

BSc thesis subject for BBI students

You always have to contact the supervisor of a subject yourself! After you decided that you will do a certain subject, please fill in the BSc thesis contract and hand it in at the biology office.

Title: Modeling Duckweed Growth In Ditches

Group: Aquatic ecology & water quality management (AEW)

Supervisor(s): Edwin THM Peeters

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Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the project: 2 weeks before the start of the course

Type of research project: data analysis (modelling)

Description: Ditches are a characteristic element in a polder landscape and may contribute to the biodiversity of the agricultural landscape. Due to eutrophication submerged vegetation disappeared in many ditches in favor of floating vegetation. The presence of duckweed mats on ditches usually results in a low ecological quality, since under these mats oxygen is too low for most animals. Harvesting duckweed (=removing it) could be a measure to avoid those bad conditions. The potential of harvesting duckweed can be studied through modeling. Some models have been developed that describe duckweed growth in spring and summer. However, models that cover the whole temporal dynamics (from spring to spring) are very scarce. Based on growth characteristics of duckweed together with data on temperature and irradiance a model will be developed and the effects of harvesting evaluated.

Title: Pattern Recognition Receptors (PRRs) important for animal health: role of TOLL-like receptors (TLR) and C-type Lectin Receptors (CLR) of carp in the recognition of pathogen associated molecular patterns (PAMPs) from yeast to protozoan parasites

Group: Cell biology and immunology (CBI)

Supervisors: Geert Wiegertjes (staff member), Anders Oestergaard (post-doc), Danilo Pietretti (PhD), Inge Fink (PhD)

Contact information: Geert.Wiegertjes@wur.nl

Period: all

Specialization: Cell and molecular biology; Human and animal health biology

Deadline: 2-3 months prior to start

Type of research project: experimental lab-work

Description: The project aims at the characterization of pattern-recognition receptors (PRRs) on myeloid cells that respond to pathogen-associated molecular patterns (PAMPs) such as β -glucans that compose fungal cell walls. PRRs that are predicted to be central to this process are C-type lectin receptors (CLRs) and TOLL-like receptors (TLRs). We focus on different receptors expressed on carp macrophages, on the signaling pathways and on their possible functions as activating receptors involved in innate immune responses to, for example, infections with parasites. Typically, you may be asked to design specific primers for real-time quantitative PCR analysis of gene expression, to characterize the activation of macrophages by colorimetric assays or by flow cytometry (scatter profiles, proliferation, phagocytic capacity, radical production), or try to raise antibodies against extracellular peptides of PRR to specifically block receptor activation.

Title: Dynamics of bent shoots in cut-rose and their role for flower production

Group: Centre for Crop Systems Analysis (CSA) – Chair of Crop Physiology / Chair of Crop & Weed Ecology (Select)

Supervisor: Jan Vos / Gerhard Buck-Sorlin

Contact information: Jan.Vos@wur.nl; Tel. 0317 - 483042

Period(s) in which subject is available: negotiable

Project is intended for specialization(s): Organismal and developmental biology

Deadline for application for the project: 1.6.2010

Type of research project: Data analysis

Description: One of the most important products of Dutch glasshouse horticulture are cut-roses. The growth of cut-roses is taking place in a highly artificial and heavily managed production system, which involves that part of the growing shoots are bent down in order to channel more assimilates to the upright shoots that are later harvested. Little is known about the dynamics of the bent canopy and its role for the upright shoots and for the entire plant. The candidate will analyse a dataset consisting of hundreds of digital images of the same bent canopy taken at hourly intervals during several months in 2009. The task will be the quantitative analysis of the timing and duration of leaf unfolding, shoot extension, etc., using the image analysis tool ImageJ. The results will be used to further parameterize an existing 3D model of cut-rose.

Title: Which environmental factors shape the root system?

Group: Centre for Crop Systems Analysis – Chair of Crop Physiology

Supervisor: Tjeerd Jan Stomph

Contact information: tjeerdjan.stomph@wur.nl or 0317-483079

Period(s) in which subject is available: all

Project is intended for specialization(s):

B. Organismal and developmental biology

D. Ecology and biodiversity

Type of research project: (data analysis/ and / experimental work)

Deadline for application for the project: end of august 2010 for period 1

Description: Roots scavenge the soil for water and nutrients. Plants direct growth of roots towards these resources, especially if these are present in pockets. At the same time, when there is competition for resources roots tend to move away from those of competitors. There is also a general trend to be have roots in the top soil rather than in deeper layers, possibly because at the start of plant growth all primordia are in the top layer. The question is how flexible plants really are in shaping their root system and which environmental factors (biotic or abiotic) are most important. We expect an experiment based on a literature research to test hypotheses related to the relative and possibly joint role of nutrients and water. Analyses aim to relate outcomes to the latest findings on within-plant signalling to stimulate root and shoot primordia outgrowth.

Title: How different are the bottlenecks in grain zinc allocation between cereals?

Group: Centre for Crop Systems Analysis – Chair of Crop Physiology

Supervisor: Tjeerd Jan Stomph

Contact information: tjeerdjan.stomph@wur.nl or 0317-483079

Period(s) in which subject is available: period 1 and 6

Project is intended for specialization: B. Organismal and developmental biology

Deadline for application for the project: at least of 10 July 2010 for period 1; 25 February 2011

Type of research project: (data analysis/ and / experimental work)

Description: In all cereal tested so far enhancing the zinc uptake by roots and zinc concentration in vegetative parts does not lead to an equivalent increase in grain zinc concentration. There do seem to be within-plant allocation barriers next to root uptake barriers. The exact tissues where zinc transport barriers are found seem to differ amongst cereals but there is lack of confirmed evidence and of direct comparisons between cereals that