGs), high blood pressure (BP), and high small dense LDL particles may contribute on their own to increased CVD risk. In several countries, the CVD risk factors are classified as a metabolic syndrome (MetS). The intervention was designed as a parallel-arm randomized, controlled intervention study. The MetS is considered a key target for prevention and treatment of CVDs. Beyond increased LDL-C, high fasting and postprandial insulin and triacylglycerols (TAGs), high blood pressure (BP), and high small dense LDL particles may contribute on their own to increased CVD risk. In several countries, the CVD risk factors are classified as a metabolic syndrome (MetS). The intervention was designed as a parallel-arm randomized, controlled intervention study.
Phylogeny and Biogeography of Charinidae Quintero, 1986
(Arachnida, Amblypygi) Based on Morphological and
Molecular Data

Supervisor(s):
Professor Nikolaj Scharff

Department:
Natural History Museum of Denmark

Date of defense: 21 March 2017
Date of awarded PhD degree: 22 March 2017

Summary:
Whip spiders (order Amblypygi) are amazing arachnids with flat body, strong and spiny pedipalps and elongate first pair of legs. This combination of characters helps these animals to hide quickly in small crevices, efficiently catch prey, and thoroughly feel the environment around them. Amblypygids are worldwide distributed, present in all tropical continents, and have five families with a total of 209 species. Charinidae is the most diverse family within whip spiders with 88 species occurring from New Caledonia to the Caribbean. This widespread and rich family was never studied in details regarding the limits of the species, the relationship of the genera and the biogeography of the main clades. Therefore, the aim of this project was to investigate Charinidae regarding its alfa-taxonomy (revision of the group), phylogeny and biogeography using molecular and morphological data in a first large-scale data generated for the Amblypygi. As a result, 36 new species of Charinus (one of the genus of Charinidae) were identified and described. A combined phylogenetic analyses (morphology+DNA) provided the first relationship hypothesis for the family, revealing a new genus (Weygoldtia) and a number of Charinus species within Sarax (another genus in Charinidae). The analysis retrieved also the close relationship of an Arabian and Southeast Asian clade within the genus Sarax and recovered a sister group relationship of the Sarax species from the Malay Peninsula to all other Southeast Asian species of the genus. In the genus Charinus, the north South American species branched together with the Caribbean species. Using Bayesian divergence dating, ages were estimated for the various Charinidae lineages, revealing a very ancient origin of the family, around 313.9 Ma, during the Carboniferous. The split between the clades of Weygoldtia and Charinus+Sarax happened by the end of the Permian (approx. 235.7 Ma) and this branching event is suggested to have been a consequence of the series of climatic catastrophes that happened during the great Permian extinctions. Remarkably, strong support was found for a Gondwanan relict of the New Caledonian fauna of the family Charinidae (Charinus neocaledonicus and C. elegans), a clade sister to the Australian species C. pescotti, given further insight information to the evolution of those islands.

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Pernille Østerbye Erthmann
Triterpenoid Saponin Biosynthesis in the Non-model Crucifer
Plant Barbarea Vulgaris: Gene Discovery, Genome Assembly, and Transformation

Supervisor(s):
Professor Søren Bak
Niels Agerbirk

Department:
Plant and Environmental Sciences

Date of defense: 20 March 2017
Date of awarded PhD degree: 23 March 2017

Summary:
Plants produce a vast array of metabolites for basic and specialized metabolism. Many of the specialized metabolites are synthesized for defense purposes, to protect the plant from predators, i.e. mammals or insects. One major group of defense compounds is the triterpenoid saponins, which are thought to interact with membrane lipids, thereby disrupting the cell membrane architecture of the predator.

In the plant Barbarea vulgaris four saponins are identified and found to be responsible for resistance towards flea beetles (Phyllotreta nemorum) and diamondback moths (Plutella xylostella). Genes involved in the biosynthesis of these saponins were recently identified; however, the complete biosynthetic pathway is not known to date. These findings set the background of this thesis, which aims to address two main goals: 1) to elucidate additional genes involved in saponin biosynthesis and 2) to study the product specificity for the already identified enzymes.

In order to identify additional genes involved in saponin biosynthesis, a draft genome of B. vulgaris was sequenced and assembled. The draft genome was used to identify UDP-glucose transferase (UGTs) enzymes able to glucosylate the backbone of known saponin structures. These UGTs were found to be organized in tandem repeats and may be the result of gene duplications.

In B. vulgaris P-type and B. vulgaris G-type two 2,3-oxidosqualene cyclases enzymes, which are the first genes in the pathway leading to saponins, are 98 % identical. Surprisingly, they differ in their product profiles, laying the foundation for the second main part of this thesis. Here, amino acid residues important for the observed product ratios were identified.

In vivo results suggest the rate limiting step for saponin biosynthesis in B. vulgaris to be the expression levels of 2,3-oxidosqualene cyclase. To support these findings, an in vivo knock-out of the OSC via CRISPER/Cas was desired. To achieve this, stable transformants of B. vulgaris with the nuclease Cas9 were generated together with a regeneration protocol for B. vulgaris roots and hypocotyls.
PHD GRADUATE FROM FACULTY OF SCIENCE

Anders Borges
Chemical Principles and Interference in the Electrical Conductance of Single Molecules

Supervisor(s): Associate Professor Gemma C. Solomon

Department: Chemistry

Date of defense: 23 March 2017
Date of awarded PhD degree: 24 March 2017

Summary:
Using special equipment it is possible to measure the electrical conductance of single organic molecules. This, in principle, allows the creation of molecular circuits, which are much smaller than those, available in consumer electronics today. But while the properties of the circuits that make up consumer electronics today such as wires, resistors and transistors are well understood according to classical circuit rules, the properties of molecular electronic components obey a different set of rules, which can be difficult to comprehend. This thesis is about comprehending why some molecules are much better electrical conductors than others even though they appear very similar. It explores the links between chemical structure and interference effects, which can increase and decrease the electrical conductance by orders of magnitude. It answers question like: When is the conductance of two identical molecular wires in parallel different than twice the conductance of a single wire? How does the conductance of a perfect insulator change with length? Are there links between chemical principles and molecular circuit rules? These questions and others are answered using a combination of simple models derived using pen and paper, extracted from advanced computer simulations and tested through analysis of thousands of individual experiments. It is demonstrated that interference effects are key to understand and design molecular circuits and that, like for classical circuits, it is possible to design molecular circuits with distinct properties.
Domenico Sagnelli
Investigation of GMO and Ancient Grains for Bioplastic and Food Application

Supervisor(s):
Associate Professor Andreas Blennow
Kim H. Hebelstrup

Department:
Plant and Environmental Sciences

Date of defense: 23 March 2017
Date of awarded PhD degree: 24 March 2017

Summary:
Thermoplastic starch is produced using conventional processing systems, such as the extrusion. The raw material for TPS production was the amylose-only (AO) a transgenic barley with a starch having 99% amylose. Control and AO prototypes crystallinity was composed of both B- and Vh- type showing the destructuration of A-type crystals. Mechanical analysis demonstrated AO having a 6-fold higher stress at break and 2.5-fold higher strain at break as compared to control. These data on AO starch confirmed that starch bioengineering has the potential for production of high-performing materials.

An alternative is all-natural and compostable composites. We casted composites films by blending starch with oat β-glucan (BG). BG decreased brittleness and improved cohesiveness with higher stress and strain values at break. Our data show that blending starch with other natural polysaccharides is a leading path to improve the functionality of all-natural polysaccharide bioplastics systems.

New types of grain starch and fibers can help to improve the lifestyle of people affected by chronic diseases, such as diabetes. Hordeum vulgare (Hv) is a major crop with nutritional and health promoting effects because of its high content of beta-glucan and other bioactive molecules. Hs, a wild ancestor of modern barley, differs from domesticated varieties and has high-value components such as prebiotic carbohydrates that have been lost during the domestication process. Glycemic indexes (predicted glycemic index, pGI) and hydrolysis rate of starch were investigated in Hs, AO and Hv cultivars. A static and a dynamic human gastrointestinal models were used for this purpose. The in vitro hydrolysis index (HI) values were correlated with in vivo GI data allowing the calculation of the pGI. The AO and Hs showed a higher content of prebiotic carbohydrates. The pGIs of the ancient and the AO line were lower (17.5 and 15.8, respectively) than the control barley (35.0). Our work supports the potential of including health-promoting grains, the high/full amylose and the ancient germplasm origin, as ingredients in grain-based products like bread and snacks.
Stine Klein Degerbøl

Encountering Contemporary Circus
Exploring Arts-based Research Methods to Understand the Embodied Learning of Contemporary Circus Students

Supervisor(s):
Associate Professor Helle Winther
Associate Professor Charlotte Svendler Nielsen

Department:
Nutrition, Exercise and Sports

Date of defense: 3 March 2017
Date of awarded PhD degree: 29 March 2017

Summary:
The dissertation is based on empirical work which was carried out in three periods of two weeks spread out over the course of a school year at the Circus Performer Department at the Academy of Untamed Creativity (AFUK) in Copenhagen (Denmark) with six participating contemporary circus students. An initiating curiosity was to understand the embodied learning of the students and for this purpose it turned out to be necessary to develop research methods in order to provide such an insight. Therefore, the research question of the study is: How can arts-based research methods be developed with the purpose of providing insight into the embodied learning of contemporary circus students? A narrative and embodied arts-based methodology was developed, followed by methodical exploration and development. The methodology is recurrent in the entire research process: In the meeting with the students as well as in the processing, analysis, and dissemination of their narratives. Four inter-connected approaches were developed: A sensuous approach, a visual approach, a narrative approach, and an audiovisual approach. Each approach manifests itself with different accentuation in different parts of the research process.

Furthermore, two analytical models related to the interview material and the audiovisual material respectively, were developed. The results are connected to and aim to contribute to arts-based educational research as well as research on embodied learning and humanistic and social science research on circus. The conclusion is that a narrative and embodied arts-based methodology opens up a variety of possibilities for studying embodied learning as well as for disseminating written and audiovisual narratives. The developed research methods seem suited to provide insight into embodied learning as they are created to accommodate this group of young people who have chosen an embodied arts-based education. The developed methodical approaches provide insight into the embodied learning of the contemporary circus students by finding and emphasizing phenomena like embodied encounters, exhaustion, struggle, and freedom.

18 The developed methodology and the methodical approaches may be applied to research on, among other things, circus, dance, movement, and sport, as well as other practices where the body is central. Furthermore, the results of the study may be relevant for research in other educational/learning contexts, e.g. skilled trade or professional bachelor programs.

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Yong Hou
Understanding Cancer Genome and Its Evolution by Next Generation Sequencing

Supervisor(s):
Professor Karsten Kristiansen

Department:
Biology

Date of defense: 23 March 2017
Date of awarded PhD degree: 30 March 2017

Summary:
Cancer will cause 13 million deaths by the year of 2030, ranking the second leading cause of death worldwide. Cutting-age technologies like next generation sequencing (NGS) enable exploring cancer genome and evolution much more efficiently. However, integrated cancer genome sequencing studies showed great inter-/intra-tumoral heterogeneity (ITH) and complex evolution patterns beyond the cancer biological knowledge we previously know. In the PhD thesis, I summarized my work on investigating inter-tumoral and intra-tumoral heterogeneity (ITH) by NGS, including 3 peer-reviewed publications about East Asia lung cancer genomes and 4 peer-reviewed publications about the inferring tumor heterogeneity using single cell sequencing. Taken together, we showed that NGS on cancers could provide novel biological insights of cancer genetics and SCS may serve as powerful tool to investigate the ITH and evolution of both primary tumor and metastatic/relapse tumor.
Mingzhi Ye
The Study of Lung Cancer Personalized Medicine Through Circulating Cell free DNA Test

**Supervisor(s):**
Professor Karsten Kristiansen

**Department:**
Biology

**Date of defense:** 23 March 2017
**Date of awarded PhD degree:** 30 March 2017

**Summary:**
As a PhD candidate, I have finished 29.5 ECTS courses study and tried to do research on lung cancer precision medicine through cell free DNA testing. My research focused on Chinese lung Adenocarcinoma (LUAD) therapy, especially in relation to molecular therapy and early screening of LUAD. And the work comprised (1) Information on the landscape of Chinese LUAD oncogenes finding new target oncogenes; (2) Development of a method for screening known target genes by the NGS; (3) Elucidation of the heterogeneity of LUAD and molecular evaluation of how this influences on the target therapy; (4), Evaluation of a new method to monitor the rejection and infection in relation to lung transplantation for lung cancer treatment; (5) Determination of cell free DNA molecular features of patients with lung peripheral nodules characterizing bio-markers that can be used for early lung cancer screening. So far, I have already published two papers on the Chinese LUAD oncogene landscape and screening for known target genes using the NGS lung cancer panel. My studies on lung cancer heterogeneity and therapy of lung transplantation are under review. By using cell-free tumor DNA and peripheral nodule ultra-deep sequencing, a prediction model based on tumor burden is to establish molecular pathological identification at early stage. This early diagnosis research work has been finished and a manuscript is in preparation for submission. Also, I joined several meetings on cancer and lung cancer during my PhD study, including CSCO, ICG and the Chinese Lung Cancer Conference etc. By collaborating with experts in the clinical and genomics field, I was one of the co-members of the CSCO NGS consensus on clinical applications in the field of cancer which we established standards on protocols, sample collection, data annotation, database, sequencing parameters and reports for lung cancer precision medicine.

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Xiao Liu
Immune Repertoire Characteristics and Dynamics in Cancer

Summary:
The diversity of T and B cells in terms of their receptors is huge in the invertebrate’s immune system, to provide broad protection against the vast diversity of pathogens. Immune repertoire is defined as the sum of total subtypes that makes the organism’s immune system, either T cell receptor or immunoglobulin. Before the emergence of high-throughput sequencing, the study on immune repertoire is limited by methodology, as it is impossible to capture the whole picture by the low-throughput tools. The massive paralleled sequencing suits perfectly the study on immune repertoire. In this thesis, I describe the experimental and analytical methodologies we developed for immune repertoire analysis. We have devoted extensive efforts on the optimization and evaluation of these pipelines. We then use the tools to investigate the characteristics and dynamic of immune repertoire on both blood and solid cancer. Specifically, we provide analysis on leukemic IGH sequences and their evolution in B-cell acute lymphoblastic leukemia, and monitor the dynamics of IGH repertoire during chemotherapy. Further, the TCR repertoire of infiltrated T lymphocytes in breast tumor and adjacent tissues was analyzed. We describe numerous interesting findings that might provide hints on immunotherapy of breast cancer.
PHD GRADUATE FROM FACULTY OF SCIENCE

Peter Kielberg Fisker
Measurements of the Causes and Consequences of Drought

Supervisor(s):
Professor with special responsibilities John Rand
Professor Henrik Hansen

Department:
Food and Resource Economics

Date of defense: 22 March 2017
Date of awarded PhD degree: 31 March 2017

Summary:
This PhD thesis is a conjunction of four manuscripts and one published paper on the measurement of disasters. The central idea is that in order to study the causes and consequences of disasters, it is necessary to separate the concept into its components: hazard, exposure, vulnerability, resilience, response, impact, etc. With this in mind, the thesis will take the reader through 4 chapters on the measurement of causes and consequences of drought and one chapter on the role of technology in disaster relief coordination.

The first chapter is about measuring drought hazard. It outlines some of the caveats of existing measures of agricultural drought often used in the economics research, and suggests the use of predicted greenness anomalies. The second and third chapter exploit the observed impacts of agricultural drought (measured as predicted greenness anomalies) on socio-economic outcomes to develop practical new ways of measuring vulnerability and resilience in the Sahel. The fourth chapter looks into one of the short term consequence of agricultural drought in Nigeria, namely the change in production methods among small-scale farmers. The fifth chapter studies one of the factors that can mediate the consequences of disasters. A case study is built around the Virtual OSOCC, an online platform for disaster relief coordination.

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Chengzhe Tian
Decision Making in Biological Systems

Supervisor(s):
Associate Professor Namiko Mitarai
Professor Kim Sneppen

Department:
Niels Bohr Institute

Date of defense: 31 March 2017
Date of awarded PhD degree: 3 April 2017

Summary:
This thesis consists of five projects in three topics with a shared theme of understanding cellular decision-making processes with mathematical modeling. In the first topic, we address the possible interaction between bacterial Toxin-Antitoxin (TA) systems and stringent response alarmone guanosine tetra- and pentaphosphate [(p)ppGpp] and examine how this interaction contributes to bacterial persistence. We show that TA systems mediate a negative feedback to early stringent response by reducing the available mRNA. We also show that the redundancy of TA systems can be realized if bacterial growth-dormancy transition is primarily mediated by (p)ppGpp fluctuation.

In the second topic, we discuss the transition paths between two stable steady states. We construct a simple model of coupled bistable gene circuits and demonstrate the possibility of bifurcation of transition path in biology. We then construct a theory to predict whether a general coupled bistable system exhibits bifurcated path or not and verify the theory through numerical simulation. We also show that a primary function of bifurcated paths is to facilitate transition by lowering the associated action.

In the third topic, we discuss the function of extrinsic noises in digital signaling using mammalian NF-kB pathway. We show that when cells are stimulated by one ligand, digital signaling allows one to independently control the fraction of responding cells (population-level response) and temporal profiles of NF-kB activity (individual-level response). We also show that under co-stimulation of two ligands, cells respond to only one input rather than both. We term this behavior "non-integrative processing" and we propose a possible mechanism by introducing an ultrasensitive negative feedback, allowing cells to block signaling pathways upon activation by one ligand.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Morten Bo Søndergaard Svendsen
Effects of Harmful Algae on the Physiology of Fishes

Supervisor(s):
Professor John Fleng Steffensen

Department:
Biology

Date of defense: 31 March 2017
Date of awarded PhD degree: 3 April 2017

Summary:
Planktonic harmful algae form blooms worldwide and are determined as harmful for many reasons. This thesis explored the effect of some of these harmful algae, specifically some that affect the physiology of fishes. The focus of the thesis was to determine what responses that fish express upon exposure to harmful algae. For two algal species, Prymnesium parvum and Alexandrium monilatum, the specific effects were determined to be respiratory, affecting the gills of the fish, making them unable to extract oxygen. For a third species, observed during a natural bloom in Denmark, an interaction of the bloom with low environmental temperatures is suggested being the cause of the observed fish mortality. Also, the impact of harmful algae exposure to fish oxygen tolerance was studied, concluding that exposure severely decreases the capability of fish to withstand low environmental oxygen conditions. Lastly, oxygen limitation in fishes was discussed and analysed using a mathematical approach, with data from literature in turn concluding on general thresholds of observed and theoretical acute oxygen tolerance.

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Nikolaj Lervad Hansen
Terpenoid Pathway Discovery in Tripterygium Wilfordii -A Chinese Medicinal Plant

Supervisor(s):
Professor Birger Lindberg Møller, Allison Maree Heskes, Björn Hamberger

Department:
Plant and Environmental Sciences

Date of defense: 31 March 2017
Date of awarded PhD degree: 3 April 2017

Summary:
Tripterygium wilfordii (Celastraceae) is a plant widely used in Chinese Traditional Medicine. The plant produces two compounds of the terpenoid class with strong anticancer activities; the diterpenoid triptolide and the triterpenoid celastrol. Should these become mainstream anticancer drugs knowledge of the genes underlying their biosynthesis would set the stage for biotechnological production methods.

The research undertaken here focused on terpenoid metabolism in T. wilfordii with special interest in triptolide and celastrol biosynthesis. The main methods employed included metabolite guided transcriptomics, high-throughput transient gene (co)expression in Nicotiana benthaniana and analytical chemistry (GC-MS and LC-MS).

Unexpectedly, a member of the terpene synthase b subfamily was found recruited to formation of miltiradiene, a possible precursor of triptolide, in a broader study of the TPS family in T. wilfordii. Attempts to identify downstream oxidative steps in triptolide biosynthesis identified CYP82D60, to facilitate incomplete aromatization of miltiradiene to dehydroabietadiene, among 49 tested candidate members of the Cytochrome P450 (CYP) superfamily. Expected first steps in celastrol biosynthesis were identified in another study of the same candidates. Specifically three CYPs (CYP712K1-3) were shown to form 3-oxofriedelan-29-oic acid and its precursor 29-hydroxyfriedelin from friedelin, which in turn was found formed by TwOSC4 of the Oxidosqualene cyclase family. A different study probed residues important for product identity in two functionally distinct but closely related class II diterpene synthases of T. wilfordii. Two residues locating to the predicted active site of the enzymes were shown to control product outcome. Finally an unrelated study of the sole diterpene synthase of Physcomitrella patens; copalyl diphosphate/kaurene synthase, demonstrated additional diterpenes formed by this enzyme.

The results of this PhD project define steps in T. wilfordii terpenoid biosynthesis of great importance for future biotechnological methods in production of celastrol and triptolide.

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Signe Bonde Rasmussen
Pesticide Leaching in a Changing Climate

Supervisor(s):
Professor Peter Engelund Holm, Associate Professor Søren Hansen, Computer Scientist Per Abrahamsen

Department:
Plant and Environmental Sciences

Date of defense: 3 April 2017
Date of awarded PhD degree: 5 April 2017

Summary:
There is a widespread consensus among scientists that the climate will change in the future, and that this change has already begun. These climatic changes will undoubtedly challenge the use of pesticides, which has been proposed to increase in the future. Accordingly, the primary aim of this PhD-project was to contribute to the knowledge of how climate change will affect pesticide leaching in the future, which was done by use of mathematical modelling. The agro-ecological model Daisy, was used in all simulations, as well as the 2 model soils: a coarse sand and a subsurface drained sandy loam containing preferential flow pathways. The sensitivity of pesticide leaching towards single high intensity events was tested by use of the artificial Chicago Design Storm (CDS), which were inserted in the driving weather file. Glyphosate showed a strong dependence, as short intense events resulted in relatively high leaching amounts under specific pre and post event weather conditions. This clearly illustrated the importance of including weather variability in pesticide fate modelling.

An ensemble of 11 climate model projections were downscaled by perturbing a weather generator calibrated on local meteorological data, resulting in 3000-year long weather series of statistically stationary climate. Effects of pesticide properties (sorption and degradation), pesticide application dates, and soil properties were included. The synthetic weather series produced in relation to objective (II) were used to simulate future changes in pesticide fate. The simulation results indicate a decreased risk in future leaching, as predicted by the ensemble mean. This accounts for all investigated pesticide properties, application dates, and soil types, and is generally caused by increased pesticide degradation. However, a degree of model uncertainty was found, as some models projected increased leaching of especially autumn applied pesticides of 13-19 % (worst case scenario). Variation in leaching result, as caused by changed weather patterns, only increased for autumn applied pesticides. It can therefore, not be concluded that potential future increases in extreme rainfall, will affect the future leaching of pesticides.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Caroline Samantha Heneka
Cosmological Structure Formation: From Dawn till Dusk. From Reionization to Galaxy Clusters

Supervisor(s):
Professor Steen H. Hansen
David Rapetti

Department:
Niels Bohr Institute

Date of defense: 3 April 2017
Date of awarded PhD degree: 6 April 2017

Summary:
Cosmology has entered an era where a lot of data is available on structure formation to constrain astrophysics and underlying cosmology. This thesis strives to both investigate new observables and modeling of the Epoch of Reionization (the epoch of our Universe, when the first galaxies form and their radiation heats and re-ionizes the neutral hydrogen around them), as well as to constrain what type of dark energy explains the observed accelerated expansion of the Universe with massive clusters of galaxies. We therefore travel from the dawn of structure formation, when the first galaxies appear, to its dusk, when a representative part of the mass in the Universe is settled in massive structures. Starting at the dawn of structure formation, we study emission line fluctuations, using simulations of cosmological volumes. They encode information about the state of the inter-galactic medium, testing neutral versus ionized medium. It thus constrains reionization, crucially depending on the first ionizing sources (galaxies), as well as the growth of structure and therefore cosmology. At dusk we employ the abundance of galaxy clusters to constrain different scenarios to explain the accelerated expansion of the Universe. We find, that the standard model and a model that exhibits more clustering are distinguishable. Lastly, a novel statistical tool is presented, which enables us to enhance the accuracy of our measurements by identifying subsets of data with systematics and hidden correlation in a model independent way.
Christian Fabiansen
Nutritional Supplementation of Children With Moderate Acute Malnutrition

Supervisor(s):
Professor Henrik Friis
Professor Kim Fleischer Michelsen

Department:
Nutrition, Exercise and Sports

Date of defense: 31 March 2017
Date of awarded PhD degree: 07 April 2017

Summary:

Moderate acute malnutrition (MAM) is widespread among children in low-income countries. Children with MAM are treated with food supplements from a matrix of either lipid-based nutrient supplements (LNS) or corn-soy blends (CSB), but there is limited evidence on the effectiveness. In the PhD thesis results are presented from the Treatfood (TF) study that used accretion of fat-free tissue, as primary outcome, to test key factors in supplementary foods.

In the main trial 95% were breastfed, mean±SD weight was 6.91kg ±0.93, with 83.5% FFM. Weight increased 0.90 kg (95%CI 0.88; 0.93) comprising 93.5% FFM. FFMI was increased by LNS (vs CSB, 0.083 kg/m², 0.003; 0.163), but not SI (vs DS, 0.038 kg/m², -0.042; 0.118). FFMI was also increased by 20%M (vs 0%M, 0.097 kg/m², -0.002; 0.196), although only marginally significant, but not by 50%M (0.049 kg/m² -0.047; 0.146).

In the TF study children with MAM showed a satisfying weight gain consisting mainly of fat-free tissue. LNS yielded more fat-free tissue and higher recovery rates than CSB, and LNS did not lead to excessive accumulation of fat. Finally, growth rates were similar for children below and above 67 cm with MAM by MUAC. The findings may have immediate relevance for malnutrition programs.

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Moderate acute malnutrition (MAM) is widespread among children in low-income countries. Children with MAM are treated with food supplements from a matrix of either lipid or dehulled soy blends (CSB), but there is limited evidence on the effectiveness.

In the TF study children with MAM showed a satisfying weight gain consisting mainly of free tissue. LNS yielded more fat-free tissue and higher recovery rates than CSB, and LNS was marginally significant, but not by 50% (0.049 kg/m²). FFMI was also increased by 20% (vs 0%, 0.097 kg/m²).

In the main trial 95% were breastfed, mean±SD weight was 6.91kg ±0.93, with 83.5% FFM. Weight increased 0.90 kg (95%CI 0.88; 0.93) comprising 93.5% FFM. FFMI was increased by 0.087 kg/m² (0.042; 0.118) and marginally significant by 0.047 kg/m² (0.002; 0.146), although only by 5% (0.002 kg/m²).

In addition, an assessment was undertaken of the use of short-term nutritional supplements with LNS or CSB (500 kcal/day), containing soy-isolate (SI) and soy-blends (CSB), but there is limited evidence on the effectiveness.

In the PhD thesis results are presented from the Treatfood (TF) study that used the deuterium dilution technique (Paper I). The main trial was a randomised 2x2x3 factorial trial comparing children with MAM by MUAC. The findings may have immediate relevance for the improvement of nutrient intakes and energy production model using sparse linear algebra, and studies its effect on the final result.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Nor Qhairul Izzreen Mohd Noor
Volatile Compounds and Inositol Hexakisphosphate (IP6) Content in Wholemeal Wheat Bread

Supervisor(s):
Associate Professor Åse Solvej Hansen

Department:
Food Science

Date of defense: 31 March 2017
Date of awarded PhD degree: 18 April 2017

Summary:
Awareness on the health effects of whole grain products has increased due to its high nutritional properties and protective effects against several lifestyle related diseases. Bread being the most common and staple food in many countries is the most suitable food product to promote the consumption of whole grain products in daily diet. However, whole grain bread had lower consumer acceptance compared to wheat bread due to the taste and the formation of volatile compounds in wholemeal wheat bread is one of the criterions that contribute to the flavour of bread. Additionally, whole grain diets can lead to decreased absorption of the minerals iron, zinc, phosphate and magnesium. This is due to the high content of phytic acid in the whole grain that binds to these minerals and resulted in lower mineral absorption in human gut that subsequently reduced the mineral bioavailability in whole grain bread.

Therefore, the overall purpose of this PhD thesis was to investigate how the fermentation conditions as temperatures and yeast levels influence the formation of volatile compounds in the crumb and crust of wholemeal wheat bread. Additionally, the changes of phytate content (hexakisphosphate = IP6) in the production of wholemeal wheat bread were also investigated as well as the effect of use of phytase-active yeasts on the phytate degradation.

In general, based on the findings of this thesis, bread fermented with 32 °C with 6% yeast might have relatively highest reduction of IP6 compared to other fermentation conditions in paper I and II due to the high fermentation temperature and high yeast level (depending on the type of yeast). In addition, bread fermented at 32°C with 6% yeast had higher peak areas of the Maillard reaction products and important fermentation product for whole meal wheat bread both in the crumb and crust which were previously reported as being important for bread and might be preferable for the industry.

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The use of Lignocellulosic Byproducts and Cellulose Nanocrystals within Particleboard Production

Summary:
The objective of this work was to study the particleboard production using Eucalyptus particles, sisal filaments, coconut filaments (coir) and sugarcane bagasse particles (SCB). All particleboards were made in three layers (face / core / face) using urea-formaldehyde adhesive (UF). Coir and sisal filaments were used in association with Eucalyptus particles, only in the inner layer (core), in proportions of 0, 10 and 20%. The SCB particles were separated into pith and fibers and the particleboards were made using only fibers and using fibers on the faces and pith in the core. SCB particleboards were also manufactured using 1% of cellulose nanocrystals (NCC), by adhesive mass, on the faces of the particleboards. The proportion of NCC was defined using urea-formaldehyde specimens, reinforced with different proportions of NCC (0, 0.5, 1, 2, 3 and 5%). For the particleboards production, a pressing cycle was used with the following characteristics: temperature of 160°C, pressure of 4 MPa and time of 8 minutes. The properties evaluated were: water absorption (WA), thickness swelling (TS), density, compaction ratio, modulus of elasticity (MOE), modulus of rupture (MOR), internal bond (IB) and thermal conductivity (TC). The particleboards reinforced with sisal did not show satisfactory results for most of the properties evaluated (MOE, MOR, WA, IB and TC), but those reinforced with coconut, showed properties very similar to the particleboards made only with Eucalyptus particles, demonstrating the potential of this material. The filaments of sisal formed tufts that impaired the dispersion of the adhesive inside the tufts, reflecting in poor physical-mechanical properties. The specimens of UF reinforced with NCC (1, 2 and 3%) presented higher results (MOE and MOR) than non-reinforced specimens did, but the same was not observed when the NCC were applied in the SCB particleboards. NCC were probably able to bind with the adhesive, decreasing the amount of sites for the bonds between the adhesive and SCB particles. Particleboards made with fibers and fibers/pith showed properties statistically equal for most properties (MOE, MOR, WA and TC). SCB showed potential for MDP production.
High stability is an essential trait for an enzyme in industrial application. Unfortunately increasing an enzyme stability either by random mutagenesis or engineering is not trivial. Natura has fortunately, already solved this problem for us. Organisms living at high temperatures, in some cases close to or above 100°C, are known as hyperthermophile and are a natural treasure chests of enzymes with high stability. The exact mechanisms employed by these organisms to increase the stability of their enzymes are not fully understood. By identifying and understanding these mechanisms we might be able to find new ways to increase the stability of enzymes. Enzymes from Sulfolobus islandicus, a hyperthermophilic organism living in the volcanic hot springs of Iceland, grow optimally at a temperature of 80°C, and similar organisms has been shown to be modified by the addition of methyl-groups to lysine’s. Lysine methylation is known from eukaryotic organisms as a signal for DNA condensation and gene regulation, and is highly regulated. This is not the case in S. islandicus where lysine methylation is unspecific and generally observed. Do to the large extent of lysine methylation in this heat loving organism and the fact the lysine methylation have been show to be temperature dependent in a close relative. it is suspected that methylation might play a role in the adaptation to the high temperature of the organisms preferred environment. To test if this is the case we tested the stability of an enzyme of S. islandicus with and without lysine methylation. We found that the enzyme was indeed stabilised by methylation but only to a minor extent. As the lack of methylation did not affect that activity of the enzymes the exact function of lysine methylation in hyperthermophiles are still not know. Protein-protein interaction were also investigated as a possible mechanism for the high stability of this enzyme. Our results indicates that this might the case as a stabilisation of the interaction increased the stability of the enzyme by 60%.
PHD GRADUATE FROM FACULTY OF SCIENCE

Fan Fan
Relationship Between Stoichiometry and Ecosystem Services in Organic Crop Production Systems

Supervisor(s):
Associate Professor Christian Bugge Henriksen
Professor Emeritus John R. Porter

Department:
Plant and Environmental Sciences

Date of defense: 21 April 2017
Date of awarded PhD degree: 27 April 2017

Summary:
Over the last five decades global ecosystem services (ES) have continued to diminish, mainly due to anthropogenic activities. Organic farming has been suggested as one possible solution to alleviate the loss of ES in agro-ecosystems due to its environmental benefits compared with conventional farming. However, only a few studies have accounted for the economic value of ES in different organic crop production systems and little is known about how organic crop production systems affect the supply of ES. Ecological stoichiometry, which is the study of the fluxes of chemical elements and the ratio between them, has been suggested as a new approach for understanding the effects of anthropogenic activities on ES. The overall objective of the PhD project was to explore the relationship between stoichiometry and ES values in organic crop production systems and explain the mechanisms behind this relationship. In order to achieve this objective the ES values and stoichiometric ratios in organic crop production systems characterized by different management practices and number of years under organic farming was investigated. The results showed that the level of organic matter input and the number of years under organic farming were positively correlated with non-marketable ES values. Increasing the number of years that a farming system stays organic and growing perennial crops can improve the sustainability of agroecosystems and contribute to mitigating the degradation of ES values. Furthermore, soil C:N stoichiometric ratio was strongly positively correlated with non-marketable ES values. These findings build quantitative connections between the fundamental chemical properties of molecules and ES values in organic crop production systems. We suggest that soil C:N stoichiometry can be used as a new approach to assess and indicate ES values in organic farming systems. The ES economic valuation of different organic crop production systems provides information for decision makers, including land managers, farmers and policy makers to help them adjust management practices, which can mitigate the loss of ES and enhance the long-term sustainability of agroecosystems.
The timing of flowering is a well-researched but at the same time incredibly complex process in angiosperms. Although we are in possession of detailed knowledge on the genetic level of flowering time regulation in the model plant Arabidopsis thaliana, it is often difficult to transfer this knowledge to other plants, like perennial woody plants growing in temperate regions. The main reason for this is a process called bud dormancy, which enables these plants to survive the harsh environmental conditions of winter. Accordingly a certain amount of cold is required for them to flower properly.

As global warming is progressing and winter chill is decreasing, we need compensation strategies to engineer flowering time, the majority of which are centered in plant breeding. An alternative approach is the treatment with compounds that compensate for missing winter chill and advance flowering time. One example is the agrochemical hydrogen cyanamide, which besides its successful application in agriculture constitutes an excellent experimental system to research controlled endodormancy release.

In this project, we treated dormant sweet cherry (Prunus avium L.) flower buds with hydrogen cyanamide, resulting in advanced endodormancy release. We further analyzed the broad spectrum of hydrogen cyanamide-induced expression changes using RNA sequencing and the levels of a range of phytohormones using metabolite profiling. Taken together, these results strongly support an activation of three main pathways as a result of hydrogen cyanamide treatment: the jasmonate pathway, the hydrogen cyanide pathway and the cytokinin pathway. We further analyzed the levels of cyanogenic glucosides and their derivatives during endodormancy and its release in sweet cherry and almond (Prunus dulcis (Mill.) D. A. Webb). Prunasin and its amide coincided with flowering time in both species.

Taken together, these results contribute to elucidating parts of the complex network regulating flowering time in perennial plants.
PHD GRADUATE FROM FACULTY OF SCIENCE

Petros Georgiadis
Willow and Poplar for Bioenergy on Former Cropland

Supervisor(s):
Professor Karsten Raulund-Rasmussen

Department:
Geosciences and Natural Resource Management

Date of defense: 21 April 2017
Date of awarded PhD degree: 27 April 2017

Summary:
Dedicated energy crops, such as short rotation woody crops (SRWC), are promising bioenergy feedstock in southern Scandinavia.
The objective of this thesis was to assess biomass production of SRWC established on former cropland, and identify their effects on soil, water and nutrients the first two decades after establishment. Two fertilization trials were established on nutrient-rich soils; one in short rotation coppice (SRC) willow and one in short rotation forest (SRF) poplar, that provided results on biomass production, water fluxes, and nutrient leaching and budgets under different fertilization regimes, and allowed comparisons between the two cropping systems. A soil survey was also conducted in SRC willow and SRF poplar, to assess the accumulation of soil organic carbon (SOC) and changes in soil properties after conversion. The results indicated that the potential for biomass production in unfertilized SRC willow has a greater biomass production potential during the first decade, but the overall production was substantially higher in SRF poplar over two decades. Annual fertilization with 60 kg N ha-1 yr-1 in SRC willow increased biomass production by 33%. The biomass production was then comparable to unfertilized SRF poplar over two decades. Fertilization of the SRF poplar had inconsistent effects on biomass production. High evapotranspiration rates were found in both SRC willow and SRF poplar, and low deep percolation. Low N concentrations in the soil solution led to low N leaching. Excessive N leaching was observed when SRC was fertilized with 240 or 360 kg N ha-1 per rotation. Comparison of adjacent cropland and SRWC stands indicated that SOC contents increase in the former plough layer after conversion of cropland to SRWC, with no difference found between SRC willow and SRF poplar. The results from the trial in SRC willow further indicated that on nutrient-rich soils, already high biomass production can be further increased with suitable fertilization regimes, and low leaching rates and soil nutrient stocks can remain balanced between inputs and outputs. Further research is recommended, for improving the fertilization regimes in SRF poplar plantations.
To evade recognition and to increase their virulence, pathogens deploy effectors into host cells to modify or remove host proteins. Plants can detect these effector mediated changes via Resistance proteins (NLRs). A model thus proposes that NLRs ‘guard’ host ‘guardees’. A corollary to this model is that forms of plant autoimmunity are due to inappropriate NLR activation. We show here that NLR triggered immunity in pat1 can be prevented by the expression of a dominant negative (DN) allele of the NLR SUMM2. We further find that this DN approach is faster than crossing in knock-outs, and has the advantage of ‘poisoning’ redundant genes in cases of NLR homo- and hetero-dimerization. To exploit this, we did a large-scale screen for suppressors of autoimmunity in Arabidopsis and found that camta3 autoimmunity is suppressed by the expression of DN versions of two different NLRs, Dominant Suppressor of CAMTA3 (DSC) 1 & 2. EDS1 levels are elevated in camta3 and CAMTA3 was claimed to negatively regulate immunity through transcriptional regulation of EDS1. In contrast, recent studies provide evidence for CAMTA3 being involved in positive regulation of an early stress response. We report here that EDS1 mRNA levels are no longer elevated in camta3 expressing DSC1-DN or DSC2-DN. This indicates that the camta3 autoimmune phenotype is likely due to inappropriate activation of the NLRs. Interestingly, we found that dsc1 or dsc2 null mutants do not suppress camta3, but camta3/dsc1/dsc2 triple mutants no longer exhibit autoimmunity. We furthermore provided evidence showing that DSC1 interacts with both CAMTA3 and DSC2 suggesting a degree of cooperation between the two NLRs in guarding of CAMTA3. Taken together our data indicate that the increased levels of immune-related transcripts in camta3 are due to NLR activation and not to the loss of CAMTA3 as a transcriptional repressor of immunity.
PHD GRADUATE FROM FACULTY OF SCIENCE

Stine Tetzchner Olsen
From Molecular Electronics to Solar Thermal Energy Storage

Supervisor(s):
Professor Kurt V. Mikkelsen

Department:
Chemistry

Date of defense: 21 April 2017
Date of awarded PhD degree: 27 April 2017

Summary:
The Sun's significant resource potential provides a solution for the world's increasing energy demand in a sustainable and responsible manner. However, the intrinsic property of the on-off cycles of the solar irradiation, i.e. day-night, sunny-cloudy, and summer-winter, constitutes a significant challenge for the utilization of solar energy. An effective technology for storing the solar energy is required. This thesis focuses on solar thermal energy storage in molecules, since it offers a very compact and effective storage method. The first chapter after the introduction of the thesis, chapter two, introduces the fundamental properties of the molecule, i.e. the electronic behaviour of the molecule in different environments, which is a key property for investigations of solar energy storage. The main focus of the research is on the electron transport in the Coulomb blockade regime. The third chapter goes into the challenge of storing solar thermal energy. A theoretical model describing both the macroscopic and the microscopic parameters of a hybrid solar thermal system consisting of a solar water heating system and a molecular solar thermal system (MOST) for energy storage is presented. The model elucidates how much stored energy different types of molecular classes can be expected to produce in a realistic system set-up. The photochromic system of dihydroazulene (DHA)/vinyleptafulvene (VHF) is of particular interest. The DHA/VHF system is found to be a very promising molecular system for solar thermal energy storage, already in its parent form. DHA absorbs near solar flux, the spectra of the two photoisomers do not overlap significantly, and the photoreaction occurs with high quantum yield. By careful chemical design, the properties of the DHA/VHF system can be tuned to be more favourable with respect to thermal energy storage. E.g. the inclusion of different substituents to the various positions of DHA/VHF is found to increase the storage capacity of the system, combining two photoswitches into one new multimode photoswitch enables stepwise energy release, and finally the possibility of controlling/triggering the photoswitch with the use of an applied voltage, when light is absent. Thus enabling the control of the thermal energy release. This thesis elucidates the great potential of solar thermal energy storage in molecules by careful chemical design of the photochromic system.

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Joanito Liberti
Molecular and Phenotypic Adaptation in Social Insect Reproductive Fluids

Supervisor(s):
Professor Jacobus J. Boomsma
Boris Baer

Department:
Biology

Date of defense: 24 April 2017
Date of awarded PhD degree: 28 April 2017

Summary:
The fluids produced by animal reproductive tracts are composed of a great variety of molecules whose effects expand well beyond the mere assistance of sperm in their voyage to fertilize eggs. In this PhD thesis I present four studies to analyse such effects in evolutionarily derived lineages of ants and bees where queens always mate with multiple males, either on a single day or, very rarely, on a few consecutive days, but never again after they have started to lay eggs.

The ability of sperm to move in a fluid environment is of key importance directly after insemination, when the ejaculates of multiple males compete for access to the sperm storage organ of a queen. I show that queen reproductive tract secretions of Acromyrmex echinatior leaf-cutting ants activate and enhance sperm motility but without discriminating between the spermatozoa of different males. In a parallel study, I show that upon mixing of ejaculates of different males in vitro, sperm become activated and swim faster when encountering seminal fluid secretions of rival males. This implies that ant sperm has evolved a self–non-self-recognition mechanism to modulate motility to improve the likelihood of storage in situations of sperm competition.

The seminal fluid of ants and bees with multiply mated queens are known to have evolved proteins that are able to kill the sperm of rival males, but the identity of the proteins involved has remained poorly understood. I sequenced the seminal fluid proteomes of four fungus-growing ant species that span the evolutionary transition from single to multiple queen-mating in the fungus-growing ant phylogeny. I then reconstructed the evolutionary histories of these proteins and identified a number of their functions related to energy production, control of oxidative stress, and proteolysis that may be important in the regulation of sperm competition.

Queens of honeybees undergo a series of physiological and behavioural changes after mating but it is not known whether any of these changes are under control of males (drones) whose reproductive interests would be reduced when their queen mate embarks on a second mating flight the next day. I experimentally show that visual perception is rapidly reduced when virgin queens receive male seminal fluid by artificial insemination. This effect is consistent with males having seminal fluid compounds that discourage queens to pursue an additional mating flight even if they would not have stored enough sperm to maximize their reproductive success.
PHD GRADUATE FROM FACULTY OF SCIENCE

Orjon Xhoxhi
Trading Relationship Performance and Market Power in Food Supply Chains

Supervisor(s):
Associate Professor Søren M. Pedersen

Department:
Food and Resource Economics

Date of defense: 15 March 2017
Date of awarded PhD degree: 28 April 2017

Summary:
The development of the agri-food industry has led to a considerable increase of intermediaries’ market power vis-à-vis farmers. There are studies and evidence that suggests that due to their power, intermediaries transfer risks and unexpected costs to farmers which compromise the innovation, modernization and restructuring of the farming sector into more efficient forms. When considering that 70% of the worlds’ poor who live in rural areas have farming business as main source of income, it becomes crucial to understand the intermediaries’ power over farmers and its impacts upon farmers’ business and livelihood.

The overall objective of this PhD study was to investigate the intermediaries’ power over farmers and its effects on trading relationship performance between them. Two farms survey were conducted, the first one was carried out in the Adana region in Turkey and had an explorative focus aiming to understand how intermediaries’ exercised their power over farmers and its determinants (Paper 1 and paper 2). The second farm survey was conducted in the region of Korça in Albania, the goal here was to: validate the measures of intermediaries’ power over farmers developed from the first study (paper 2), investigate how intermediaries’ power affects farmers-intermediaries trading relationship performance (paper 3) and analyse the determinants of contract farming and its effects on post-harvest losses (paper 4).

Intermediaries and farmers need to understand that nowadays relationship are a source of competitive advantage and only by building good relationship between them, they can achieve above average profits. Therefore, the study suggests that social innovation in farmers’ intermediaries trading relationships in developing in particular is necessary is a must. Furthermore, policy maker and firm managers (e.g. exporters, processors) could reduce post-harvest losses through contract farming but only if they provide the necessary services and timely market access for farmers.
PHD GRADUATE FROM FACULTY OF SCIENCE

Tomasz Prytula
Hyperbolic Isometries of Systolic Complexes

Supervisor(s):
Professor Jesper Michael Møller
Damian Osajda

Department:
Mathematical Sciences

Date of defense: 25 April 2017
Date of awarded PhD degree: 28 April 2017

Summary:
The notion of curvature is one of the fundamental concepts in geometry. Intuitively, the curvature describes how a given surface bends when we look at it from the point of view of an observer standing on the surface. For example, a sphere has positive curvature as it bends the same way in every direction, and the Euclidean plane has curvature equal to 0 because it does not bend at all - it is flat.

The most interesting are the surfaces (and other geometric objects), that have nonpositive curvature. These are harder to picture, as they cannot be embedded into our 3-dimensional Euclidean world (intuitively, at every point they bend in the two opposite directions). But this also permits them to have a more interesting geometric structure; in general nonpositively curved spaces have many more symmetries than the positively curved ones.

In my thesis I study symmetries of the combinatorial analogues of spaces of nonpositive curvature - the systolic complexes. I am interested in symmetries that can be iterated an infinite number of times and never become trivial. These are called ‘hyperbolic isometries’. For example, a translation along some line is a hyperbolic isometry of the Euclidean plane.

In my work I adapt techniques from the classical setting of nonpositive curvature to the combinatorial one, and use these techniques to see how the hyperbolic isometries of systolic complexes may look like. After obtaining some knowledge about individual isometries, I look at all of them together and try to see how they interact with each other. All isometries of a given systolic complex form an algebraic object called a group.

Most of the results of my thesis describe how various algebraic properties of groups of isometries of systolic complexes are reflected in geometry of these complexes. For example, one of the theorems asserts that for such a group of isometries, a certain algebraic dimension is always bounded by the dimension of a systolic complex.

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Anne B. Stephansen
Photoinduced Dynamics of Neutral, Cationic, and Anionic Species: Time-resolved Photoionization and Photodetachment Investigations

Summary:
In contrast to ground state thermal chemistry, where internal energy is distributed throughout molecules in a statistical manner, photo-activation of a reaction entails initial localization of internal energy in a highly non-statistical manner. The results is often reaction rates faster than what statistical models predict, and a stronger interplay between molecular structure and (photo)-reactivity. This thesis explores photoinduced processes of various types in neutral, anionic, and cationic molecules.

Intersystem crossing (ISC) in neutral organic species is usually assumed to be slow due to its spin-forbidden nature. This assumption has been challenged during the past decade by several observations of ultrafast ISC in organic molecules. In this thesis, the photoinduced properties of three different classes of organic compounds are studied and compared to discuss whether the current description of ISC is adequate.

Nucleobase anions are posited to be involved in DNA damage, where the molecular dipole moment of a nucleobase acts as electron-antenna and gateway for the electron to access DNA. The abilities of adenine, thymine, and uracil to capture photo-transferred electrons are studied in this thesis. Non-statistical conformational dynamics of the nucleobase anions is found to prolong the anion lifetimes, which could be implicated in the DNA damage process.

The study of cation dynamics aims at understanding peculiar isotope effects in the photo-decomposition of haloalkanes. Photoionization activates strongly non-statistical dynamics that allows for investigation of correlations between molecular conformation and the isotope effect. While being preliminary, the investigation indicates that this novel way of exploring isotope effects can reveal new (dynamical) insight into isotope effects.

Common for all reactions discussed in this thesis is that the early dynamics initiated upon photon absorption have large impact on the evolution of the reaction.
PHD GRADUATE FROM FACULTY OF SCIENCE

Martin Kühnel

Graphene Derivatives as Electrode Material - From Macroscopic to Microscopic Applications

Supervisor(s):
Associate Professor Kasper Nørgaard
Professor Bo Wegge Laursen

Department:
Chemistry

Date of defense: 28 April 2017
Date of awarded PhD degree: 4 May 2017

Summary:
The performance of electronic devices has in the last decades undergone a rapid development. However, this development has started to saturated and new technologies and materials are needed to maintain the current pace of development. One material that has attracted a lot of attention since its discovery in 2004 is graphene. Graphene is a monoatomic thick 2-dimensional sheet of carbon atoms, with many exciting properties, amongst others extremely high conductivity, flexibility and transparency.

This thesis has focused on the development of graphene materials for use in various applications. One project focused on the development of graphene-based inks for large-scale printing of flexible and transparent electrodes. For optimization of the graphene electrodes, a detailed study of the electron behavior in the graphene electrodes was performed.

The second part of my thesis regarded molecular electronics, specifically the production of solid-state molecular electronic devices where graphene was utilized as electrode material in three different ways; i) as protective interlayers in molecular devices, ii) as high-quality electrode material at sub-Kelvin temperatures for solid-state molecular electronics, iii) as electrode on molecular vertical field-effect tunneling transistors.
Nikitha Susan Saji

Accretion and Early Evolution of Earth: Insights from Nd-isotope Systematics of Meteorites and Archean Terrestrial Rocks

Supervisor(s):
Professor Martin Bizzarro

Department:
Natural History Museum of Denmark

Date of defense: 27 April 2017
Date of awarded PhD degree: 4 May 2017

Summary:
Planetary systems like our own solar system form from the gravitational collapse of dense cores of gas and dust in interstellar molecular clouds. Following the formation of the central star, in our case - the Sun, the rest of the core material gradually coalesce to form planets like Earth in a rotating proto-planetary disk. Our understanding of the assembly of planetary bodies in the solar system comes primarily from the debris of planet formation delivered to us in the form of meteorites. Evidence for the variety of stellar sources that originally contributed material to the solar system and the ensuing proto-planetary disk processes that finally resulted in the assembly of planets is preserved in meteorites and their components in the form of isotopic signatures. Deciphering this information, which is generally present in the formation of subtle variations in isotope composition, requires high analytical capabilities. In this thesis, a state-of-the-art technique to measure the Nd-isotope composition of geological materials is developed and is applied to understand the genetic relationship between Earth and various solar system reservoirs in terms of primary of stellar components. It is found that heterogeneous distribution of a multitude of distinct nucleosynthetic components are necessary to explain the range of Nd-isotope compositions observed in bulk solar system reservoirs. Further, the short-lived 146Sm-142Nd chronometer permits one to explore the chemical differentiation processes in planetary bodies in its infancy. By studying the radiogenic 142Nd variations in some of the oldest rocks preserved on Earth, much can be learned about the early state of its crust-mantle system. The high-precision Nd-isotope measurements of Archean terrestrial rocks show that the early chronology of Earth and Moon is intimately related and that Earth probably settled into the dynamic regime it is in today much earlier than otherwise known.
Nina Persson
Identification and Evaluation of Next-generation PTM-specific Antibodies: A Microarray-based Approach

Summary:
Antibodies are one of the body’s own natural defense against disease. When virus, bacteria or parasites are invading the body, the number of antibodies are rapidly rising and binding specific to the invaders and labelling them for the rest of the immune system to take care of. Today it’s possible to generate antibodies specific to predefined structures, e.g. only binding to one specific structure of the protein. This has opened for a new era of therapies were antibodies can be injected directly into patients. As the antibodies are engineered to only bind to the disease associated structures and not intervening with anything else, they will send the right signal to the rest of the immune system that will act and solve the problem.

Over the past 30 years, it has become possible to treat cancer, autoimmune diseases, inflammatory diseases, organ transplantations and infectious diseases, with antibodies. With gained knowledge about the initiation and spreading of various cancer, new targets on the cancer cells have been identified as well as a possibility to produce new antibodies for diagnosis and therapy. The identification of antibodies, only binding to a specific target on the cancer cells, remains a bottleneck in the antibody production. It would be beneficial to exclude non-specific antibodies at an early stage to avoid problems in the downstream evaluation process.

Many proteins in animals are glycoproteins, proteins carrying different carbohydrates structures. These glycoproteins are essential for the optimal function of the protein. In cancer, there is a change in the structure of carbohydrates which effect the function of the glycoprotein. The Tn-antigen is a truncated and early terminated carbohydrate chain correlating with different cancers ability to form metastases and spread.

In this thesis, a new assay for early identification of specific antibodies is described. With this screening assay, a new specific carbohydrate binding antibody, G2-D11, was identified. Specific to the Tn antigen. No reactivity toward other related carbohydrate structures was seen, making it stand out from other antibodies targeting the same structure. New tailor-made antibodies were engineered on the basis of the G2-D11 structure. The specificity changed from only binding to the Tn-antigen to also include the peptide backbone. This illustrates the usefulness of antibody engineering and the strength of our antibody development concept for identification of new carbohydrate binding antibodies.
Asker Daniel Brejnrod
Bioinformatics for Discovery of Microbiome Variation

Supervisor(s):
Professor Søren Johannes Sørensen

Department:
Biology

Date of defense: 5 May 2017
Date of awarded PhD degree: 8 May 2017

Summary:
DNA sequencing have opened up new opportunities to investigate the microbial world. By sequencing full and selected parts of the DNA pool from a variety of samples it is possible to gain a new understanding of both the identity and function of microbes. These tools can be used in many contexts from environmental microbiology, to discovery of clinical relevant associations of microbiome-host interactions. In several parts we leverage existing bioinformatics tools as well as develop new ones to enable novel discoveries of microbial associations. First we benchmark existing statistical tools for microbiome discovery and urge consideration in choosing the best ones. Second we develop a new tool for investigating the functional content of horizontally transferred genetic elements in metagenomic data, then apply it to generate hypothesis about microbial functions that has the dual property of enhancing microbial fitness while being detrimental to the host. Finally, we integrate several types of molecular data and environmental parameters from a long-term copper contaminated site, to investigate the impact of pollution on the microbial lifestyles, a relevant question as many sites has comparable pollution. These contributions can help researchers with general discovery in the microbiome field, and advance our knowledge on soil microbes.
Effects of Wood Ash on Soil Fungi

Supervisor(s):
Associate Professor Rasmus Kjøller
Professor Håkan Wallander

Department:
Biology

Date of defense: 4 May 2017
Date of awarded PhD degree: 11 May 2017

Summary:
Reutilizing biomass ashes has been proposed to counteract soil acidity and to save fertilizer inputs by recycling nutrients such as calcium, magnesium and phosphorus. However, the heavy metal content of biomass ashes, such as cadmium, is a major environmental concern. This work is part of the project ASHBACK (www.ashback.dk) which addresses the potentials and possible problems in re-distributing wood ash.
The aim of this work was to determine the effects of biomass ashes application in agricultural and forest soils focusing on soil microbial communities.
Two study sites were used, one in an agricultural field where different biomass ashes were evaluated as replacements for phosphorus fertilizers, and a second one in a Norway spruce forest where different amounts of wood ash were spread to study the effects on ectomycorrhizal (ECM) fungi, bioaccumulation of metals in fruit bodies, and microbial communities. In addition, laboratory experiments were run to compare the effects of wood ash with lime and cadmium to separate the pH and cadmium effects.
It was found that barley yield, and its nutrient and metal contents were not affected by biomass ashes. In the Norway spruce experiment, ECM fungal growth and activity remained unaffected. Moreover, ECM fungal richness, diversity and community composition did not change with wood ash additions. Fruit bodies collected from wood ash treated plots did not bioaccumulate more heavy metals than control plots. When analysing soil microbial communities, changes only occurred with extremely high wood ash additions. With these extreme treatments bacterial growth increased while fungal growth decreased. Finally, the laboratory experiments revealed that the microbial responses to wood ash were induced by soil pH changes rather than the increase in cadmium.
In conclusion, biomass ashes can replace P fertilizers in agriculture without presenting any harmful effects. Furthermore, wood ash can also be re-distributed to the forest without representing any risks for microbial communities.
PHD GRADUATE FROM FACULTY OF SCIENCE

Casper Skovgaard Andersen
Intense Training as a Means to Improve Running Performance and the Adaptation of Muscle Tissue

Supervisor(s):
Professor Jens Erik Bangsboe
Thue Kvorning

Department:
Nutrition, Exercise and Sports

Date of defense: 26 April 2017
Date of awarded PhD degree: 11 May 2017

Summary:
While a plethora of studies have documented the beneficial effect of intense training on performance, movement economy and muscular adaptations in trained subjects (reviewed in Iaia & Bangsbo 2010; J Bangsbo 2015; Hostrup & Bangsbo 2016), knowledge in certain areas are lacking. Examples of these areas are: how performance develops when intense training is performed for a prolonged period, how performance develops when intense training is performed very frequently, how training in the weeks before an important competition should be structured to gain the most from an intense period of training, and how performance is affected when a period of intense training is repeated. Thus, the overall aim of this PhD project was to investigate the effect of different compositions of intense training on performance, movement economy and muscular adaptations.

The findings from the present PhD study suggest that performing intense training, in the form of speed endurance training (SET), for a relatively short period improves short and long-term performance. Both a prolonged period of SET as well as a period with increased frequency of SET improves short-term performance further, but a prolonged period does not extrapolate to further improved long-term performance not even if SET frequency is doubled. Short-term performance was better after 16 days of reduced training volume (tapering) compared to before the period with increased frequency of SET, which supports the idea of an overload phase combined with a tapering phase to improve short-term performance. 8 days of tapering was sufficient to improve 10-km performance, but since performance was not better compared to before the period of increased frequency of SET, the value of combining an overload phase with tapering to improve 10-km performance is low. In line with the literature on "muscle memory", performing a second intervention of SET and a basic volume of aerobic training might have a greater impact on performance than the initial intervention, while the initial 10-km performance gain is of the same magnitude, if a period of intense training is repeated. Changes in short-term performance were found together with muscular adaptations of importance for the development of fatigue with specific changes in the expression of Na+/K+ pump isoforms and proteins related to Ca2+ re-uptake. The changes in 10-km performance were associated with improved running economy and anaerobic capacity, thereby blueprinting the relevance of intense training.
PHD GRADUATE FROM FACULTY OF SCIENCE

Lisbeth T. Nielsen
Ice Flow Modelling of the Greenland Ice Sheet

Supervisor(s):
Associate Professor Christine S. Hvidberg

Department:
Niels Bohr Institute

Date of defense: 8 May 2017
Date of awarded PhD degree: 11 May 2017

Summary:
Models of ice flow have a range of application in glaciology, including investigating the large-scale response of ice sheets to changes in climate, assimilating data to estimate unknown conditions beneath the ice sheet, and in interpreting proxy records obtained from ice cores, among others. In this PhD project, the use of ice flow models for the interpretation of the age-structure of the Greenland ice sheet, i.e. the depth within the ice, at which ice deposited at given times are found at present day. The structure of these layers is determined by flow conditions and accumulation rates, thus analyzing these archived can improve constrains on past accumulation rates and patterns, an important component of the mass budget of the ice sheet. Two different observational data sets of this archive were investigated, one derived from radio-echo sounding data, covering a large area in central and northern Greenland, the other obtained from a deep ice core in northern Greenland, containing information on past changes in high temporal resolution at this location. Further, paleo simulations of the Greenland ice sheet using ice sheet models offers the possibility of deriving reconstructions of past ice sheet topography, flow and extent, consistent with the dynamics of ice flow and the imposed climate forcing. The large-scale response of the ice sheet modelled by such approaches can potentially be used as input to more detailed analysis of the age-structure.

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Caroline Lindberg
Growth of Ag-seeded III-V Nanowires and TEM Characterization

Supervisor(s):
Professor Jesper Nygård
Assistant Professor Jessica Bolinsson

Department:
Niels Bohr Institute

Date of defense: 10 May 2017
Date of awarded PhD degree: 17 May 2017

Summary:
Nanowires are small cylinders with a diameter of ten to hundreds of nanometers and a length which can extend several micrometers. These nanowires are highly interesting since their small size might give the materials of the nanowire different properties compared to the corresponding bulk material. The nanowires can consist of either a single compound material such as Si or Ge or multiple compound materials such as GaAs, InAs or InGaAs. The most common ways to grow GaAs or InAs nanowires with molecular beam epitaxy is to use Au, Ga or In particles placed on a substrate. At the correct temperature, As flux and Ga or In flux a nanowire will precipitate beneath the particle. In this project we have investigated the possibility to use Ag as seed particle instead of Au.

We have conducted experiments to grow Ag-seeded GaAs nanowires on GaAs substrates and Ag-seeded InAs nanowires on InAs substrates. The particles were formed by the thin film annealing process where a thin Ag film heated on a substrate breaks up into particles. We have varied both the temperature and the atom fluxes to find good growth parameters for nanowires. After growth scanning electron microscopy and transmission electron microscopy have been used to evaluate the growths.

We have succeeded to grow both Ag-seeded GaAs nanowires and Ag-seeded InAs nanowires on respective substrate. For the GaAs nanowires we could grow both pure wurtzite nanowires and pure zinc-blende nanowires depending on the crystal direction of the substrate. The yield of vertical nanowires on GaAs(100) substrates were 45-50%. For the InAs nanowires the growths were more uneven and the samples exhibited both curly, inclined and vertical nanowires. We obtained InAs nanowire growth in the temperature range 370-445°C. At higher temperatures the nanowire growth probably ceased due to an increased evaporation of As in connection to the Ag particles.
PHD GRADUATE FROM FACULTY OF SCIENCE

Mads Lichtenberg
Microscale Canopy Interactions in Aquatic Phototrophs

Supervisor(s):
Professor Michael Kühl

Department:
Biology

Date of defense: 4 May 2017
Date of awarded PhD degree: 17 May 2017

Summary:
Photosynthetic production and light utilization efficiencies in aquatic organisms and microbial communities is determined by the irradiance incident on the system, which on a macroscale is dependent on factors such as, water depth and turbidity. However, on a microscale the light field inside phototrophic tissues and communities is determined by interactions between the incident light and the optical properties of the system, which is influenced by pigmentation, organization of tissue structural components, and the intracellular organisation of phytoelements. Our current understanding of how photosynthesis is influenced by light interactions is largely based on studies of terrestrial plants where canopy interactions have been described across scales; from landscape-level down to the organization of individual chloroplasts. How light interactions and photosynthetic efficiencies are influenced by microstructural heterogeneities in the organization of aquatic tissues and communities is largely unexplored although a few papers have described the importance of community structure on whole-community production. In this thesis, it was the aim to investigate if fundamental links exist between the microscale organization of aquatic photosynthetic tissues and biofilm communities, their optical properties, and photosynthetic efficiencies and to investigate whether canopy-like effects are relevant for the microscale regulation of aquatic phototrophs similar to what is found in terrestrial plants.

This was investigated in a range of aquatic phototrophs such as macroalgae, reef-building corals, and photosynthetic biofilms and it is demonstrated that a microscale stratification of the internal light- and chemical environment exists across the investigated systems, with concomitant internal gradients of photosynthesis and respiration. A comparative analysis between terrestrial and aquatic photosynthetic systems is given and it is discussed if aquatic microscale structure/function relationships can be described conceptually similar to terrestrial canopy interactions.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Adam Lund
Spatio-Temporal Modeling of Neuron Fields

Supervisor(s):
Professor Niels Richard Hansen
Professor Per Ebbe Roland

Department:
Mathematical Sciences

Date of defense: 19 May 2017
Date of awarded PhD degree: 29 May 2017

Summary:
The starting point and focal point for this thesis was stochastic dynamical modelling of neuronal imaging data with the declared objective of drawing inference, within this model framework, in a large-scale (high-dimensional) data setting. Implicitly this objective entails carrying out three separate but closely connected tasks; i) probabilistic modelling, ii) statistical modeling and iii) implementation of an inferential procedure. While i) - iii) are distinct tasks that range over several quite different disciplines, they are joined by the premise that the initial objective can only be achieved if the scale of the data is taken into consideration throughout i) - iii).

The strategy in this project was, relying on a space and time continuous stochastic modelling approach, to obtain a stochastic functional differential equation on a Hilbert space. By decomposing the drift operator of this SFDE such that each component is essentially represented by a smooth function of time and space and expanding these component functions in a tensor product basis we implicitly reduce the number of model parameters. In addition, the component-wise tensor representation induce a corresponding component-wise tensor structure in the resulting statistical model. Especially, the statistical model is design matrix free and facilitates an efficient array arithmetic. Using proximal gradient based algorithms, we combine this computationally attractive statistical framework with non-differentiable regularization to form computationally efficient inferential procedure with minimal memory foot prints. As a result we are able to fit large-scale image data in a mathematically sophisticated dynamical model using a relatively modest amount of computational resources in the process.

The contributions presented in this thesis are computational and methodological. The computational contribution takes the form of solution algorithms aimed at exploiting the array-tensor structure in various inferential settings. The methodological contribution takes the form of a dynamical modelling and inferential frame- work for spatio-temporal array data. This framework was developed with neuron field models in mind but may in turn be applied to other settings conforming to the spatio-temporal array data setup.
PHD GRADUATE FROM FACULTY OF SCIENCE

Anders Jensen
Liquefaction of Biorefinery Lignin for Fuel Production

Supervisor(s):
Professor Claus Felby
Professor John Nielsen

Department:
Geosciences and Natural Resource Management

Date of defense: 15 May 2017
Date of awarded PhD degree: 29 May 2017

Summary:
Lignocellulosic biorefineries can be an important piece of the puzzle in fighting climate change. Present, biorefineries that produce ethanol from lignocellulose are challenged in working on market terms as the two product streams ethanol and lignin are low value products. The aim of this project has been to increase the value of the lignin stream. Recent regulations on shipping exhaust gasses in coastal waters dictate lower sulfur emissions which require ships to use low sulfur fuels for propulsion. This opens or expands a very large market for low sulfur fuels because a shift from traditional sulfur containing bunker fuel is needed. The lignin stream from lignocellulosic biorefineries could provide a source for the production of sulfur free fuels and this is what has been explored and demonstrated in this PhD project.

The chemical reactions taking place in lignin during hydrothermal pretreatment of wheat straw has been investigated by size exclusion chromatography and NMR spectroscopy. It was found that contrary to literature reports on hydrothermal pretreatment of hardwood the lignin in wheat straw depolymerizes. The argument for this depolymerization is that unlike hardwood lignin, grass lignin (e.g. wheat straw) contains tricin that can act as a polymerization inhibitor during pretreatment.

A solvolysis reaction involving ethanol and hydrothermally pretreated wheat straw lignin from the pilot scale biorefinery Inbicon in Denmark was tested at lab scale. Here it was found that in a batch reactor it is possible to produce a biooil from lignin. Yields up to 85 % were achieved at very low lignin loadings (2 g lignin in 100 ml) in ethanol. At higher loadings of 10–40 g lignin in 100 ml ethanol yields between 40 and 20 % were achieved. Further the oil was found to be more deoxygenated at higher loadings. The effect of increased reaction time was found to be beneficial for oil yields but also caused an increase in solvent consumption and so there is a trade-off where a compromise has to be found in the event of an up scaled reaction. The reactions that cause solvent consumption during the process were identified and this knowledge might help to lower solvent consumption in future processing. From these batch reactor results it was found that solvolysis of hydrothermally pretreated lignin in a primary alcohol holds a large potential and two patent applications were filed and two manuscripts for publication of the results were prepared and is presented here.

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Summary:
Malaria caused by Plasmodium falciparum infection has for centuries been a major concern for international public health. The World Health Organization (WHO) estimates that over 212 million cases with more than 429,000 deaths worldwide every year (mainly children). To date, artemisinin isolated from the Chinese medicinal herb, Artemisia annua L. is the best anti-malaria treatment, as it is highly effective against multiple drug-resistant strains of malaria. However, the production of artemisinin in A. annua is limited due to the low yields obtained from the farmed herbs. In the present study, we report the development of a simple, sustainable, and scalable production platform of artemisinin; the in vivo biosynthesis of artemisinin in the moss Physcomitrella patens through engineering of the complete artemisinin biosynthetic pathway into P. patens. The result of this bioengineering suggests P. patens is a promising host for the biotechnological production of high value compound such as artemisinin.
Summary:
Since the discovery of the Ice Ages it has been evident that Earth’s climate is liable to undergo dramatic changes. The previous climatic period known as the Late Pleistocene saw large oscillations in the extent of ice sheets covering the Northern hemisphere. Understanding these oscillations known as Dansgaard-Oeschger (DO)-events would add to our knowledge of the climatic system and – hopefully – enable better forecasts. Likewise, to forecast possible future sea level rise it is crucial to correctly model the large ice sheets on Greenland and Antarctica.

This project is divided into two parts. The first part concerns time series analysis of ice core data obtained from the Greenland Ice Sheet. We analyze parts of the time series where DO-events occur using the so-called transfer operator and compare the results with time series from a simple model capable of switching by either undergoing a bifurcation or by jumping at random. We find that the DO event time series is most consistent with the model undergoing a random transition.

In the second part, we use a simple model of an ice sheet subject to constant and fluctuating temperatures, respectively. We find that the steady state volume of the ice sheet is lower for fluctuating temperatures than for a constant temperature. This finding may have implications for future long-range ice sheet projections, as the steady state ice sheet volume could be underestimated in studies using a constant temperature.
PHD GRADUATE FROM FACULTY OF SCIENCE

Wenzheng Liu
Interplay of Bacterial Interactions and Spatial Organisation in Multispecies Biofilms

Supervisor(s):
Professor Søren Johannes Sørensen

Department:
Biology

Date of defense: 18 May 2017
Date of awarded PhD degree: 29 May 2017

Summary:
Microorganisms frequently co-exist in matrix-embedded microbial communities with high species diversity in natural environments. Member species usually exhibit non-random spatial organization and occupy their own favorite microenvironment, mainly driven by nutrient availability, microbial physiological properties and interspecies interactions. Individual species residing in multispecies biofilms often receive growth advantages that their single-species biofilm counterparts cannot offer, such as enhanced biomass production, resistance to antimicrobials and capability utilizing complex compounds. Spatial organization of member species is believed to play important roles in shaping the development, structure and function of multispecies communities, leading to the increased growth fitness mentioned above.

By studying a reproducible four-species biofilm, we found that low abundance key species and can significantly impact the spatial organisation of other member species (e.g. leading to species intermixing) and hereby have a positive effect on biofilm formation. We also identified that interspecies facilitation, synergistic interaction and competition is simultaneously functioning among all member species using meta-transcriptomics technology, leading to the growth synergy of the community. The findings in the study highlight the importance of investigating spatial organisation of species and elements of complex microbiomes, which will indispensably promote our understanding of species interactions and microbial ecology in combination with meta-omics technologies.
Xiaoyuan Guo
Plant Cell Wall Polysaccharide Analysis During Cell Elongation

Supervisor(s):
Professor Peter Bjarne Ulvskov
Professor William Willats, Assistant Professor Jozef Mravec

Department:
Plant and Environmental Sciences

Date of defense: 17 May 2017
Date of awarded PhD degree: 29 May 2017

Summary:
Plant cell walls are complex structures whose composition and architecture are important to various cellular activities. Plant cell elongation requires a high level of rearrangement of the cell wall polymers to enable cell expansion. However, the cell wall polysaccharides dynamics during plant cell elongation is poorly understood. This PhD project aims to elucidate the cell wall compositional and structural change during cell elongation by using Comprehensive Microarray Polymer Profiling (CoMPP), microscopic techniques and molecular modifications of cell wall polysaccharide.

Developing cotton fibre, pea and Arabidopsis thaliana were selected as research models to investigate different types of cell elongation, developmental elongation and tropism elongation. A set of comprehensive analysis covering 4 cotton species and 11 time points suggests that non-cellulosic polysaccharides contribute to dynamics of primary cell wall during cotton fibre developmental elongation. Extensin arabinosyl side chain length is modified during cotton fibre development and the content of extensins is indicative to fibre quality. In tropism elongation research, we detected content change of β-1, 4-galactan in auxin induced elongation on pea stem and a possible physiological correlation between galactan and extensins. To further characterize the role of β-1,4-galactan in elongation we used Virus-Induced Gene Silencing (VIGS) technology to downregulate the PsGALS2B gene - a pea orthologue of Arabidopsis GT92 galactosyltransferase involved in β-1,4-galactan synthesis. The silenced plants showed severe defects in elongation ubiquitously. Both developmental and tropism elongation research point out that β-1, 4-galactan plays important role in plant cell elongation.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Sascha Müller
Stable Oxygen-18 and Deuterium Isotopes - Applications in a Maritime-temperate Lowland Environment

Supervisor(s):
Professor Peter Engesgaard
Assistant Professor Søren Jessen

Department:
Geoscience and Natural Resource Management

Date of defense: 8 February 2017
Date of awarded PhD degree: 30 May 2017

Summary:
The application of stable Oxygen-18 (18O) and Deuterium (2H) isotopes, as a tracer for fluxes between different compartments of the water cycle was subject of the present PhD-thesis. During a three year period, temporal data from a wide range of water cycle constituents was collected from the Skjern River catchment, Denmark. The presented applications focused on studying the isotopic 'input signal' to the hydrosphere in the form of precipitation, the isotopic 'output signal' with its related dynamic processes at a coastal saltwater-freshwater interface (groundwater isotopes) and the temporal development within a given lowland headwater catchment (stream water isotopes).

Based on our investigations on the precipitation isotopic composition a local meteoric water line (LMWL) was constructed and expressed as: \( \delta^{2}H = 7.4 \delta^{18}O + 5.36\%o \). Moreover, we showed that under maritime temperature climate influence, humidity is the main driver for the temporal and spatial isotopic development and temperature plays only a secondary role.

Based on our investigations at a coastal lagoon aquifer we could improve quantifications of seasonal saltwater-wedge dynamics, based on isotopic tracers combined with salinity. We can link the observed seasonal regression/transgression pattern to the inland recharge cycle, which is expressed in hydraulic head configuration and submarine groundwater discharge rates at the fieldsite. Nonetheless, those observed dynamics could not be simulated due to numerical limitations.

By the use of different transit time estimation methods, comparing isotopic input signal (precipitation) to the isotopic output signal of a catchment (as stream isotopic compositions) mean transit times (MTT) for a headwater catchment were derived. Estimates suggested the stream water to be dominated by water of very young age. Those results are in contrast to earlier age estimations from groundwater samples just beneath the stream. We therefore suggest the conceptualization of the hydrological conditions at this headwater catchment to be revised.
Mongolians is an interesting and characteristic ethnic group of East Asians. Lots of genetic studies have proposed its potential roles in human evolution, including dispersal of East Asians and the peopling of Native Americans. Establishing and expansion of Mongol Empire around one thousand years ago evidently indicates its pivotal roles in the shaping of modern Eurasians, and also mainly contributed to its intricate population demography. Additionally, under nomadic lifestyle, several characteristic traits are prevalence in the population, such as hypertension, BMI/obesity, Type 2 Diabetes (T2D), and so on. Wide application of next generation sequencing (NGS) technologies have made more and more human populations to be decoded, and it is also providing an optimal opportunity to learn this under-explored population.

We first sequenced the genome of a Mongolian male individual and built a reference genome for Mongolians, which is comparable with human genome (hg19/GRCh37). We then sequenced Mongolian population from six representative Mongolian tribes. We presented a referred genetic variation catalogue with high performance for Mongolians, which can be widely applied to the genotype imputation of the associations between genotypes and phenotypes. Using the genomic data, we investigated the population genetic structure and inferred population demography. The results presented the same conclusion that modern Mongolians were derived from multiple ancestors. The further analyses indicated that gene flows frequently occurred among the populations of the north regions of Asia and Europe, including Siberia and North Europe. We additionally integrated the genomic data of Mongolians and other global populations to explore the debate of dispersal of East Asians. The analyses evidently support the model of southward migration. In the final study, we targeted 28 T2D associated variants reported previously and only replicated 11 of them are associated with T2D in Mongolians through association analysis, which confirmed the heterogeneity of T2D in Mongolians.

Assembly of Mongolian genome draft, sequencing of Mongolian population, and building of Mongolian reference panel, are the tastes of learning this interesting ethnic group. It will lay a good foundation for exploring the detailed scenarios of evolution, diversity, adaptation and genetic diseases, not only in Mongolians, but also in Chinese, East Asians and more.
PHD GRADUATE FROM FACULTY OF SCIENCE

José Víctor Moreno Mayar
Ancient and Modern Genomics of the Peopling of the Americas

Supervisor(s):
Professor Eske Willerslev
Anna-Sapfo Malaspinas

Department:
Natural History Museum of Denmark

Date of defense: 8 May 2017
Date of awarded PhD degree: 1 June 2017

Summary:
Genome-wide studies, particularly from ancient samples, have substantially expanded our understanding of human evolutionary history. Although ancient DNA research remains challenging due to contamination and post-mortem DNA damage, technological and methodological improvements have boosted a transition from amplifying and sequencing a handful of short DNA fragments to generating high coverage human genomes of single individuals, to producing hundreds of ancient whole genomes in single studies. Moreover, high-throughput sequencing has made it possible to analyze ancient genetic data with an unprecedented resolution. The first chapter of this thesis presents the implementation and extensive testing of a statistical method for estimating contamination from high-throughput sequencing data based on haploid chromosomes. The two remaining chapters present two applied research projects focused on the peopling of the Americas (early and more recent) from the perspective ancient and modern genomics.

It is now accepted that anatomically modern humans expanded out of Africa and colonized most of the Old World by 30 kya. Subsequently, they crossed Beringia, the land bridge connecting Northeast Asia and Alaska, after the Last Glacial Maximum. However, archaeology, anthropology, linguistics and even genetics have not reached a consensus on key aspects such as the number of migration waves, their origin and their time and routes of entrance. The second and main chapter of this thesis presents the first human genome from Terminal Pleistocene Alaska; the most likely entryway into the New World. The findings based on this genome support a single founding source population for all Native Americans. Moreover, this ancient genome allowed for the re-assessment of the origin of two subsequent migrations that likely gave rise to Na-Dene-speaking and Inuit populations. The last chapter of this work aims at exploring a more recent, trans-Pacific contact between Polynesians and Native Americans. Genotype data from modern-day Rapanui revealed that they carry Native American ancestry, which derives from an admixture event that antedates the presence of Europeans in the region. These findings provide new insights into the initial peopling of the Americas as well as secondary contacts with an unprecedented resolution, which could only be achieved by generating genome-wide data.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Mette Bendixen
Delta Dynamics – Evolution of Sedimentary Coasts in Greenland in a Changing Climate

Supervisor(s):
Associate Professor Aart Kroon
Professor Bo Elberling

Department:
Geosciences and Natural Resource Management

Date of defense: 24 May 2017
Date of awarded PhD degree: 1 June 2017

Summary:
A warming climate affects the entire planet, but the Arctic experience a warming that is faster than elsewhere in the world. This influences several processes affecting the evolution of the Arctic coast, and increasing erosion are detected throughout large parts of these high-latitude coasts. The warming air temperature affects the soil temperature and permafrost thaws and destabilizes the material in the coastal zone. Only limited work has focused on coastal areas in Greenland and the current knowledge on these areas is sparse.

This PhD thesis investigates coastal evolution with a special focus on changes in deltaic environments both in during the Holocene and in a modern changing climate. It is demonstrated how a modern warming climate directly affects delta dynamics, and that Greenlandic deltas are prograding, contrary to the global trend showing eroding Arctic coasts. Moreover, it is revealed that the increasing proglacial freshwater runoff, caused by a lowering of the surface mass balance of the Greenland Ice Sheet is the main determining agent in delta progradation. Finally, it is shown that beach ridges located in deltaic environments constitute a solid base for reconstruction of changes in past sea-level variation in Greenland when using ground-penetrating radar.
Relena Rose Ribbons

Seeing the Forest for the Trees: Tree Species Effects on Soil Microbial Communities and Nutrient Cycling Dynamics

Summary:
Tree species influence soils above and belowground communities through leaf litter and root inputs. Soil microbial communities can directly influence tree growth and development through processes such as decomposition of leaves, and indirectly through chemical transformation of nutrients in soils as an influence of altered C:N ratios due to leaf litter and root inputs. This thesis aims to document some of the mechanisms by which trees influence soil microbial communities and nitrogen cycling processes like gross and net ammonification and nitrification. This thesis also aims to determine the role of site nitrogen status in modulating those tree species effects. The effects of tree species on ammonification and nitrification rates in forest floors and mineral soils were explored, and related to functional genetic markers for ammonia-oxidation by archaea and bacteria (amoA AOA and AOB), bacterial denitrification (nirS and nirK), and the general markers for bacteria (16S) and fungi (ITS). Two paired high-resolution laboratory methods were used to investigate the relationships between trees, soils, and the microbial communities, including molecular techniques such as quantitative polymerase chain reaction (qPCR) to target gene abundances in soils, and 15N pool-dilution experiments to understand how ammonium and nitrate are produced and consumed in soils. Soil samples were collected from two common garden experiments, named EP571 in Canada (Ribbons et al. 2016), and in Denmark, and both 15N and qPCR-based techniques were used to determine tree species effects and attribute N cycling processes to the abundances of functional genes. At EP571, western red cedar (Thuja plicata) forest floor nitrogen transformation rates differed from Douglas-fir (Pseudotsuga menziesii), Sitka spruce (Picea sitchensis), and western hemlock (Tsuga heterophylla), which corresponded with western red cedar having highest abundances of bacterial 16S and amoA AOA genes. Collectively, these stories shed light on the important functional role of soil microbes in forest soil N cycling. This thesis also highlights the use of isotope and microbial techniques for parsing out relationships between site, tree species identity and ecosystem functions, with the largest links observed between gross ammonification and microbial communities.
Bernardette Cichon
Morbidity, Iron Status and Anaemia in Children with Moderate Acute Malnutrition

Supervisor(s):
Professor Henrik Friis
Associate Professor Vibeke Brix Christensen

Department:
Nutrition, Exercise and Sports

Date of defense: 1 June 2017
Date of awarded PhD degree: 7 June 2017

Summary:
In humanitarian emergencies, children with moderate acute malnutrition (MAM) are treated with food supplements, either in the form of corn-soy blends (CSBs) or lipid-based nutrient supplements (LNS), but there is limited evidence about their effectiveness. The Treatfood trial, a 2x2x3 randomised factorial trial carried out in the Province du Passoré in Burkina Faso, had the objective to investigate the effectiveness of CSBs or LNSs (500kcal/day) with either soy isolate or dehulled soy and different quantities of dry skimmed milk (0, 20 or 50% of total protein) on a wide range of outcomes. In this thesis data from the Treatfood trial was used to investigate prevalence of morbidity, inflammation, iron deficiency (ID) and anaemia in children with MAM and to determine the impact of supplements on these outcomes.

1609 6-23 months old children with MAM were enrolled in the trial. More than 80% of children had inflammation, an infection on the day of admission and/or been ill in the two weeks prior to enrolment according to maternal recall. Furthermore, the fact that morbidity data only explained a small amount of variation in acute phase proteins (APPs) and that approximately 47% of asymptomatic children had elevated APPs indicated a presence of subclinical inflammation. The causes and consequences of the latter require further investigation (Paper I). Prevalence of anaemia and elevated serum soluble transferrin receptor (sTfR) was 70% and 83%, respectively. Because the biomarker of iron stores serum ferritin (SF) is affected by inflammation, SF concentrations were adjusted for inflammation using linear regression models (Paper II). Prevalence of low SF adjusted for inflammation (SFAI) at baseline was 38%.

There was an effect of LNS vs CSB on haemoglobin (Hb) (2 g/L, 95% CI: 1; 4), SFAI (4.2 μg/L, 95% CI: 2.9; 5.5), sTfR (-0.9 mg/L, 95% CI: -1.3; -0.6) and C-reactive protein (0.8 mg/L, 0.4; 1.2). There was no impact of CSB vs LNS on malaria. There was no effect of type of soy and milk protein content on Hb, SFAI, sTfR, C-reactive protein and malaria. While LNS lead to better Hb and iron status prevalence of anaemia, low SFAI and elevated sTfR remained high, that is 53%, 29% and 70%, respectively. The higher concentrations of APPs in children who received LNS require further investigation (Paper III).

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ORCI received LNS requirements that is 53%, 29% and 70%, respectively. The higher concentrations of APPs in children who and milk protein content on Hb, SFAI, 0.4; 1.2). There was no impact of CSB vs LNS on malaria. There was no effect of type of soy µg/L, 95% CI: 2.9; 5.5), sTfR (There was an effect of LNS vs CSB on haemoglobin (Hb) (2 g

Prevalence of low SF adjusted for inflammation (SFAI) at baseline was 38%. Because the biomarker of iron stores serum ferritin (SF) anaemia and elevated serum soluble transferrin receptor (sTfR) was 70% and 83%, respectively. Asymptomatic children had elevated APPs indicated a presence of subclinical inflam

Causes and consequences of the latter require further investigation (Paper I). Prevalence of morbidity, iron deficiency (ID) and anaemia in children enrolment ac

In humanitarian emergencies, children with moderate acute malnutrition (MAM) are treated with food supplements, either in the form of corn and to det

The Treatfood trial, 1609 6

Summary: The aim of the present PhD thesis was to examine the role of exercise intensity and β-adrenergic signaling in PGC-1α mediated exercise training-induced adaptations in skeletal muscle. The following hypotheses were addressed: 1) Exercise-induced PGC-1α mRNA responses and intracellular signaling in human skeletal muscle depend on adrenaline levels or metabolic stress. 2) PGC-1α mediated exercise and exercise training-induced adaptive metabolic responses in mouse skeletal muscle depend on exercise intensity. 3) β-adrenergic signaling contributes to exercise training-induced metabolic adaptations in mouse skeletal muscle through PGC-1α. Paper I demonstrated that differences in plasma adrenaline and muscle metabolic stress during exercise do not reinforce exercise-induced PGC-1α mRNA response in human skeletal muscle. In addition, differences in exercise-induced AMPK and p38 signaling were not associated with differences in the PGC-1α mRNA responses in human skeletal muscle. Paper II demonstrated intensity dependent increases in LC3I and LC3II protein in mouse skeletal muscle late in recovery from acute exercise and increased LC3II protein with exercise training independent of exercise intensity and volume in WT mice, and this occurred without changes in oxphos and cyt c protein content. Furthermore, acute exercise and exercise training did not increase LC3I and LC3II protein in PGC-1α KO mice. In addition, exercise-induced mRNA responses of PGC-1α isoforms were intensity dependent. Paper III demonstrated that β-adrenergic signaling is required but not sufficient for exercise-training-induced adaptations in skeletal muscle AKT2 protein, and not involved in exercise training independent of exercise intensity and volume in WT mice, and this occurred without changes in oxphos and cyt c protein content. Furthermore, acute exercise and exercise training did not increase LC3I and LC3II protein in PGC-1α KO mice. In addition, exercise-induced mRNA responses of PGC-1α isoforms were intensity dependent. Paper III demonstrated that β-adrenergic signaling is required but not sufficient for exercise-training-induced adaptations in skeletal muscle AKT2 protein, and not involved in exercise-training adaptations in oxidative and autophagy markers, although acute β-adrenergic stimulation may induce responses. In conclusion, β2-adrenergic signaling mediates exercise-induced PGC-1α mRNA responses with most potent stimulation of the alternative promotor of the PGC-1α gene in mouse skeletal muscle, but neither elevated plasma adrenaline nor metabolic stress augment exercise-induced PGC-1α mRNA response in human skeletal muscle. While β2-adrenergic signaling increases mRNAs of metabolic related proteins in a PGC-1α dependent manner, prolonged β2-adrenergic stimulation may reduce skeletal muscle metabolic capacity when PGC-1α is lacking in skeletal muscles.

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Cecilia Lökvist  
Modeling Spatiotemporal Dynamics of DNA Methylation

**Summary:**
Epigenetics explains how cells with identical genetic material can have different gene expression patterns and thereby varying phenotypes. By the definition used in this thesis, a “mark” is considered to be epigenetic if it affects gene expression, is stable over time and is inherited upon cell division. The patterns of epigenetic marks depend on enzymes that ensure their maintenance and introduction. Using theoretical models, this thesis proposes new mechanisms for how enzymes operate to maintain patterns of epigenetic marks. Through analysis of experimental data this work gives new insight into how epigenetic marks are distributed in the human genome.

In the first part of the thesis we investigate DNA methylation and maintenance of methylation patterns throughout cell division. We argue that collaborative models where CpG sites collaborate reproduce the bistable methylation patterns of CpG islands rather than the standard model where they do not collaborate. Furthermore, to model a CpG island which is typically surrounded by methylated CpG sites, we also need to include collaborative demethylation. To further reproduce the observed inverse relation between the methylation of clusters of CpG sites to the number of CpG sites within the clusters in the human genome, we assume that demethylases and methylases act with different spatial ranges where demethylases and methylases act within shorter and longer ranges, respectively.

We also propose another explanation for the observations on methylation of CpG clusters through the link between DNA methylation and histone modifications. Here we include histones more explicitly in another type of model that speaks out the duality of the two aspects, DNA methylation and histone modifications. Additionally, we investigate the link between nucleosome occupancy and DNA methylation and find nucleosome occupancy to be correlated to gene expression rather than DNA methylation and CpG sites. In the final part we model a pluripotency network and discuss the role of DNA methylation in reprogramming.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Inger H. Winkelmann

Supervisor(s):
Professor Tom Gilbert

Department:
Natural History Museum of Denmark

Date of defense: 2 June 2017
Date of awarded PhD degree: 8 June 2017

Summary:
The studies in this thesis take advantage of recent advances in DNA sequencing technologies to investigate the biology of two highly charismatic marine animal species, which have for different reasons remained poorly described. The first of these species is the giant squid, Architeuthis dux, which has been shrouded in mystery for centuries. The first two chapters of this thesis are devoted to lift part of the mystery, by sequencing entire mitochondrial genomes (Chapter 1) and several thousands of nuclear SNPs (single nucleotide polymorphisms, Chapter 2) from a globally distributed set of giant squid samples. The questions that these studies were designed to address included basic biology, such as the number of extant species, as well as other outstanding questions about migratory behavior and demographic history. The third chapter explores questions about the red lionfish, Pterois volitans, which has in recent years been introduced to the western Atlantic Ocean, resulting in the most devastating marine invasion in recorded history. Previous to this event, there was rather little scientific interest in this tropical fish, and thus the study was designed to shed some light on the biology of the species. Samples from across the invaded and native ranges were collected, and thousands of SNPs sequenced, in order to do this. Questions of interest included, again, such basic things as the number of species, as well as how the invasive populations may have changed in comparison to the native populations in the Indian and Pacific Oceans, and possibly which of the regional populations in the native range were the source of those individual fish, which first found their way to the Atlantic.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Konstantinos Vavitsas
Photosynthetic Production of Diterpenoids in Chloroplasts and Cyanobacteria

Supervisor(s): Professor Poul Erik Jensen

Department: Plant and Environmental Sciences

Date of defense: 7 June 2017
Date of awarded PhD degree: 12 June 2017

Summary:
Terpenoids are one of the largest classes of chemical compounds, some of them with industrial interest as nutraceuticals, biofuels, or chemical feedstocks. Diterpenoids are a large terpenoid subclass, and their chemical structure consists of a core skeleton of 20 carbon atoms. This skeleton can be further modified by cyclizing enzymes, and be decorated by the addition of chemical groups. Even though they are mainly plant-derived compounds, diterpenoid production in photosynthetic organisms is rather unexplored, with a few successful studies reported in the literature. In this thesis, I elaborate on the potential of using plant chloroplasts and cyanobacteria as biosynthetic vessels, with a focus on diterpenoid production, and on the potential direct linking of photosynthesis to drive electron-consuming enzymes, such as the monooxygenases cytochrome P450s. I subsequently present the full localization of a diterpenoid biosynthetic pathway within the Nicotiana benthamiana chloroplast, and the protein modifications required to achieve this goal. Faster-growing and simpler photosynthetic systems, however, have a larger bioproduction potential. Therefore I examine the effects of introducing two heterologous biosynthetic pathways in the cyanobacterium Synechocystis sp. PCC 6803, using targeted metabolite analysis and computational modelling. Finally, I present a novel genetic engineering technique for the moss Physcomitrella patens, where PCR-amplified DNA fragments can be inserted into the organism and be assembled correctly by its native homologous recombination mechanisms. This theoretical and experimental work puts together the existing knowledge on terpenoid production and photosynthetic biotechnology, reveals the existing limitations and potential bottlenecks, and paves the way for future work towards the optimal use of photosynthesis to drive terpenoid production.
Lau Dalby Nielsen

Structures and Interactions of Proteins in the Brain - The Interaction between LRP1 and Aβ & Structure and Self-Assembly of Arc

Supervisor(s):
Associate Professor Kaare Teilum

Department:
Biology

Date of defense: 31 May 2017
Date of awarded PhD degree: 12 June 2017

Summary:
Alzheimer's Disease can be caused by an imbalance in the brain homeostasis of the Amyloid β (Aβ) peptide. It has been hypothesized that impaired clearance of Aβ from the brain to the blood, which can lead to Aβ accumulation in the brain, is major cause of developing sporadic Alzheimer's Disease at old age. The majority of Aβ is cleared from the brain by receptor mediated transport over the blood brain barrier. In this thesis the interaction between one such receptor, the low density lipoprotein receptor related protein 1 (LRP1), and Aβ was investigated. Here in, is reported data that elucidates the molecular mechanism underlying the receptor binding to Aβ, including which amino acid residues in the Aβ peptide that are important for the binding. Which are important findings for understanding fundamental steps in the biology leading to Alzheimer's Disease development. The data presented also indicate that LRP1 not only interacts with the monomer specie of Aβ, but also the toxic oligomer form of Aβ (suspected to be the main driver of Alzheimer's Disease development), and the fibril form known from the Amyloid plaques formed in the brain of patients.

The ability to learn things and form memories is closely linked to synaptic plasticity, which controls how easy neurons can transmit signals between one another. The immediate early gene coding for the Activity-regulated cytoskeleton-associated protein (Arc) is highly involved in the regulation of synaptic plasticity. In this thesis the 3 dimensional structure of one of the domains in Arc has been solved using NMR. Furthermore the binding between Arc and the N-methyl-D-aspartate receptor (NMDAR) intracellular tail was investigated. This interaction may play an important role in regulation of the NMDAR mediated change in synaptic plasticity. Which is a crucial step in processes such as learning and memory formation.
Supervisor(s):
Professor Søren Balling Engelsen
Professor Antonio Randazzo

Department:
Food Science

Date of defense: 8 May 2017
Date of awarded PhD degree: 12 June 2017

Summary:
Metabolomics is the scientific discipline that identifies and quantifies endogenous and exogenous metabolites in different biological samples. Metabolites are highly informative components of a biological system, due to their closeness to the organism’s phenotype. The combined use of NMR spectroscopy and chemometrics techniques, is able to provide the metabolic “fingerprint” of the various samples.
The PhD project focused on the analysis of various samples covering a wide range of fields, namely, food and nutraceutical sciences, cell metabolomics and medicine, using a metabolomics approach. Indeed, the first part of the thesis describes two exploratory studies performed on Algerian extra virgin olive oil and apple juice from ancient Danish apple cultivars. Both studies revealed variety-related peculiarities that would have been hardly detected by means of traditional analysis. The second part of the project includes four metabolomics studies performed on samples of biological origin. In particular, the first study is related to a recent emerging field: cell metabolomics. Indeed, tumour cells were treated with novel anticancer drugs in order to understand their in vitro action. The second and the third studies concern the evaluation of the effects of functional food ingredients, as β-glucans and phytosterols, on in vivo animal models. In particular, β-glucans hypocholesterolemic action was investigated by analysing rat plasma and faecal samples.
This study confirmed the role of barley β-glucans role in increasing faecal bile acids excretion in hypercholesterolemic rats and showed, for the first time, a modulation of the primary and secondary bile acid excretion, depending on the molecular weight of the β-glucans employed. In the other study, the effects of phytosterols on a murine colitis model, was investigated. NMR experiments analysis on the liver metabolome revealed the role of these plant sterols in restoring the homeostatic equilibrium of the living system. Thus, in both cases, the interesting results reported suggest the use of these nutraceutical products for the investigated diseases.
The last study explores the differences in the follicular fluid metabolome of hyper- and normoinsulinemic women affected with Polycystic Ovary Syndrome, providing preliminary but interesting relationships between serum hormones and follicular fluids metabolites.

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Sabrina Stanimirovic
Elucidating the Roles of MAP Kinases in the Moss Physcomitrella Patens

Supervisor(s):
Professor John Mundy

Department:
Biology

Date of defense: 2 June 2017
Date of awarded PhD degree: 12 June 2017

Summary:
The evolutionary transition of plants from aquatic to terrestrial environments resulted in adaptations to cope with various stresses and threats. Plant plasma membrane receptors, recognize extracellular signals and initiate immune and abiotic stress responses. MAP kinase (MPK) cascades transduce signals from such receptors by phosphorylating substrate proteins, which effectuate appropriate responses. By generating deletion lines of MPK genes in the simple, non-vascular moss Physcomitrella patens, I provide interesting evidence that MPKs may be important in the understanding of evolutionary changes of plant immunity required for the conquest of land by plants. I describe the role of MPKs (MPK3, MPK5, RAK1 & double knockout RAK1/RAK2) upon abiotic stress by characterizing the phenotypes and morphological changes there may be during stress treatments. I characterized the mutant phenotypes during treatment with phytohormones and osmotic and light stress. The thesis contains of a general introduction to plant immunity and the role of MPKs in signaling processes related to immunity, abiotic stress, and plant development in both vascular and non-vascular plants. The focus is on abiotic stress and development changes in the MPK mutants. Results are presented in the result part of the thesis, and in a draft manuscript summarizing data on novel rosetta proteins which combine a protein Nα-terminal acetyltransferase (NATD) and a MPK, here we called RAKs (Rosetta-Acetyltransferase-Kinase). The thesis and work on these MPK mutants gives the laboratory a great start on several future publications, since many of the mutant lines have interesting phenotypes with and without exposure to abiotic stresses.
Studies on the Action Potential from a Thermodynamic Perspective

Summary:
Nerve impulse, also called action potential, has mostly been considered as a pure electrical phenomenon. However, changes in dimensions, e.g. thickness and length, and in temperature along with action potentials have been observed, which indicates that the nerve is a thermodynamic system.

The work presented in this thesis focuses on the study of the following features of nerve impulses, and interpretations from a thermodynamic view are provided. (1) Two impulses propagating toward each other are found to penetrate through each other upon collision. The penetration is found in both bundles of axons and nerves with ganglia. (2) Attempts have been made to measure the temperature change associated with an action potential as well as an oscillation reaction (Briggs-Rauscher reaction) that shares the adiabatic feature. It turns out that some practical issues need to be solved for the temperature measurement of the nerve impulses, while the measured temperature change during the oscillation reaction suggests that there is a reversible adiabatic process and a dissipative process. (3) Local anesthetic effect on nerves is studied. Local anesthetic lidocaine causes a significant stimulus threshold shift of the action potential, and a slight decrease in the conduction velocity. (4) The conduction velocity of nerve impulses as a function of the diameter of the nerve is investigated with stretched ventral cords from earthworms. The velocity is found to be constant with a decrease of the diameter, indicating that the conduction velocity is independent of the diameter of the nerve. All the above results can be explained by a thermodynamic theory for nerve impulses, i.e. the Soliton theory, which considers the nerve impulses as electromechanical solitons traveling without dissipation.

Finally, the magnetic field generated by a nerve impulse is measured with a sensitive atomic magnetometer developed by our collaborators from the Quantum Optics (QUANTOP) group in our institute. The magnetometer can be operated at room or body temperatures, and magnetic field from nerve impulses can be measured several millimeters away. This provides a promising technique for medical applications.
PHD GRADUATE FROM FACULTY OF SCIENCE

Jacob Vorup
Health and Physiological Adaptations of Small-Sided Ball Games in Untrained Older Adults Aged 65-93 Years

Supervisor(s):
Professor Jens Bangsbo

Department:
Nutrition, Exercise and Sports

Date of defense: 6 June 2017
Date of awarded PhD degree: 14 June 2017

Summary:
Aging is associated with a physiological decline that contributes to loss of physical function and increased risk of adverse cardiovascular events and development of type 2 diabetes. The vast majority of research has focused on traditional exercise activities such as brisk walking, cycling or resistance training in the prevention of this physiological decline with age. However, untrained elderly may be reluctant to participate in multiple training sessions a week, and may also be unwilling to take part in intense exercise due to motivational reasons. Thus, efficient and motivating exercise activities that can promote physiological function and health in elderly are needed.

The aim of the present thesis was to examine the use of small-sided ball games as a health promoting activity in untrained older adults aged 65-93 years. Three 12-week randomized controlled training studies examining the effect of small-sided ball game training on physical function, body composition, aerobic capacity, blood lipids and insulin resistance as well as markers of systemic inflammation in untrained older adults were conducted.

The small-sided ball game training resulted in a number of adaptations important for health, including improved physical function, reduced heart rate at rest and during submaximal exercise, a drop in body fat, and reductions in LDL cholesterol, triglycerides and insulin resistance. Furthermore, it was demonstrated that regular participation in small-sided ball games does not compromise daily physical activities in older untrained adults. Importantly, small-sided ball games was shown to be a motivating, safe and enjoyable exercise activity with a high degree of social connectedness that easily can be implemented in untrained older adults.

In conclusion, small-sided ball games of 16-24 min twice a week led to a number of physiological adaptations important for health and physical function in untrained older adults aged 65-93 years. These adaptations may reduce the risk for developing age-associated chronic diseases. Thus, small-sided ball game training appears to be recommendable as a health-promoting activity in untrained older adults aged 65-93 years.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Henriette Lyng Røder

Co-existence in Multispecies Biofilm Communities

Supervisor(s):
Associate Professor Mette Burmølle
Professor Søren Johannes Sørensen

Department:
Biology

Date of defense: 17 June 2017
Date of awarded PhD degree: 19 June 2017

Summary:
Bacteria predominantly live in biofilm, where they are organized in a matrix which enables them to adhere to each other as well as surfaces. Bacteria in biofilm have been found to display increased tolerance e.g. towards antibiotics and dehydration. Biofilms will often consist of several distinct species, which enhance the complexity of the bacterial interactions and lead to emergent properties that cannot be anticipated solely from single species studies.

The aim of this thesis was to unravel how species interact and how this affects the diversification of communities, especially focusing on multispecies biofilm. My studies show that bacteria are indeed shaped by their neighboring species and can obtain increased protection by living in a multispecies biofilm, as other members may offer protection. It was uncovered that bacterial long-term co-existence, leads to enhanced biomass production in multispecies biofilm. This was tested across a range of different environments and the finding demonstrates that the biofilm lifestyle can lead to increased fitness for the bacteria.

Furthermore, it was also tested how species affected the diversification of coexisting species by following them over time. It was found that one species promoted specific adaptations in the coexisting species, resulting in a morphologically distinct variant. Interestingly, this new variant was able to benefit both species, showing that bacteria can indeed shape each other's adaptation.

These results highlight the importance of evaluating community interactions when we study bacteria and when we try to understand bacterial adaptations.
PHD GRADUATE FROM FACULTY OF SCIENCE

Annemarie Lundsgaard Bahnsen
Dietary Fat - Insulin Sensitivity and Molecular Substrate Metabolism

Supervisor(s):
Professor Bente Kiens

Department:
Nutrition, Exercise and Sports

Date of defense: 16 June 2017
Date of awarded PhD degree: 20 June 2017

Summary:
The effect of increased dietary fat content on insulin sensitivity and molecular metabolism was investigated both during energy excess and under weight maintaining conditions in healthy and non-obese men. In study I, it was demonstrated that three days’ intake of a diet with 78 E% unsaturated fat, coupled with 75% energy excess, reduced insulin sensitivity. In muscle, the content of sn-1,3 DAG was increased, but while insulin signaling was intact, the accumulation of this DAG isomer did not seem to be involved in the insulin resistance. Rather, FA oxidation was increased, mediated by decreased PDH-E1α protein content and increased inhibitory PDH-E1α Ser300 phosphorylation, which point a link between between PDH-mediated pyruvate conversion to acetyl-CoA and insulin-stimulated glucose disposal in muscle.

In study II, the effect of six weeks’ intake of 64 E% high-fat diets enriched in either polyunsaturated or saturated fat were investigated under eucaloric conditions. After both diets, the capacity for FA uptake into muscle was increased, via an increased content of lipid binding proteins. The FA oxidation was increased, and as in study I, PDH-E1α Ser300 phosphorylation was increased after both interventions. Plasma concentration of the ketone body 3-hydroxybutyrate was increased after both PUFA and SFA, indicating an increased hepatic beta-oxidation, and from a lower occurrence of C16:1n-7 in plasma, hepatic de novo lipogenesis was downregulated. Together, these adaptations enabled the handling of the high dietary fat load without detrimental metabolic effects, and insulin sensitivity was unchanged after both the PUFA and SFA intervention.

After both hypercaloric and eucaloric high fat intake, basal hepatic glucose production was decreased, and post-absorptive plasma TG concentration was markedly reduced, together with other indices that hepatic metabolism was actually changed in a non-diabetic direction. In study II, mice were fed the human PUFA and SFA diets under eucaloric conditions for six weeks. In the liver of these mice, a marked suppression of proteins involved in gluconeogenesis and de novo lipogenesis confirmed the human observations.

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João Miguel da Silva Martins
Computational Studies of Drug Resistance

Supervisor(s):
Professor Kresten Lindorff-Larsen

Department:
Biology

Date of defense: 21 June 2017
Date of awarded PhD degree: 23 June 2017

Summary:
Drug resistance has been an increasing problem in patient treatment and drug development. Starting in the last century and becoming a major worry in the medical and scientific communities in the early part of the current millennium, major research must be performed to address the issues of viral and bacterial resistance to common-use inhibitors. Understanding the evolutionary pressures by which these arise and predicting future possible resistance mutations is of the utmost importance in developing better and less resistance-inducing drugs. A drug’s influence can be characterized in many different ways, however, and the approaches I take in this work reflect those same different influences. This is what I try to achieve, through seemingly unrelated approaches that come together in the study of drug’s and their influence on proteins and vice-versa. Specifically, I aim to understand through combined theoretical ensemble analysis and free energy calculations the effects mutations have over the binding affinity and function of the M2 proton channel. Parallel to this, this work also focuses on ensembles and prediction of experimental measurements through the use of the rotamer library approach for the calculation of EPR, PRE and FRET data. Through this I have, therefore, increased the knowledge and the breadth of tools available to study drug resistance in a variety of systems, both from an energetic approach to a structural approach.
Andrea Barghetti

Investigating Membrane-Bound Argonaute Functions in Arabidopsis

**Supervisor(s):**
Associate Professor Peter Brodersen

**Department:**
Biology

**Date of defense:** 20 June 2017
**Date of awarded PhD degree:** 23 June 2017

**Summary:**
Investigating the mechanisms that cellular life evolved to regulate gene expression is of fundamental importance for the understanding of how organisms develop and survive in their environment. RNA interference (RNAi) is an important mechanism of gene regulation, present in most eukaryotic organisms, including plants. Argonaute proteins are central components of RNAi. They bind a vast variety of RNA molecules of 20-24 nucleotide length, termed small silencing RNA (sRNA), and by targeting RNA and DNA through sequence complementarity they regulate the expression of a great amount of genes. Argonautes perform some of their important functions in association with endomembranes, but what processes require membrane-bound argonautes as well as what mechanism mediates such association are still largely unknown. In this thesis I describe the work I have done on plant Argonaute proteins to advance our understanding of how they associate with cellular membranes and of which cellular processes are regulated upon such event.

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Courtney Addison
Ethics and Experiment: An Ethnography of Clinical Gene Therapy

Supervisor(s): 
Professor Jesper Lassen  
Professor Peter Sandøe

Department:  
Food and Resource Economics

Date of defense: 9 June 2017  
Date of awarded PhD degree: 23 June 2017

Summary: 
This thesis is an anthropological study of gene therapy. Gene therapy is an experimental medical technique, in which modified DNA is used as a therapeutic for diseases that have a whole or partial genetic cause. Clinical trials of gene therapies are underway in many countries around the world. However, social scientists have yet to devote much attention to this ethically contentious and medically complex field. This project aimed to identify and explore social and ethical factors shaping gene therapy practice in clinical settings. It is based on six months of participant observation in a London children’s hospital (the UKCH), thirty-two interviews with key actors in the gene therapy field, and scientific and policy document analysis. One of the main interests of this research is with the politics of ethics. The thesis shows that ‘ethical boundary work’ was central to establishing the credibility of gene therapy, and the authority of its practitioners. The politics of ethics can also be discerned in practice: the UK research ethics system structures scientific work but cannot account for the various, complex, and on-going ethical dilemmas that patients and practitioners face when undertaking gene therapy. The thesis explores some such dilemmas. It also identifies translation, the process of moving research from pre-clinical phases to clinical trials, as a key challenge for contemporary gene therapy, due to the material, technical, and social changes this shift entails. Translation requires building new relationships between patients, practitioners, regulators, and industry partners, and involves navigating conflicting or unclear expectations. As the first ethnographic exploration of gene therapy, this research contributes a new body of knowledge about the socio-ethical complexities of an under-examined scientific field.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Ebbe Engholm
Development of High Affinity Virus Receptor Ligands by Combinatorial Synthesis and High-Throughput Screening Methods

Supervisor(s):
Professor Klas Ola Blixt
Professor Morten Meldal

Department:
Chemistry

Date of defense: 19 June 2017
Date of awarded PhD degree: 23 June 2017

Summary:
Sialic acid is a very common sugar in the human glycosylation, and it is often presented in large amounts on the surface of the cells. Because of its location, many viruses bind to sialic acid prior to infection, including Influenza A virus (IAV) and Adenovirus 37 (Ad37).

Because of this, sialic acid analogs have a great potential in the treatment of many diseases, and many analogs have been developed, but only very few drugs have entered the market. Most analogs have been developed through specific synthesis towards a certain structure which, based on crystal structures and computer modulations, is believed to bind a certain target well.

In this project, a split and mix synthesis was applied to produce thousands of compounds simultaneously. This One-bead, One-compound library was subjected to an assay where the bead containing structures with a high affinity for IAV or Ad37 turned blue. The material was subsequently cleaved from the resin, and the structure of the hits was identified by mass spectrometry. These hits were then resynthesized, coupled to an array glass slide, and the affinity for the viruses were reevaluated.

Furthermore, 2 methods for the detection of virus-glycan interaction were developed. One consisted of a microarray containing a mix of monovalent and multivalent glycans. The multivalent glycans consisted of mucins with specific glycans attached. The binding of viruses to this array showed an increase in the binding for multivalent glycans compared to monovalent. Furthermore, the neuraminidase enzyme of the IAV, which cleaves off sialic acid, seemed not to be an obstacle for the detection of virus-binding on the multivalent glycans. In the other method, Giant Unilamellar Vesicles (GUVs) coated with Neu5Ac-glycans were used in a novel assay, where clustering of the glycans were observed when adding IAV. The subsequent dissociation of the GUVs proved that this assay could also be used to measure neuraminidase cleaving.

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Jianxiao Song
Effects of Metals on Antibiotic Resistance and Conjugal Plasmid Transfer in Soil Bacterial Communities

Supervisor(s):
Associate Professor Kristian K. Brandt

Department:
Plant and Environmental Sciences

Date of defense: 16 June 2017
Date of awarded PhD degree: 23 June 2017

Summary:
The soil environment has been recognized as an important reservoir of antibiotic resistance determinants. Co-selection for antibiotic resistance by metals via different mechanisms contributes to environmental selection of antibiotic resistance in metal contaminated soils. Conjugal plasmid transfer is generally considered one of the most important co-selection mechanisms since multiple resistance genes can be carried by the same plasmid. Bacterial community permissiveness (i.e. the fraction of a community that can receive self-transmissible conjugal plasmids) is also of crucial importance for bacterial adaptation and evolution in general. This PhD thesis focused on the impact of metals (Cu and Zn) on the development of antibiotic resistance in bacterial communities in soils exposed to different degrees of anthropogenic disturbance ranging from ‘pristine’ permafrost soils to highly contaminated agricultural soils. In addition, the effect of long term Cu contamination on soil bacterial community permissiveness towards conjugal plasmid uptake was investigated. In conclusion, the study demonstrates a potentially important role of metals for environmental selection of antibiotic resistance in soil bacterial communities. Co-selection by metals was observed both in ’pre-antibiotic era’-like bacterial communities and in corresponding communities from agricultural soils. Long term adaptation to metal stress did not significantly increase the permissiveness of the soil bacterial community towards conjugal plasmid transfer.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Maj-Britt Nordfang
Preferences, Behaviour and the Design of Financial Contracts

Supervisor(s):
Professor Mogens Steffensen

Department:
Mathematical Sciences

Date of defense: 14 June 2017
Date of awarded PhD degree: 23 June 2017

Summary:
Today's insurance and financial markets are characterized by and ever increasing complexity and product choice. How do we assist individual household consumers in making informed choices about their financial positions in these markets? This thesis consists of five separate research papers that are all in some way concerned with the design or regulation of financial contracts in relation to consumer preferences under uncertainty. First, the design of mortgage products in relation to consumer preferences in a market with a stochastic interest rate is examined. We derive the (extreme) characteristics of an investor who optimally chooses either a fixed rate mortgage or an adjustable rate mortgage. We also show how adjustable rate mortgages by construction have a build-in cap on the adjustable rate in contrast to what could be perceived from standard financial advice. Next, optimal investments of an investor with time-inconsistent preferences in a Black-Scholes market is explored. We derive the optimal investment strategy of an investor with a scaled mean-variance objective and derive an approximation to the optimal investment strategy of an investor who continuously measures utility with respects to an updated wealth-dependent reference point. Finally, the implications of a ban on risk-classification in an insurance market with a low-risk and high-risk customer groups with homogeneous utility preferences is examined and discussed. We illustrate how solidarity in premiums between the low- and a high-risk group of insurance customers may lower the premiums of the high-risk customers without affecting the premium level of the low-risk customers when a solvency capital requirement is imposed. The papers highlight how the risk preferences of individual consumers relate to the design of financial contracts and the regulation thereof. It is our intention that the insights gained in the thesis contributes to a better understanding of the complex financial decisions faced by individual consumers today.

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A 'Foodomic' Approach for the Evaluation of Food Quality and its Impact on the Human Metabolome

Supervisor(s):
Professor Søren Balling Engelsen
Associate Professor Francesco Capozzi

Department:
Food Science

Date of defense: 26 May 2017
Date of awarded PhD degree: 26 June 2017

Summary:
In recent years, omic sciences have been increasingly employed in many research fields thanks to their high-throughput capabilities and holistic approach. Among the omics sciences, metabolomics and foodomics have recently emerged for the investigation of food and nutrition and their relation to the individual health and wellness status. The analytical platforms used are ideal for non-targeted analysis, due to their capability of detecting and identifying a large set of variables (or metabolites) in complex biological samples. The most employed metabolomics techniques are mass spectrometry and nuclear magnetic resonance spectroscopy, empowered by the advent and advancement of multivariate data analysis.

This thesis outlines the analytical pipeline of the foodomic approach and highlights the current challenges in the field, tracing the path of modern foodomics from the definition and description of food quality to the profiling of the human metabolome, and the investigation of the impact of food on human health, the prevention of diseases and the identification of biomarkers of health status.

The impact of factors such as genetic modification or farming method was investigated in plant-based foods. And the effect of the food matrix and digestion on the stability and bioaccessibility of specific molecules was assessed.

The animal metabolome was also studied, for example investigating the effect of antibiotic treatment on necrotizing enterocolitis as a model for the treatment of this condition in human newborns, too.

The human metabolome (plasma, serum, urine) was then explored, firstly to develop specific algorithms for the search of dietary biomarkers in observational studies. Moreover, food intake biomarkers have been discovered in an intervention study (i.e. galactose for milk intake) and will be further investigated. Research was also carried out to investigate on specific disease-related biomarkers and to discover possible trajectories from a disease state to a healthier condition.
Bird migration is the seasonal movements between geographically discrete areas. The areas are often far apart and the routes or directions to reach the areas are often fixed. More than 2.1 billion birds migrate from the breeding area in Europe to their over-wintering grounds in sub-Saharan Africa every year. In recent decades these migrants have been declining causing concern for their persistence. In this thesis I investigated the link between timing of arrival to the breeding area and the survival. I identified important areas during migration and wintering. Lastly, I investigated if the same habitat is used in breeding and winter, if space and habitat use differed between species and how the species responds to farmland activities in their winter habitat. I found survival differences between long- and short-distance migrants. Long-distance migrants arriving early had low survival compared to those arriving at intermediate dates. In contrast, short-distance migrants which arrived earliest had the highest survival compared to those that arrived later. Additionally long-distance migrant males generally arrived before it was optimal for their survival, while females arrived at optimal times. In the species I tracked from Denmark, I found all individuals used a south-west route through Spain and along the Atlantic coast before they diverged in their route and terminated migration in the savanna zone of West Africa. More than 3000 km separated the eastern and western-most birds, suggesting low connectivity. Not all species used same habitat in winter as during breeding and some of the migrants changed from being territorial during breeding to being non-territorial in winter. There was a difference in the responses to farmland activities between species: providing better habitat for some species but worse for others. Overall, the findings in this thesis indicate that the competition for early spring arrival in long-distance migrants have survival consequences, which may influence their potential to adapt to climatic changes. While migratory routes can be highly conserved within a species, individuals can show large variation in wintering sites. Generally there seems to be larger variation between species with regards to niche-tracking than previously thought, which is also true with respect to their response to human induced changes to the landscape, indicating differences in vulnerability to land cover changes. These findings add to our knowledge of migrant bird research and are of importance to improve the conservation of long-distance migrants wintering in sub-Saharan Africa.
Summary:

The fast and non-destructive nature of infrared spectroscopy makes it a very useful technology for measurements of the chemical composition of complex food products.

The supercontinuum laser is a new light source that combines the collimated beam of a laser with the broad range of wavelengths of a lamp. The supercontinuum laser is therefore different from the traditional lamps used for infrared spectroscopy because of its strong and spatially coherent beam. This work set out to find possible food applications that would benefit from such a light source.

In this thesis work the advantages of the supercontinuum laser compared to a traditional infrared lamp were investigated in two cases: (1) to use the power of the supercontinuum laser to measure β-glucan through intact single barley seeds at the previously inaccessible long wavelength near infrared region. (2) to use the supercontinuum laser in combination with a 10.6 km long dispersive fiber to produce a new type of solid state all fiber spectrometer. The functionality of the new spectrometer was demonstrated in two simple food model systems: sugar in water and melamine in milk powder. In the future more studies and some instrument optimization are required in order to evaluate the potential of this instrument in food applications.

The chemical information retrieved from infrared spectroscopy can sometimes be difficult to interpret. An additional goal was therefore to increase the spectral interpretation by correlating different infrared information. Therefore this thesis work included 2D NIR IR spectroscopy to the bread staling (hardening) process which is one of the major sources of food waste. Using this type of correlation spectroscopy in combination with deuterium experiments significantly increased the interpretation of the spectral changes during staling.
In this thesis work the advantages of the supercontinuum laser compared to a traditional infrared lamp were investigated in two cases: (1) to use the power of the supercontinuum laser to measure the previously inaccessible long wavelength near infrared region. (2) to use the strong and spatially coherent beam. This work set out to find applications that would benefit from such a light source.

The supercontinuum laser is therefore different from the traditional lamps by correlating different infrared measurements with a mean concentration, and soil types. In particular, longer history of GVP along with fertilization and availability have taken place in major Chinese GVP soils impairing the quality of the adjacent freshwaters by eutrophication through surface/subsurface P mobilization. Although studies have reported massive P accumulation in Chinese GVP soils, potential risk of soil P mobilization as a function of soil labile P content and physiochemical soil properties remains poorly documented. Hence, this study has aimed to address the three following objectives. (1) To document P leaching from Chinese GVP soils as a function of P bonding/availability. (2) To test the performance of the DGT P method as a strong predictor of soil solution P (PSol) mobility in 75 GVP samples covering a broad range of soil properties (3) To document the marked accumulation of P in Chinese GVP soils as a function of region, soil type, and duration of cultivation, and to investigate if subsoils can act as a filter to keep leachate concentrations to the surrounding below threshold values.

Overall, very high P contents were measured in 75 representative Chinese GVP top soils (0-20 cm) with total P and Olsen P varying from 260 to 11,200 mg kg⁻¹ and 5 to 740 mg kg⁻¹, respectively. These large variations reflect the significant differences in vegetation history, intense fertilization, and soil types. In particular, longer history of GVP along with fertilization in larger quantities caused higher soil P availability and eventual risks of P mobilization from alkaline coarse-textured soils. Very high dissolved reactive P (DRP) concentrations with a mean of 3.43 mg L⁻¹ were found in the leachates from P rich coarse-textured Tongshan soils. In contrast, DRP leaching from fine-textured Guli soils rarely exceeded the suggested environmental P threshold of 0.1 mg L⁻¹. In accordance, a change-point Olsen P value above 41 mg kg⁻¹ led to substantial DRP leaching from Tongshan soils. Of all soils in this area, over 80% were found at high risk for P mobilization.
The bright and colorful Neotropical butterflies of the Heliconius genus are avoided by most insectivorous predators. Inexperienced birds and lizards may bite Heliconius butterflies, but immediately release them due to their toxic taste. The distastefulness of these butterflies is associated with the presence of defense compounds called cyanogenic glucosides (CNglcs), which deter predators because of their bitterness and the release of hydrogen cyanide upon degradation. Heliconius butterflies and basal heliconiines biosynthesize the aliphatic CNglcs linamarin and lotaustralin. Additionally, Heliconius larva can take up the cyclopentenyl CNglc epivolkkenin from Passiflora, their obligatory host plants. The research presented in this PhD thesis demonstrates that sequestration of cyclopentenyl CNglcs is not exclusively a trait of Heliconius, and probably arose in a common ancestor of the entire heliconiine subfamily. Despite sequestration of these compounds being an older adaptation than expected, biosynthesis of aliphatic CNglcs is hypothesized to be even more ancient, arising in lepidopterans before butterflies and moths diverged from a common ancestor. In addition, this study shows that epivolkkenin is not the only CNglc that Heliconius larvae can sequester from Passiflora. Many other cyclopentenyl CNglcs were found in Heliconius imagines, and feeding assays demonstrated that aliphatic and aromatic CNglcs can also be taken up by these larvae, although these structures are not as common in Passiflora as cyclopentenoids. Modified CNglcs were not sequestered, and Passiflora could therefore have diversified their repertoire of CNglcs in order to decrease their nutritional value to heliconiines. Heliconius use CNglcs not only for defense: These butterflies have more CNglcs than they can actually degrade into cyanide. During its life cycle, Heliconius melpomene is most cyanogenic when it is a mature adult, due to intense biosynthesis of aliphatic CNglcs. Males of this species transfer linamarin and lotaustralin during copula to females, confirming earlier suggestions that CNglcs are used as nuptial gifts by Heliconius. Mature adults contain cyclopentenyl CNglcs consumed and accumulated during the larval stage, but these compounds are not transferred to peers during mating or to the offspring. We speculate that the mature adults catabolise these CNglcs to retrieve nitrogen and/or to utilize their volatile degradation products during mating communication between males and females.
Implications of the Primary Cilium in Cellular Signaling and Brain Development

Summary:
Primary cilia are microtubule-based signaling organelles, emanating from the cell body on most cells in growth arrest. They comprise a highly conserved membrane structure, and coordinate a variety of cellular processes in development and homeostasis, including cell differentiation, migration, cell cycle regulation, and cell division. Defects in ciliary function is associated with a plethora of multi-systemic disorders affecting a variety of functions, including hearing, vision, kidneys, and liver. These are collectively termed ciliopathies. Maintenance and formation of the primary cilium critically relies on the trafficking to and from the organelle, as well as along the axoneme in a process mediated by the concerted actions of intraflagellar transport particles and BBSome complexes. At the base of the cilium, vesicles accumulate, collectively supplying the cilium with signaling proteins, receptors, axonemal building blocks, and membrane. Collectively, these processes ensure the carefully regulated exit and entry of signaling mediators to/from the cilium, enabling the multitude of sensory functions of the organelle.

Centrioles play a central role in cilium formation. During every cell cycle, they transition between basal bodies associated with primary cilium formation, and spindle poles responsible for organizing the mitotic spindle. These processes are of critical importance to brain development, in which the rapid expansion of the neuronal stem cells forms the basis of the mammalian brain. Primary microcephaly (MCPH) is a neuro developmental disorder in which patients are born with significantly smaller brains than average. Retarded cell cycle progression as a result of compromised centrosome structure and/or function constitutes the main underlying mechanism in disease etiology.
Collectively, the results obtained during these studies provide novel insight into the mechanisms governed by the primary cilium. We identified a novel mechanism in the etiology of MCPH, and greatly contribute to the expansion of the current understanding of genetic mechanisms underlying human disease and development.
Purification and Biochemical Characterization of the Yeast ABC Transporter Pdr11p - Towards Unravelling the Sterol Transport Mechanism

**Summary:**

All living organisms are built of cells. Walls made of lipid membranes define the outer boundaries of the cell and create rooms with specialized functions. Sterols constitute an essential lipid class in eukaryotic membranes where they affect the fluidity of the membrane and the activity and localization of proteins. Therefore, the sterol distribution in cells is tightly controlled.

To assist this regulation a number of membrane-embedded proteins transport sterols in or out of the cell. The majority of sterol transporters belong to a protein family called ABC transporters. Severe human diseases like Tangier disease and atherosclerosis have been linked to malfunctioning ABC sterol transporters. An understanding of the precise transport mechanism can improve treatment.

Because of the vast amount of processes going on at cell level, the specific role of the sterol transporters is difficult to dissect. As a trick, one can simplify the system by isolating the transporter and putting it back in a model membrane that only contains the basic elements. The major challenge is to get the protein out of its native environment without loss of functionality. In order to do this, yeast can be genetically modified to produce the sterol transporter in large amounts and to add a prey-mark to the protein. With the right preparations and bait, one can fish out the specific type of proteins from a sea full of different proteins.

The thesis describes the optimized procedure for the first isolation of the sterol transporter, Pdr11p, from the yeast Saccharomyces cerevisiae and for putting it back into a model system. Additionally it contains a characterization of Pdr11p regarding inhibition and stimulation of activity revealing some remarkable distinctions from similar transporters which may point towards regulatory mechanisms of the sterol transport.
PHD GRADUATE FROM FACULTY OF SCIENCE

Weiwei Huang
Climate Responses in Growth and Wood Anatomy of Important Forest Tree Species in Denmark

Supervisor(s):
Professor Jørgen Bo Larsen
Senior Researcher Jon Kehlet Hansen

Department:
Geosciences and Natural Resource Management

Date of defense: 26 June 2017
Date of awarded PhD degree: 29 June 2017

Summary:
The climate change, like drought episodes and seasonal warm temperatures, is a challenge for forest management decisions, which will affect growth, mortality and species composition of future forests both directly and mostly negatively. However, the long-term impacts of drought and high temperatures on growth responses of tree species are very poorly understand in Danish forest. Present dissertation through dendroecological approach assessed the growth responses, concerning annual increment, xylem anatomy and wood property, of eight different dominant tree species, namely Picea abies (L.) Karst., Picea sitchensis (Bong.) Carr., Abies alba Mill., Abies grandis (Dougl.) Lindl., Pseudotsuga mensiesii (Mirb.) Franco, Larix kaempferi (Lamb.) Carr., Quercus robur L. and Fagus sylvatica L., in Danish forest to long-term drought and high temperatures, aiming at identifying a species portfolio matching future climate.

Based on the results, we anticipate that projected more severe and frequent drought and warmer autumn and summer in the future will become a major threat for important temperate forest species and may change forest composition and decrease forest productivity. Based on the present results and supported by literature Q. robur is expected not only to tolerate the expected future climate including increasing water stress but also will presumably even prosper from the rising temperature. All other tested species are expected to decrease growth and vitality, but to different degrees. The native F. sylvatica is expected to decrease growth when periods of drought are getting more frequent. Among the imported conifer species P. menziesii is expected to have the highest degree of climatic adaptability/tolerance, whereas L. kaempferi and P. abies are ranked as the most climatic intolerant species, mainly due to their low drought tolerance (both species) and susceptibility to high autumn temperature (only P. abies).

Overall, this dissertation not only improves the understanding of how drought and high temperatures have impacted and will influence the growth of tree species in Danish forest, which can be used as inputs to forest management decisions regarding adaptation to an uncertain climatic future. It also demonstrates that old common garden trials can be a valuable tool for addressing forest management issues on species portfolios to climate change.

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Anette Lisbeth Benthholm

"Du må ikke løbe uden for banen". En processociologisk undersøgelse af inklusion af elever med autisme og ADHD i skoleidrætten

Supervisor(s):
Associate Professor Lone Friis Thing

Department:
Nutrition, Exercise and Sport

Date of defense: 27 June 2017
Date of awarded PhD degree: 3 July 2017

Summary:


Følgende væsentligste konklusioner er, at i praksis har idrætslærerne en tendens til at betragte problemet iboende barnet og ikke ud fra en inkluderende tilgang. Lever fokuseleverne ikke op til de civiliserede omgivelsesformer eller evner at vise skam, begrænser det deres muligheder for at blive inkluderet, og derfor kan de elever, det var tiltenkt at inkludere blive ekskluderet. Fokuselevernes generelle sociale position på klassen har indflydelse på deres sociale position i idrætsundervisningen, uanset om de har gode idrætskompetencer eller ej. Antallet af elever og voksne i idrætsfigurationen har også indflydelse på mulighederne for at blive inkluderet, idet et stort antal begrænser fokuselevernes idrætsdeltagelse og skaber mindre tryghed for dem. Konklusionerne vil have flere pædagogiske implikationer, der kan være med til at fremme en inkluderende undervisning for elever med autisme og ADHD.

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Anzhela Malysheva
Interdisciplinary Approach to Nanotoxicology: Analytical Studies into Complex Behaviour of Nanoparticles During Toxicity Tests

Summary:
Engineered nanomaterials (ENMs) became an integral part of the consumer and industrial products used daily in our society. Despite of increasing production and use of goods containing silver nanoparticles (AgNPs), and their inevitable release into the environment, the processes controlling their environmental fate and toxicity are yet to be fully understood. There are several reasons for the persistence of this knowledge gap: NPs show complex colloid behaviour which is likely to be affected by both primary particle-specific characteristics and the biotic/abiotic factors of the surrounding environment; the assessment of toxicological activity and mechanisms is complicated by unstable exposure conditions resulting from various transformation processes of NPs during the test. Many current toxicological studies lack the sufficient analytical characterisation of AgNPs under the relevant test conditions, leading to incorrect interpretations of toxicity data. Clearly, the physicochemical analysis is essential to understanding of fate and behaviour of AgNPs in the environment, as well as uptake and distribution within organisms. This objective can be achieved by integrating analytical approach into the nanotoxicological assessment and adopting the available nanometrological tools for NP analysis. This doctoral thesis focuses on promoting cross-fertilization between fields of toxicological and environmental research and investigates methodological integrations advantageous for the ENM analysis in both environmental and biological media. The work presented in this thesis details studies into behaviour of Ag-containing NPs, monitoring physicochemical transformations, NP-cell interactions, and uptake. In addition, it exemplifies the use of single particle inductively coupled mass spectrometry (SP-ICP-MS) as routine method in nanotoxicology. The results demonstrate how the presence of exposed organisms may affect the behaviour of AgNPs during the test, show the significance of NP-cell interaction and uptake for the toxic mechanisms, and confirm the relevance of complementary analytical data for the correct interpretation of toxicological data. Lastly, a number of possible future implementations in nanometrological analysis are discussed that may help to advance the use of these tools in nanotoxicological field.

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In this PhD project the three Australian plant species Acacia ligulata A.Cunn. ex Benth, Santalum spicatum (R.Br.) A.DC and Santalum lanceolatum R.Br were investigated for their bioactivity and chemistry. These plant species have been traditionally used by Aboriginal Australians for symptoms often associated with bacterial infections. Further, A. ligulata has been described as a food source, where seeds and possible whole pods were used to prepare food. However, people of the Yankunytjatjara language group in Central Australia also had knowledge that eating from this food would “make your hair fall out”. Different tissue parts from the three species were used to prepare crude extracts for an initial screening study using antibacterial, cell cytotoxicity and α-amylase and α-glucosidase enzyme inhibition assays where several promising activities were observed. The mature pod extract from A. ligulata was found to be the most potent in the cell cytotoxicity assays and was thus further investigated by activity-guided fractionation. This led to the isolation of two novel triterpenoid. Both compounds were also found to be moderately cytotoxic to a melanoma cell line and a normal human skin cell line. Triterpenoid saponins have in general been shown to be cytotoxic towards different cell lines likely due to their amphiphilic structure. An initial study of the mechanism of action using flow cytometry showed that a mixture of the two triterpenoid saponins induce apoptosis in the melanoma cells. Saponins in plants are often described as defence compounds with ecological roles such as protection against herbivores and fungi. Mass spectrometry imaging revealed that the two triterpenoid saponins, a putative saponin pathway intermediate, and four putative saponins were present primarily in the outer parenchyma layer of the pod tissue. This particular storage site indicates a role as defence compounds. The results obtained in this PhD project have highlighted several bioactivities of crude extracts from A. ligulata, S. spicatum and S. lanceolatum with potential for further investigations. The study has provided Western scientific evidence supporting the traditional knowledge about these plant species. In addition, two novel triterpenoid saponins were isolated from the mature pods of A. ligulata and shown to contribute to the in vitro cytotoxicity of the crude mature pod extract by an apoptotic mechanism. These are the first compounds isolated from A. ligulata and the first triterpenoid saponins from any legume pod (Fabaceae) to be spatial localised in the pod tissue.
Aldo Ricardo Almeida Robles

Occurrence and Biogenesis of Seco-Triterpenoids: A Focus on the Biosynthetic Pathway of α-Onocerin in Ononis spinosa

Summary:
Triterpenoids are secondary metabolites synthesized by oxidosqualene cyclases (OSCs), a class of enzyme that converts the linear squalene-oxide to single or multi-ring products in a dynamic process called cyclization. The cyclization cascade is powered by a migrating carbocation that through a series of 1,2-methyl and hydride shifts gives a series of conformationally discrete carbocation intermediates, the eventual loss of a proton generates a neutral reaction product. Seco-triterpenoids are a type of triterpenoids with an opened ring which may derive from an unusual deprotonation process of an OSC or modification steps on a full-ring skeleton post cyclization. The bioactivity and biosynthesis of the seco-triterpenoids is intriguing, and yet underexplored.

In this thesis a review of structure-activity relationships of seco-triterpenoids is presented. Seco-cycloartanes report the highest cytotoxicity, while seco-dammaranes displayed anti-retroviral activities and 3,4-seco-oleananes had neuroprotective activities. In addition, the distribution of seco-triterpenoids across the plant phylogeny reveals they are restricted to specific plant families. Finally, the co-occurrence of seco-triterpenoids with ring openings at the same position in distantly related plant families hints that seco-triterpenoid pathways may result from convergent evolution. The hypothesis that seco-triterpenoid pathways evolve convergently was tested by studying the α-onocerin pathway in Ononis spinosa and Lycopodium clavatum. These led to the characterization of two OSCs in O. spinosa (OsONS1 and OsONS2) which are able to produce α-onocerin individually. Contrary to the α-onocerin pathway in L. clavatum in which two different cyclases are needed for α-onocerin synthesis. Moreover, an OSC phylogenetic analysis indicated the onocerin synthases of O. spinosa arose from a different evolutionary route than those in L. clavatum. In addition, two SQEs of O. spinosa specialized for onocerin production were described and named OsSQE1 and OsSQE2. These SQEs displayed protein-protein interactions with OsONS1 and proved to boost the onocerin production of OsONS1. Finally, protein-protein interactions between enzymes from the onocerin and cucurbitacin pathways were tested and the results revealed that protein-protein interactions are not conserved amongst SQEs and OSCs from different plant species. With this thesis, we have paved the way for exploring pharmaceutical valuable seco-triterpenoids, and have also provided novel insight into triterpenoid biosynthesis and evolution.
Traditional shifting cultivation systems are rapidly undergoing a broad land use transition towards commercialized and market-oriented systems in the uplands of Southeast Asia – a transition widely encouraged by governmental policies and development initiatives and with implications to both ecologically-sensitive upland areas and the livelihoods of an estimated 14 – 34 million people in often marginalized and vulnerable communities.

Thus, the overall aim of this Ph.D. project was to study the effects to land productivity and livelihoods as upland strategies undergo the transition from rice-based shifting cultivation towards such commercialized and market-oriented systems, with the broad objectives being: i) to document the effect on soil fertility restoration by the shortening of fallows, an initial strategy for intensification that occurs at the onset of agricultural commercialization; and ii) to identify and describe upland livelihood strategies and diversification trends of increasing commercialization to determine the requisites required for household market integration and to assess the impacts to livelihood diversity, food security and system productivity.

The main summarising conclusions of this Ph.D. project are: i) the function and importance of fallow, both environmentally and socially, should not be underestimated and should be reflected in implemented policies and development initiatives that are made specific to the local-contexts; ii) physical infrastructure development and accessibility should be prioritised if households and communities are to have equal opportunities to engage in upland commercial agriculture and market-integration; iii) food security is imperative in the minimisation of risk for households transitioning towards market integration and can be attained either through paddy land or reliable market access (and fair farm contracts); and iv) a pro-poor growth approach, meaning an equal distribution of resources, fair access to credit and social services, and diverse income-generating opportunities, coupled with the development of infrastructure, should be a priority of the Government of Lao P.D.R. and any development initiatives.
Alexander Kurganskiy
Integrated Modelling of Physical, Chemical and Biological Weather

Supervisor(s):
Professor Eigil Kaas
Professor Alexander Baklanov

Department:
Niels Bohr Institute

Date of defense: 7 July 2017
Date of awarded PhD degree: 19 July 2017

Summary:
Integrated modelling of physical, chemical and biological weather has been widely considered during the recent decades. Such modelling includes interactions of atmospheric physics and chemical/biological aerosol concentrations. Emitted aerosols are subject to atmospheric transport, dispersion and deposition, but in turn they impact the radiation as well as cloud and precipitation formation.

The present study focuses on birch pollen modelling as well as on physical and chemical weather with emphasis on black carbon (BC) aerosol modelling. The Enviro-HIRLAM model has been used for the study. This is an online-coupled meteorology-chemistry model where chemical constituents and different types of aerosols are an integrated part of the dynamical model, i.e., these constituents are transported in the same way as, e.g., water vapor and cloud water, and, at the same time, the aerosols can interactively impact radiation and cloud micro-physics.

The birch pollen modelling study has been performed for domains covering Europe and western Russia. Verification of the simulated birch pollen concentrations against in-situ observations showed good agreement obtaining the best score for two Danish sites: Copenhagen and Viborg. It was verified that the birch pollen emissions and concentrations, as expected, depend strongly on the air temperature, relative humidity, wind speed and precipitation emphasizing the importance of accurate meteorological forecasts in order to perform operational birch pollen forecasts.

The BC modelling study was performed for a modelling domain covering most of the Northern Hemisphere with focus on the EU and Arctic regions. Verification of BC concentrations against observations showed a good agreement for the EU air quality measurement sites. However, the Arctic region turned to be much more challenging. The aerosol feedbacks to the physical atmosphere were also studied, and the model simulations indicated that the aerosol feedbacks induced the following changes: reduction of the net downward short-wave surface radiative fluxes, reduction of near surface air temperature, increase of total cloud cover and cloud water and a decrease in precipitation amount.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Daniel Vik
Quantitative Aspects and Dynamic Modelling of Glucosinolate Metabolism

Supervisor(s):
Professor Barbara Ann Halkier
Associate Professor Meike Burow

Department:
Plant and Environmental Sciences

Date of defense: 26 June 2017
Date of awarded PhD degree: 25 July 2017

Summary:
The presented thesis is a collection of scientific manuscripts describing various aspects of glucosinolate metabolism. Glucosinolates are chemical defense compounds found in certain plants such as broccoli, mustard and kale. Their primary role is to defend the plant against attack by insects or disease. Glucosinolates are converted into different kinds of highly reactive compounds, some of them being really nasty and thereby scaring off enemies of the plant. Understanding the way the plant produce and degrade glucosinolates is important for our broader understanding of how plants interact with dangers such as insects and diseases, and it has implications for developments in agriculture and medicine.

In this thesis I present the implementation of a new technology platform that makes it possible to measure the levels of the individual enzymes responsible for glucosinolate production. I use this technology to compare several genetic mutants and the effects of hormone treatment. The results show that mRNA reflects the enzyme levels accurately across mutants, but that the enzyme levels are not accurately reflected in the mRNA levels upon hormone treatment. These findings would suggest that the enzyme levels are somehow regulated by currently unknown mechanisms.

To try to find out what these possible mechanisms could be, my colleagues and I examined the physical interactions of glucosinolate producing enzymes. We combined two complementary large-scale genomics approaches to search for proteins that would interact with the glucosinolate enzymes. Our findings show that the enzymes of glucosinolate production interact with proteins that are involved in broader physiological processes. In addition, I examined the role of a small protein which based on genetic expression data would appear to be linked to glucosinolate biosynthesis.

Finally, I constructed a mathematical model describing the degradation of glucosinolates, and how the degradation of one particular glucosinolate could influence plant growth and defense by manipulating a central growth hormone.

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Dyana Wijayanti
A Praxeological Study of Proportionality in Mathematics Lower Secondary Textbooks

 Supervisor(s):
Professor Carl Winsløw

 Department:
Science Education

 Date of defense: 4 July 2017
Date of awarded PhD degree: 25 July 2017

 Summary:
Research on the uses and contents of mathematics textbooks has expanded over the past decades, due to the central role textbooks occupy in mathematics teaching worldwide. However, the methodology of analysing the texts themselves often appears underdeveloped or even naïve, especially when it comes to specific mathematical content.

The central idea of this thesis is to deploy the anthropological theory of the didactic, and especially the notion of praxeology, to analyse how textbooks treat three specific and related areas (or more precisely, sectors) of mathematical contents for lower secondary school, namely "proportion and ratio" (in Arithmetics), "similar plane figures" (in Geometry), and "linear functions" (in Algebra). This leads to a new and very precise methodological tool for analysing the practices (types of tasks, techniques) supported by the textbooks through examples, explanations and exercises; it also allows us to analyse how these practices are organised or unified through the theoretical contents, and how the theoretical level may enable the texts to establish explicit links between different sectors.

By constructing praxeological reference models, we obtain a powerful and precise tool to compare the priorities or profiles of different textbooks, their alignment with national examination practices, curricula, etc. We have devoted separate attention to study why certain mathematical links between the three sectors seem to be absent or underdeveloped in textbooks, and explanations are found both in terms of the mathematical notions used (for instance, how "linearity" is defined) and in terms of the historical development of the didactic transposition, as evidenced by textbooks from different periods of time.
Matias Lolk
Dynamical Systems and Algebras Associated with Separated Graphs

Supervisor(s):
Professor Mikael Rørdam

Department:
Mathematical Sciences

Date of defense: 30 June 2017
Date of awarded PhD degree: 25 July 2017

Summary:
There are a number of open problems in non-commutative ring theory and operator algebras related to the cancellation properties of the non-stable K-theory of exchange rings. The importance of a particular cancellation property known as separativity has crystallized over the years and let researchers to ask whether every exchange ring is separative. Although this problem is still wide open, it seems to be the common belief that non-separative exchange rings do exist - and that it is simply very difficult to construct them.

The algebras associated with separated graphs should be thought of as building blocks for constructing such examples, and this thesis is concerned with the general study of these algebras. Using their descriptions as crossed products arising from a topological dynamical system, we perform an extensive study of their ideal structure, including characterizations of both simplicity and primeness. We completely characterize those algebras that enjoy the exchange property and observe that they are always separative. Consequently these algebras are merely building blocks for attacking the separativity problem - they do not themselves pose counterexamples. Finally, we prove that nuclearity of the separated graph C*-algebras is equivalent to a certain graph-theoretic condition.
Janne Folke Bialik
Mechanisms Underlying Profibrotic Epithelial Phenotype and Epithelial-Mesenchymal Crosstalk

Supervisor(s):
Professor Stine Falsig Pedersen
Professor András Kapus

Department:
Biology

Date of defense: 26 June 2017
Date of awarded PhD degree: 28 July 2017

Summary:
Tubulointerstitial fibrosis (TIF) is the final pathway through which chronic kidney disease progresses toward renal failure. Tubular injury is a key feature of TIF but the exact role of the epithelium remains a matter of debate. In vivo only a small subset of myofibroblasts (MFs) appears to originate from the epithelium, through epithelial-MF transition (EMyT). The emerging view is that the injured epithelium is a critical driver of fibrosis via acquiring a profibrotic epithelial phenotype (PEP), characterized by cytoskeletal remodeling, ROS production, and fibrogenic cytokine secretion, priming interstitial cells for fibroblast-MF transition. The cytoskeleton- and TGFβ-regulated transcriptional coactivators, myocardin-related transcription factor (MRTF) and the Hippo pathway effector TAZ are central for EMyT, and are implicated in organ fibrosis; however, their roles in epithelial reprogramming are unclear. The aim of this thesis was to elucidate (i) the mechanism of TGFβ-induced TAZ expression in kidney fibrosis, (ii) the roles of MRTF and TAZ in PEP, (iii) how MRTF and TAZ regulate the oxidative state of the epithelium, and (iv) if the ensuing ROS production regulates TAZ. We found that Nox4 and ROS production increases in EMyT and is prevented by inhibition of MRTF. Inhibition of TAZ in vitro and in vivo decreased Nox4 expression and ROS production. Pharmacological inhibition studies revealed increased TAZ expression by TGFβ in a Smad-independent, p38- and MK2-dependent, redox-sensitive process, mediated by MTRF in a translocation-independent manner. Importantly, conversely, TAZ was also regulated by Nox4, creating a feedback loop. Singlet oxygen producers, Verteporfin and Rose Bengal, UV radiation, and to some extent H2O2, decreased monomeric TAZ protein level, by partly different mechanisms, uncovering a complex regulation of TAZ by ROS/oxidative stress. Finally, in the unilateral ureteral obstruction (UUO) model of obstructive nephropathy, mRNA expression of the profibrotic cytokines TGFβ, PDGF-B, CTGF, and IHH, as well as TAZ was increased in whole kidney compared to that in sham operated animals. Inhibition of MRTF by CCG-1423 decreased TGFβ- and TAZ expression after UUO. Importantly, using laser capture microdissection we could show that the tubular (epithelial) expression of TGFβ, CTGF, and TAZ increased after UUO and this was prevented by CCG-1423. In an in vitro model of mechanical stress of epithelial cells, we showed that cytokine expression, key feature of PEP, increased upon stretch and this was prevented by inhibition/knockdown of MRTF and TAZ.
Filip Kazimierz Malinowski
Noise Suppression and Long-Range Exchange Coupling for Gallium Arsenide Spin Qubits

Supervisor(s):
Professor Charles Marcus
Associate Professor Ferdinand Kuemmeth

Department:
Niels Bohr Institute

Date of defense: 3 August 2017
Date of awarded PhD degree: 4 August 2017

Summary:
Quantum computation is one of the holy grails of the modern physics, and electronic spins are perfect candidates for qubits (bits of quantum information). Electrons in semiconducting nanostructures, such as quantum dots, can be particularly easily manipulated. However, the quantum character (coherence) of the electronic spins can be easily lost due to interaction with the environment, e.g. nuclear spins in the host crystal, electrons localized on nearby impurities or vibrations of the crystal lattice. During my studies I explored two techniques to minimize the loss of quantum coherence.

First is to introduce additional symmetries in an array of electronic spins. The underlying idea is that different charge distributions will be affected by the electrical noise in a different manner, which leads to decoherence. I demonstrate that symmetrization of the array minimizes the difference in charge distributions related to different spin states, leading to increased coherence times.

Second technique is to induce self-cancellation of the noise, by means of so-called dynamical decoupling. In a nutshell, the noise is acquired with a certain sign, which can be reversed with a quantum NOT gate. Therby the noise before and after the NOT gate cancels itself out. I demonstrate experimentally that this method can be applied to low-frequency and certain kinds of high-frequency noise. Exploiting this technique I extend the electronic coherence time in gallium arsenide by five-orders-of-magnitude.

Another challenge I faced is execution of the two-qubit logical gate between distant spins. In the thesis I demonstrate that a multielectron quantum dot (essentially a puddle of tens of electrons) can mediate exchange interaction between distant spins, enabling multi-qubit operations. Moreover, using an interaction mediator relaxes constraints in the fabrication of the sub-micrometer quantum dot devices and facilitates scaling of quantum dot arrays.
Annelies Jaspers
The Monodromy Property for K3 Surfaces Allowing a Triple-Point-Free Model

Supervisor(s):
Associate Professor Lars H. Halle

Department:
Mathematical Sciences

Date of defense: 5 July 2017
Date of awarded PhD degree: 7 August 2017

Summary:
The aim of my thesis is to study under which conditions K3 surfaces allowing a triple-point-free model satisfy the monodromy property. This property is a quantitative relation between the geometry of the degeneration of a Calabi-Yau variety X and the monodromy action on the cohomology of X: a Calabi-Yau variety X satisfies the monodromy property if poles of the motivic zeta function induce monodromy eigenvalues on the cohomology of X.

Let k be an algebraically closed field of characteristic 0, and set K = k((t)). We focus on K3 surfaces over K allowing a triple-point-free model, i.e., K3 surfaces allowing a strict normal crossings model such that three irreducible components of the special fiber never meet simultaneously. Crauder and Morrison classified these models into two main classes: so-called flowerpot degenerations and chain degenerations. This classification is very precise, which allows to use a combination of geometrical and combinatorial techniques to check the monodromy property in practice.

The first main result is an explicit computation of the poles of the motivic zeta function for a K3 surface X allowing a triple-point-free model and a volume form on X. We show that the motivic zeta function can have more than one pole. This is in contrast with previous results: so far, all Calabi-Yau varieties known to satisfy the monodromy property have a unique pole.

We prove that K3 surfaces allowing a flowerpot degeneration satisfy the monodromy property. We also show that the monodromy property holds for K3 surfaces with a certain chain degeneration. We don’t know whether all K3 surfaces with a chain degeneration satisfy the monodromy property, and we investigate what characteristics a K3 surface X not satisfying the monodromy property should have. We prove that there are 63 possibilities for the special fiber of the Crauder-Morrison model of a K3 surface X allowing a triple-point-free model that does not satisfy the monodromy property.

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Divergence and Adaptive Capacity of Marine Keystone Species

Supervisor(s):
Professor Tom Gilbert
Professor Per J. Palsbøll

Department:
Natural History Museum of Denmark

Date of defense: 14 July 2017
Date of awarded PhD degree: 7 August 2017

Summary:
A combination of multiple anthropogenic actions and rapid environmental alterations impact the marine environment today and execute pressure on marine organisms. An understanding of population divergence patterns, population sizes, and local adaptive capacities is an important baseline for the design of sustainable resource management measures and effective conservation actions. In this thesis, I took a population genetic approach to shed light on the above features of three different keystone organisms in the North Atlantic and Baltic Sea ecosystems.

In the case of the grey seal, my colleagues and I combined modern and historic nuclear and mitochondrial genetic markers with zooarchaeological, demographic, and life history data, in order to investigate the processes that drove colonization, extinction, and re-colonization of two subspecies in the Baltic and North Sea. We discovered that a combination of environmental and anthropogenic impacts drove historic subspecies divergence, while it seems likely that Danish waters represent a place of subspecies-reconnection in the near future.

Another study focuses on humpback whales in the only two known North Atlantic breeding grounds in the West Indies and Cape Verde. Humpback whales in Cape Verde seem to have undergone several historic and more recent population declines, and today may be at or below a minimum viable population size. In addition, the amount of long-term average gene flow between the two breeding grounds is very limited, and indeed is of the same level of magnitude as genetic differentiation in humpback whales between ocean basins.

Last, the genome-wide population divergence patterns in two economically and ecologically important sand lance species in the Baltic Sea and North Sea were investigated. This study took one step beyond focusing on the genome alone, and additionally drew on information about the associated fish gut and environmental water bacterial communities. We found that the Baltic Sea harbors unique genetic populations of sand lances that are differentiated from the North Sea. We further confirmed that Baltic Sea A. tobianus exist as two genetic stocks co-occurring in the same habitat. Further, the gut microbial communities of sand lances are not a mere reflection of environmental microbes, but rather the fishes themselves seem to excerpt some degree of internal control and selection.
Afton Marina Szasz Halloran
The Impact of Cricket Farming on Rural Livelihoods, Nutrition and the Environment in Thailand and Kenya

Supervisor(s):
Associate Professor Nanna Roos
Associate Professor Sander Bruun

Department:
Nutrition, Exercise and Sports

Date of defense: 1 August 2017
Date of awarded PhD degree: 9 August 2017

Summary:
A growing amount of attention is being placed on the potential of edible insect species to address the global challenge of food and nutrition security. Even greater attention is put on the handful of insect species which can be easily domesticated and raised en masse. Some of these species belong to the Gryllidae (cricket) family. The oldest and most developed example of cricket farming for human consumption comes from Thailand. For nearly 20 years, thousands of rural Thai farmers have adopted and developed these unique farming systems, providing not only food for their households but also employment and income. This development has resulted in the promotion of small- and medium-scale insect farming systems in rural communities in low- and middle-income countries such as Kenya. However, the policy environment for cricket farming, the social and environmental impacts in Thailand and the adoption of cricket farming in Kenya are not well understood. There is therefore a critical need for further research into the impacts of cricket farming on nutrition, rural livelihoods and the environment.

This thesis addresses this research gap through reviewing the literature and empirically examining cases from both Thailand and Kenya. The main objective is to assess the impact of cricket farming on the rural livelihoods, nutrition and the environment in rural Thailand and Kenya. The results of this thesis contribute to GREEiNSECT, a research project which assesses the contribution of insects to green economy in Kenya.

Overall, this thesis concludes that established cricket farming has had a positive direct impact on rural livelihoods in Thailand by providing an alternative income source and by strengthening social and human capital. In Kenya, cricket farming systems are still under development and few farmers are aware of them. It can also be concluded that crickets are an environmentally sustainable animal source food.
PHD GRADUATE FROM FACULTY OF SCIENCE

Martin Dybdal
Array Abstractions for GPU Programming

Supervisor(s):
Associate Professor Martin Elsman

Department:
Computer Science

Date of defense: 9 August 2017
Date of awarded PhD degree: 11 August 2017

Summary:
The shift towards massively parallel hardware platforms for high-performance computing tasks has introduced a need for improved programming models that facilitate ease of reasoning for both users and compiler optimization.

A promising direction is the field of functional data-parallel programming, for which functional invariants can be utilized by optimizing compilers to perform large program transformations automatically. However, the previous work in this area allow users only limited ability to reason about the performance of algorithms. For this reason, such languages have yet to see wide industrial adoption.

We present two programming languages that attempt at both supporting industrial applications and providing reasoning tools for hierarchical data-parallel architectures, such as GPUs.

First, we present TAIL, an array based intermediate language and compiler framework for compiling a large subset of APL, a language which have been used in the financial industry for decades. The TAIL language is a typed functional intermediate language that allows compilation to data-parallel platforms, thereby providing high-performance at the fingertips of APL programmers.

Second, we present FCL, a purely functional data-parallel language, that allows for expressing data-parallel algorithms in a fashion where users at a low-level can reason about data-movement through the memory hierarchy and control fusion will and will not happen. We demonstrate through a number of micro benchmarks that FCL compiles to efficient GPU code.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Mathias Bæk Tejs Knudsen
New Results on Hashing, Labeling Schemes and Algorithms

Supervisor(s):
Professor Stephen Alstrup
Professor Mikkel Thorup

Department:
Computer Science

Date of defense: 4 August 2017
Date of awarded PhD degree: 11 August 2017

Summary:
In this thesis, we show several new results on hashing, labeling schemes and algorithms. There is not space in the abstract to mention all the results, but a result from each area is highlighted:

Linear hashing: We consider the classic hash function $h(x) = ((ax+b) \text{ mod } p) \text{ mod } n$, where $a,b$ are chosen uniformly at random from $\{0,1,2,\ldots,p-1\}$. We prove that when using $h$ in hashing with chaining the expected size of the longest chain is $n^{1/3+o(1)}$, which is the first improvement on the folklore bound of $O(\sqrt{n})$. Appeared in [FOCS’16].

Adjacency labeling for trees: We show that there exists an induced universal graph with $O(n)$ nodes for the family of forests on $n$ nodes. We hereby solve an open problem being raised repeatedly over decades, e.g. in Kannan, Naor, Rudich [STOC’88], Chung [J. of Graph Theory’90], Fraigniaud and Korman [SODA’10]. Joint work with Alstrup and Dahlgaard [FOCS’15].

Even cycle detection: For any constant $k$ we give an algorithm that in time $O(m^{2k/(k+1)})$ determines if a graph with $m$ edges contains a cycle of length $2k$. This improves upon a result by Yuster and Zwick [J. Discrete Math 1997] who gave an $O(n^2)$ algorithm for this problem and noted that it is "plausible to conjecture that $O(n^2)$ is the best possible bound in terms of $n$", where $n$ is the number of nodes in the graph. If this conjecture is true, then our result is optimal in terms of $n$ and $m$. Joint work with Dahlgaard and Stöckel [STOC’17]
PHD GRADUATE FROM FACULTY OF SCIENCE

Nynne Marie Rand Ravn
Carbon Dioxide Exchange in the Arctic
The effect of a Changing Climate on Soil Carbon Turnover in Tundra Heaths

Supervisor(s): Professor Anders Michelsen
Professor Bo Elberling

Department: Biology

Date of defense: 10 August 2017
Date of awarded PhD degree: 11 August 2017

Summary:
This PhD thesis addresses different aspects of climate change effects on C dynamics in the Arctic. The focus has been on i) changes in ecosystem respiration (ER), age of the carbon (C) sources, gross ecosystem production (GEP) and the net ecosystem exchange (NEE) in response to long- and short-term climate manipulations and ii) comparisons of CO2 fluxes and organic nutrient utilization between ecosystems occurring from different latitudes and dominated by different vegetation types. These aspects are important to understand the effects of climate change on the CO2 balance in the Arctic and its potential positive feedback on global climate change. Furthermore, comparisons between arctic ecosystems across different latitudes or dominated by different vegetation can validate predictions based on data from one ecosystem to other arctic settings.

Based on the observations presented in this PhD thesis I conclude that increased summer temperature in the short-term perspective increases the emission of CO2 to the atmosphere and that contribution of old soil C might also be increased. The consequence can be a short-term positive feedback on climate change. In the long-term, higher temperatures will still stimulate ER, but the loss of old soil C is probably less pronounced. I speculate that enhanced plant biomass in response to long-term warming can cause GEP to increase and leave NEE unaltered. Hence, the risk of warming induced long-term positive feedback on climate change might be reduced. The new balance in the C cycling might though be sensitive to limitations of GEP due to for instance late snowmelt or herbivory. Ecosystems at higher latitude might respond most rapid to increased temperature and nutrient addition compared to ecosystems from lower arctic latitude but the pattern in the responses seem similar between different shrub heaths.

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Adaptations in Bacterial and Fungal Communities to Termite Fungiculture

Summary:
Nearly 30 MYA, a subfamily of termites, Macrotermitinae, started an obligate mutualistic relationship with the basidiomycete fungus Termitomyces. Fungus-growing termites maintain the ecosymbiont in optimal growth conditions and Termitomyces provides the food source and an external plant decomposition factory for the termites. This association ensured such a successful history since the origin of fungiculture that none of the two symbionts has abandoned the system. The adoption of the fungus by the eusocial termites has triggered changes in the colony, and here I focus on the responsive changes in the bacterial and fungal communities. This thesis shows that fungus-growing termite gut microbiotas are compositionally consistent over time. Fungus comb structures, where Termitomyces is cultivated in the nests, harbour bacterial communities that change over time. These fungus comb microbiotas are largely termite species-specific due to major contributions from gut deposits during comb formation. We also find that gut bacterial communities are structured according to termite caste and species rather than colonies; thus, reflecting different caste roles and diets. Royal pair microbiotas are extremely skewed and dominated by a few bacterial taxa, reflecting the specialised dietary intake and reproduction-centred lifestyle of the queen and king. We therefore propose that division of labour extends beyond the termites to their gut bacterial communities. We also show that Termitomyces-fed cockroaches undergo compositional changes in their gut microbiotas. However, their gut microbiotas remained distinct from those of termites. This thesis also shows that non-Termitomyces fungi were essentially absent in combs, and that Termitomyces fungal crops are maintained in monocultures as heterokaryons with two or three abundant ITS variants in a single fungal strain. We also tested for the presence of antifungal metabolites in Termitomyces or comb bacteria and found that both Termitomyces and chemical extracts of fungus combs inhibit a number of antagonistic fungi, but not the same ones. This indicates that there is likely a bacterial contribution to antifungal defences in fungus-growing termite nests. We finish the main part of the thesis by arguing that an integrated view of homogenous comparative genomic analyses and insect-associated microbiotas is required to improve our understanding of social insect disease-defences and how eusociality influenced insect immunity.
Permafrost affected soil systems represent 17% of the global land area. It has been shown that these soil systems contain a large amount of organic carbon that have the risk to be released as greenhouse gasses to the atmosphere by microbial processes. The active layer of soil overlaying permafrost in the Arctic is subjected to dramatic annual changes in temperature and soil chemistry, which may affect microbial community both in structure and activity. However there is only sparse knowledge on the responses of the microbial community where the soil is being thawed and frozen during seasonal change in the active layer permafrost.

The main focus of this thesis was therefore to investigate the microbial community composition in the active layer permafrost and the expressed functions during temperature changes, i.e. seasonal changes and a more refined analysis during thawing and freezing. The objective was further to investigate the turnover time for taxonomic marker 16S rRNA transcripts in soil at different temperature.

The findings of the thesis resulted in five manuscripts. Manuscript I investigated the microbial community and showed a distinct community for both winter and summer. The microbial community composition was more homogenous in the winter samples compared to summer samples. Manuscript II showed that contamination from top soil layer was detected in permafrost core samples. Therefore we developed a protocol for determining and avoiding contamination during post-drilling procedure to prevent contamination in future permafrost sampling. Findings from manuscript III and IV, showed a combination of initial stress response, decrease in potential fungal activity and grazing of bacteria by protozoa as the active layer thawed. This may indicate that the degradation of organic carbon from these soil systems is delayed. Finally manuscript V investigated the turnover time of bacterial 16S transcripts in soil at different temperatures. It was estimated that the half-life of rRNA transcripts was 7.1 and 25 days when incubated at 20 °C and 5 °C, respectively.
Summary:
The use of plant extracts in animal feeding trials has been considered as a potential alternative to improve the redox stability of meat. Bioactive compounds from plant extracts can provide the antioxidative mechanisms required to improve animal health and welfare and, to protect meat against oxidation. Pharmacological properties and antioxidant effects have been associated to the extract of hops and to the extracts of yerba mate. However, the effects of hops and yerba mate as dietary supplement for animal feeding on the metabolic profile and the redox stability of meat have not been reported yet. Addition of extract of mate to a standard maize/soy feed at a level of 0.5, 1.0 or 1.5% to the diet of feedlot for cattle resulted in an increased level of inosine monophosphate, creatine, carnosine and of conjugated linoleic acid in the fresh meat. The tendency to radical formation in meat slurries as quantified by EPR spin-trapping decreased for increasing mate extract addition to feed especially after storage of the meat indicating an increased resistance to oxidation for meat. Addition of hops extract at different levels (0, 30 ppm, 60 ppm, 240 ppm) to the diet of broilers demonstrated to have significant effects on the averaged concentration of polar metabolites that are of relevance for meat quality. The major metabolic differences between control group (no supplements) and broilers fed different levels of beta acids were achieved using 30 ppm of supplement. As determined by EPR spin-trapping, increased redox stability was obtained in the samples referring to the animals fed 30 ppm of lupulones and may be related to the highest level of endogenous antioxidants, especially anserine, carnosine and NADH. Myosin and actin were recognized as the main targets of protein oxidation in meat. Myofibrillar proteins from animals fed with hops beta acids showed to be less susceptible to oxidation when compared to control group. Mate and hops beta acids extracts demonstrated to be promising additives to feedlot for, respectively, cattle and broilers and can improve the oxidative stability, nutritive value, sensory quality, and consumer acceptance of meat.
Ulrik Sidenius
The Therapy Garden Nacadia®
The Interplay Between Evidence Based Health Design in Landscape Architecture, Nature-Based Therapy and the Individual

Supervisor(s): Professor MSO Ulrika K. Stigsdotter

Department: Geoscience and Natural Resource Management

Date of defense: 18 August 2017
Date of awarded PhD degree: 23 August 2017

Summary:
The therapy garden Nacadia® is designed to provide a setting and framework for a nature-based therapy (NBT) program for people suffering from stress-related illnesses. It was established through an evidence-based health design in landscape architecture (EBHDL) process, an interdisciplinary collaborative process that used state-of-the-art evidence and expert knowledge on therapy gardens and NBT. This PhD project is an exploratory study that examines the relationship between the design of a therapy garden, a nature-based therapy program and citizens with severe stress. The overall aim is to gain a deeper understanding of and develop more knowledge about landscape architecture in a therapeutic intervention under Danish conditions. Data were collected from 42 severely stress citizens during a 10 week NBT program in Nacadia. Several data collection and data processing methods were used: Landscape analyses, observations, participants' logbooks, interviews and questionnaires.

The first part of the study determined how the different types of activity were distributed around the garden and that the most preferred rooms were described as: “Enclosed”, or “slightly closed” but with a “view out”, to “see far”, and “see the sky” to get a “sense of expanse”. It gave the participants the feeling that their “backs were covered” and that they were “protected from behind”. Such places were preferred for emptying the mind, reflecting in peace or getting small experiences. The second part of the study shows that the participants in NBT experience it as a dynamically evolving process in which they explore and develop to understand themselves and life from new perspectives, and to live life from new approaches that can be implemented in their own lives after the NBT. The level of their capacities increases linearly. A third part of the study conclusively evaluates the garden design in relation to its original aim and objectives. A number of successes and minor failures in Nacadia were identified. Overall, the design of the garden meets the original objectives satisfactorily. The issue of exposure was the biggest problem in the design. Further the third study develops a model for diagnostic post occupancy evaluations (DPOE) of therapy gardens. It is an effective tool for ensuring health-promoting effects in accordance with the aims and objectives of the landscape design.

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The Therapy Garden Nacadia®

The interplay between evidence-based health design in landscape architecture, nature-based therapy and the individual

Supervisor(s):
Professor MSO Ulrika K. Stigsdotter

Department:
Geoscience and Natural Resource Management

Date of defense: 18 August 2017
Date of awarded PhD degree: 23 August 2017

Summary:
The therapy garden Nacadia® is designed to provide a setting and framework for a nature-based therapy (NBT) program for people suffering from stress-related illnesses. It was established through an evidence-based health design in landscape architecture (EBHDL) process, an interdisciplinary collaborative process that used state-of-the-art evidence and expert knowledge on therapy gardens and NBT. This PhD project is an exploratory study that examines the relationship between the design of a therapy garden, a nature-based therapy program and citizens with severe stress. The overall aim is to gain a deeper understanding of and develop more knowledge about landscape architecture in a therapeutic intervention under Danish conditions. Data were collected from 42 severely stressed citizens during a 10-week NBT program in Nacadia. Several data collection and data processing methods were used: Landscape analyses, observations, participants' logbooks, interviews, and questionnaires.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Syed Ajijur Rahman
Incorporation of Trees in Smallholder Land Use System: Farm Characteristics, Rates of Return and Policy Issues Influencing Farmer Adoption

Supervisor(s):
Professor Jette Bredahl Jacobsen
Professor John Healey

Department:
Food and Resource Economics

Date of defense: 15 August 2017
Date of awarded PhD degree: 31 August 2017

Summary:
The main cause of tropical deforestation is conversion to agriculture, which is continuously increasing as a dominant land cover in the tropics. The loss of forests greatly affects biodiversity and ecosystem services. Agroforestry systems have been proposed as a mechanism for sustaining both biodiversity and its associated ecosystem services in agricultural areas, by increasing tree cover, while maintaining agricultural production. This thesis aims to assess the rates of return resulting from incorporating trees into food-crop-based smallholder agricultural systems, in order to assess the economic and social potential of agroforestry systems, and the barriers to their widespread adoption in the study sites in eastern Bangladesh and West Java, Indonesia. Data were collected through rapid rural appraisal, focus group discussions, field observation, semi-structured interviews of farm households and key informant interviews of state agricultural officers. Five main agroforestry systems exist in the Java study area, and all of them exhibit a noticeable diversity in terms of both species composition and utilization. In both Java and Bangladesh the inclusion of tree crops in seasonal agriculture improved the systems’ overall economic performance (NPV), even when it reduced understory crop production. Tree ownership was associated with more permanent rights to farmland and was prestigious in the community, which also helped strengthen social cohesion when the products (fruit, vegetables, etc.) were shared with neighbors. Agroforestry farmers were less involved in forest clearing and forest products collection indicating that agroforestry may contribute positively to conservation of local forests. However, seasonal agriculture has a higher income per unit of land area used for crop cultivation compared with the tree establishment and development phase of agroforestry farms. There is thus a trade-off between short-term loss of agricultural income and longer-term economic gain from planting trees in farmland. Various conditions can facilitate tree farming as some farmers are reluctant to implement agroforestry. Therefore there is a need for a carefully designed landscape approach supported by coherent local communities and competent government policies. In land-use classifications agroforestry systems are not recognized as forestry, but like forests they provide tree products and services. Classification will always be problematic if a binary system is applied, thus a more sophisticated approach should be adopted that incorporates the economic and environmental characteristics of a wider range of systems.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Christian Majenz

Entropy in Quantum Information Theory – Communication and Cryptography

Supervisor(s):
Professor Matthias Christandl

Department:
Mathematical Sciences

Date of defense: 29 August 2017
Date of awarded PhD degree: 1 September 2017

Summary:
Entropies have been immensely useful in information theory. In this Thesis, several results in quantum information theory are collected, most of which use entropy as the main mathematical tool.

The first one concerns the von Neumann entropy. While a direct generalization of the Shannon entropy to quantum mechanical states, the von Neumann entropy behaves differently. The latter does not, for example, have the monotonicity property that the latter possesses: When adding another quantum system, the entropy can decrease. A long-standing open question is, whether some more complicated inequalities of the Shannon entropy, so-called unconstrained non-Shannon type inequalities, hold or fail for the von Neumann entropy. Here, a new constrained inequality is proven, a step towards a conjectured inequality by Linden and Winter.

Like many other information-theoretic tasks, quantum data compression has recently been analyzed in the so-called one-shot setting, where the considered task has to be achieved once at a time. This has required some additional mathematical machinery, compared to the well-studied asymptotic case that can be analyzed using a technique called "decoupling". We introduce a natural generalization of this technique, catalytic decoupling, that is fit to replace standard decoupling in the one-shot scenario.

Quantum teleportation is one of the most basic building blocks in quantum Shannon theory. A variant, port based teleportation, cannot be implemented perfectly, and the resource requirements grow boundlessly for smaller and smaller error tolerances. We prove several lower bounds on the necessary resources to achieve port based teleportation for given input size and error. As a byproduct, a new lower bound for the size of the program register for an approximate universal programmable quantum processor is derived.

Finally, the mix is completed with a result in quantum cryptography. While quantum key distribution is the most well-known quantum cryptographic protocol, considerable effort has been directed at generalizing classical cryptographic security properties to the case of quantum messages. We give an improved definition for quantum non-malleability, a property that ensures that an adversary cannot modify a message in a meaningful way, and investigate its properties and relationship to authentication.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Isabelle Laude
Mapping Spaces, Centralizers, and p-Local Finite Groups of Lie Type

Supervisor(s):
Professor Jesper Grodal

Department:
Mathematical Sciences

Date of defense: 24 August 2017
Date of awarded PhD degree: 1 September 2017

Summary:
The thesis is in the field of algebraic topology where abstract spaces are studied using different invariants. Groups are algebraic structures and there exist spaces that encode different algebraic properties of groups. In this thesis we compare such encodings from a variety viewpoints stemming from such invariants.

More specifically we study the space of maps from the classifying space of a finite p-group to the Borel construction of a finite group of Lie type G in characteristic p acting on its building. Here, the second space can be seen as the space embodying the local information at a prime.

The first main result is a description of the homology with Fp-coefficients, showing that the mapping space, up to p-completion, is a disjoint union indexed over the group homomorphism up to conjugation of classifying spaces of centralizers of p-subgroups in the underlying group G. We complement this description by determining the actual homotopy groups of the mapping space. These results translate to descriptions of the space of maps between a finite p-group and the uncompleted classifying space of the p-local finite group coming from a finite group of Lie type in characteristic p, providing some of the first results in this uncompleted setting.
PHD GRADUATE FROM FACULTY OF SCIENCE

Søren Dahlgaard
Tabulation Hashing for Large-Scale Data Processing

Supervisor(s):
Professor Mikkel Thorup
Professor Stephen Alstrup

Department:
Computer Science

Date of defense: 17 August 2017
Date of awarded PhD degree: 1 September 2017

Summary:
The past decade has brought with it an immense amount of data from large volumes of text to network traffic data. Working with such large-scale data has become an increasingly important topic, giving rise to many important problems and influential solutions. One common denominator between many popular algorithms and data structures for tackling these problems is randomization implemented with hash functions.

A common practice in the analysis of such randomized algorithms, is to work under the abstract assumption that truly random unit cost hash functions are freely available without concern for which concrete hash function to employ. However, the choice of hash function is of huge importance, as the theoretical guarantees of a randomized algorithm rely crucially on this choice, and the analysis breaks down completely when too simple hash functions are used. Furthermore, hashing is often employed as an “inner-loop” operation and evaluation time is thus of utmost importance.

This thesis seeks to bridge this gap in the theory by providing efficient families of hash functions with strong theoretical guarantees for several influential problems in the large-scale data regime. This is done by studying families of tabulation-based hashing – a method for constructing very efficient hashing schemes based on table lookups and word parallelism.
Testing Cosmological Models

Summary:
The concordance model of cosmology is remarkable for its apparent simplicity, and vast range of predictions. Yet its two most well known and infamous ingredients, dark energy and inflation, have so far avoided all attempts at direct observation. Even so, theorists invent ever more exotic models, and experiments must keep up at an ever increasing pace, preserving both precision and accuracy in the analysis.

In this thesis I compute corrections to large scale structure observables, corrections we expect solely due to general relativity. The calculations can be perceived in two ways. The pessimist will say these effects are unwanted systematics in the search for primordial physics, the optimist will see it as a chance to test general relativity to ever increasing precision. Regardless, these effects must be computed as part of the interpretation of coming observations.

I calculate the predicted bispectrum in galaxy number counts from general relativistic effects. This includes in particular lensing, which will systematically shift the observed relativistic effects for observations of large scale structure. Furthermore, I develop and explore a scheme for fast computation of the galaxy number count spectra, in the flat-sky approximation.

The last part of the work is a numerical analysis of the resulting spectra. I analyse both the potential observability of individual bispectra, and their correction due to general relativistic effects. It is clear from the results that lensing must be carefully included in any attempt at accurately extracting primordial bispectra.
PHD GRADUATE FROM FACULTY OF SCIENCE

Ann-Sophie Iuel-Brockdorff
Acceptability of Supplementary Foods for Children with Moderate Acute Malnutrition and Feeding Behaviors During Home-Based Treatment

Supervisor(s):
Professor Henrik Friis
Affiliate Associate Professor Vibeke Brix Christensen

Department:
Nutrition, Exercise and Sports

Date of defense: 1 September 2017
Date of awarded PhD degree: 4 September 2017

Summary:
Moderate acute malnutrition (MAM) affects around 33 million children and is a major global health problem, but there is currently no standardized practice for the management of MAM, despite the development of lipid-based nutrient supplement (LNS) and enhanced versions of corn-soy blend (CSB) as supplementary foods for the treatment of MAM. Information on acceptability and feeding behaviors is crucial when it comes to the understanding of the effectiveness of supplementary foods for the treatment of MAM. The Ph.D study was conducted as part of the TreatFOOD trial, a randomized controlled trial assessing the effectiveness of new formulations of supplementary foods for children with MAM with different quantities of milk and different qualities of soy. It included a mixed method approach using questionnaires, focus group discussions, home visits and interviews.

The study found that although all products received good ratings, LNS was more appreciated as was both LNS and CSB with high content of milk. In terms of organoleptic parameters such as taste, texture and odour, the content of milk and quality of soy did not affect acceptability. CSB was not as readily consumed as LNS and was to a higher degree considered difficult to manage. Both products were considered as a medical treatment and beneficial to child’s health. An encouraging and more tactile feeding style was more likely to be applied when feeding with LNS, while a forced feeding style was more frequently applied when feeding CSB, which was often served unprepared and not as frequently as recommended. Finally, a certain degree of household sharing of both CSB and LNS was found.

The findings presented in this thesis support the findings related to the effectiveness of the TreatFOOD supplements by determining how and for what reasons supplements developed for the treatment of MAM are accepted in the given context and how, when, where and by whom they are used. Thereby the findings contribute to the evidence base related to the management of children with MAM.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Laure Berthier
Ultraviolet Extensions of Particle Physics
The Standard Model: Le Malade Imaginaire

Supervisor(s):
Professor Poul Henrik Damgaard

Department:
Niels Bohr Institute

Date of defense: 1 September 2017
Date of awarded PhD degree: 4 September 2017

Summary:
The discovery of the Higgs boson in 2012 at the Large Hadron Collider completed the Standard Model field content. Many questions though remain unanswered by the Standard Model triggering a search for new physics. New physics could manifest itself at the Large Hadron Collider by the discovery of new particles. However, the lack of new resonances might suggest that these new particles are still out of reach which leaves us with few options. Two possibilities are explored in this thesis. The first is to study precision measurements which might indicate new physics as small deviations from the Standard Model predictions. The second is to construct an ultraviolet completion of the Standard Model which allows for a naturally light Higgs while maintaining a sizable hierarchy between the Higgs mass and the cutoff scale of the theory.

A general approach to parametrize small deviations from the Standard Model is by the use of effective operators. We consider all operators of higher dimensions made of the Standard Model’s fields while respecting its symmetries. The Standard Model effective field theory is obtained by adding these operators to the Standard Model. In this thesis, we use electroweak precision data to set constraints on a subset of the parameters of the Standard Model effective field theory. Furthermore, we develop a novel statistical method to fit for the parameters of the Standard Model effective field theory which accounts for the missing higher orders of these parameters in the theoretical predictions of the observables.

Finally, we study a nonrelativistic ultraviolet completion of the Standard Model which restores technical naturalness while keeping a hierarchy between the Higgs mass and the cutoff of the Standard Model. More precisely, the theory allows for a naturally light Higgs while preserving a hierarchy of seven orders of magnitude and reasonable magnitudes for the gauge coupling, the Yukawa couplings and the Higgs quartic self-interaction.

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Madeleine Ernst

An Evolutionary Perspective on Drug Discovery in the Plant Genus Euphorbia L. (Euphorbiaceae)

Supervisor(s):
Professor Nina Rønsted, Associate Professor Henrik Toft
Simonsen, Olwen M. Grace, Niclas Nilsson

Department:
Natural History Museum of Denmark

Date of defense: 25 August 2017
Date of awarded PhD degree: 4 September 2017

Summary:
Plants have been widely used in traditional medicine around the world and are still the source of many drugs. However, the rate at which new plant-derived drugs are discovered is slow and recent estimates of biodiversity loss, as well as the need for tackling global healthcare threats, urge for systematic and time-efficient approaches in finding new drug candidates. Through evolutionary processes, plants have adapted to their environment by producing a variety of specialized molecules, which they, for example, use to combat herbivores or attract pollinators. These molecules also often exhibit biological activities with pharmaceutical interest.

Consequently, specialized molecules, as well as plants used in traditional medicine, are not arbitrarily distributed across evolutionary trees. Evolutionary approaches to plant-based drug discovery suggest that this information can be used in the search for new drugs. The genus Euphorbia (spurges) is among the largest genera of flowering plants with an almost cosmopolitan distribution. Its species richness and remarkable diversity in growth forms have made it a model group for understanding plant evolution and diversification. Also, spurges produce an often highly toxic sap containing specialized molecules with known pharmaceutical interest. In this PhD project, the genus Euphorbia was chosen as a model group for studying evolutionary approaches to plant-based drug discovery. It was found that species used in traditional medicine are not randomly distributed across the evolutionary tree. Euphorbia specialized molecules and biological activities were investigated using mass spectral molecular networking, 3D mass spectral imaging as well as high-resolution bioactivity profiling in cell-based high-throughput screening assays of over 40 species sampled from the Botanical Garden in Copenhagen. Pharmaceutically highly relevant molecules were found to be most diverse and abundant in species native to Europe, Africa, and Asia, compared to species native to the Americas. It is hypothesized that these species are subject to a coevolutionary plant-herbivore arms race, leading to more diverse and biologically active molecules.
Neutron Scattering Studies of Low Dimensional Magnetic Systems

Summary:
In magnetic materials the main interactions are of quantum mechanical nature and even though the models describing these can be relatively simple the resulting physical behaviour can be extremely complex and hard to predict. Understanding these emergent quantum phenomena is both crucial for future technologies where manipulating and controlling the quantum states of electrons is a long term goal, but at the same time one of the major challenges in condensed matter physics.

Neutron scattering as a technique is unique in the sense, that the due to the interaction between the spin of the neutron and the magnetic moments within the sample, it possible to study both the magnetic ground state of the system and its characteristic magnetic excitations. Knowing both of these is often the key to deciphering the physical properties of a material, that can be compared to theoretical models.

This thesis is divided into two parts, one concerning the complex magnetic dynamics of the low dimensional quantum magnet CoCl$_2$ 2D2O. Here we have discovered several new and exotic features in the excitation spectrum, which have been compared to theoretical models.

The other part is concerned with the design of neutron optics for the European Spallation Source, currently under construction in Lund, Sweden. The European Spallation Source (ESS) is a pan-European high power neutron facility, which has the potential to become the world's most powerful neutron source. At the moment a total of 15 instruments have been selected for construction and each of these instruments have specific requirements for the neutrons needed for their experiments, which means that it is necessary to have specialised neutron optics tailor made for each instrument.
Knud Ryom
Unge, holdspil og medborgerskab. Det dårlige selskab?
Et lokalt aktionsforskningsprojekt på Ydre Nørrebro

Supervisor(s): Professor Reinhard Stelter

Date of defense: 1 September 2017
Date of awarded PhD degree: 4 September 2017

Summary:
The overall purpose of this study was to examine how an action research oriented and community psychological approach might influence a social change in a local neighbourhood and how it was perceived by the participants - young boys (12-16 years) from a socially challenging neighbourhood in Copenhagen. The project involved: 1) organized youth sports (football) in the local community, 2) coaching and mentoring sessions in school, and 3) various new learning techniques. The possible influences of these three studies as part of an overall experiment over time (2 years) in regard to social capital, social resilience, life-skills and citizenship were investigated.

The theoretical framework of this study was primarily based on previous works by Reason & Bradbury (2008), Orford (2008), Berliner et al. (2005), Putnam (2000), Cefei (2009), Gould & Carson (2008) and Biesta (2013).

The design of the study was within a qualitative framework, with special emphasis on ethical responsible research (Denzin, 2015). Methodological multi-method (Brewer & Hunter, 2006) approach was used to ensure thorough knowledge, which was necessary when working in real life setting and with a complex research area. Methods used included questionnaires, interviews, fieldwork and observations. The use of a questionnaire in action research and quantitative framework is discussed as a fruitful new path in action research (Greenwood & Levin, 2011; Marti, 2016). Data were collected from participants at the local school and partner school (acting as a control group in the quantitative analysis, but involved still involved in the project), including all boys aged 12-16 at both schools.

The main results showed that: a) the project enhanced self-concept, b) enhanced physical competencies, c) enhanced social networks at the school, and d) the cooperation competencies in the classes were improved, results which increased the participants' motivation in school. The results challenge the public notion that bridging activities (Putnam, 2000) are preferred when working with boys from socially challenging communities. This project suggests that bonding might be a good first step if the aim is social resilience and citizenship. Results also points towards a synergy effect between coaching and team sport participation when working with social connectiveness (Ryom et al., 2017). Further studies are needed.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Peter Elsborg
Volition and Motivation’s Influence on Weight Loss Maintenance in the Period Following an Intensive Lifestyle Intervention

Supervisor(s):
Associate Professor Anne-Marie Elbe
Professor Emeritus Getrud Ursula Pfister

Department:
Nutrition, Exercise and Sports

Date of defense: 4 September 2017
Date of awarded PhD degree: 4 September 2017

Summary:
The aim of this thesis was to investigate how motivation and volition influence the difficult task of weight loss maintenance for individuals battling obesity in the period that follows an Intensive Lifestyle Intervention (ILI). To reach this aim, the three individual research studies was conducted. In Study 1 the Volition in Exercise Questionnaire was validated in a sample of 836 university students. In Study 2, a longitudinal study, mixed model analysis of 164 ILI participants revealed that exercise specific volition and motivation influence the task of weight loss maintenance in the period that follows an ILI. Study 3, an interview based qualitative study of 11 successful and 4 unsuccessful ILI weight maintainers, showed that important challenges in the period that follows the ILI, were explained by volition as described in the Personality Systems Interaction Theory and the basic psychological needs and motivation quality described in the Self-determination Theory. Overall, this thesis underlined the importance of including all phases of the Rubicon Model of Action Phases when investigating the motivational aspect of weight loss maintenance following an obesity intervention.

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Marta Lomas Vega
Internal and External Factors Shaping Movement and Distributions of Trans-Saharan Migrants

Supervisor(s):
Associate Professor Kasper Thorup

Department:
Natural History Museum of Denmark

Date of defense: 1 September 2017
Date of awarded PhD degree: 6 September 2017

Summary:
The migratory programme provides birds with the capacity to seasonally migrate long distances every year. Using tracking methods, my thesis investigates internal (innate) and external factors of this programme, specifically, (1) how juvenile small birds migrate, (2) how the environment influences migration, and (3) large-scale patterns influenced by the migration programme; migration strategy and genetic population structure.

To investigate the innate migration programme, I track migrating juvenile common cuckoos. This species is suitable to study the innate migration programme since it, as a brood parasite, has no contact with its biological parents, and migrates alone at night. Experimentally displacing juvenile cuckoos, I also investigate whether the navigation ability is inherited. Using a novel migration-route for the species, non-displaced juveniles reached population winter grounds, and displaced juveniles did not show evidence of displacement compensation. In conclusion, the innate mechanism of migration in cuckoos can facilitate migration to population winter grounds, and possibly includes a simple navigation capability enabling juveniles to compensate for crosswind on the move, but not for experimental displacement.

To study external influence, I investigate the relation between migration schedules and seasonal changes in food resources, and look at the potential influence of climate change projections on the migration routes of several long-distance migrants. Results indicate that these migrants adjust the migration schedules to food resource availability, and climate projections suggest migration routes may be affected in the future. I also investigate local movement patterns in relation to food availability to ground-truth global patterns. I find influence of food availability, but chick rearing, temperature and rain are also important factors.

To investigate large-scale variation in migration strategy, I use southern European migrants and compare their strategies to those of northern migrants. Results suggest southern migrants are less time-constrained than northern migrants in autumn, and this may be related to the shorter migration distance. Finally, using genomic analysis, I investigate population structure of the red-backed shrike, as a first step to infer its migration route history. Results indicate more differentiation between distant populations.

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This PhD-study revolves around the 1755 and 1625 explosive eruptions from Katla volcano. Katla is one of the most dangerous volcanoes in Iceland and has previously sent ash raining down on Northern Europe, including in 1755 and 1625. A similar eruption in the present day would cause major disruption to air traffic and current unrest suggests that another eruption may be imminent.

There are two aims of this PhD-study. One is obtain eruption parameters for the 1755 and 1625 eruptions to assess the size of the eruptions. The second aim is to understand the high-explosivity basaltic eruptions in Iceland. I answered these two research questions by studying the 1755 and 1625 eruption deposits.

To obtain eruption parameters, I dug 53 holes in soils around Katla to measure thicknesses of the tephra layers. I took ash samples to measure the size of the ash grains. From the thickness measurements I could model the erupted volume and mass in 1755 as 1.20-1.50 km3 and 1.84-2.45-1012 kg and in 1625 as 1.12-1.36 km3 and 1.53-1.94-1012 kg. This shows much more material was erupted than previously estimated. Then I used the weight and volume of some of the field samples as inversion inputs in a tephra dispersal model (Tephra2). The Tephra2 model calculates how tephra settles around the volcano during an eruption using the size of the ash grains and wind conditions. I estimated an average height of the plume of 14.4 km for the 1755 eruption and of 16.6 km for the 1625 eruption. Finally I classified the eruptions as subplinian to plinian (VEI 4-5) showing the eruptions were larger than previously thought.

Furthermore I have used the correlation between ash grain shapes and magma fragmentation to understand the explosivity of Icelandic basaltic eruptions. I measured shapes of ash grains from 6 different basaltic eruptions in the new automated Particle Insight dynamic shape analyzer. I created a reference dataset and used statistics to select the best shape parameters for a new classification diagram. The diagram shows that the explosivity of Katla is a result of both magmatic degassing and water/magma interaction. This is a new fast method to successfully assess magmafragmentation.
PHD GRADUATE FROM FACULTY OF SCIENCE

Von Yi Yap

Legume Integration as an Agroecological Intensification Option for Smallholders in Uplands of Southeast Asia

Supervisor(s):
Professor Andreas de Neergaard
Associate Professor Thilde Bech Bruun

Department:
Plant and Environmental Sciences

Date of defense: 1 September 2017
Date of awarded PhD degree: 8 September 2017

Summary:
The transition from swidden agriculture to intensified maize (Zea mays L.) monoculture in uplands of Southeast Asia has led to the decline in soil fertility, which necessitates the use of fertilisers to sustain crop productivity. Although the integration of legumes via relay cropping offers the opportunity to improve soil fertility and crop productivity, legume adoption by maize smallholders remains low. A combination of participatory rural appraisal tools, field trials and greenhouse pot experiment was carried out to investigate the feasibility of integrating legumes into maize-based cropping systems as an agroecological intensification option for smallholders in the uplands of Southeast Asia. The results showed that maize monocropping and maize/legume relay cropping had similar economic returns, implying that switching from the conventional maize monocropping to maize/legume relay cropping could be a low-cost pathway towards agroecological intensification. A positive maize yield response to phosphorus (P) fertiliser application was observed under high water availability but not under low water availability, indicating that maize-legume intensification with moderate use of fertiliser-P inputs could be a feasible option for upland smallholders under normal weather conditions but not under drought conditions. The top-down intervention approach by the extension agents in promoting the innovation of legume integration into maize-based cropping systems without considering farmers’ needs and local testing of optimum planting practices resulted in failure of the innovation. The profitability of growing legumes, labour availability, financial status of the household and access to extension services were the major factors influencing the decisions of resource-poor maize smallholders in legume adoption. In a nutshell, introducing legumes as relay crops into maize-based cropping system can be an agroecological intensification option for the smallholders in uplands of Southeast Asia. However, it may be risky for the farmers if the first year integration of legumes coincides with drought events. Also, the type of intervention approaches by the extension agents needs to be considered to ensure sustained adoption of legume innovation.

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Alessandro Pirrotta
Modulating Pathways for Electron and Energy Transfer Through Molecules

 Supervisor(s):
Associate Professor Gemma C. Salomon

Department:
Chemistry

Date of defense: 31 August 2017
Date of awarded PhD degree: 11 September 2017

Summary:
Energy transport efficiency and electric conductance are molecular properties that motivates the development of optoelectronic materials, energy storage, and electronic devices. Several experimental techniques allow measurement of these properties and regularly, modeling is employed to find correlations between chemical structure and molecular properties. This dissertation discusses the interplay between modeling and experiments toward the assessment of new relations between the molecular structure and properties. In particular, it has been shown how simulations can push the development of new experimental techniques, demonstrate the potential of already established techniques, and work in synergy with experiments. It is demonstrated how the use of modeling can expand our understanding of how chemical structure affects molecular properties, which will enable us to design molecules with specific electron and energy transfer properties.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Juliane Große

Urban Structure and Sustainable Transport
Exploring the Relationship Between Urban Structure and Travel Behaviour and the Role of Urban Planning in Northern Europe

Supervisor(s):
Associate Professor Trine Agervig Carstensen
Associate Professor Christian Fertner, Niels Boje Groth

Department:
Geosciences and Natural Resource Management

Date of defense: 7 September 2017
Date of awarded PhD degree: 11 September 2017

Summary:
Transport is responsible for one third of the energy consumption and one quarter of the greenhouse gas emissions in the European Union. Although technological improvements have fallen short of inducing the required reductions, transport is still predominantly the subject of a technology debate. On the contrary, the potential for structural changes in travel behaviour has not been sufficiently exploited yet.

This PhD study explores the relationship between urban structure and travel behaviour and the role of urban planning in promoting more sustainable travel patterns. The study conceptualises the role of urban planning by means of a multiple-case study of the three medium-sized Northern European cities, Eskilstuna, Turku and Tartu, that was conducted based on qualitative methods.

Further, the study investigates the relationship between the urban structure of people’s living environment and their travel behaviour by integrating daily modality styles (work and leisure), and weekend and holiday travel behaviour in a comprehensive analysis. Moreover, the phenomenon of compensatory leisure travel is addressed. For this purpose, a questionnaire survey was carried out in an urban district (Østerbro) of central Copenhagen and in a small town (Borup) in the commuter belt of Greater Copenhagen.

The study achieves a comprehensive understanding of travel behaviour and qualifies the role of urban structure in relation to further determinants. The influence of urban structure is largely limited to daily travel (bounded trips). Beyond urban structure, other determinants such as socio-economic factors, personal preferences and lifestyle, which are partly reflected in residential choices, have a significant influence on travel behaviour. This becomes particularly evident in weekend and holiday travel (non-bounded trips). Additionally, summer cottage use among city dwellers indicates some sort of compensatory leisure travel.

Consequently, urban planning can optimise urban structure and cooperate in transport planning, but structural adaptations of travel behaviour require also the involvement of higher tiers of policy-making.

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CaCO₃ minerals, including calcite and aragonite, are commonly occurring and widely found in marine environments. As a biomineral, CaCO₃ is formed by many of the living organisms in the oceans. Biominal growth is complex and depends on both organic molecules and inorganic ions to control morphology and growth rates. My research explored the combined influence of the common seawater ions, Mg²⁺ and SO₄²⁻, because both are present when CaCO₃ forms inorganically and as a product of biomineralisation. Mg²⁺ and SO₄²⁻ are both known inhibitors of CaCO₃ growth, so I wanted to investigate any synergistic effects caused by the MgSO₄⁰ ion pair.

The thesis results were acquired through wet chemistry, surface spectroscopy, crystallographic analysis and microscopic techniques combined with computer modelling. My findings support the hypothesis that the MgSO₄⁰ ion pair plays a role in Mg uptake in calcite. However, the influence of the MgSO₄⁰ ion pair is negligible on the rate of calcite growth, i.e. the system’s kinetics. The increased inhibition of calcite growth caused by MgSO₄ (aq) compared to Mg²⁺ can be explained by individual effects of Mg²⁺ and SO₄²⁻. For aragonite no increase in growth inhibition was gained from combining Mg²⁺ and SO₄²⁻. The inhibition mechanism for calcite growth was blockage of step sites, which hinders adsorption of the CaCO₃⁰ ion pair. Step blocking is the only inhibition mechanism for SO₄²⁻. For Mg²⁺, step blocking accounts for > 90 % of the inhibition effect and another < 10 % results from Mg²⁺ creating ion pairs with CO₃²⁻, which reduces the CaCO₃⁰ ion pair concentration.
Obesity prevalence is increasing and obesity increases the risk of type II diabetes and CVD. Dietary modulation is applied in prevention and treatment of obesity, but an optimal diet to improve weight loss maintenance has not been found. Recently, it has been observed that the composition of bacteria in the gut (gut microbiota) is associated with obesity and obesity-associated diseases. However, a deeper understanding of how the host metabolism is affected by dietary modulation of the gut microbiota is warranted. The objective for this PhD thesis was to investigate how nutrition affects the gut and the microbiome in relation to obesity and obesity-associated diseases. The objective was investigated by the following studies. In Study I, the effect of calcium intake on fecal fat excretions was investigated. 189 subjects collected fecal samples for five days and had a 1-day visit where metabolic markers and anthropometric data were collected. In Study II, the effect of protein supplementation on weight loss maintenance was investigated. 220 subjects went through an 8-week weight loss period followed by a 24-week weight maintenance period. Measurements included; anthropometry, appetite sensation and energy expenditure. In Study III, the effect of a prebiotic fiber (AXOS) and polyunsaturated fatty acid (PUFA) intakes on the gut microbiota composition was investigated by a cross-over trial with two 4-week diets periods and a 4-week washout period. Fecal samples and metabolic markers were collected from 30 subjects before and after each diet period. Results showed that calcium intake was not associated with fecal fat excretion, however, negatively associated with total and LDL cholesterol and blood pressure. Protein supplementation did not improve weight loss maintenance, despite sustained effects of appetite sensation and energy expenditure. AXOS intake changed the gut microbiota composition, but beneficial changes in metabolic markers were not observed. PUFA intake did not alter microbiota composition, but lowered blood pressure. In conclusion, the current evidence does not support that protein supplementation improves weight loss maintenance. Convincing evidence supports that calcium intake improves blood pressure and lipid profile, while an effect on fecal fat remains inconclusive. AXOS intake alters gut microbiota, whereas the effect of fat quality is inconclusive due to the limited literature.
PHD GRADUATE FROM FACULTY OF SCIENCE

Ursula Kehlet
Meat and Appetite Regulation - Effects of Fiber Addition and Cooking Methods

Supervisor(s):
Professor Anne Raben
Margit Dall Aaslyng

Department:
Nutrition, Exercise and Sports

Date of defense: 15 September 2017
Date of awarded PhD degree: 20 September 2017

Summary:
Obesity is a significant risk factor for lifestyle related diseases. Foods capable of suppressing hunger and decreasing energy intake could be an efficient tool in obesity prevention. Dietary protein and fiber have been suggested to enhance satiety. A combination of dietary fiber and protein could therefore be beneficial in the formulation of satiety enhancing foods. Moreover, cooking is known to induce structural, physical and chemical changes of the meat proteins, which in turn may affect protein digestibility and potentially affect satiety.

Denmark is one of the world’s leading exporters of pig meat. Although pork is an important source of dietary proteins, some pork products are also characterized as high fat products containing more than 10 g fat per 100 g. In this context, the Danish meat industry puts a lot of effort into developing meat products with a healthier nutritional profile. Thus, it is relevant to provide scientific evidence of the satiating effects of new formulations of pork products.

Different strategies can be applied to potentially enhance the satiating properties of pork. Processed meat products such as meatballs can serve as a matrix for the addition of fiber ingredients. Based on their high protein and fiber contents, high-fibre meatballs could provide a dual mechanistic action that would lead to greater satiety. For whole muscles, cooking is known to induce structural, physical and chemical changes of the meat proteins, which in turn may affect protein digestibility and potentially affect satiety.

The overall aim of this PhD thesis was to investigate the effects of fiber addition to meatballs and the effects of cooking methods of pork on appetite regulation. The PhD thesis is based on three human meal test studies, one sensory study and one analytical study related to the characteristics of fiber meat products.

In conclusions, the present PhD thesis suggests that meatballs with rye bran and pea fiber enhance satiety, although this is limited to subjective measures of appetite. Furthermore, the satiating properties of pork muscles remained unaffected by LTLT sous vide cooking.

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Mads Bertelsen
Software for Simulation and Design of Neutron Scattering Instrumentation

Supervisor(s):
Associate Professor Kim Lefmann

Department:
Niels Bohr Institute

Date of defense: 22 September 2017
Date of awarded PhD degree: 27 September 2017

Summary:
Software developments related to neutron scattering instrumentations are presented. Neutron scattering is a powerful technique that can be used to deduce the positions and movements of atoms in crystals. To achieve this, a sample is placed in an instrument specialized for the appropriate length scales and time resolution, where a neutron beam is led to interact with the sample. Neutron beams are delivered by guides consisting of mirrors that can reflect neutrons for low angles of incidence. Designing such a guide relies on computer simulations that take considerable effort to write. The guide_bot software package is presented that automatically generates the required simulation programs from very limited user input. These simulations can optionally include developed constraints that minimize unwanted background from the source, while still preserving the majority of the useful beam intensity. Guides designed using guide_bot are presented, and the software is used to design guides for a variety of source candidates for the European Spallation Source currently under construction in Lund, Sweden. The data collected in that survey was part of the foundation on which the final decision on source geometry was made. When conducting a neutron scattering experiment on an instrument, there are several sources of uncertainty and possibly systematic errors. Many of these can be simulated by the McStas simulation package so that they may be minimized during design of the instrumentation. McStas was expanded by generalizing the handling of neutrons that scatter multiple times within complicated geometries, allowing researchers to study related systematic errors in greater detail. Two existing instruments were simulated using McStas and the developed expansions, MARI in England and MACS in USA. Simulated data had some deviations from the measured data, yet for most aspects the simulations accurately reproduced the measurements.
Novel Use of Tat Components to Increase Metabolic Flux in Light-Driven Biosynthesis

Summary:
Oxygenic photosynthesis provides plants, algae and cyanobacteria the ability to convert solar energy and CO₂ into complex organic molecules. Thus tapping into photosynthesis for synthetic biology efforts has a huge potential for the industrial production of fuels and high value bioactive compounds in a sustainable way. The dhurrin pathway typically resides in the ER of Sorghum bicolor and involves a dynamic metabolon formed by two P450s, a UDP-glucosyltransferase and a P450 oxidoreductase. This pathway has been relocated to the chloroplast where photosystem I and ferredoxin serve as an efficient electron donor to the P450s, bypassing the involvement of the P450 oxidoreductase. Nevertheless, translocation of the pathway from the ER to the chloroplast creates complications, such as intermediate diversion into other pathways. This thesis focuses on challenges related to substrate channeling that arise when relocating a biosynthetic pathway into the chloroplast, as well as possible solutions.

Paper I compares the potential of chloroplasts and cyanobacteria as sustainable biosynthetic compartments and hosts for metabolic engineering. An estimation of the percentage of photosynthetic electrons that can be redirected into the biosynthesis of products is given. The availability of photosynthetic reducing power appears to be non-limiting whereas the redirection of the fixed carbon seems to be main challenge for achieving higher product yields.

On paper II a novel strategy where the membrane anchors of the dhurrin pathway enzymes were exchanged with components of the Tat system, in the chloroplast of Nicotiana benthamiana is described. The aim was to co-localize the pathway enzymes and improve substrate channeling. This strategy led to a 4-fold increase in dhurrin titers and to a reduction of intermediate and side-products.

Paper III describes a similar approach in Synechocystis sp. PCC 6803. The Tat domains of the fusion proteins appeared to be cleaved off and no substrate channeling was observed. However, several physiological and morphological differences where observed in the dhurrin producing strains, which displayed light-sensitive and iron-deficient like phenotypes.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Sally Winther
Brown Adipocyte Function – A Study of Signaling and Fuel Pathways

Supervisor(s):
Associate Professor Jacob B. Hansen

Department:
Biology

Date of defense: 22 September 2017
Date of awarded PhD degree: 27 September 2017

Summary:
The worldwide increase in obesity and diabetes is a major concern for public health. Therefore finding new ways to increase energy expenditure and combat excess weight is of great importance. Brown adipose tissue is a specialized form of fat tissue in that it rather than store excess calories burns them. The brown fat cell can, when activated, take up large amounts of sugar and fat from the blood stream and combust them, releasing all the energy simply as heat in a process known as thermogenesis. Hence, activating thermogenesis is being explored as a mean to increase energy expenditure and stabilize blood sugar. Physiologically this energy wasting property of brown fat is stimulated by cold, and can be mimicked by administration of noradrenaline.

In this thesis we investigate the signaling pathways mediating the response to adrenergic stimulation. We find two new regulators of this process SYK and GSK3. We find that SYK is important for the development of brown fat, and that it is a positive regulator of thermogenesis in brown fat cells. We also establish that GSK3 is a negative regulator of the thermogenic response, and consequently inhibition of GSK3 has the potential to increase energy wasting in brown fat cells. This thesis also investigates the sugar (glucose) metabolism in brown fat, and underpins that brown fat have a large ability to combust glucose. We identify HIF-1α as an important regulator of glucose oxidation, and investigate the influence of glucose metabolism on thermogenic activation of brown fat cells.

In conclusion this PhD thesis reveal novel regulatory mechanisms controlling energy wasting and sugar combustion in brown adipose tissue. Since these processes are being explored as potential targets in treating obesity and diabetes the data presented are of great importance not only for basic adipose tissue biology, but potentially also for human disease.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Chelsea Chisholm
Functional Traits Drive Plant Community and Ecosystem Response to Global Change Across Arctic and Alpine Environments

Supervisor(s):
Professor Carsten Rahbek
Professor Nathan Sanders

Department:
Natural History Museum of Denmark

Date of defense: 22 September 2017
Date of awarded PhD degree: 2 October 2017

Summary:
While environmental variables, such as temperature and precipitation, are expected to directly influence plants and the habitats they live in (known as the ecosystem), what is less known is how changes to which plant species are found in a given locale may indirectly cause changes to ecosystem properties or function (e.g., the balance of carbon from the atmosphere to soil). In this thesis I attempt to disentangle the relative importance of these two contributing factors using information on characteristics of plants that tell us something about how these species function in their environment. I use experiments and observations in alpine and arctic regions to examine how these characteristics, or ‘functional traits’, contribute to interactions between species and ecosystem function. Understanding the response of these regions to drivers of global change is essential as both alpine and arctic areas are expected to be severely impacted by climate change in the future.
Eva Rotenberg
Algorithms and Data Structures for Graphs

Supervisor(s):
Professor Mikkel Thorup
Associate Professor Christian Wulff-Nilsen

Department:
Computer Science

Date of defense: 27 September 2017
Date of awarded PhD degree: 2 October 2017

Summary:
A graph consists of a set of vertices and a set of edges between vertices. Graphs are a popular mathematical model for road maps, communication networks, electrical circuits, social networks, disease transmission networks, job assignments, resource allocation, and more. A special class of graphs are planar graphs, which are those that can be drawn on a piece of paper without any pair of edges crossing. For planar graphs where each edge can only be traversed in one direction, a fundamental question is whether there is a route from vertex A to vertex B in the graph. We show how such a graph can be represented in a very compact way (linear space), such that we can still answer very fast (constant time) to questions of the form: "is there a path from A to B?"

When edges can be traversed in either direction, the graph is connected if for any two vertices of the graph, there is a path between them. However, for many practical purposes, e.g. in communication networks, it is important for the graph to be highly connected: If the removal of few vertices or edges would disconnect the graph, this points to a vulnerability in the network; an indication that the network connectivity may be about to break down. This is particularly challenging, because in the real world, graphs rarely stay as they are: Links in the communication network fail, a road becomes inaccessible or slow, or — social networks change all the time. We show how to represent a graph in a compact way, such that we can give fast answers to questions of the form: "Is there an edge such that all paths between A and B go via that edge?" and which can quickly be updated when edges are inserted or deleted.

We further show how to represent a planar graph such that we can quickly update our representation when an edge is deleted, and such that questions of the form: "How many non-crossing paths are there between A and B?" can quickly (in constant time) be answered by: "None", "One", "Two", or "At least 3".

Higher connectivity also has theoretical applications. Indeed, we study the problem of finding a tour that visits every vertex exactly once, and such that two consecutive vertices are at most 2 edges apart. For general graphs, it is NP-hard even to decide if such a tour exists, but when the graph is highly connected in the sense that it does not contain a vertex whose removal would disconnect it, we give a linear time algorithm for outputting such a tour. The previous best algorithm for this had quadratic running time.
Summary:
Pluvial floods in highly urbanized areas are a frequently occurring problem for society due to intense rainstorms and the continuous sealing of the urban landscape. Permeable pavement (PP) systems offer more benefits for dealing with pluvial floods. The aim of this thesis is two-fold: 1) to explore the hydrological performance of PP systems as a means of supporting urban storm water management, and 2) to assess the planning and design prerequisites for this performance as a means of strengthening urban resilience.

The research for this PhD thesis included three studies, each with their own specific aims. In Study I, four types of PP surfaces and three types of sub-base aggregates were combined and tested when built as six independently lined constructions into an existing parking area in Copenhagen. In Study II, a multiple case study, nine existing PP systems were tested for their surface permeability in two periods with an interval of one year and the results related to each site’s unique history of sedimentation. In Study III, a single-case study was used to explore suitable areas for converting existing paved areas on municipal land to PP systems, with due respect to spatial constraints. To highlight the potential hydraulic benefits of a conversion, calculations were made for a 10-year and 100-year design storm. Results show considerable variation in annual reductions of storm water volumes among the six PP systems tested. Variation ranged from almost zero to one-third, while volume reduction and lag-time to single events were more homogeneous across the PP system tested. Performance was associated with surface properties as well as sub-base aggregate properties (Study I). On-site sedimentation factors, particularly the perimeter design and adjacent land cover and land use, affect the surface permeability, potential to a level that override the effect of maintenance. This finding underscores the importance of proactive design and planning (Study II). In a dense urban context, there is considerable potential for siting PP systems. Regardless of whether the PP systems are unlined or lined, the hydraulic capacity is considerable and could be a valuable asset in addressing pluvial floods and storm water management on a city-wide scale (Study III). The studies described in this PhD thesis demonstrate that PP systems can contribute to improved urban storm water management, better landscape design and enhanced urban resilience.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Josue Leonardo Castro Mejia
Towards Understanding the Trajectory and Interactions of the Gut Microbiome in Healthy Older Humans

Supervisor(s):
Professor with special responsibilities Dennis Sandris Nielsen
Professor Søren Balling Engelsen

Department:
Food Science

Date of defense: 28 September 2017
Date of awarded PhD degree: 2 October 2017

Summary:
The human gastrointestinal tract gathers a complex community of microorganisms denominated the gut microbiome (GM). Mounting evidence suggests that imbalances in GM composition may trigger metabolic abnormalities in the host, which may impact muscle composition and frailty among older individuals. Here, we investigated food-preferences and dietary records, GM, host-metabolome and anthropometric/body-composition measurements (ABCm) of 100 home-dwelling subjects (65+ years) recruited by the CALM project. Through ABCm-stratification, two phenotypes were identified (high-, low-fitness). High-fitness individuals reported higher carbohydrate-intake that corresponded with plant-derived compounds in the gut metabolome (e.g. azelaic acid). Contrarily, early-onset of physiological decline (low-fitness) corresponded with lower abundance of GM members (e.g. Lachnobacterium, Akkermansia) associated with signaling-functions (e.g. cellular-antigens), as well as signs of an impaired glucose-metabolism possibly mediated by GM-to-host interactions. With a subset of this cohort, we also elucidated clusters of phage-bacteria interactions. In response to that interplay, we observed fluctuations in the functional properties of GM and metabolic responses in the host, as estimated on high-density lipoprotein (HDL) and estimated Glomerular filtration rate (eGFR) levels. Two biomarkers often used to predict the risk of developing metabolic syndrome. Along with that, we optimized two methods for phage-extraction based on tangential-flow filtration (TFF) and polyethylene glycol precipitation (PEG). Through our improved procedures, we reported significantly higher yields of viral-like particles and associated DNA, suitable for evaluation of morphological profiles and a variety of molecular genetic analyses. Through this project, we provide an overview of factors influencing GM composition among older subjects, its connotations on host metabolism and physiological decline, methodologies and future prospect of our findings. Our work constitutes one step forward in the race of understanding the trajectory and interactions of the GM in older subjects and their implications on well-being.

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Ning Tang
Metal Binding by Food Components

Supervisor(s):
Professor Leif H. Skibsted

Department:
Food Science

Date of defense: 25 September 2017
Date of awarded PhD degree: 2 October 2017

Summary:
For calcium binding: Electrochemical method (calcium ion selective electrode) combined with quantum mechanical calculations (density functional theory) were used to investigate the calcium binding affinity of the amino acids and small glycine peptides. The effects of the ionic strength and pH on calcium binding affinity were discussed. Optimized structures of calcium amino acids or peptides complexes were obtained through density functional theory calculations. These optimized structures provide the possible calcium binding mechanism by amino acids or peptides. Such study provides useful information for the future development of calcium supplements.

For zinc binding: Isothermal titration calorimetry was applied to investigate the zinc binding affinity of amino acids, peptides and whey proteins. Enthalpy entropy compensation effect was observed for zinc binding by the investigated amino acids, peptides and proteins. The thiol group or imidazole group containing amino acids, peptides and proteins which exhibited strong zinc binding ability were selected for the interaction study. The interaction between the above selected food components with zinc citrate or zinc phytate will lead to the supersaturation of zinc citrate or zinc phytate due the complex formation between zinc and these food components. The mechanism for this observed supersaturation effect indicates the formed supersaturated zinc solutions will improve zinc bioavailability. Such study provides a better understanding of zinc binding by the food components which can be used for improving zinc absorption.

For iron binding: The iron(IV) binding protein, ferrylmyoglobin, was investigated for the iron binding study. Tyrosine based food components were selected to reduce the ferrylmyoglobin. The kinetics of this redox reaction was studied using stopped flow spectroscopy and multivariate curve resolution analysis. The reaction mechanism was investigated through quantum mechanical calculations. Based on the obtained thermodynamic parameters that relevant for reduction of ferrylmyoglobin, the quantitative structure activity relationship model for reducing ferrylmyoglobin by tyrosine based food components were established by applying partial least square regression. Such study provides useful information for developing muscle foods.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Xiaolei Xie
Analysis of Heavy-Tailed Time Series

Supervisor(s):
Professor Thomas Mikosch, Associate Professor Jeffrey Collamore, Professor Rolf Poulsen

Department:
Mathematical Sciences

Date of defense: 29 September 2017
Date of awarded PhD degree: 2 October 2017

Summary:
This thesis is about analysis of heavy-tailed time series. We discuss tail properties of real-world equity return series and investigate the possibility that a single tail index is shared by all return series of actively traded equities in a market. Conditions for this hypothesis to be true are identified.

We study the eigenvalues and eigenvectors of sample covariance and sample auto-covariance matrices of multivariate heavy-tailed time series, and particularly for time series with very high dimensions. Asymptotic approximations of the eigenvalues and eigenvectors of such matrices are found and expressed in terms of the parameters of the dependence structure, among others.

Furthermore, we study an importance sampling method for estimating rare-event probabilities of multivariate heavy-tailed time series generated by matrix recursion. We show that the proposed algorithm is efficient in the sense that its relative error remains bounded as the probability of interest tends to zero. We make use of exponential twisting of the transition kernel of an \textit{Markov additive process}, and take advantage of asymptotic theories on products of positive random matrices.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Chunli Zhao
Understanding the Preconditions for Revitalizing Bicycle Transport in Beijing, with a Reference Study from Copenhagen

Supervisor(s):
Associate Professor Trine Agervig Carstensen, Associate Professor Anton Stahl Olafsson, Thomas Sick Nielsen

Department:
Geosciences and Natural Resource Management

Date of defense: 26 September 2017
Date of awarded PhD degree: 2 October 2017

Summary:
Rapid urbanization and the growth in the number of motorized vehicles has dramatically marginalized cycling in Chinese cities since the end of the 1990s. The deterioration in air quality and the urban environment is severely challenging urban livability and public health. The cities are seeking effective policies to alleviate these problems, while revitalizing bicycle transport has become one of the cores of mobility policy. Being the capital city, Beijing has a significant influence on other Chinese cities. Previously, Beijing had a strong bicycle culture, but today it is under severe pressure from the increased use of automobiles. Thus, the objective of this study is to identify and understand the preconditions for revitalizing bicycle transport in Beijing, and to develop effective strategies for making a comprehensive policy to revitalize bicycle transport in an increasingly motorized urban context. The study applied socio-ecological model to explore the preconditions that potentially influence changes in travel behavior towards cycling in the following four domains: individual, social environment, physical environment and policy. The study applied multiple approaches by employing quantitative and qualitative methods. Data were collected through structured survey research, semi-structured interviews, a review of historical documents and spatial data analyses. The analyses were carried out through statistical methods and a hermeneutic approach. The study has enriched the body of knowledge in at least three ways. First, it has provided empirical findings regarding the preconditions for revitalizing urban bicycle transport from a developing country’s perspective, where research still is sparse. Secondly, the study has examined how the preconditions are formed by multiple factors including individual, social environment, physical environment, and policy, which enabled me to suggest a comprehensive strategy for policy making for bicycle transport revitalization in Beijing. Thirdly, infrastructure planning principles and experiences in Beijing and Copenhagen were compared, which facilitated knowledge transfer between a mega-city in a developing country context and a medium sized city in a developed country context, as well as between a less and more successful cycling city. The study unfolded the research problem on a detailed level, and it is expected that the findings will not only be relevant to Beijing, but that the lessons learned in this study may also inspire other cities in China and other countries.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Michael Küffmeier
Accretion Processes in Star Formation

Supervisor(s):
Professor Åke Nordlund

Department:
Niels Bohr Institute

Date of defense: 8 September 2017
Date of awarded PhD degree: 9 October 2017

Summary:
Astronomical observations of circumstellar disks around young stars strongly support the idea of Kant and Laplace that planets form inside these disks. Therefore, these circumstellar disks are commonly referred to as protoplanetary disks. A protoplanetary disk forms because of angular momentum conservation during the collapse of a dense region of cold gas called a prestellar core. Such cores frequently form at different locations inside larger regions referred to as molecular clouds. Due to computational limitations, previous models of star and protoplanetary disk formation ignored the influence from different environments. I carried out state-of-the-art simulations to account for the natural birth environments of stars. Using the Adaptive Mesh Refinement technique that allows resolving the region around the star in more detail, I zoom-in onto the process of star formation without neglecting information about the larger scale properties. In my thesis, I show that the variations in stellar environments have important consequences for the formation process of stars and their corresponding protoplanetary disks. Moreover, I find that the measured variations of the radioactive Aluminum abundance in the young solar system are most likely not the result of an injection associated with supernova explosions, but can be explained by evaporation on dust grains. Another main result is that the properties inherited from the parental cloud – such as magnetic field and the level of turbulent motion of the gas – have a decisive influence on the formation process of stars and their corresponding disks. Specifically, temporary infall in the presence of a disk may cause episodic accretion events onto the star. This means that the star shines with variable brightness during its formation phase. Given that planets already start to form in young protoplanetary disks, I aim for establishing the link between the star formation process and the era of planet formation. As a first step, I contributed a solver that accounts for the effects of non-ionized gas in protoplanetary disks to a new code framework called DISPATCH.

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The research presented in this PhD thesis utilise the cosmopolitan weed, Plantago major, and its closest taxonomic relatives, as model vascular plant species to advance our understanding in the broad areas of plant evolutionary biology and ecology. Plantago major is a highly successful introduced plant species that has found its way from its native origins in Europe to a diversity of biomes throughout the world. Its ability to tolerate and flourish in such a vast array of environmental conditions, its high phenotypic plasticity and efficient dispersal, as well as its important cultural ties and medicinal value, makes it a prime candidate for study. Over longer evolutionary timescales, phylogenetic relationships are inferred between P. major’s closest taxonomic relatives in the globally distributed Plantago section Plantago, and strong evidence is provided to support theories of long-distance dispersal, founder effects, and rapid speciation. We take advantage of today’s high throughput techniques for genome-wide sequencing and metabolome-wide screening, and apply a multidisciplinary approach to address outstanding research questions including how this weedy species migrated around the world, what factors are involved in its successful colonisation of new ranges, and to what extent variation in the plant’s metabolome is linked to genomic and environmental variation. At a regional scale, P. major is found to have a highly resilient metabolome, and geographic region is found to be the most important predictor of metabolic phenotypes across Denmark. On a global scale, we find evidence in the genomic signatures of worldwide populations that the P. major migrated to new ranges with the assistance of early colonists, and their successful colonisation of new ranges is attributed to prior adaptations to climate and anthropogenic disturbance in two successful genotype lineages. Strong links between shared genetic ancestry and metabolic phenotypes are uncovered at the global scale, though varying environmental conditions across the global range also influence the expression of metabolic traits, in an otherwise resilient metabolome. We ultimately explore how this successful species can shed light on the fields of invasion biology, landscape genomics, and improve knowledge of local adaptation and species responses to global change.
PHD GRADUATE FROM FACULTY OF SCIENCE

Sara Harðardóttir
Marine Battlefields
Toxic Diatoms and Their Copepod Grazers

Supervisor(s):
Associate Professor Nina Lundholm, Professor Torkel Gissel Nielsen, Uwe John Ree

Department:
Natural History Museum of Denmark

Date of defense: 22 September 2017
Date of awarded PhD degree: 9 October 2017

Summary:
Phytoplankton species are photosynthetic organisms found in most aquatic habitats. In the ocean, phytoplankton are tremendously important because they produce the energy that forms the base of the marine food web. Zooplankton feed on phytoplankton and mediate the energy to higher trophic levels as they are an important food source for various marine animals. For both phyto- and zooplankton predation is a major cause of mortality, and strategies for protection or avoidance are important for survival. Diatoms of the genera Nitzschia and Pseudo-nitzschia are known to produce a neuro-toxin, domoic acid (DA). Despite the toxin production, Pseudo-nitzschia cells are never the less consumed by e.g. copepods that seem resistant to the toxin and can further vector the toxin into the food web.

The aim of this thesis is to examine the interaction between toxic diatoms and their copepod grazers. Not all diatom species reacted by producing toxin when exposed to grazing copepods, suggesting that the trait is specific to certain diatoms. When exposed to a carnivore copepod that does not pose a threat to the diatom cells, because it does not prey upon diatoms, the toxic Pseudo-nitzschia seriata does not elicit DA, in contrary to what it does when exposed to a herbivore copepod, indicating that the trait is grazer specific and needs a reliable threat. In all the experiments conducted for this thesis, there was a total lack of evidence of grazing reduction when the copepods were exposed to the toxin. But it became evident when examining the gene expression in the copepod Calanus finmarchicus after ingestion of DA, that the copepod is affected by the intake of DA. Multiple genes are repressed after toxin exposure. Behavioral changes will increase the mortality of copepods, and by testing escape responses in two species of Calanus it became evident that intoxicated copepods suffer reduced escape jumps. Another aim for this work is to explore the biosynthetic pathway of DA, using predator cues to trigger DA production in P. seriata in order to reveal regulation of genes involved in DA synthesis. Most importantly it is proposed that the C10 isoprenoid product for biosynthesis of DA arises from the methylyerythriol phosphate metabolic pathway.

In conclusion: Interaction between toxic diatoms and their grazers affects both opponents, and the interaction results in toxin progressively being mediated in the food web.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Rasmus Sylvester Bryder
Boundaries, Injective Envelopes, and Reduced Crossed Products

Supervisor(s):
Associate Professor Magdalena Musat
Professor Mikael Rørdam

Department:
Mathematical Sciences

Date of defense: 6 October 2017
Date of awarded PhD degree: 10 October 2017

Summary:
Recently, the possible boundary actions of a discrete group have been shown to unveil a lot of information about its reduced group C*-algebra. Of particular interest is the situation when the reduced group C*-algebra is simple, in which case we say that the group is C*-simple. In 2014, Kalantar and Kennedy gave a complete description of C*-simplicity in terms of boundary actions. Examples of C*-simple groups include the non-abelian free groups, and often exhibit very non-commutative behaviour.

We consider a class of groups devised by Higman, Neumann and Neumann, nowadays known as HNN extensions, and we give necessary and sufficient criteria for C*-simplicity of an HNN extension, in terms of a natural boundary action admitted by this type of group. Moreover, we show that C*-simplicity of a group is rigid enough of a property to reveal all maximal ideals of a reduced twisted crossed product over this group.

Finally, we consider the equivariant injective envelope of a C*-algebra, which is the minimal C*-algebra containing a given C*-algebra equipped with a group action, such that any equivariant completely positive map into it may always be extended. We relate the ideal structure of a reduced crossed product to the ideal structure of the reduced crossed product over the equivariant injective envelope, and verify a C*-algebraic inclusion of centres of equivariant injective envelopes. This has notable consequences for the ideal structure of a reduced crossed product of a prime C*-algebra over a C*-simple group.

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Mohammed Hussen Alemu  
Consumer Preferences and Demand for Insect-Based Food Products in Developing Countries: Empirical Perspectives on Consumer Heterogeneity, Tasting Experience, Peer Influence and Value Elicitation Methods

Supervisor(s):  
Associate Professor Søren Bøye Olsen

Department:  
Food and Resource Economics

Date of defense: 2 October 2017  
Date of awarded PhD degree: 11 October 2017

Summary:  
Edible insects are touted as a promising source of nutritious food which can be used to increase the availability of protein. They are environmentally friendly as they contribute to the reduction of greenhouse gas emissions as a result of their high feed conversion efficiency property. Their production requires less input than livestock production which has an important implication for household insect production as well as large-scale commercialization. Stakeholders in the food sector have recently focused on establishing the insect production sector. Nevertheless, there are a number of issues that need to be investigated before the production is fully optimized. This thesis investigates consumer demand in terms of consumers' preferences and willingness-to-pay (WTP) for insect-based food products in Kenya. The results of the thesis reveal that consumers have positive preferences and are willing to pay for the insect-based food products. The results further reveal that most consumers have positive attitude towards insects as food. Tasting the new insect-based foods products lead to increase in consumer demand whereas observing others (peers) reacting negatively to the products has the opposite effect. Furthermore, the results show that consumers' WTP for the insect-based food products are higher in hypothetical surveys than in real field experiments in which consumers are required to purchase one of the products according to their choices. This leads to hypothetical bias problem. This problem can be removed or reduced by using hypothetical mitigation strategies as shown in this thesis. Overall, the results of this thesis imply that insect-based foods can be used to improve household nutrition and food security in Kenya as the demand is present. Commercialization of insect-based food products can thus be a viable business. The main contributions of this thesis to the scientific literature is that it highlights the importance of taking consumers' attitude, tasting experience and peer effects into account when examining consumers' food choice and purchase behavior. Furthermore, the findings of the thesis suggests that consumer studies based on hypothetical market scenarios should use ex-ante hypothetical bias mitigation strategies to remove and/or reduce hypothetical bias in situations where it is not possible to employ nonhypothetical approaches.
Ana Gorete Campos de Azevedo
Non-Target Effects of the Ectomopathogenic Fungus Metarhizium brunneum (BIPESCO 5/F52) on Predatory Arthropods

Summary:
The overall objective of this PhD thesis was to investigate the interactions that may occur when combining natural enemies of an herbivore. This was done by assessing the non-target effects of the generalist entomopathogenic fungus Metarhizium brunneum on four different predatory arthropods (Publication I) as well as the effects on the resulting biocontrol in a multitrophic context (Publication II) and predator behavioral changes resulting of the entomopathogen presence (Publication III). Exposure to soil-applied M. brunneum under laboratory conditions resulted in a range of fitness responses to the high concentration of M. brunneum in soil, from no response, to intermediate and high response. A greenhouse study was conducted to assess the possible effects of combining the predatory midge Aphidoletes aphidimyza and M. brunneum applied in soil to suppress the aphid population infesting maize plants. A. aphidimyza applied alone suppressed the aphid population more effectively than M. brunneum applied alone. However, the aphid population was most suppressed when both agents were combined, even though the suppression was less than additive. The study of the behavioral changes of A. aphidimyza females in the presence of M. brunneum revealed that gravid A. aphidimyza are able to perceive the risk posed by M. brunneum and react to that by choosing a pathogen-free site for offspring. In conclusion, non-target effects of M. brunneum on predatory arthropods may be expected. However, knowledge of the life cycles of the predatory arthropods and the optimal timing for releasing the natural enemies can reduce the risk of antagonistic interactions. Findings confirm that A. aphidimyza females are able to change their oviposition behavior in the presence of the entomopathogen. It furthermore confirms that the side-effects of soil application of M. brunneum on the performance of a predatory arthropod can be considered minor since it did not disrupt the suppression of aphids.
PHD GRADUATE FROM FACULTY OF SCIENCE

Frederik van der Bom
Long-Term Fertilization Impacts on Soil Fertility and Resource Use - Effect on Soil P Cycling, Microbial Functioning, Crop Productivity and Nutrient Use Efficiency

Supervisor(s):
Professor Lars Stoumann Jensen
Associate Professor Jakob Magid

Department:
Plant and Environmental Sciences

Date of defense: 9 October 2017
Date of awarded PhD degree: 13 October 2017

Summary:
Agriculture is facing the challenge of feeding a growing world population. At the same time, concerns about the environmental effects of current and historical fertiliser use, as well as global climate change, requires re-thinking of how food is produced.
This PhD study focussed on how historical nutrient inputs, and variable soil fertility conditions, affect growth, productivity, and resilience of cereal crops, and examined the effects on soil phosphorus pools and soil microbial communities. The majority of the work took place in or around the Long-Term Nutrient Depletion Trial at the KU experimental farm in Taastrup, Denmark. The field was purposely depleted of nutrients for 30 years before the introduction of different long-term (20 years) nutrient applications, and can therefore provide relevant information for future management.
In most of the years, reasonably good yields could be attained, but it was clear that sufficient nutrient availability is essential at critical growth periods of the crop. In combination with a detailed study of soil P availability and forms, these results give a preliminary indication that on this soil, shifting from the traditional cropping methods to new strategies with lower P inputs may be feasible.
Long-term animal slurry applications resulted in a higher soil pH, greater C accumulation and microbial P concentrations, and had a strong enhancing effect on soil bacterial diversity and microbial substrate use. All in all, it is clear that these inputs have additional benefits, over and above the nutrient contents.
Finally, plants that are better at taking up P from the soil under limiting conditions could play an important role in improving sustainability, but experiments with modern cereal varieties suggest that modern breeding has resulted in very similar varieties. Breeding programmes should focus on improving current crop varieties to perform better under low-P conditions.

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Henri J. Suominen
Two-Dimensional Semiconductor-Superconductor Hybrids

Supervisor(s):
Professor Charles M. Marcus

Department:
Niels Bohr Institute

Date of defense: 12 October 2017
Date of awarded PhD degree: 16 October 2017

Summary:
This thesis investigates hybrid two-dimensional semiconductor-superconductor (Sm-S) devices and presents a new material platform exhibiting intimate Sm-S coupling straight out of the box. Starting with the conventional approach, we investigate coupling superconductors to buried quantum well heterostructures, observing clear evidence of supercurrent, and the first direct spectroscopy of an induced superconducting gap in a two-dimensional electron gas. Nonetheless, these experiments reveal inhomogeneous contacts and a soft-induced superconducting gap, likely due to disorder at the Sm-S interface.

To overcome these issues we integrate the superconductor directly into the semiconducting material growth stack, depositing it in-situ in a molecular beam epitaxy system under high vacuum. We present a number of experiments on these hybrid heterostructures, demonstrating near unity interface transparency and a hard induced superconducting gap. Furthermore the thin superconducting (<10 nm) aluminum films allow for the application of large in-plane magnetic fields without destroying superconductivity. In such a scenario we investigate the magneto-transport properties in S-Sm-S junctions, revealing anomalous Fraunhofer diffraction, qualitatively in agreement with a complex interplay between Zeeman coupling, spin-orbit interaction and disorder.

Finally by patterning quasi-one-dimensional structures we observe coalescing Andreev bound states stabilizing at zero energy in large magnetic fields, in agreement with previous reports of Majorana modes in semiconductor nanowires. By offering a patternable two-dimensional platform, our approach opens up the door to experiments probing the predicted topological properties in this system.
Martin Søndergaard Christensen
Regularity of C*-Algebras and Central Sequence Algebras

Supervisor(s):
Professor Mikael Rørdam

Department:
Mathematical Sciences

Date of defense: 6 October 2017
Date of awarded PhD degree: 16 October 2017

Summary:
The main question under consideration is whether the absence of characters on the central sequence algebra associated with a unital and separable C*-algebra characterizes tensorial absorption of the Jiang-Su algebra. The main results of the thesis are: This question has an affirmative answer for the class of Villadsen algebras of the first type, admitting a standard decomposition with seed space a finite CW complex and the class of Villadsen algebras of the second type. Also, for the larger class of unital, simple, separable and nuclear C*-algebras, the stronger requirement that the central sequence algebra is k-locally almost divisible suffices to conclude tensorial absorption of the Jiang-Su algebra.

Secondary results include the proof that the Villadsen algebra of the second type with infinite stable rank fails the corona factorization property. This is the first example of a unital, simple, separable and stably finite C*-algebra with a unique tracial state failing this property. As a by-product of investigating whether the corona factorization property is equivalent to regularity, for simple and separable C*-algebras, a characterization of asymptotic regularity is given, in terms of the Cuntz semigroup associated with the C*-algebra. Finally, for a substantial class of unital, separable and Jiang-Su absorbing C*-algebras, an example of an ideal which is not a sigma-ideal is provided, marking the first examples of such ideals in central sequence algebras.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Niccolò Maffezzoli
Sodium, Iodine and Bromine in Polar Ice Cores

Supervisor(s):
Associate Professor Paul Vallelonga

Department:
Niels Bohr Institute

Date of defense: 12 October 2017
Date of awarded PhD degree: 16 October 2017

Summary:
This research focuses on sodium, bromine and iodine in polar ice cores, with the aim of reviewing and advancing their current understanding with additional measurements and records, and investigating the connections of these tracers with sea ice and their feasibility as sea ice indicators. Modern Arctic sea ice decline clearly yields further motivation in this direction, as the reconstruction of past sea ice conditions could provide clues to the mechanisms in play nowadays and in the future projections. Na, Br and I have been measured by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) in ice core records retrieved in both Greenland and Antarctica.

The dissertation is presented as a monograph. It is structured in a way that would logically bring the reader from the broad perspective of sea ice and ice cores into the physical and chemical transformations of these impurities from emission to deposition and finally to their determination in ice cores and interpretation of their climatic significance. After a general introduction to sea ice and ice cores, the thesis addresses sodium, bromine and iodine with a theoretical perspective and a particular focus on their connections with sea ice. The physical and chemical properties of sea salt aerosols are described, along with halogen chemistry at polar latitudes. The use of sodium and bromine as sea ice tracers is introduced.

Finally, the thesis reviews the published ice/snow measurements of bromine and iodine at polar latitudes, including a selection of sodium records. The additional measurements performed during the research activities are also displayed. With the goal of presenting and extending the state-of-the-art of knowledge of bromine and iodine in polar snow, a critical comparison between the proxies is adopted, trying to elucidate the established and the unknown features and their potential as sea ice indicators. The last section is dedicated to the measurements of sodium and bromine in the Renland core, which could provide the first ice core-based reconstruction of Arctic sea ice in the Greenland Sea for the last 125,000 years.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Helena Steinocher
Class I Cytokine Receptors:
Interactions in the Membrane

Supervisor(s):
Professor Birthe Brandt Kragelund

Department:
Biology

Date of defense: 13 October 2017
Date of awarded PhD degree: 17 October 2017

Summary:
The members of the class I cytokine receptor family are involved in a wide range of cellular processes and of high pharmaceutical importance, however, even though the transmembrane receptors have been studied for decades, it has not been fully elucidated yet, how these receptors induce their intracellular response. The overall goal of this thesis was to improve the understanding of class I cytokine receptor activation and regulation at an atomic level. Two members of the class I cytokine receptor family, the human growth hormone receptor (hGHR), and the human erythropoietin receptor (hEPOR) have been investigated. The two receptors form homodimers and bind their cognate hormone in a 2:1 complex. It has been proposed that prior to hormone binding dimerization occurs mainly between the transmembrane domains (TMD) of the two receptor chains.

A new purification method, utilizing the unique characteristics of membrane spanning helices, was designed and hGHR TMD and hEPOR TMD produced in sufficient amounts for spectroscopic investigations. The isolated hGHR TMD was revealed to associate in dimeric complexes in detergent micelles and first presumptions about the dimer interface could be made. Further, the minimal determinants for specificity between membrane spanning helices were investigated with small artificial low complexity peptides, prior found to activate the EPOR in cells. The placement of single methyl group in the so called transmembrane aptamers (traptamers) determined the stabilizing effect the traptamers on the hEPOR TMD dimeric complex in detergent micelles.

To gain a better understanding of hGHR regulation a point mutation in the hGHR intracellular domain (ICD), which has recently been linked to lung cancer, was characterized. The mutation was found to decrease binding of suppressor of cytokine signaling 2 (SOCS2) to the GHR by changing the structural characteristics of the SOC2 binding site.

It can be concluded that the work of this thesis paved the way for a new way of thinking about interactions between membrane spanning helices and underlined the importance of negative regulation of GHR signaling.
PHD GRADUATE FROM FACULTY OF SCIENCE

Emil S. Jørgensen
Diffusion Models Observed at High Frequency and Applications in Finance

Supervisor(s):
Professor Michael Sørensen

Department:
Mathematical Sciences

Date of defense: 13 October 2017
Date of awarded PhD degree: 19 October 2017

Summary:
The recent introduction of algorithmic trading in finance has lead to more and more financial transactions taking place over short time intervals and every day millions of stocks and financial derivatives are traded on exchanges around the world. The economic incentive for applying sophisticated mathematical and statistical tools to analyze such high-frequency data requires little explanation; institutional investors can obviously benefit from a better understanding of the intricate dynamics of stock markets and help them provide a much better product for their respective clients. My PhD thesis deals with various estimation problems related to stock price data, with main emphasis on analyzing the properties of these estimators in a hypothetical scenario where the time between consecutive price observations goes to zero. An important part of the analysis of stock market data lies in choosing a model that adequately describes the observed fluctuations of a particular stock over time, and we focus on a popular class of statistical models that assign a great deal of randomness into the future behaviour of the stock, but remain subject to satisfactory mathematical analysis.

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Louise de Bang
Characterizing the Effects of Brassinosteroids on Root Development in Monocot Plant Species

Supervisor(s):
Professor Søren K. Rasmussen
Professor Poul Erik Jensen

Department:
Plant and Environmental Sciences

Date of defense: 16 October 2017
Date of awarded PhD degree: 19 October 2017

Summary:
The plant hormone brassinosteroid (BR) is known to affect a wide range of biological aspects, here among promotion of plant growth. Since the discovery of this class of plant steroids in the 1970s, BR has been a target when breeding for increased biomass production in plants. In this PhD study two different approaches for targeting BRs, with the purpose of increasing biomass, has been carried out.

The first approach was based on the so-called leaf-unrolling test and aimed at quantifying brassinosteroid sensitivity in a collection of different wheat genotypes. However, a combination of practical and technical reasons hampered the application of this method. Instead, an alternative BR sensitivity assay was developed based on the effects synthetic BR analogs have on root growth.

The second approach was based on the reverse genetics technique TILLING, a method to identify mutations in specific genes. With TILLING, two mutants of selected BR-related genes were identified in a Brachypodium distachyon mutant population. However, compared to the wild type, the mutants did not produce more biomass.

The work with BR effects on plant root growth stimulated an interest for roots and root development, which resulted in a one year stay in Professor Elison B. Blancfors lab. During this period, basic studies of BR effects on plant root development were carried out. As a central finding, it was shown that BR affects the anti-gravity growth response of roots, the autotrophic straightening, through stabilization of filamentous actin.

Also basic studies of the root system architecture (RSA) of young wheat seedlings were conducted in order to clarify the mechanisms behind the distinct growth angles of the three first appearing embryogenic roots. Root system architecture of plants has gained major interest in recent years, because it is found to be very important, not only for plant establishment, but also for plant fitness and performance in different environments.

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Molecular Simulations of CO2 at Interfaces
A Combined Force Field and Quantum Mechanical Study of CO2 Geologic Sequestration in Carbonate Rocks

Supervisor(s):
Professor Susan L. S. Stipp
Associate Professor Martin P. Andersson

Department:
Chemistry

Date of defense: 13 October 2017
Date of awarded PhD degree: 20 October 2017

Summary:
CO2 anthropogenic emissions into the atmosphere have long been recognized as the main driver for global climate change and ocean acidification. Carbon sequestration in geologic formations is a promising approach for decreasing the net amount of CO2 emitted into the atmosphere. Different options for geologic storage of CO2 have been proposed. Carbonate minerals are ubiquitous, limestone, chalk and marble constitute a significant fraction of the sedimentary rock record and the formations are generally porous so their probable response to CO2 sequestration needs to be investigated.

CO2 geologic sequestration relies on various trapping mechanisms that act over different time scales, where effectiveness is determined by phenomena that occur at the interfaces between CO2, pore fluids and the pore surfaces. Solid theoretical understanding of the nanoscale interactions that result from the interplay of intermolecular and surface forces acting at the interface is currently limited we need better insight into the underlying interactions.

Achieving representative subsurface conditions in experiments is challenging and reported data are affected by experimental uncertainties and sometimes are contradictory. Molecular modelling is a valuable tool for complementing experimental studies and it can help us interpret results and gain insight under conditions where experiments are difficult or impossible to perform. In this thesis, molecular modelling predictions of relevant physicochemical parameters for CO2 geologic sequestration are reported. The results provide a base for comparing the few, widely variable experimental data that are reported in the literature and can help us gaining a fundamental understanding of the sequestration process and assessing the risks and environmental impacts associated with it.
Yuanyuan Wang
Solid-Phase Reactions of Iminium Ions: 
Cyclized Peptide Derivatives
-Towards GPCR Agonists

Supervisor(s):
Professor Morten Meldal
Associate Professor Frederik Diness

Department:
Chemistry

Date of defense: 13 October 2017
Date of awarded PhD degree: 20 October 2017

Summary:
This thesis describes the new development of intramolecular N-carbamoyliminium ions cyclization on peptide based solid phase for the synthesis of pharmaceutically interesting peptidomemetics towards GPCRs agonists.
First, the formation of N,N'-aminals by nucleophilic attack of the peptide backbone during intramolecular N-carbamoyliminium cascade (INCIC) reaction is found to be reversible under strongly acidic conditions. The N,N'-aminal is likely to be the kinetic product of many INCIC reactions and stable in the absence of acid. The introduced azide and alkyne residues in the side chain of N,N'-aminal products were further functionalized by combing CuAAC reactions. A series of highly stereoselective compounds containing triazole motif was synthesized with high yields and purity under the optimized conditions. The introduced functional groups by using different substituted alkyne or azide are ready for further modification.
The N-carbamoyliminium ions formed through INCIC reactions applying the masked aldehyde building block AbaBB may undergo auto-oxidation to quinazoline-2,4-diones in the absence of a suitable nucleophile on the side chain or backbone of the peptide. The auto-oxidation reaction proved to be independent of copper catalysts. The structure is confirmed by comparison with products obtained from solution-phase synthesis under the same conditions.
Reactions of cyclic N-carbamoyliminium ions with Cu-acetylides through A3 reactions on solid phase were developed. The introduction of different functional substituted alkyne into peptide chains opens up a myriad of opportunities for further diversification of peptide-like molecules. A combinatorial hex-peptide library towards potential MC4R agonists is synthesized by application of the high yield and stereoselective intramolecular N-carbamoyliminium Pictet-Spengler reactions. The reaction conditions were optimized. The combinatorial library is well stored and ready for the future biological on-bead screening. A series of pentapeptides with Pictet-Spengler products are synthesized and the solution biological tests with the HEK 293 cells expressing MC4Rs were carried out.
PHD GRADUATE FROM FACULTY OF SCIENCE

Julie Buhl-Wiggers

Essays on the Economics of Education in Sub-Saharan Africa

Supervisor(s):
Professor with special responsibilities John Rand

Department:
Food and Resource Economics

Date of defense: 23 October 2017
Date of awarded PhD degree: 30 October 2017

Summary:
Increasing levels of education has been especially important in the quest for reducing poverty and have accordingly been a high priority for both international organizations and local governments. However, some doubt have been cast on extent to which these increases in the level of education will lead to economic growth. One of the most concerning factors is that academic skills remain low despite increases in the access to education. In Africa, 15-20% do not have full competencies in reading or basic math when they leave primary school. Shedding light on how to improve learning is a central topic of this dissertation and three of the four main chapters focus on different aspects of learning disparities. While the first three main chapters focus on the determinants of learning, the last chapter is more concerned about the non-pecuniary effects of the recent expansion of the educational system in Africa. The dissertation contains four self-contained chapters that all address questions central to the African context: Gender, infectious diseases, teacher quality and ethnic vs. national identity.

The main finding of Chapter 2 is that new challenges are emerging as boys are now starting to under-perform in academic tests compared to girls. We argue that it is time to shift the research agenda from girls to gender, recognizing the vulnerabilities of boys and girls. Chapter 2 finds that that exposure to malaria in early childhood has significant negative effects on performance in English literacy during primary school. This corroborates the view that malaria is a public health challenge to educational achievement and that impaired academic performance is the likely channel linking early life malaria exposure with economic outcomes in adulthood. In Chapter 3 we find that even in a resource-constrained context as northern Uganda variations in teacher quality do explain a significant part of the variation in learning. This suggests that shifting the worst performing teachers to the level of the best performing could have a large impact on learning. The last Chapter points to the complexity of public education and how power and political interests are important elements of the provision of public education. I find that increased education as did increase national identity. However, the extent to which this also increased national cohesion is more doubtful as the reform did not increase the tolerance towards non-co-ethnics.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Ulla Margrit Dolde
Role of MicroProteins in Controlling Diverse Biological Pathways

Supervisor(s):
Associate Professor Stephan Wenkel

Department:
Plant and Environmental Sciences

Date of defense: 18 October 2017
Date of awarded PhD degree: 30 October 2017

Summary:
MicroProteins are small, single-domain proteins that act by dimerization with larger multi-domain proteins and can prevent them from forming functional complexes. To date, 22 microProteins have been identified in plants that regulate their targets by sequestering them into non-productive complexes. The two orthologues microProteins, miP1a and miP1b were identified using a computational analysis. MiP1a and miP1b are small B-Box containing proteins that change the biological activity of CONSANS (CO), a major regulator of flowering in Arabidopsis thaliana. They are known to be the first microProteins that regulate their target by forming a high-order complex. They form a trimeric complex with CO and the transcriptional repressor TOPLESS (TPL) which converts CO into a floral repressor. Currently, all identified and characterized microProteins regulate transcription factors. Using a computational approach novel microProtein candidates were identified in several sequenced genomes that may affect complex formation of a wider range of multi-domain proteins. In Arabidopsis thaliana conserved putative microProteins were identified and classified into protein classes dependent on their putative ancestor and protein-protein-interaction (PPI) domain. Using a synthetic microProtein approach, we demonstrate that microProteins are able to regulate multi-domain proteins belonging to different protein classes. Furthermore, these results revealed that microProteins may provide a useful tool for post-translational regulation in plant due to their function in protein regulation.
PHD GRADUATE FROM FACULTY OF SCIENCE

Vivek Shah
Exploration of a Vision for Actor Database Systems

Supervisor(s):
Associate Professor Marcos Antonio Vaz Salles
Professor Fritz Henglein

Department:
Computer Science

Date of defense: 26 October 2017
Date of awarded PhD degree: 30 October 2017

Summary:
We are witnessing dramatic growth in the variety and volume of interactive data intensive services, and also in the performance of computing hardware. Consequently, these are exciting times to design scalable high-performance software systems in order to enable productive development and deployment of these services.

Existing popular approaches to building these services either use an in-memory database system or an actor runtime. We observe that these approaches have complementary strengths and weaknesses. In this dissertation, we propose the integration of actor programming models in database systems. In doing so, we lay down a vision for a new class of systems called actor database systems.

To explore this vision, this dissertation crystallizes the notion of an actor database system by defining its feature set in light of current application and hardware trends. In order to explore the viability of the outlined vision, a new programming model named Reactors has been designed to enrich classic relational database programming models with logical actor programming constructs. To support the reactor programming model, a high-performance in-memory multi-core OLTP database system named REACTDB has been built.

Our experiments with multiple benchmarks demonstrate the flexibility of the programming model in empowering application developers to reason about and improve performance of their programs by leveraging parallelism in application logic under ACID guarantees. Our experiments also establish the scalability of the system and its efficient low-overhead design and implementation on modern hardware.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Yanyan Su
Light Manipulation and Photonics Applications of Diatom Frustules

Supervisor(s):
Professor with special responsibilities Marianne Ellegaard
Associate Professor Nina Lundholm

Department:
Plant and Environmental Sciences

Date of defense: 25 October 2017
Date of awarded PhD degree: 30 October 2017

Summary:
Diatoms are one of the most dominant groups of phytoplankton, contributing more than 25% of the world’s net primary production. Apart from their enormous ecological significance, diatoms are distinguished by their unique, intricate and elaborate silica-based cell walls, with species-specific nanostructural patterns, which can inspire the nanotechnological capability of humans. More and more efforts have been made to attempt to utilize the diatom frustules for different applications purposes, but most of them are still in their infancy as most of these investigations are based on single valves. Further, in order to facilitate their applications, manipulation or control of the nanostructure of frustules is desirable.

The effect of different light spectra on the morphology of centric diatom Coscinodiscus granii has been investigated. It has been shown that different light spectra lead to significant changes in frustule morphology after 14 days of cultivation under different light treatments and that these changes in morphology is sufficient enough to cause the differences in photonic properties of the frustules. Further work on the long-term effects has been shown that C. granii could be maintained over a 10-months period at monospectral light and that most of the changes in frustule morphology induced by different light treatments could be maintained after 10 months cultivation and the variability in some of the morphological parameters was even reduced.

The effect of different light spectra on the cellular silicon concentration of C. granii has been studied. The change in cellular silicon concentration is mainly due to changes in the thickness of frustule. The potential adaptive mechanism might be related to adjustments in the sinking rates affected by controlling the cellular silicon concentration. This will eventually optimize the light utilization under different light treatments.

Finally, the spectral properties of drop-casted layers of both rinsed frustules and dried intact cells of three diatom species (C. granii, Thalassiosira punctifera and Thalassiosira pseudonana) have been investigated, with special focus on the transmission and reflectance in the UV range. The influence factors on the spectral properties of rinsed frustules have been addressed.

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PHD GRADUATE FROM FACULTY OF SCIENCE

André Anda
Excitation Energies in Light-Harvesting System 2 and Anharmonic Effects in Linear Absorption, Fluorescence and Two-Dimensional Electronic Spectroscopy

Supervisor(s):
Associate Professor Thorsten Hansen

Department:
Chemistry

Date of defense: 26 October 2017
Date of awarded PhD degree: 2 November 2017

Summary:
Photosynthetic organisms harvest light using molecular complexes consisting of pigments embedded in a protein frame. Despite intense research over many years, a full understanding of the light-harvesting process remains elusive. The intricacy of the structures and the experimental data is a tough challenge for the quantum chemical methods and the simulation protocols, but there is plenty of room for improvement in both departments. This thesis investigates how next-level quantum chemical methods can be applied in order to feed more accurate data into the simulation models of the excitation energy transfer. Used in conjunction with cheaper methods, it is demonstrated that the geometrical factors behind the excitation energy modulation of pigments can be investigated. On the simulation side, new theoretical methods were developed to study the effect of anharmonic vibrations in absorption and emission spectra, as well as in two-dimensional electronic spectroscopy. The role of vibrations in light-harvesting has attracted a lot of interest, but has predominantly been modelled using harmonic oscillators. The developed methods lift this restraint and will aid the interpretation of anharmonic features in linear and two-dimensional electronic spectroscopy. The new tools provide another level of detail which will contribute to an improved description of light-harvesting processes.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Éverton Carvalho dos Santos
Physical Capture and Release of Drug Molecules, Water and Cations by a Smectite Clay

Supervisor(s):
Associate Professor Heloisa Nunes Bordallo

Department:
Niels Bohr Institute

Date of defense: 10 October 2017
Date of awarded PhD degree: 2 November 2017

Summary:
In this PhD project we investigated the potential application of the synthetic smectite Fluorohectorite (Fh, Cx(Mg(6-x)Lix)Si8O20F4, where C is the interlayer cation) as a drug carrier. To achieve this goal, we studied the capture (and release) of the antibacterial agent Ciprofloxacin (CIPRO, C17H18FN3O3) by (from) Li-Fluorohectorite (LiFh, Li1.2(Mg4.8Li1.2)Si8O20F4). To complement and support such understanding, the cation exchange process in LiFh and the hydration pathways in NiFh were also analyzed.

Using XRD (X-rays powder diffraction) and EDS (Energy Dispersive X-ray Spectroscopy) we verified that the cation exchange either from Li+ to Na+ or from Li+ to Ni2+ in Fh occurs within 5 minutes, while the inverse path exceeds 60 minutes (the time scale of the experimental conditions). A similar behavior was observed during studies of capture and release of CIPRO. By means of XRD, TGA/IR (Thermogravimetric Analysis coupled to an Infrared spectrometry) and DSC (Differential Scanning Calorimetry) studies we observed that the transition between hydrated states of NiFh does not occur in abrupt steps, such as in the case of LiFh and NaFh. Moreover, the average size of the clay particles decreases during the transition between pure hydrated states, while the lattice strain increases with relative humidity. Finally, by means of XRD, TGA/IR, UV-Vis and EFW (Inelastic Neutron Scattering - Elastic Fixed Window approach), we showed that CIPRO’s capture is pH-dependent, being more efficient at acidic pHs, and that Fh can capture at least 25 % more CIPRO than other systems reported on literature. Release studies showed that, during the first 20, hours the controlled CIPRO’s release from the clay layers is mostly thermally activated and the value of Arrhenius activation energy indicates that the CIPRO’s release can be discussed as a diffusion-controlled cation exchange process. Finally, via bacterial and toxicological tests, we demonstrated that the effectiveness and toxicity of pure CIPRO is unaffected in the clay-drug complex.

These results bring new advances to drug carrier studies as it adds Fh to the list of promising materials for such applications. Furthermore, even if this study has focused on Li-Fh and CIPRO, our findings can be easily extended to other clay minerals and drug molecules, as the results and experimental conditions summarized in this thesis can assist on setting up novel studies.

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Isak Buhl-Mortensen
One-Point Functions in AdS/dCFT and Integrability

Supervisor(s):
Professor Charlotte Kristjansen

Department:
Niels Bohr Institute

Date of defense: 1 November 2017
Date of awarded PhD degree: 6 November 2017

Summary:
Super Yang-Mills with a co-dimension one defect is studied, in particular, the field theory setup that arises in the D3-probe-D5 brane construction of the Karch-Randal idea. We look at the case where $k \geq 2$ D3-branes are absorbed by the D5, giving rise to a domain wall defect that separates the field theory into an SU($N - k$) theory and a broken SU($N$) theory. The defect allows for interesting one-point functions in the SU(2) sub-sector already at tree-level. One-point functions in this sub-sector are computed, key results include the closed determinant formula at tree-level valid for all $k$, and subsequently a concise one-loop result for $k = 2$. The one-loop result is conjectured to be exact for the BMN vacuum. A major feat is the diagonalization of the bulk action around the fuzzy-funnel background, as it opens up for many novel tests of the AdS/dCFT correspondence. Results for the BMN one-point functions are compared with string theory in the double-scaling limit. Agreement is found at tree-level and subsequently an all loop conjecture is made based on integrability.
Thomas Berlok
Weakly Collisional and Collisionless Astrophysical Plasmas

Supervisor(s):
Professor with special responsibilities Martin E. Pessah, Assoc. Prof. Troels Haugbølle, Assoc. Prof. Tobias Heinemann

Department:
Niels Bohr Institute

Date of defense: 27 October 2017
Date of awarded PhD degree: 6 November 2017

Summary:
The radiative component of many astrophysical systems is in the plasma state, i.e., it consists of a highly ionized gas in which the electrons are dissociated from the ions. Understanding the dynamics of plasmas is therefore of prime importance for astrophysics and a variety of methods to study plasmas have been developed during the last century. Weakly collisional and collisionless astrophysical plasmas are not well described by ideal magnetohydrodynamics (MHD) whose validity depends on a high collision frequency. This thesis aims to address this issue by moving beyond ideal MHD and the scope of the thesis is twofold. Firstly, we investigate helium mixing in the weakly collisional intracluster medium of galaxy clusters using Braginskii MHD. Secondly, we present a newly developed Vlasov-fluid code which can be used for studying fully collisionless plasmas such as the solar wind and hot accretions flows. The equations of Braginskii MHD are used to study weakly collisional, stratified atmospheres which offer a useful model of the intracluster medium of galaxy clusters. Using linear theory and computer simulations, we study instabilities that feed off thermal and compositional gradients. We find that these instabilities lead to vigorous mixing of the composition and discuss the potential consequences for X-ray observations of galaxy clusters. Collisionless plasmas can be subject to microscale velocity-space instabilities which are not well-described by Braginskii MHD. In contrast, Vlasov-fluid theory captures all the kinetic phenomena associated with the ions and is thus well suited for studying collisionless plasmas. We have developed a new 2D-3V Vlasov-fluid code which works by evolving the phase-space density distribution of the ions while treating the electrons as an inertialess fluid.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Jeppe Thulin Østerberg
Examining Zinc Transporting P-Type ATPases by Genome Editing

Supervisor(s):
Professor Michael Palmgren

Department:
Plant and Environmental Sciences

Date of defense: 3 November 2017
Date of awarded PhD degree: 8 November 2017

Summary:
Zinc is an essential micronutrient in plants. It is taken up from the soil by the plant roots and transported from there throughout the plant tissues, as a final destination ending up in the plant progeny, the seed. In this route from soil to seed, several bottlenecks occur. The export of zinc into apoplastic gaps is required both for xylem loading in the roots and for loading into the apoplastic space in the seeds, the tissue surrounding the next plant generation. The movement of the positively charged zinc ions out of the symplast is against the electrochemical gradient and thus requires active transport. Both in the model plant Arabidopsis thaliana and in the cereals, the P1B2-ATPases have been demonstrated to be involved in the loading of zinc into the xylem, and here we demonstrate that the Arabidopsis P1B2-ATPase AtHMA2 and AtHMA4 are involved in loading of zinc into the seed apoplast. The P1B2-ATPases contain extended C-terminal domains that are believed to serve an autoregulatory function. Studies on the Arabidopsis P1B2-ATPase AtHMA4 have demonstrated that increasing size deletions of the C-terminal domain results in a gradual increase in the pump’s complementation ability of a zinc hypersensitive yeast strain. The emergence of the CRISPR/Cas9 technology enables us to examine the effect of such C-terminal truncations of AtHMA4 in planta by generating premature stop codons in the C-terminal domain by precision mutagenesis. Here, I present the generation of several such C-terminal truncation mutants of AtHMA4. The use of genome editing tools holds the potential to generate precise mutations while obtaining a non-transgenic plant within two generations. The creation of such non-transgenic but improved plants by genome editing techniques is discussed here in a series of reviews, along with the legal, financial and philosophical implications of using these techniques in crops. One of the feasible uses of genome editing techniques is to repair detrimental mutations that may have occurred in crop plants during domestication in genes controlling traits that could not be selected for. One such trait is the grain zinc content of rice, which varies greatly within domestic rice cultivars and is reported to be higher in wild rice relatives. Here, I report the examination of a mutation in OsHMA2 from the domesticated rice Oryza sativa ssp. japonica cv. Nipponbare, in a region which is otherwise conserved within other rice and monocot plant species.

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Sophie Konstanze Lambertz
Identification and Characterization of Jasmonate Transporters:
The Role of Jasmonate Efflux in Plant Defense and Development

Supervisor(s):
Associate Professor Hussam Hassan Nour-Eldin

Department:
Plant and Environmental Sciences

Date of defense: 18 August 2017
Date of awarded PhD degree: 8 November 2017

Summary:
Jasmonates accumulate within seconds when plants are attacked by herbivores or experience mechanical damage. As signaling molecules they link damage associated patterns to appropriate responses in the plant body, by inducing the plant defense systems and adapting growth and development in the plant. Loss of jasmonate biosynthesis leaves the plant almost helpless against a variety of herbivores and necrotrophically living pathogens.
One of the best known characteristics of jasmonates is, that they are lowly abundant under normal growth conditions but reach high levels not only at site of the stimulus but also in distal tissues. The systemic accumulation has been the focus of many studies, which proposed that jasmonate is transported over long and short distances to induce defense responses. However, our knowledge of jasmonate transporting elements is marginal.
In this thesis, two jasmonate efflux proteins (JEFFs) were identified in a functional screen. We found that JEFF mediated efflux mechanism is conserved in homologs of different angiosperm species. To investigate if the JEFFs are involved in jasmonate mediated defense induction, their contribution to the resistance against the herbivore Spodoptera littoralis and the fungus Botrytis cinerea was tested. Wounding assays indicate that the JEFFs are involved in systemic induction of the defense compounds glucosinolates, which may be caused by a JEFF mediated shift of jasmonate precursors to the biologically active form of jasmonates. Further, jasmonate efflux may be involved in root growth responses as well as in the regulation of leaf growth. These results underline the importance of spatio-temporal jasmonate signaling and propose that jasmonate fluxes across the plasmamembrane regulate phenotypic plasticity.
Creating Interdisciplinarity Within Monodisciplinary Structures

Summary:
This PhD thesis was part of the development project ‘Interdisciplinary education at UCPH’. It explored the linkages between interdisciplinary research and education, and followed the concrete development and execution of interdisciplinary educational activities. The analysis is based on a literature study reviewing 60 peer-reviewed international papers on interdisciplinary teaching practices and a fieldwork including observations and interviews across five interdisciplinary research projects in the Excellence Programme for Interdisciplinary Research at UCPH. The findings from the analysis are as follows:
While interdisciplinary teaching is increasingly popular in higher education, very few empirical accounts have found their way to the peer-reviewed literature. The limited outlet of cases and empirical accounts affect the way, interdisciplinary teaching practices are perceived and practiced.
The fieldwork mapped a range of one-off interdisciplinary educational activities taking placed primarily as elective courses at the master’s and PhD levels. In addition to these activities, there were also multiple unreported student-driven activities, linked to the research projects and taking place in the interstices of the monodisciplinary structures.
The analysis of interviews with 25 PhD students in the research projects highlighted students navigating expectations raised by the Principal Investigators of the interdisciplinary projects and by the monodisciplinary structures of the university, by limiting the scope for experimentation and detours.
An analysis of the official documents at programme level and of local interdisciplinary efforts at project level showed that the lack of definitions, of set criteria and of aims for the interdisciplinary activities in the programme had visible effects on the local practices of interdisciplinarity.
There are discrepancies in the use of the term interdisciplinarity. This has repercussions for the practices and incentives of creating interdisciplinary education, research and collaboration. Hence, interdisciplinary teaching and learning practices has to engage in a continuous balancing of different dynamics and interests.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Toms Buls

Physical Behaviour of Calcareous Nannofossil Ooze and Effects of Clay and Organic Matter on Pelagic Sediment stability: Experimental Approach Using Laboratory Flumes

Supervisor(s):
Professor Lars Stemmerik
Associate Professor Kresten Anderskouv

Department:
Geosciences and Natural Resource Management

Date of defense: 27 October 2017
Date of awarded PhD degree: 10 November 2017

Summary:
This thesis explores the subject of physical behaviour of ancient calcareous nannofossil ooze that eventually formed kilometre-thick Upper Cretaceous chalk succession over vast areas of NW Europe and more than 65 Ma years later forms valuable hydrocarbon and ground-water reservoirs. This thesis is unique as it uses a “hands-on” approach utilising experimental sedimentology methods studying ancient sediment mobility. This would provide better constraints on the strength of the bottom currents of the Late Cretaceous Chalk Sea, potentially lead to improvement of chalk depositional models and interpretation of paleocirculation patterns from the sediment record.

In order to achieve the goals of the project, a method to produce calcareous nannofossil ooze was developed and tested allowing acquiring an unconsolidated and un lithified analogue of the chalk. Further studies tested the erosional and depositional behaviour of the produced experimental nannofossil ooze utilising laboratory flumes. These experiments observed general decrease of calcareous nannofossil ooze mobility with decreasing bed porosity and with increasing concentration of clay and organic matter within the studied bed porosity range (85–60 %). Overall bed porosity decrease and higher concentrations of clay and organic matter seemed to more affect the erosion rate decrease than the erosion threshold increase. Clay was generally less effective in bed stabilisation compared to organic matter. Extracellular polymeric substances (EPS) organic matter was a more potent stabiliser than the marine particulate organic matter proxy sourced from the cultivated phytoplankton.

Experiments at sub-erosion threshold current velocities identify potential alternative sediment transport mode in the form of “surface creep“ in high porosity beds (> 80 %).

The deposition experiments observed potential calcareous nannofossil ooze aggregation and flocculation, a fact that has previously been identified in chalk sedimentology literature as of unlikely occurrence.
Allan Christian Petersen
The CH2Cl2+ System in the Gas Phase
- An Experimental and Computational Investigation

Supervisor(s):
Professor Theis Ivan Sølling

Department:
Chemistry

Date of defense: 10 November 2017
Date of awarded PhD degree: 16 November 2017

Summary:
The dichloromethane molecular ion CH2Cl2(+) is studied by mass-spectrometric methods in the Mass-analyzed Ion Kinetic Energy (MIKE) experiment and by ab-initio computational methods. In the MIKE-experiment, metastable CH2Cl2(+) ions undergo the spontaneous reaction CH2Cl2(+) → CH2Cl(+) + Cl. The obtained MIKE-spectra are significantly influenced by Collision-Induced Dissociation (CID), and a subtractive process is applied to separate CID from the spontaneous reactions. The spontaneous reactions are characterized by a Kinetic Energy Release (KER) and an intramolecular Kinetic Isotope Effect (KIE) on the competing Cl-atom loss from CH2(35Cl)(37Cl)(+). Both are of unusual magnitude; respectively 0.06 meV, which is an exceptionally low KER, and a factor 9, which is an extraordinarily high KIE. The CH2Cl2(+) ion is computationally investigated by MP2, CCSD and eom-CCSD methods. Electronic state symmetry viewed within the C2V point group is applied to calculate energies, frequencies and establish potential energy surfaces. Adiabatic dissociation reactions are studied for each electronic state by stretching the C-Cl bond. Non-adiabatic dissociation reactions are also studied. They involve anti-symmetric vibrational modes in the reactant, and the equivalent modes in the product. A reaction mechanism of electronic predissociation is presented with a reaction coordinate of strong curvature. The reaction dynamics effectively accounts for the low KER via a bob-sled effect and qualitatively also allows for the KIE interpretation entering by the predissociation rate. Nine similar systems are also experimentally investigated. Several hereof display identical characteristics and they can be interpreted by an identical reaction mechanism.
Max Herzog
Mechanisms of Flood Tolerance in Wheat and Rice: The Role of Leaf Gas Films During Plant Submergence

Supervisor(s):
Professor Ole Pedersen

Department:
Biology

Date of defense: 9 November 2017
Date of awarded PhD degree: 16 November 2017

Summary:
Most crops are sensitive to excess water, and consequently floods have detrimental effects on crop yields worldwide. In addition, global climate change is expected to regionally increase the number of floods within decades, urging for more flood tolerant crop cultivars to be released. The aim of this thesis was to assess mechanisms conferring rice and wheat flood tolerance, focusing on the role of leaf gas films (see picture below) during plant submergence. Leaf gas films contribute to rice and wild wetland plant flood tolerance, but their role in submergence tolerance of dry land crops had not been investigated.

The current thesis encompasses a literature review manuscript on wheat flooding tolerance, and four manuscripts assessing physiologic, metabolomic and genetic response of wheat subject to complete submergence. Reviewing the literature showed that wheat germplasm holds genetic variation toward waterlogging (soil flooding), and highlighted traits such as improved internal aeration of the root system as conferring tolerance. However, further work is required in order to explore the available genetic resources. Manipulating leaf gas film presence affected wheat and rice submergence tolerance such as plant growth and survival. However, leaf gas film retention times did not differ between 14 winter wheat cultivars, and leaf gas films did not prevent significant salt intrusion during rice submergence in saline water. Thus, a future prominent role of leaf gas films in improving (i) wheat submergence tolerance and (ii) rice salinity tolerance was not generally supported due to the low genetic variability in wheat, and significant salt intrusion into rive leaves, respectively. Meanwhile, other experimental work documented contrasting submergence tolerance between two wheat cultivars, and suggested possible mechanisms conferring tolerance for future breeding efforts.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Abdulfatah S. Adam
Applied and Behavioural Economics Essays on Obesity
Intervention Strategies in Retail Settings

Supervisor(s):
Professor Jørgen Dejgård Jensen
Associate Professor Leif Jonas Nordström

Department:
Food and Resource Economics

Date of defense: 8 November 2017
Date of awarded PhD degree: 20 November 2017

Summary:
Several studies have shown that food stores, and the availability of healthier products in those stores, are important contributors to healthy eating patterns among customers who frequent the stores (Glanz and Yaroch, 2004, Story et al., 2008), and that grocery stores and supermarkets can play a unique role in helping to reverse the obesity epidemic (Morland et al., 2006, The Food Trust, 2011). As a result, several interventions strategies targeting food purchased at retail food stores have been suggested (Story et al., 2008, Thaler and Sunstein, 2003, Waterlander et al., 2013). Among these are narrowing the information asymmetry gap via improved food labeling, price incentives, changing stores’ choice architecture, and product reformulation. While all suggested interventions are considered in a review paper (paper I), the remainder of the thesis is limited to the latter three interventions of prices, choice architecture (nudging) and product reformulation. Throughout the thesis main outcome variables are total calorie sales used as a proxy for healthfulness of targeted products, and total sales revenue used to benchmark store performance pre- and post-intervention periods.

A takeaway from the results is that interventions which combine price, information and easy access to and availability of healthy foods with interactive and engaging nutrition information, if carefully designed can help customers of food stores to buy and consume more healthy foods. When taken separately, product reformulation seems to be most cost-effective compared to shelf space management intervention and temporary price cuts.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Alexandru Vlasceanu
Dihydroazulene/Vinylheptafulvene (DHA/VHF)
Systems Towards Molecular Solar-Thermal Energy Storage

Supervisor(s):
Professor Mogens Brøndsted Nielsen

Department:
Chemistry

Date of defense: 27 October 2017
Date of awarded PhD degree: 20 November 2017

Summary:
In the face of increasing pressure by the global community towards the development of sustainable energy solutions, molecular solar-thermal (MOST) systems have been proposed as a reasonable technological alternative. The defining characteristic of any potential MOST system is the ability to undergo a reversible light-induced isomerization (charging) from a low-energy ground state to a high energy metastable state, from which a triggered relaxation (discharge) to the ground state is accompanied by a release of thermal energy. One system that has perhaps not received as much attention in this respect has been the dihydroazulene/vinylheptafulvene (DHA/VHF) system. Technical shortcomings such as low, uncompetitive energy storage capacities and the lack of a reasonable triggering mechanism for the thermal energy release are likely part of the reason for this system’s regular absence from literature in this field. Inspired by recently proposed ideas, the introduction of tension and strain towards addressing these two issues of the DHA/VHF system has been the overarching theme of this thesis.

By the same principle that stretching a rubber band allows for the capture and storage of potential energy in a mechanical system, so too might the light-induced stretching of cyclic structures on the molecular level.

Through the synthetic modification of such photoactive molecular systems, it was found that the introduction of ring strain can significantly influence the energy charging and discharging cycles of system. Thermal energy release could be induced to occur in a stepwise manner, on both a fast and slow timescale, hypothetically addressing both immediate and long-term energy discharge requirements. In addition to this, a theoretical study also indicates that the smallest cyclic structures exhibit the highest energy storage capacities. These studies provide further support for the idea of using molecular rubber bands to capture and store solar energy.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Jon Egelund
Cardiometabolic Risk Factors and Cardiac Health in Pre- and Postmenopausal Women: Adaptations to Intense Aerobic Exercise Training

Supervisor(s):
Professor Ylva Hellsten

Department:
Nutrition, Exercise and Sports

Date of defense: 17 November 2017
Date of awarded PhD degree: 20 November 2017

Summary:
The menopausal transition leads to a drastic decrease in sex hormones and is associated with an increased risk for metabolic and cardiovascular disease. The increased risk is thought partly to be the consequence of reduced estrogen levels. Physical activity is known to have potent health effects on the cardiovascular system and whole body metabolism, reducing the likelihood of cardiometabolic disease. However, so far this has been sparsely examined in recent postmenopausal and late premenopausal women.

This PhD project examined the effect of the menopausal transition and of a 12 week training period with intense aerobic cycling on cardiometabolic risk factors as well as cardiac adaptation. A group of late premenopausal (n=43) and a group of recent postmenopausal women (n=40) with only a small age difference (4.2 years) between the groups were recruited. All women were healthy and sedentary. The women underwent examinations for cardiometabolic risk factors, e.g. blood pressure, glucose tolerance, body composition and blood lipids. At baseline, the postmenopausal women had higher cholesterol levels but other risk factors were similar. After training, the cardiometabolic risk profile was improved in both groups. The women had more lean body mass, lower diastolic blood pressure and resting heart rate, improved glucose tolerance and reduced cholesterol levels.

Cardiac examination with echocardiography (n=73) and cardiac magnetic resonance imaging (cMRI) (n=28) showed similar heart structure with only minor differences in function between the two groups. After training, both groups had increased left ventricle mass and had improved on several parameters related to cardiac function. Myocardial perfusion was assessed by cMRI at rest and during stress. At rest the perfusion was lower in the postmenopausal women compared to the premenopausal women. After training both groups showed lower perfusion than before. Stress myocardial perfusion, was similar in the groups. After training, the groups combined presented a lower stress myocardial perfusion. The thesis results emphasize the importance of physical activity for women’s cardiometabolic health before and after menopause.

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Summary:
Simulating the movements of individual atoms allows us to look at and investigate the physical processes that happen in an experiment. In this thesis I use simulations to support and improve experimental studies of breaking gold nano-junctions. By using molecular dynamics to study gold nanowires, I can investigate their breaking forces under varying conditions, like stretching rate or temperature. This resolves a confusion in the literature, where the breaking forces of two different breaking structures happen to coincide. The correlations between the rupture and reformation of a gold junction are studied, and when the same analysis methods are used on both simulated and experimental results, we see a striking similarity. The simulations are used to understand what atomic movements could happen in the experiments. Finally, I develop a classification method, using conductance traces as input, to predict the structure of a gold junction just as it breaks. This method is based on artificial neural networks and can be used on experimental data, even when it is trained purely on simulated data. The method is extended to other types of experimental traces, where it is trained without the use of simulated data.
PHD GRADUATE FROM FACULTY OF SCIENCE

Vandasue Lily Rodrigues
Identification of Novel Components in MicroProtein Signaling

Supervisor(s):
Associate Professor Stephan Wenkel

Department:
Plant and Environmental Sciences

Date of defense: 16 November 2017
Date of awarded PhD degree: 20 November 2017

Summary:
Plants have evolved complex strategies in making developmental decisions. One of these is floral initiation—the transition from the vegetative to the reproductive state. This critical switch needs to be perfectly timed in order to ensure reproductive success. One of the main transcription factors activating the florigen flowering locus T (FT) is called CONSTANS (CO). CO is targeted by microProteins miP1a and miP1b, which function by sequestering CO in a non-functional complex. Consequently, plants overexpressing the microProteins exhibit a significantly delayed transition to flowering, because of the lack of active CO. This study aims at identifying the mechanism by which these microProteins act by identifying factors involved in miP signaling. We describe the formation of a miP1a/b-CO complex together with the transcriptional corepressor TPL and the histone demethylase JM14. Taken together, our findings suggest that these interacting components are part of a larger repressor complex preventing premature floral transition.

Till date, all the miPs described in plants target transcription factors. The lack of diversity of protein target classes can be attributed to the lack of functional characterization of smaller proteins. Using a computational approach, we identified putative microProteins that could target a diverse variety of protein classes. Using a synthetic microProtein approach, we demonstrate that miPs can target a diverse variety of target proteins, which makes them of interest as potential biotechnological tools.
Ramūnas Digaitis
The Biophysics of Plant Cell Wall Degradation

Supervisor(s):
Senior Researcher Lisbeth Garbrecht Thygesen
Postdoc Emil Engelund Thybring

Department:
Geosciences and Natural Resource Management

Date of defense: 17 November 2017
Date of awarded PhD degree: 24 November 2017

Summary:
Accelerated lignocellulosic biomass degradation, depending on its application, can be both beneficial as well as undesirable. Enhanced degradation of bio-based materials, e.g. wood structures, may substantially reduce their service life and therefore is unwanted. Fast lignocellulose fractionation to soluble sugars, on the other hand, is particularly advantageous in biorefineries, where the efficient lignocellulose depolymerisation is central. Lignocellulose degradation, occurring in nature or driven in biorefineries, is a highly complex process where a number of biotic and abiotic factors may contribute to the degradation in a confounded way. Simultaneous exposure to several degrading factors, for instance, could potentially synergistically accelerate degradation of plant biomass.

This study investigated the interrelationship between mechanics and enzymes in degradation of two substantially different lignocellulosic biomass materials, namely flax (Linum usitatissimum L.) fibres and Scots pine (Pinus sylvestris L.) veneers. Mechanical and enzymatic treatments were applied either individually, simultaneously or in a sequential manner, where enzymatic hydrolysis was preceded or proceeded by mechanical treatment. During the enzymatic hydrolysis of flax fibres, mechanical treatment was also applied interruptedly. In addition, factors which potentially enhance physical fibre breakdown (i.e. agitation intensity, type of agitation) as well as impact enzymatic catalysis rate (i.e. enzyme concentration, solid loading) were investigated. To learn more about the enzymatic breakdown of lignocellulose (e.g. enzyme specificity), hydrochloric acid, instead of enzymes was used to mitigate flax fibre attrition during mechanical treatment.

This study showed for the first time that there is a synergistic effect between enzymatic and mechanical degradation on solid wood. For individual fibres, mechanical forces as well as enzyme concentration and solid loading were found to considerably contribute to fibre attrition during hydrolysis. Specifically, higher mixing intensity, free fall distance and enzyme concentration enhanced attrition rate of flax fibres. Increasing solid loading, on the other hand, had the opposite effect. Further, it was observed that mechanical agitation negatively affects enzyme activity.
were compared to the initially planned treatment. The results showed that the effect of the leterious alleles because of this demographic history and body phantom that was program med to perform breath-holds mimicking the patients. It is of great importance to ensure that the position of the tumor remains unchanged to start using the breath-hold technique, which would enable more lung be safely treated with proton therapy. “cradle” from which all plains zebra populations film dose detector s. The experiment showed that to a large extent, the variations occurring day-to-day based management decisions. I

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demonstrate the advantages of NGS data in the framework of population genetics for elucidating demographic inferences, important for understanding conservation efforts, selection and mutational burdens. 

In the first whole-genome study of waterbucks, we investigated the divergence process in a large African mammal. Our results showed that the population structure conformed to two isolated subspecies, but we also found that there has been historical gene flow in certain parts of the species range. We also found a lack of recent gene flow within one of the subspecies even across short distances, which suggests an anthropogenic effect on the waterbuck population connectivity and therefore possibly near-future conservation concerns. Investigating the plains zebra, we disentangle the complex genetic structure across a large geographical area and further provide detailed insights into the past phylogeography of this species, including finding a likely plains zebra “cradle” from which all plains zebra populations arose some 367kya. The genetic structure identified in the plains zebra is also different from what has been found using morphometrics, which supports the use of genomic information to supplement morphology-based management decisions. 

From a study of exomic sites in the Inuit population, we show that the demographic history of the Inuit is the most extreme in terms of population size, of any human population. We identify a slight increase in the number of deleterious alleles because of this demographic history and support our results using simulations. We use this to show that the reduction in population size experienced by the Inuit will improve mapping of disease-alleles, which are uncommon in populations with larger population size.

PhD Graduate from Faculty of Science

Casper-Emil Tingskov Pedersen
Demographic Inferences from Large-Scale NGS Data

Supervisor(s):
Assoc. Professor Anders Albrechtsen, Assoc. Professor Hans Redlef Siegismund, Assistant Professor Rasmus Heller

Department:
Biology

Date of defense: 20 November 2017
Date of awarded PhD degree: 27 November 2017

Summary:
The development of Next Generation Sequencing (NGS) methods have revolutionized the speed and cost of doing large-scale genomic analyses. Furthermore, the quantity of sequences produced facilitate analyses of a number of non-model organisms as well as deeper and more theoretical predictions for e.g. human genetics. In this thesis, the three papers presented demonstrate the advantages of NGS data in the framework of population genetics for elucidating demographic inferences, important for understanding conservation efforts, selection and mutational burdens.

In the first whole-genome study of waterbucks, we investigated the divergence process in a large African mammal. Our results showed that the population structure conformed to two isolated subspecies, but we also found that there has been historical gene flow in certain parts of the species range. We also found a lack of recent gene flow within one of the subspecies even across short distances, which suggests an anthropogenic effect on the waterbuck population connectivity and therefore possibly near-future conservation concerns. Investigating the plains zebra, we disentangle the complex genetic structure across a large geographical area and further provide detailed insights into the past phylogeography of this species, including finding a likely plains zebra “cradle” from which all plains zebra populations arose some 367kya. The genetic structure identified in the plains zebra is also different from what has been found using morphometrics, which supports the use of genomic information to supplement morphology-based management decisions.

From a study of exomic sites in the Inuit population, we show that the demographic history of the Inuit is the most extreme in terms of population size, of any human population. We identify a slight increase in the number of deleterious alleles because of this demographic history and support our results using simulations. We use this to show that the reduction in population size experienced by the Inuit will improve mapping of disease-alleles, which are uncommon in populations with larger population size.

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Link: www.science.ku.dk/english/research/phd/student/phdtheses
Hypothesis: The ORCID populations w Experienced by the Inuit will improve mapping of disease support our results using simulations. We use this to show that the reduction in population size a slight increase in the number of de.

In the first whole-genome study of waterbucks, we investigated the divergence process in a species, including finding a likely plains zebra geographical area and further provide detailed insights into the past phylogeography of this large African mammal. Our results showed that the population structure conformed to two demographic inferences, important for understanding conservation efforts, selection and demonstrate the advantages of NGS data in the framework of population genetics for elucidating theoretical predictions for e.g. human g.

The development of Next Generation Sequencing (NGS) methods have revolutionized the speed of doing large-scale genomic analyses. Furthermore, the quantity of sequences that can be sequenced at a reasonable cost of doing large studies has increased dramatically.

It is of great importance to ensure that the position of the tumor remains unchanged in certain parts of the patient's body phantom that was programmed to perform breath-holds mimicking the patients breathing of the patient, which makes such treatments challenging. One of few existing solutions to this problem is to deliver the radiation dose while the patient holds his or her breath. It is of great importance to ensure that the position of the tumor remains unchanged throughout the whole treatment. Different reasons causing changes in the tumor position need to be carefully studied. Proton therapy is namely commonly given once per day for several weeks. The aim of this thesis was to evaluate the effect of the motion during the treatment and the day-to-day anatomical variation.

Simulations of the patients' treatment based on repeated breath-hold computed tomography (CT) scans were compared to the initially planned treatment. The results showed that the effect of the motion during and between the treatments was small. The simulations also showed that smaller tumors were more sensitive to motion, and, therefore they need to be treated with caution. These results were also confirmed by experiments. These experiments were carried out with a human-like upper-body phantom that was programmed to perform breath-holds mimicking the patients during a breath-hold treatment. The patients' tumors were 3D-printed and inserted into the phantom together with film dose detectors. The experiment showed that to a large extent, the radiation dose that was detected in the tumor resembled the radiation dose that was planned to the tumor.

Overall, the variation in tumor position during the treatment and variations occurring day-to-day were shown to have a small effect on the planned dose to the patients. These results encourage proton therapy clinics to start using the breath-hold technique, which would enable more lung cancer patients to be safely treated with proton therapy.

Summary:
Proton therapy is a treatment of cancer with great potential over other treatment options. As the treatment is local, i.e. it only gives effect where it is administered, it is of great importance that the patient is absolutely still during treatment, to avoid giving harmful radiation dose to healthy tissue. For lung cancer specifically, the tumor might move during the treatment because of the breathing of the patient, which makes such treatments challenging. One of few existing solutions to this problem is to deliver the radiation dose while the patient holds his or her breath. It is of great importance to ensure that the position of the tumor remains unchanged throughout the whole treatment. Different reasons causing changes in the tumor position need to be carefully studied. Proton therapy is namely commonly given once per day for several weeks. The aim of this thesis was to evaluate the effect of the motion during the treatment and the day-to-day anatomical variation.

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Link: www.science.ku.dk/english/research/phd/student/phdtheses
PHD GRADUATE FROM FACULTY OF SCIENCE

Melanie S. Montes
Population Genetics of Phytophthora Infestans

Supervisor(s):
Professor Søren Rosendahl
Associate Professor Rasmus Kjøller

Department:
Biology

Date of defense: 24 November 2017
Date of awarded PhD degree: 27 November 2017

Summary:
Phytophthora infestans is the potato late blight pathogen, most famous for its role in the Great Famine in Ireland in the 1840s. It is still a large problem today, costing about a billion Euros in yield loss and chemical control each year on potatoes in Europe alone. It also has a profound environmental cost, as potatoes are extensively sprayed with fungicides to prevent outbreaks. If one were able to predict whether a coming epidemic had certain genes that gave it fungicide resistance or made it particularly aggressive, it would help farmers make more informed decisions about whether or not to spray their crops, and potentially lower the use of fungicides. In this thesis the groundwork was laid for such a forecasting system, by describing the structure of P. infestans outbreaks in Denmark: how it reproduces and spreads. The populations were found to mostly reproduce clonally, and showed a high diversity of lineages, with different strains appearing from field to field. Different strains were also tested for their resistance to the fungicide metalaxyl, and it was shown that there is potential for linking genetic markers to resistance. In a pilot study it was then tested whether P. infestans sporangia could be collected from the air using a spore trap in a potato field, and quantified based on their DNA content. It was found that even trace amounts of sporangia could be detected, showing the potential for using spore traps in forecasting systems, but weather patterns were still more reliable in predicting outbreaks than the number of sporangia quantified from the spore trap.

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Link: www.science.ku.dk/english/research/phd/student/phdtheses
Nina Kirkegaard
Weaver Ants to Control Fruit Fly Damage to Tanzanian Mangoes

Supervisor(s):
Associate Professor Henrik Vlk Lütken, Associate Professor Theodosy Msogoya, Senior Researcher Hans Joachim Offenberg

Department:
Plant and Environmental Sciences

Date of defense: 22 November 2017
Date of awarded PhD degree: 27 November 2017

Summary:
Do weaver ants protect mangoes from fruit flies in small-scale Tanzanian farms?

Fruit flies are reported to infest 40% of the mangoes produced in Africa. Weaver ants live in mango trees and in plantations their presence has a deterrent effect on fruit flies. This study investigated whether small scale mango farmers in Tanzania are likely to adopt this technique. These farmers do not see fruit flies as their biggest problem; early harvest secured a low infestation level and mangoes warm up sufficiently to kill fruit fly eggs and larvae when packed for transport. Most farmers (80%) thought weaver ants have no consistent effect on fruit fly infestation. Independent studies confirmed this view. This suggests the natural population of weaver ants is insufficient to protect mangoes from fruit flies so farmers have little incentive to invest in weaver ant technology. Analysis of volatiles in ant-infested trees did not clearly identify any compounds likely to be responsible for a deterrent effect. The profile of volatiles may, however, depend on the genotype of the mango.
PHD GRADUATE FROM FACULTY OF SCIENCE

Rocío Hiraldo López-Alonso
Green Capitalist Economies Through a Focus on Labour: Enclosures, Exploitation and Class Conflict

Supervisor(s):
Professor Christian Lund

Department:
Food and Resource Economics

Date of defense: 17 May 2017
Date of awarded PhD degree: 27 November 2017

Summary:
The recent promotion of monetary incentives for preserving the environment is being interpreted as a means of advancing capitalist interests. Until present most research on this topic has concentrated on the strategies used by conservation organisations, private companies and development institutions, while little is known about how people working to make a living (hereafter “workers”) are experiencing the development of green economies. This thesis seeks to fill this gap. It studies how the conditions of workers’ labour are being shaped by the social relations of production enabling the development of nature-based tourism and forestry-related payment for ecosystem service (PES) projects in a group of villages in the Sine-Saloum delta, Senegal.

Based on a six-month period of primarily qualitative fieldwork research and drawing conceptually on Marx’s critique of political economy, it explores three ways in which the social relations of capitalist production in this green economy have shaped labour conditions: a) the privatisation of 1800 hectares of mangrove forest through the creation of a tourism-oriented protected area; b) the activity of work in nature-based tourism and forestry-related PES projects; and c) workers’ mobilisations against exploitation and expropriation.

The thesis shows how, through expropriation, exploitation and class conflict, the green economy benefits capitalist owners while separating workers from the ownership of their labour. Forest privatisation belongs to a broader process of primitive accumulation where workers enable capital accumulation through their adaptations to capital. Production in the green economy is based on social relations that perpetuate poverty, inequality and neo-colonial relations in neoliberal Senegal. The different contribution of nature-based tourism and PES projects to capital accumulation and the importance of class conflict, workers’ disagreement and hope in this case study emphasise the heterogeneity and unpredictability of green economies. Socially-committed researchers will benefit from integrating labour and the relations of production in their analyses.

ORCID No:
Link: www.science.ku.dk/english/research/phd/student/phdtheses
PHD GRADUATE FROM FACULTY OF SCIENCE

Troels Henriksen
Design and Implementation of the Futhark Programming Language

Supervisor(s):
Associate Professor Cosmin Oancea
Professor Fritz Henglein

Department:
Computer Science

Date of defense: 15 November 2017
Date of awarded PhD degree: 27 November 2017

Summary:
For the past ten years, advances in computer performance has arrived primarily in the form of increasing the amount of hardware parallelism that can be exploited. In particular, we have seen the rise of massively parallel accelerators, such as GPUs, which are capable of impressive computational performance compared to sequential CPUs.

Unfortunately, the complexity of programming these devices has left their use the domain of experts. The core issue is that conventional imperative programming models do not scale up to massively parallel programming, and the new programming models that have been proposed have not been implemented in ways that deliver the desired performance.

My research centers on taking one of these models, functional array programming, and demonstrating how it can be used as the foundation for a new programming language, called Futhark, that permits an efficient implementation. My thesis shows the properties of Futhark that permits the generation of efficient low-level GPU code from machine-neutral high-level specifications. In particular, I discuss how the language constructs directly give rise to a range of compiler optimisations that are used to transform the program under compilation in both time and space.

For an empirical evaluation on 21 benchmarks, the Futhark compiler is able to achieve runtime performance comparable with hand-written GPU code. As thus, my research shows a viable way towards flexible and performant high-level code for high-performance accelerators.
Emil Glibstrup
Total Synthesis: Synthetic Development Towards Teichoic Acid & Redox Economy in (-)-Jorumycin

Supervisor(s):
Associate Professor Christian Marcus Pedersen

Department:
Chemistry

Date of defense: 17 November 2017
Date of awarded PhD degree: 28 November 2017

Summary:
The overall theme of the research presented in the thesis is focused around natural product total synthesis, in a broad sense of the area. Part I is focused on the carbohydrate chemistry developed towards the total synthesis of teichoic acids from Streptococcus pneumoniae. Part II is focused on the chemistry developed to improve the redox economy in the total synthesis of the natural product (-)-jorumycin.

Part 1: The field of teichoic acid synthesis is increasing in popularity as these natural products have proven interestingly biologically along with a great potential as vaccines. In our strides towards the total synthesis of teichoic acids from S. pneumoniae we first needed to synthesize the appropriate building blocks. In the initial synthesized building blocks we encountered a number of unforeseen problems. But finally, by developing a new synthetic route for galactosamine derivatives, we were able to synthesize the initial building blocks required. Utilizing our building blocks, we embarked on assembly of the terminal fragment of the teichoic acid. To this end we also had to adjust our synthetic strategy, but finally achieved the assembly of 3-4 variants of the terminal pseudotrisaccharide.

Part 2: The tetrahydroisoquinoline antitumor and antibiotics family is an extremely potent group of natural products. They have a novel mode of action and with their high potency, they have attracted interest from not only chemists, but also biologists and the pharmaceutical industry. One member of the family has even been approved as an antitumor drug. Joining a long-running project at Caltech, we embarked on the task of optimizing the redox economy of the developed route. To this end we set out to modify the existing route in order to allow for the double use of a so-called Boekelheide rearrangement. After extensive optimization, we achieved the double Boekelheide rearrangement improving the redox economy to only consist of two oxidations instead of the previous two reductions and two oxidations. Shortly before hand-in of the thesis the total synthesis of (-)-jorumycin was achieved by the postdoc, Dr. Eric Welin, also working on the project.
PHD GRADUATE FROM FACULTY OF SCIENCE

Gustavo Hassemer
Phylogenetic, Taxonomic and Biogeographic Studies of the Genus Plantago (Plantaginaceae)

Supervisor(s):
Professor Nina Rønsted

Department:
Natural History Museum of Denmark

Date of defense: 24 November 2017
Date of awarded PhD degree: 28 November 2017

Summary:
Plantago, a cosmopolitan group of mostly herbaceous plants distributed all over the world including over 250 species, is a genus of difficult taxonomy, mainly because of its reduced morphology, which features relatively few characters for species classification and identification. This thesis includes research that advances the phylogenetic, taxonomic and biogeographic knowledge of the genus Plantago. Field observations and an extensive revision of herbarium collections and taxonomic literature were used to describe three new species, P. hatschbachiana, P. humboldtiana and P. nebularis, and propose a new name, P. zoellneriana, two new combinations, P. napiformis and P. pretoana, 13 synonymisations, 12 revalidations and 23 typifications. Additionally, many species had their distribution and conservation status assessed or updated. Furthermore, the most comprehensive molecular phylogenetic investigation of Plantago subgenus Plantago to date is presented, applying modern high-throughput sequencing techniques of the plastome as well as the nuclear encoded ITS regions. Cytonuclear discordance is observed, but is attributed mainly to lack of resolution in the ITS region. This improved phylogenetic knowledge was applied to support the proposal of a new sectional classification of Plantago subgenus Plantago, and based on the phylogenetic results one new section, Plantago sect. Pacifica, was created. The results of this thesis highlight the importance of applying both morphological studies and state-of-the-art high-throughput DNA data to resolve outstanding taxonomic puzzles exemplified by the plant genus Plantago.
PHD GRADUATE FROM FACULTY OF SCIENCE

Tomasz Cieplak
Development and Application of a Low Volume, Increased Throughput In Vitro Model Simulating the Passage Through Small Intestine

Supervisor(s):
Professor with special responsibilities Dennis Sandris Nielsen

Department:
Food Science

Date of defense: 24 November 2017
Date of awarded PhD degree: 28 November 2017

Summary:
The gastrointestinal tract (GIT) is an organ system responsible for food digestion, absorption of nutrients and the expelling of waste. Due to the high demand to test the intestinal faith of pharmaceutical and bioactive food formulations, there is great interest from food, bioscience and pharmaceutical industries to simulate this complex system. Human intervention studies are still the golden standard for digestion simulation, but they are hampered by high costs, difficulties in accessing samples and ethical constrains. To address these issues, different in vivo models of animals have been developed. All existing dynamic in vitro GIT models are limited by high working volumes and low throughput, which renders any screening effort virtually impossible. In this project we described development of a low volume increased throughput in vitro model of the small intestine (duodenum, jejunum, ileum) as a screening platform for the study of food digestibility, intestinal survival of probiotics and absorption of drugs and small nutrients. Moreover to simulate microbiota of the small intestine, consortium of seven strains was made and incorporated into the in vitro model of the small intestine. The TSI was employed and proved its usefulness in a variety of applications by testing the following: (1) survival of three probiotic strains in the human small intestine (2) viability of microencapsulated probiotic bacteria in the human small intestine, (3) performance and persistence of a bacteriophage cocktail in the human small intestine, (4) behaviour of probiotic Bacillus sp. spores in the stomach and small intestine of in vitro simulated piglets.

The model proved to be a cost-efficient, fast and reproducible method for the simulation of the passage through the small intestine. The development of the TSI model is the next step towards a simple and cost-efficient benchtop GIT model with high screening possibilities, which will allow reducing the usage of live animals in experimental studies.

ORCID No:
Link: www.science.ku.dk/english/research/phd/student/phdtheses
PHD GRADUATE FROM FACULTY OF SCIENCE

Mikkel Abrahamsen
New Results on Classical Problems in Computational Geometry in the Plane

Supervisor(s):
Professor Mikkel Thorup
Associate Professor Christian Wulff-Nilsen

Department:
Computer Science

Date of defense: 24 November 2017
Date of awarded PhD degree: 5 December 2017

Summary:
In this thesis, we revisit three classical problems in computational geometry in the plane. (1) An obstacle that often occurs as a subproblem in more complicated problems is to compute the common tangents of two disjoint, simple polygons. The common tangents are the up to four lines that touch each polygon so that the entire polygon lies on one side of the line. For instance, the common tangents turn up in problems related to visibility, collision avoidance, shortest paths, etc. We provide a remarkably simple algorithm to compute all common tangents of two disjoint simple polygons. It is the first algorithm to be optimal with respect to both the time and the amount of memory used. The set of common tangents provides basic information about the convex hulls of the polygons—whether they are nested, overlapping, or disjoint—and our algorithm thus also decides this relationship. (2) One of the best-known problems in computational geometry is the art gallery problem, which was already studied in the early 70s. Here we study the classical version of the problem where we are given a map of an art gallery (a simple polygon with vertices at integer coordinates) and we have to decide whether a given number of guards can be placed in the gallery so that they guard the entire gallery. We give an explicit example of a polygon where three guards are sufficient, but only if they are placed on specific points with irrational coordinates. If the coordinates of the guards are required to be rational, then four guards are needed. We furthermore prove that the art gallery problem is exactly as difficult as deciding whether a given equation from a very fundamental family of equations has a solution. (3) A natural clustering problem for points in the plane, which has been studied since the early 90s, is the minimum perimeter sum problem. Here, we are given some points in the plane and we want to find the way to partition the points into two clusters so that when we put a fence around each cluster, we use as little fence as possible in total. The fastest previously known algorithm had quadratic running time and we provide an algorithm with running time nearly proportional to the number of points.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Ingo Leonardo Stotz Canales
Couple Global Models of Mantle and Lithosphere Dynamics: Identifying the Forces Governing Pacific Plate Motions since the mid-Miocene

Supervisor(s):
Associate Professor Giampiero Iaffaldano

Department:
Geosciences and Natural Resource Management

Date of defense: 1 December 2017
Date of awarded PhD degree: 6 December 2017

Summary:
Almost all surface processes, including motions of the lithospheric plates, can be related to underlying mantle circulation. Geological expressions across Earth’s surface, such as the Andean mountain range in South America, the ancient cratons of Australia and the African continent’s unusual topography are evidence of this. In turn, these topographic features have an impact on the mantle convection, modulating and organizing its convective planform. A record of the interaction between shallow- and deep-rooted processes is observable on the ocean-floor, which records changes in the velocity (i.e. the direction and magnitude) of lithospheric plates. In this thesis, we have developed novel coupled global numerical models of mantle and lithosphere dynamics and, subsequently, used these to test hypotheses on the force-balance governing motion of the Pacific plate since the mid-Miocene. These coupled models provide predictions of global plate velocities, which can be compared to reconstructed plate velocities, thus allowing us to unravel the driving mechanisms underpinning these motions over the recent geological past. Rapid plate motion changes (i.e. those accomplished within a few Myr) are increasingly being identified from studies of the ocean-floor magnetisation pattern and plume-related volcanic tracks. However, despite these advances, the forces dictating the motions of the Pacific plate, since the Neogene, remain debated, due to the difficulties associated with disentangling the signals related to plume drift from those associated with plate-motion changes. As a part of this thesis, we reconstructed the Pacific plate’s absolute motion since the mid-Miocene (15 Ma) at high temporal resolution, building on previous efforts to mitigate the impact of finite-rotation data noise. This reconstruction evidenced a large change in the absolute Pacific plate-motion direction, between 10 and 5 Ma. We subsequently used our coupled global numerical models of the mantle and lithosphere dynamics to demonstrate that this Pacific plate motion change is a consequence of the arrival of the Ontong Java Plateau at the Melanesian arc. Furthermore, we demonstrate, for the first time, that the sub-Pacific asthenosphere features a significant component of pressure-driven flow (i.e., Poiseuille), and that this accounts for more than half of the Pacific plate motion over at least the past 15 Myr. Our results highlight the power and, indeed, the need for coupled models of mantle and lithosphere dynamics, thus opening up a whole new class of problem to future geodynamical research.

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Karen A. Martinez-Swatson

Domesticating Deadly Carrots: Insights into the Biosynthesis of Thapsigargin Within the Genus Thapsia L.

Supervisor(s):
Professor Nina Rønsted
Associate Professor Henrik Toft Simonsen

Department:
Natural History Museum of Denmark

Date of defense: 17 November 2017
Date of awarded PhD degree: 6 December 2017

Summary:
The demand of thapsigargin both in drug development (Mipsagargin, a prodrug for the treatment of solid tumours) and as a tool to investigate cell death has been very high and is set to increase substantially. However, the compound is only available through the extraction of fruits from wild populations on Ibiza of Thapsia garganica, a species which belongs to the poorly defined genus Thapsia L. There is, therefore, a pressing need to discover thapsigargin's biosynthetic pathway and to develop alternative production platforms. This PhD project, explored the species delimitation and chemical diversity of the genus Thapsia within the subtribe Daucinae. Looking at T. garganica specifically, it was found that the primary trigger for this chemical variation was tissue damage inflicted by herbivores and that locality played a significant role in determining an individual’s chemotype. Finally, part of this project was to identify the site of biosynthesis of thapsigargin. A histochemical analysis coupled with MALDI imaging enabled us to conclude that the specialised structures in the roots play an important part in producing and storing the highly toxic compounds the species uses to defend itself against herbivory.
Salik Anders Rosing
Where Did It Come From, Where Did It Go?
Carbonate Production and Resedimentation in the Cretaceous Chalk Sea

Supervisor(s):
Professor with special responsibilities Christian J. Bjerrum

Department:
Geosciences and Natural Resource Management

Date of defense: 30 November 2017
Date of awarded PhD degree: 6 December 2017

Summary:
This thesis deals with aspects of carbonate productivity and sediment transport in the Chalk Sea. The Chalk Sea was a shallow sea, which covered much of Northwestern Europe during the Late Cretaceous, 100-66 million years ago.
In this sea, the thick chalk deposits known from Møns and Stevns klinter in Denmark and the White Cliffs of Dover in Great Britain was formed, as the carbonate shells of algae rained to the seafloor.
In the modern day, the chalk is a source of clean ground water and of oil and gas. In addition to these practical applications, the chalk also contains information about the climate of the Earth at the time when it was deposited.

This thesis presents numerical modelling work which shows how winter cooling and strong winds could create dense water currents in the Chalk Sea. These currents then moved the chalk sediment around the basin, creating thick drifts in some places and shallow troughs in others.

An additional model shows how banks and mounds on the sea floor could have created disturbance in the water column, bringing nutrient rich bottom waters to the surface. These nutrient rich waters led to better conditions for algae, and as a consequence, to a larger production of carbonate shells and thicker chalk deposits around the banks and mounds.

Another body of work presented in the thesis deals with the use of stable isotopes preserved in sea floor sediments to study the direction of ocean currents in the past. The ratio between different isotopes of the metal Neodymium varies between ocean basins, and currents carry these differences with them. By studying the ratio between these isotopes in seafloor sediments, we can tell where the water above the sediment bed came from.

By using this method, the results presented in the thesis shows, that the Danish sector of the Chalk Sea was relatively restricted, and had a high input of Neodymium from the nearby continent. A connection to the modern day Mediterranean region is shown to be unlikely.
PHD GRADUATE FROM FACULTY OF SCIENCE

Lise Tjørring

The Home, the Family and the Energy Advisor: Social and Gendered Engagements in Energy Renovations and Flexible Electricity Use

Supervisor(s):
Associate Professor Tove Enggro Boon
Associate Professor Quentin Gausset

Department:
Food and Resource Economics

Date of defense: 16 November 2017
Date of awarded PhD degree: 7 December 2017

Summary:
Denmark has the ambitious goal of becoming fossil-free by 2050. The responsibility of accomplishing the 2050 goal has been partly delegated to local energy companies, which are now obligated by law to reduce their customers’ energy consumption. One of the energy companies’ main target groups are private households, which account for approximately 30% of total energy consumption.

This industrial PhD thesis results from a partnership with the Danish energy company SE. Based on the anthropological methods of participant observation and qualitative interviews, the households are investigated from within. The empirical focus is on the households’ potential to perform energy renovations of their homes and adopt flexible electricity use.

Four papers investigate what characterises the social and gendered engagements among the home, the family and the energy advisor and the implications that these engagements have for energy renovations and flexible electricity use.

Main findings are: 1) due to gendered energy consuming practices and social gender norms, mainly women came to be responsible for flexible electricity use and mainly men came to be responsible for energy renovations, and 2) whereas the energy advisor perceived the home as a technical construction to be improved, the people living there perceived it a home embedded with social meanings. Four of those social meanings were investigated and found to relate to decisions on energy renovations: people’s position in the lifecycle, personal events, social relations, historical conditions and social status.

These findings call for new methods to increase the number of energy renovations and the likelihood of adopting flexible electricity use. We must focus on the home not only as a technical issue that can be improved but also as a dwelling space that contains gendered practices, cultural norms and social engagements among the home, the family and the energy advisor.
Routes to novel phosphine-peptide hybrid scaffolds for enantioselective catalysis through phosphine-containing amino acid analogues were investigated. P,P-dichlorophenylphosphine was used as a precursor in the exploration of constructing phosphine-containing building blocks for combination with solid-phase peptide synthesis. Nucleophilic substitution on P,P-dichlorophenylphosphine with ethynylmagnesiumbromide or TIPS/TMS-acetyldimethyldichlorophosphine did not yield the desired dialkynated phosphine. A novel triphenyl phosphine sulfide amino acid analogue was observed. Two triphenylphosphine-based amino acid analogues were obtained on solid support and one of them was utilized as an anchor for elongation of peptides showing compatibility with solid-phase peptide synthesis. An unexpected route to heterobifunctional organophosphorus scaffolds containing an ethylene glycol moiety and a carboxylic acid function was discovered and the compounds were structurally elucidated via NMR and mass spectroscopy. Two of these compounds were incorporated into peptides. An existing method of obtaining peptides containing secondary amines in the peptide backbone have been expanded for incorporation of functional amino acids as well (His(Trt), Gln, Gln(Trt), Cys(tBu), Thr(OrBu), azido-Dab, Asp(OrBu), Arg(Pmc)) yielding a range of novel modified peptides. Peptides containing one secondary amine were phosphinylated and captured as either phosphine-boranes or oxides. Both borane and oxide protection of phosphine-peptide hybrids allowed deprotection of the peptide side-chain protecting groups while leaving the phosphine group untouched. Treating this class of borane-protected phosphine-peptide hybrids with DABCO in toluene liberated the phosphine-borane group from the peptide. Treating mono-phosphinylated peptides with allyl palladium chloride dimer did not yield an observable phosphine-palladium complex. A peptide containing two secondary amine sites was synthesized, phosphinylated and complexed to both palladium and copper. The palladium complex was utilized successfully as a palladium catalyst in a model Sonogashira reaction and the copper complex was utilized successfully in a copper(I)-catalyzed alkyne-azide cycloaddition.
PHD GRADUATE FROM FACULTY OF SCIENCE

Giedrė Bačinskaja
The Role of the Saccharomyces Cerevisiae Rdh54 DNA Translocase at Kinetochores

Supervisor(s):
Professor Michael Lisby

Department:
Biology

Date of defense: 1 December 2017
Date of awarded PhD degree: 7 December 2017

Summary:
The integrity of the genome is continuously challenged from both endogenous and exogenous sources. In order to maintain genomic stability, the cell has acquired sophisticated surveillance mechanisms of genome integrity. One of these mechanisms is the DNA damage checkpoint, which detects DNA lesions and initiates appropriate cellular responses, including cell cycle arrest and DNA repair. Another essential aspect in preserving genome integrity is the accurate chromosome distribution between daughter cells at cell division. This is mainly achieved due to activities of the spindle assembly checkpoint (SAC), which responds to unattached kinetochores or lack of tension between sister chromatids and arrests the cell cycle until all chromosomes are properly attached to the spindle. However, if the trigger activating either the DNA damage checkpoint or the SAC persists, then cell cycle arrest will not necessary be maintained indefinitely, because the cell can re-enter the cell cycle through a process termed adaptation.

In this study, I investigated the role of the Saccharomyces cerevisiae Rdh54 DNA translocase at kinetochores. Rdh54 is involved in DNA repair by homologous recombination (HR) and is required for adaptation to the DNA damage checkpoint. At the cell biological level, fluorescently tagged Rdh54 localizes not only to DNA repair sites but also to kinetochores. To understand the functional importance of Rdh54 localization to kinetochores, I screened for potential interaction partners of Rdh54 at the kinetochore using bimolecular fluorescence complementation (BiFC) and found that Rdh54 shows extensive interactions with the outer kinetochore. Furthermore, I showed that cells lacking Rdh54 function are deficient in resuming cell cycle progression in the presence of benomyl, an agent that depolymerizes microtubules, thereby inducing the SAC. Based on these and other data, I proposed a model, where Rdh54 promotes adaptation not only to the DNA damage checkpoint but also to the SAC by competing with SAC proteins for binding sites at the kinetochore in late metaphase, thus reducing SAC signaling and facilitating the escape from cell cycle arrest mediated by the SAC. Further analysis will test this model experimentally.

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Link: www.science.ku.dk/english/research/phd/student/phdtheses
PHD GRADUATE FROM FACULTY OF SCIENCE

Maria Gliemann Hybholt
Women, Health and Exercise in the Time Bind of Everyday Life
A Micro-sociological Study of Middle-aged Women’s Participation in a Research-based Training Intervention Utilising Spinning

Supervisor(s):
Associate Professor Lone Friis Thing
Associate Professor Laila Susanne Ottesen

Department:
Nutrition, Exercise and Sports

Date of defense: 6 December 2017
Date of awarded PhD degree: 7 December 2017

Summary:
Less than 25% of Danish women report that they exercise enough to obtain the health benefits of physical activity. To understand adequate physical activity among Danish women it is important to take into consideration the individual experiences of the complex everyday life.

This thesis studies which enabling and constraining aspects middle-aged (46-57 years) women experience in relation to a research based exercise intervention. And furthermore, how the relation between work, family and leisure influences their exercise participation.

The empirical material consists of observations, 9 focus group interviews and 21 follow-up individual interviews with a total of 52 women. They all participated in a three months exercise intervention with an hour of spinning three times a week. Through a micro sociological perspective, using Norbert Elias and Arlie Hochschild as theoretical framework, the thesis concludes:

The biomedical understanding of spinning as a highly efficient form of exercise, the liberating community among the participating women, the feeling of obligation toward the researchers, the risk of losing respect in their social everyday life, and the time-limited period all contribute to the women adhering to the exercise intervention. Furthermore, the women’s relation to their civilised bodies also enable their exercise participation through disciplining as well as liberating discourses regarding the idealized healthy middle-aged female bodies. Nonetheless, the women’s (lack of) exercise participation in everyday life is highly connected to the dynamic power relations between work, family and leisure. Hence, work and family have a predominant status in many of the women’s everyday lives which constrains their adherence to sufficient health-promoting exercise. Many of the women experience an overwhelming feeling of guilt because they can’t manage the same tasks at work and in the family during the exercise intervention. Following this, the majority of the women (again) postpone or condense exercise after the intervention. Health-promoting exercise is therefore a highly complex phenomenon, which to a great extent must be understood as a societal responsibility.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Rafael Rodrigues da Costa
The Physiology of Microbial Symbionts of Fungus-Farming Termites

Supervisor(s):
Associate Professor Michael Thomas-Poulsen

Department:
Biology

Date of defense: 30 November 2017
Date of awarded PhD degree: 7 December 2017

Summary:
Fungus-growing termites along with their microbial symbionts represent a conspicuous example of multipartite symbiosis. The genomic complementarity found in the genome of these three organisms seems to be the key explanation for the ecological success achieved by them. Nevertheless, many aspects of the physiology of this complex mutualistic interaction remain obscure. Thus, this thesis has as main focus different physiological aspects of this symbiosis, and we gained deeper understanding on (i) the enzymatic aspects of plant biomass decomposition within the nest of fungus-growing termites; (ii) how the functional roles of gut symbionts reflect the fungal diet adopted by these termites; and (iii) how the growth capacities of Termitomyces fungi could explain the degree of interaction specificity displayed between the termite host and the fungus symbiont. By using different enzyme screening techniques, fungal growth assays, transcriptomics and metagenomics, and working with collaborators to supplement his work with plant biomass compositional analyses, My PhD thesis is comprised of three original research manuscripts. In the Chapter 1 I looked at the enzyme expression and activity at different times of the decomposition process and it was shown that a wide range of carbohydrate active enzymes are produced by the fungus symbiont and gut bacteria. In Chapter 2 I demonstrated that the fungus-farming termites gut microbiota is adapted to decompose fungus biomass, probably due the adoption of a fungus-based diet by these termites. Lastly, In Chapter 3 we I gained deeper information on interaction specificity between termite-fungus, where Termitomyces cultured in different carbon sources seems to display growth patterns based on phylogenetic placement rather than on termite host species, and this goes in agreement with previously reports where new combinations of termite-fungus can take place in nature.
Trees for Future Forests: Genetic and Plastic Responses in Woody Species to Abiotic Factors of Climate Change

Supervisor(s):
Senior Researcher Jon Kehlet Hansen
Professor Erik Dahl Kjær

Department:
Geosciences and Natural Resource Management

Date of defense: 24 November 2017
Date of awarded PhD degree: 14 December 2017

Summary:
The aim of the PhD thesis is to explore different genetic and plastic mechanisms with which trees can adapt and evolve with changing climates. The thesis focus on the abiotic factors associated with climate change, especially raised temperatures and lack of precipitation. Adaptive traits such as phenology which is sensitive to changes in temperature and drought resistance as a response to water scarcity are studied. Quantitative genetics is extensively used in field phenotyping to identify the availability of sufficient genetic variation within species. Other phenotyping techniques such as molecular markers, dendrochronology and assessment of physiological traits were used in order to compliment field phenotyping. The thesis consists of six manuscripts aimed at imparting knowledge on the use of available genetic and plastic responses in effective climate change adaptation practices in forestry. The results of the thesis demonstrate the adaptive potential in woody species against impacts of climate change. But the long rotation age of these species and the uncertainty around the pace and effect of climate change makes adaptation challenging. Phenotypic plasticity in adaptive traits can render a relatively faster adaptation mechanism in trees. The study also demonstrates the importance of establishing and maintaining forest field trials as they are source of vital information regarding the amount of genetic diversity contained within species. The results also call for wider collaboration of traditional forest genetics with other phenotypic techniques such as latest molecular analysis, dendrochronology, physiological and anatomical studies in order to enable faster identification of species/genotypes suited for future climates.
Çiğdem Yücel Falco
Colloidal Formulations for Probiotics Delivery
and Pickering Systems

Supervisor(s):
Associate Prof. Jens Risbo
Associate Prof. Marité Cárdenas

Department:
Food Science

Date of defense: 4 December 2017
Date of awarded PhD degree: 14 December 2017

Summary:
The application of colloidal materials for the formulation of food products is essential and unavoidable for the creation of innovative functional foods.

One emerging functional food area is the efficient probiotics delivery due to viability losses during storage, food processing, and digestion without a successful encapsulation system. The existing encapsulation systems are still lack of fulfilling the main requirements for probiotics delivery such as protection during gastric passage and release in intestine.

Another challenge in food formulations is the identification of new food-grade ingredients to ensure physical stability during shelf life of food. In this regard, the replacement of classical emulsifiers with solid particles is an advancing research area. However, the number of food-grade solid particles investigated is still insufficient.

This PhD thesis investigates hydrogel based colloidal formulations to generate acid resistant probiotic delivery systems using mainly layer by layer technique (Paper I, II & IV), and the functionalisation of edible probiotics as colloidal building blocks and structure modulators in food products (Paper III & V).

Anionic sulfated β-glucan and milk proteins were suggested as new coating biomaterials. They demonstrated potential to endure low pH during gastric passage, as shown by physical stability, and potential to release the encapsulated probiotics in the intestine, as shown by changes in the coating structure or their dismantling at simulated experimental conditions. The use of chitosan as a cationic biomaterial was found to be inevitable in formulations. In another study, it was shown that the submillimetre-sized beads of genipin crosslinked hydrogels of chitosan and dextran sulphate could not release the bacteria at relevant conditions. Furthermore, the culturability of cells after encapsulation was found to be not only related to components of formulation, but also to a lack of efficiency in releasing the cells from the encapsulation system.

The physically and chemically surface activated bacteria were shown to stabilise Pickering foams and emulsions. The microstructure of systems revealed the several arrangements of bacteria at the oil (air)-water interface suggesting a complex stabilisation mechanism.

In conclusion, this PhD thesis provides new insight by improving existing formulations and bringing new ideas into the functional food area by introducing novel suitable ingredients.

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The thriving of the Next-Generation sequencing (NGS) technologies in the past decade have dramatically revolutionized the field of human genetics. We are experiencing a wave of several large-scale whole genome sequencing studies of humans in the world. Those studies vary greatly regarding cohort composition, sequencing strategy and sample size. One of the main considerations when designing the project is the trade-off between the number of sequenced individuals and the per-sample sequencing depth. Several statistical models and theories were established. Validations of the models and methods will be reflected by the analysis of real data.

This thesis covers studies in two human genome sequencing projects that distinctly differ in terms of the studied population, sample size and sequencing depth.

In the first project, we sequenced 150 Danish individuals from 50 trio families to 78x coverage. The sophisticated experimental design enables high-quality de novo assembly of the genomes and provides a good opportunity for mapping the structural variations in the human population. We developed the AsmVar approach to discover, genotype and characterize the structural variations from the assemblies. Our assembly-based method boosts up the power to accurately discover large and complex structural variants. We have identified and validated the extensive existence of structural variation in the human population including many novel insertions. The structural variants are almost symmetric in size structure and are generally in high linkage disequilibrium with the known SNPs. They derived from various mechanisms that could be inferred from the sequence breakpoints. In addition, we identified five novel structural variation association signals in the key FTO gene region when using the Danish reference panel to impute genotypes in the Danish Genetics of Overweight Young Adults (GOYA) obesity cohort and prove the clinical usage of the Danish reference panel in genome-wide association studies.

In the second project, we have collected ultra-low depth sequencing data of more than 140,000 Chinese pregnant women. We developed and applied novel methods to analyzing the data that are accumulating rapidly and now reach millions of sample scale. We show that we are able to discover mutations with allele frequencies down to around 0.2% and to explore fine-scale population structure and ancestry across the 31 administrative divisions and the 45 ethnic groups in the country. Most importantly, we achieved median imputation accuracy of 0.92 for 737K polymorphic loci. Association studies of two common traits height and body mass index on the imputed loci replicated many previously known association loci and reveal several new genome-wide significant signals. While the large number of samples and the low per-sample sequencing depth proposed enormous methodological and computational challenges, we demonstrated its utility in terms of population genetics and medical genomics.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Tamil Chelvan Meenakshi Sundram
Identification and Characterization of Biosynthetic Components Involved in Vitex agnus-castus Diterpenes Biosynthesis

Supervisor(s):
Professor Birger Lindberg Møller
Assistant Professor Irini Pateraki

Department:
Plant and Environmental Sciences

Date of defense: 8 December 2017
Date of awarded PhD degree: 14 December 2017

Summary:
Vitex agnus-castus L. (Vac) is a medicinal plant used in the treatment of women’s menstrual disorders. Additionally, Vac extracts are reported to have dopaminergic activities and anti-cancer properties. The bioactivity of Vac extracts is partly attributed to diterpenoids carrying furan or lactone rings. Here, we investigated the biosynthesis of these Vac diterpenoids. Initially, by using MALDI-MSI analysis, we found Vac diterpenoids to be mainly localized in the glandular trichomes (GTs) of Vac leaves and fruits. Analysis of a GT-specific transcriptome database, coupled with expression studies, identified six candidate genes involved in the biosynthesis of Vac specialised diterpenoids: three class II Vac diterpene synthases (VacTPSs) (VacTPS1, VacTPS3 and VacTPS5), two class I VacTPSs (VacTPS2, and VacTPS6), and a cytochrome P450 (VacCYP76BK1). Next, VacTPSs were functionally characterized in planta. VacTPS1 was identified as peregrinol diphosphate synthase while VacTPS3 as syn-copalyl diphosphate synthase. Pairing VacTPS1 with VacTPS2 yielded vitexagnusin D and 9,13(R)-epoxy-labd-14-ene, while pairing with VacTPS6 yielded labd-13(16),14-dien-9-ol. Coupling VacTPS3 with VacTPS2 yielded vitexifolin A and coupling with VacTPS6 yielded two different products: dehydroabietadiene and syn-isopimara-7,15-diene. Expression of VacTPS5 alone resulted in the production of kolavenyl and pairing with VacTPS2, produced kolavelool. E. coli in vitro dITPS assays were employed to verify the in planta results. In vitro dITPS enzymatic assays of single class II VacTPS (VacTPS1 and VacTPS3) as well as couple of VacTPS1 and VacTPS6, did not show any additional diterpene products when compared to in planta results. Meanwhile, pairing VacTPS3 with VacTPS6 in in vitro assays only afforded syn-isopimara-7,15-diene. The work for expressing a functional VacTPS2 in e. coli is still ongoing. The enzymatic activity of converting peregrinol into labd-13Z-ene-9,15,16-triol by VacCYP76BK1 was confirmed through Saccharomyces cerevisiae in vitro microsomal assays and yeast in vivo assays. We next attempted to engineer a green platform for Vac diterpenes biosynthesis in Synechocystis. To this extend, we only managed to produce syn-copalyl diphosphate by expressing VacTPS3 in Synechocystis cells.

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Never Cry Wolf - The Origin and Genomic History of the Indigenous Greenland Dogs and Wolves

Summary:
Since the first European exploration of Greenland, widespread admixture between sled dogs and wild wolves has been reported and today wolf blood in sled dogs is widely assumed. However now for the first time this legendary bloodline is investigated using full nuclear genome analysis, including both modern and ancient individuals. There is found several historic populations of Greenland dogs, but a large reduction in modern diversity. Further, most surprisingly, there is found no wolf gene flow in any sled dogs. Focusing on wolves there is found a distinct Polar population endemic to Axel Heiberg's Land, Ellesmere Island and Greenland. It is concluded that wolf-dog admixture in Greenland is a myth and not biological authentic. Further, it is concluded that the Polar wolves that inhabit Greenland have been there for centuries, and is genetically distinct from any other wolf in the Arctic. Regarding Greenland dogs, these results can be used to encourage conservation efforts of local dogs, by testifying how genetic diversity in Greenland dogs distinguishes them amongst the world’s dogs, most importantly by having their major pedigree to over 9,500 years old sled dog ancestors.
PHD GRADUATE FROM FACULTY OF SCIENCE

Bjørn Dueholm
Spatial and Molecular Aspects of Hemiparasites on Acacia spp.

Supervisor(s):
Professor Birger Lindberg Møller; Professor Philip Weinstein;
Dr Björn Robert Hamberger; Dr Susan Semple

Department:
Plant and Environmental Sciences

Date of defense: 6 November 2017
Date of awarded PhD degree: 18 December 2017

Summary:
More than 4,500 plant species worldwide parasitise other plants, i.e. they take up water and nutrients from the hosts. The parasitic plants use these stolen resources to fuel their own growth. The majority of parasitic plants can photosynthesise and thus produce some of their own sugars. Parasitic plants with this resource-mixture are called hemiparasites. Australia has a great diversity of hemiparasites, some that tap into the hosts’ roots (e.g. Australian sandalwood) and others that tap into the hosts’ shoots (e.g. mistletoes and hemiparasitic vines). This project investigated Acacia hosts of these different types of hemiparasites, utilising a broad range of spatial and molecular techniques, in order to ascertain how neighbouring plants of hemiparasites are affected and whether hemiparasites indirectly affect other organisms associated with the hosts, for instance insect herbivores.

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Sarah Hagel Svendsen
Arctic Emissions of Biogenic Volatile Organic Compounds—
from Plants, Litter and Soils

**Supervisor(s):**
Professor Riikka Rinnan
Professor Anders Michelsen

**Department:**
Biology

**Date of defense:** 14 December 2017
**Date of awarded PhD degree:** 18 December 2017

**Summary:**
Significant amounts of compounds (BVOCs) are emitted from soil and from living and dead plants. These emissions may influence the atmospheric chemistry and the climate. Climate warming will be most pronounced in the Arctic and this will likely have a large effect on the BVOC emissions. Despite this, BVOC emissions from arctic ecosystems are sparsely studied and measurements of high arctic soil and dead plants are completely lacking. In this thesis, I have studied ecosystem BVOC emissions from a high arctic soil moisture gradient, from dead plants from high and low arctic heaths at increasing temperature and from high arctic soils and permafrost soils during a thaw event and at increasing temperature. Ecosystem BVOC emissions were measured in the field and BVOC emissions from soils and dead plants were measured from laboratory incubations. Results showed that the ecosystem BVOC emissions were highly dominated by terpenoids but that the composition of terpenoids differed between different plant species. Dead plant emissions were less dominated by terpenoids than the ecosystem emissions were, however they still constituted approximately 50% of the total emissions. I suggested that the dead plant emissions derived both from bacteria and directly from the dead plants and that the relative importance of these two sources differed between different plant species. Furthermore, I found that emissions of non-terpenoid BVOCs were dominating the emission profile from the soils and that the magnitude of the soil emissions depended greatly on the soil water content and temperature. A warmer arctic climate will likely alter the composition of arctic plant species, cause a thawing of permafrost soil and change soil characteristics such as the water content. Results presented in this thesis suggest that these changes will alter the both the composition of arctic BVOCs emitted and increase the emission magnitude.

This thesis can help to improve our understanding of future BVOC emissions for the Arctic.

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Signe Hillerup Larsen
Dynamics of Upernavik Isstrøm - Controlling Mechanisms of Ice Stream Flow

Summary:
Fast flowing ice streams are responsible for draining the vast majority of the Greenland ice sheet. During the past few decades, the ice streams have undergone rapid acceleration and retreat Greenland wide. However, the controlling mechanism of the dynamic changes are still not well understood. Due to the ice streams' importance for the drainage of the entire ice sheet, the fifth assessment report (AR5) of the Intergovernmental Climate Panel (IPCC) deemed uncertainties in the flow of ice streams one of the major uncertainties in predicting future changes of the Greenland ice sheet. In this thesis, the dynamical changes at Upernavik Isstrøm (UI), Northwest Greenland, are analysed and an ice flow model is used to study specific controlling mechanisms of the ice stream flow. The analysis of observations of velocity, thickness and calving front position changes, reveals asynchronous behaviour of the neighboring ice streams at UI. However, overall dynamical changes at UI are in line with general trends in the region. Thus, establishing UI as an optimal study site for detailed process studies of controlling mechanisms of ice stream flow. A model study of velocity changes at the end of the melt season in 2014, reveals that the ice streams are increasingly sensitive to melt water changes towards the front. Part of the spatial trend in sensitivity is attributed to the softening effect of water entering the shear margins. A second model study focussing specifically on reproducing the observed flow, establish that including softer shear margins in ice flow models will improve the models ability to reproduce fast flow. Thus, a method for defining softer shear margins in ice flow models, without knowing details about the mechanisms behind the softening, is suggested to be included in future model studies of ice stream flow. The thesis establish the importance of understanding the inhomogeneity of the ice viscosity to be able to correctly model the dynamics of ice streams, and thus to be able to predict future changes of the Greenland ice sheet.
Camilla Lemming
Recycling Phosphorus from Wastewater
Plant Availability of Phosphorus from Sewage Sludge and Related Products

Supervisor(s):
Associate Prof. Jakob Magid, Prof. Lars Stoumann Jensen,
Associate. Prof. Sander Bruun, Prof. Charlotte Scheutz

Department:
Plant and Environmental Sciences

Date of defense: 14 December 2017
Date of awarded PhD degree: 20 December 2017

Summary:
Phosphorus (P) is an essential plant nutrient and a non-renewable resource of which the future supply to agriculture is challenged by limited and geopolitical unevenly distributed mineral P reserves. Recycling of P from waste is an important mean to minimise the dependence on the limited mineral P reserves. Wastewater represents the largest urban flow of P in waste. Hence, knowledge about plant P availability of products from the wastewater treatment system, and also comparison to other waste P sources and mineral P is essential to obtain an efficient recycling and to prioritise between different P recycling options. The work of this PhD focused on the plant P availability of sewage sludge, a P-rich residue from wastewater treatment which is commonly applied to agricultural soil in Denmark. The overall objective of the PhD work was to evaluate the plant availability of P in sewage sludge and other wastewater products, and to relate this to the availability from other P-containing waste products and mineral P fertiliser. The research conducted within this PhD provided important knowledge regarding P availability from sewage sludge, including: variability, effects of sludge thermal drying and incineration of sewage sludge, relation to other P sources from both within and outside the wastewater treatment system and over different time perspectives, availability of residual P accumulated in soil after long-term excess P applications to soil, effect of soil pH, and influences of the spatial distribution in soil. Hence, the results from this PhD can contribute to a better understanding of the utilisation of the already applied sewage sludge P, and serve as input for potential changes in wastewater and sludge management to enhance efficient P recycling from wastewater to agriculture.
Kuong Khov
Impact of Multi-micronutrient-fortified Rice on Micronutrient Status, Health, and Cognitive Performance in Schoolchildren in Cambodia

Supervisor(s):
Associate Professor Nanna Roos, Frank T. Wieringa, Professor Henrik Friis, Jacques Berger, Chhoun Chamnan

Department:
Nutrition, Exercise and Sports

Date of defense: 15 December 2017
Date of awarded PhD degree: 20 December 2017

Summary:
Micronutrient deficiencies can delay cognitive development, increase morbidity and mortality, keeping millions of children from reaching their full potential. Multi-micronutrient fortified rice (MMFR) could be a promising strategy to reduce the prevalence of micronutrient deficiencies in Cambodia. This PhD study is part of the FORISCA study, a cluster-randomized intervention study conducted in 2012-2013 in Kampong Speu, Cambodia, with the purpose to evaluate the impact of 3 types of fortified rice (UltraRice original, UltraRice new, and NutriRice) distributed through school meal program on micronutrient status, health and cognitive performance of schoolchildren. Subjects were all children from grades 1 to 6 (ages 6 to 16 years) in the participating schools. A sub-sample of 125 children per school (500 per intervention group) was randomly selected for nutritional assessment, parasite infection and cognitive performance. Paper I showed a high stability of iron and zinc in all types of fortified rice (coated, cold and hot extruded), while retention of vitamin A was significantly affected by storage. This paper complements another paper reported a high stability of iron and zinc during cooking, but high losses of vitamin A. Paper II showed that soil-transmitted helminth infection was prevalent in 18% of the participating schoolchildren and dominated by hookworm (95%). Hookworm was associated with iron status but not vitamin A and zinc status, nor with inflammation or anthropometric status. Moreover, hookworm infection was associated with lower cognitive performance, an effect most likely mediated through lower body iron. Paper III showed a very high prevalence of zinc deficiency assessed by serum concentration among participating schoolchildren, which was partly but not completely, corrected by 6 months consumption of MMFR. The prevalence of folate deficiency was also reduced by the consumption of MMFR. The highest increase in serum zinc concentrations was observed in the children receiving the rice with the highest content of zinc (NutriRice).This paper complements another paper of FORISA shown the impact of MMFR on iron and vitamin A status of the same schoolchildren. It is concluded that introduction of MMFR into school meal programs and for any other target populations is a promising intervention in combination with other health and nutrition-sensitive programs such as water sanitation and hygiene and effective deworming program.
In conclusion, two brown seaweeds, *L. digitata* and *U. pinnatifida* wastewater, process-water is explored as an alternative source of water. Process-water stems from processing equipment usually already present in the dairy industry and can replace potable water where huge savings both on monetary and environmental impact can be achieved. The present study involves the investigation of crude extracts of dried seaweed Bioactivity: Effects on Glucose Liberation. The in vitro findings especially point to alginate and fucoxanthin as likely inhibitors. This may help to delay the development of T2D in patients with impaired glucose tolerance who consume starch. The present study involves the investigation of crude extracts of dried edible seaweeds for their ability to inhibit the carbohydrate digestive enzymes, α-amylase and α-glucosidase. Bioactive compounds from selected edible seaweeds that inhibit α-amylase and α-glucosidase were identified. The edible seaweeds that show high potential in inhibiting the enzymes were selected to investigate their effects on the postprandial blood glucose and insulin levels following a starch load in a human meal study. The brown seaweeds, *Laminaria digitata* and *Undaria digitata* potently inhibit α-amylase and α-glucosidase activities. Polyphenolics, alginates and fucoxanthin found in the selected edible seaweeds are potentially the bioactive factors that helped to inhibit these enzyme activities. In the human meal study the focus is on the effects of edible seaweeds on postprandial blood glucose and insulin concentrations. There was no significant effect in plasma glucose but both brown seaweeds lowered postprandial insulin response following consumption of *L. digitata* or *U. pinnatifida* compared to the control meal. In conclusion, two brown seaweeds, *L. digitata* and *U. pinnatifida* inhibited α-amylase and α-glucosidase activities, showing chemical diversity with a possibly use for future functional foods. The in vitro findings especially point to alginate and fucoxanthin as likely inhibitors. The observed change in human insulin response may further support that brown seaweeds, particularly *U. pinnatifida*, might be used as a potential functional food to control blood glucose level following starchy meals.

**Summary:**

Long term effect of hyperglycaemia or high blood sugar level is one of the risk factor of diabetes. High blood glucose levels may be caused by glucose absorbed in the small intestine following carbohydrate intake or by excessive production of glucose by liver cells. Maintenance of normal plasma glucose concentration is essential for the human health. Limiting intake of high Glycemic Index (GI) foods and having the right food intake such as functional food that contain α-amylase and/or α-glucosidase inhibitors may lower the average blood sugar levels. Thus, it may help to delay the development of T2D in patients with impaired glucose tolerance who consume starch. The present study involves the investigation of crude extracts of dried edible seaweeds for their ability to inhibit the carbohydrate digestive enzymes, α-amylase and α-glucosidase. Bioactive compounds from selected edible seaweeds that inhibit α-amylase and α-glucosidase were identified. The edible seaweeds that show high potential in inhibiting the enzymes were selected to investigate their effects on the postprandial blood glucose and insulin levels following a starch load in a human meal study. The brown seaweeds, *Laminaria digitata* and *Undaria digitata* potently inhibit α-amylase and α-glucosidase activities. Polyphenolics, alginates and fucoxanthin found in the selected edible seaweeds are potentially the bioactive factors that helped to inhibit these enzyme activities. In the human meal study the focus is on the effects of edible seaweeds on postprandial blood glucose and insulin concentrations. There was no significant effect in plasma glucose but both brown seaweeds lowered postprandial insulin response following consumption of *L. digitata* or *U. pinnatifida* compared to the control meal. In conclusion, two brown seaweeds, *L. digitata* and *U. pinnatifida* inhibited α-amylase and α-glucosidase activities, showing chemical diversity with a possibly use for future functional foods. The in vitro findings especially point to alginate and fucoxanthin as likely inhibitors. The observed change in human insulin response may further support that brown seaweeds, particularly *U. pinnatifida*, might be used as a potential functional food to control blood glucose level following starchy meals.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Peter Bæk Skou
Process-water Characterisation and Quality Monitoring in the Dairy Industry - Moving Towards Replacing Potable Water

Supervisor(s):
Associate Professor Frans van den Berg
Professor Søren Balling Engelsen

Department:
Food Science

Date of defense: 15 December 2017
Date of awarded PhD degree: 20 December 2017

Summary:
The dairy industry is a major consumer of potable water with large volumes being used in cleaning operations and for facility needs such as heating / cooling media. In an attempt to bring down water use and also minimize discharge of wastewater, process-water is explored as an alternative source. Process-water stems from processing equipment usually already present in the dairy industry and mainly concerns membrane filtration permeate as well as evaporator condensate. During processing process-water is reclaimed and, if suitable, it can replace potable water where huge savings both on monetary and environmental impact can be achieved.

The aim of this thesis was to perform detailed chemical characterisation of process-water streams and identify and test relevant measurement techniques, thus establishing basic knowledge on process-water quality monitoring possibilities.

Two process-water streams at the Arla Foods Ingredients processing facilities have been investigated in the thesis work: 1, membrane permeate and 2, evaporator condensate. In membrane permeate urea was found as the main organic compound permeating the membrane, while relatively large molecules were also found to permeate in low concentrations. Near infrared spectroscopy was investigated as a potential monitoring technique and was found to be sufficiently sensitive in a laboratory set-up. However, thorough uncertainty estimation was needed to ensure confidence in the predictions.

Evaporator condensates were characterised with a number of techniques and results indicate that aromatic amino acids consistently were present in condensates from several processing lines. However, no conclusive identification was reached pointing towards the necessity to run alternative analytical techniques.

The project also led to exploring extreme value theory as a way to characterise production processes’ distribution and dynamics.

In conclusion the investigated process-water streams appeared to be very clean, making quantification and identification of contaminating compounds challenging.

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PHD GRADUATE FROM FACULTY OF SCIENCE

Dino Destefano
Investigating Slopes of Overconvergent Modular Forms

Supervisor(s):
Professor Ian Kiming

Department:
Mathematical Sciences

Date of defense: 18 December 2017
Date of awarded PhD degree: 21 December 2017

Summary:
Modular forms are specific functions on the complex numbers that exhibit a high degree of symmetry. These mathematical objects are of great interest because they often allow to connect otherwise very different areas of mathematics. As an example, in 1996 Richard Taylor and Andrew Wiles finally proved Fermat’s last theorem: their proof relied on showing a specific connection between modular forms and certain geometric objects called elliptic curves.
To each modular form are assigned two integers: the level, denoted by $N$, and the weight, denoted by $k$. The space of modular forms of fixed level $N$ and weight $k$ is a vector space that we can then study using linear algebra and linear operators. In the classical theory of modular forms the relation between the spaces of the same weight but different levels are generally well understood. On the other hand, relations between modular forms of different weight are much harder to show. To partially study this problem, one can fix a prime number $p$ and generalize the classical modular forms to $p$-adic overconvergent modular forms. We can still assign a level and a weight to these more general objects and they still form vector spaces by fixing the level and the weight. In this context, one can obtain important information on the modular forms by studying the eigenvalues of a specific linear operator called $U$. These eigenvalues are called slopes of the $U$ operator or slopes of overconvergent modular forms. These slopes encode many properties of classical and overconvergent modular forms.
In this thesis we focus on the case of level $N=1$ and primes $p=5$, 7 and 13 and we are able to provide lower bounds for the possible slopes of the $U$ operator in these cases. As an application, we infer from this result some arithmetic relation between certain spaces of classical modular forms of level 1 and varying weight $k$. 

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Sofie Lindskov Hansen

Single-Photon Manipulation in Photonic Circuits

**Summary:**
Quantum dots in photonic nanostructures has long been known to be a very powerful and versatile solid-state platform for conducting quantum optics experiments. The present PhD thesis describes experimental demonstrations of single-photon generation and subsequent manipulation all realized on a gallium arsenide platform. This platform offers near-unity coupling between embedded single-photon emitters and a photonic mode, as well as the ability to suppress decoherence mechanisms, making it highly suited for quantum information science applications.

In this thesis we show how a single-photon router can be realized on a chip with embedded quantum dots. This allows for on-chip generation and manipulation of single photons. The router consists of an on-chip interferometer where the phase difference between the arms of the interferometer is controlled electrically. The response time of the device is experimentally shown to be in the sub-microsecond range.

The performance of the device is limited by the reflections from the out-coupling gratings used, and we thus develop a new type of out-coupling grating that reduces reflections as well as increasing the coupling efficiency to the fiber. The grating design is inspired by a well-known design from silicon photonics and is adopted for quantum dot emission wavelengths. The new gratings offer a fivefold increase in efficiency compared to the gratings used previously. These results are found from transmission measurements and have been recently been confirmed in single-photon experiments.

Lastly, an examination of some of the possible applications of quantum dots efficiently coupled to the propagating mode of a photonic crystal waveguide is presented. Specifically, we describe how we can realize propagation-direction-dependent light matter interactions in engineered structures, and how we can utilize a well coupled quantum dot to realize giant nonlinearities at the single photon level.
PHD GRADUATE FROM FACULTY OF SCIENCE

Thomaz Edson Veloso da Silva
Educometrics: From Theory to Application

Supervisor(s):
Professor João César Moura Mota
Professor Rasmus Bro

Department:
Food Science

Date of defense: 7 December 2017
Date of awarded PhD degree: 21 December 2017

Summary:
Nowadays, in the educational context, emphasis has been placed on the collection and analysis of data by scientists from several areas of knowledge, such as: psychology and economics. These professionals analyze data and their results can be used, for example, to aid in the decision making of a public policy. However, educational measures have become very popular and can encompass all the multidimensionality contained in the educational process, from teaching and learning to social interaction in the classroom. Understanding of data analysis in a classroom needs to be done by teachers and pedagogues who know exactly the empirical significance of the variability of a particular measured variable. In this sense, this thesis conceptualizes, discusses, defines and applies Educometrics, which is recognized as an area of knowledge that makes use of multivariate statistical models to analyze data related to educational contexts. After establishing the concept of Educometrics, we apply some mathematical models in the learning context of teaching in distance learning. A sample of 791 students answered the updated QEOn questionnaire for three courses and the factorial structure of the questionnaire was valid from the application of factorial analysis. The principal component analysis and the Parafac2, bilinear and multilinear models, respectively, were applied and able to identify intrinsic behaviors in relation to the 34 statements contained in the QEOn questionnaire. As a conclusion, the application of models that allow pedagogical intervention in the classroom as it is the key of the support provided by the educometrics developed throughout this thesis.
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PHD GRADUATES
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<td><strong>HOLST-HANSEN, Thomas</strong></td>
<td>Graduated: 23 January 2017</td>
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<td>Inflammation – Modelling Function and Failure of the Innate Immune System</td>
<td>Supervisor: Ala Trusina</td>
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<td><strong>IAKOUPOV, Ivan</strong></td>
<td>Graduated: 23 February 2017</td>
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<td>Enhancement of optical nonlinearities with stationary light</td>
<td>Supervisor: Anders Søndberg Sørensen</td>
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<td><strong>KURGANSKIY, Alexander</strong></td>
<td>Graduated: 19 July 2017</td>
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<td>Integrated Modelling of Physical, Chemical and Biological Weather</td>
<td>Supervisor: Eigil Kaas</td>
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<td><strong>KÜFFMEIER, Michael</strong></td>
<td>Graduated: 9 October 2017</td>
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<td>Accretion Processes in Star Formation - Accounting for Different Stellar Environments</td>
<td>Supervisor: Per Åke Nordlund</td>
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<td><strong>LARSEN, Signe Hillerup</strong></td>
<td>Graduated: 18 December 2017</td>
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<td>Dynamics of Upernavik Isstrøm – Controlling Mechanisms of Flow</td>
<td>Supervisor: Christine Schott Hvidberg</td>
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<td><strong>LINDBERG, Anna Helmi Caroline</strong></td>
<td>Graduated: 17 May 2017</td>
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<td>Growth of Ag-seeded III-V Nanowires and TEM Characterization</td>
<td>Supervisor: Jesper Nygård</td>
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<td><strong>LÖVKVIST, Cecilia Elisabet</strong></td>
<td>Graduated: 8 June 2017</td>
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<td>Modeling Spatiotemporal Dynamics of DNA Methylation</td>
<td>Supervisor: Kim Sneppen</td>
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<td><strong>MAFFEZZOLI, Niccoló</strong></td>
<td>Graduated: 16 October 2017</td>
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<tr>
<td>Title</td>
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<td>Sodium, Iodine and Bromine in Polar Ice Cores</td>
<td>Paul Travis Vallelonga</td>
<td>4 August 2017</td>
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<td>MALINOWSKI, Filip Kazimierz</td>
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<td>Noise Suppression and Long-Range Exchange Coupling for Gallium Arsenide Spin Qubits</td>
<td>Charles Masamed Marcus</td>
<td>8 June 2017</td>
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<td>From Pore Scale to Turbulent Flow with the Unstructured Lattice Boltzmann Method</td>
<td>Joachim Mathiesen</td>
<td>16 October 2017</td>
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<td>Search for Dark Matter Annihilation in the Galactic Halo using IceCube</td>
<td>Stefania Xella</td>
<td>9 October 2017</td>
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<td>Ice Sheets &amp; Ice Cores, Data Analysis &amp; Stochastic Modelling</td>
<td>Peter Dalager Ditlevsen</td>
<td>1 September 2017</td>
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<td>Testing Cosmological Models, Will the Real Non-Gaussianity Please Stand Up</td>
<td>Subir Sarkar</td>
<td>20 February 2017</td>
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<td>Ice Flow Modelling of the Greenland Ice Sheet Investigating the Use of Ice Flow Models in the Interpretation of the Age-Structure of the Greenland Ice Sheet</td>
<td>Christine Schött Hvidberg</td>
<td>28 February 2017</td>
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<td>Viscoelastic and Dynamic Properties of Embryonic Stem Cells</td>
<td>Lene Broeng Odds recovery</td>
<td>19 January 2017</td>
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<td>Colossal Creations of Gravity - From Clusters of Galaxies to Active Galactic Nuclei</td>
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<td>Study of Forward Elastic $pp$ Scattering at $\sqrt{s} = 8$ TeV with the ALFA Detector</td>
<td>Peter Henrik Hansen</td>
<td>20 February 2017</td>
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<td>SUOMINEN, Henri Juhani</td>
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<td>Two-Dimensional Semiconductor-Superconductor Hybrids</td>
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<td><strong>WANG, Tian</strong></td>
<td>12 June 2017</td>
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<td>Studies on the Action Potential From a Thermodynamic Perspective</td>
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<td>Supervisor: Thomas Rainer Heimburg</td>
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<td><strong>WINther, Malte Nordmann</strong></td>
<td>3 February 2017</td>
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<td>Trace Gas Evolution in the Present and Past Atmosphere</td>
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<td>Supervisor: Thomas Blunier</td>
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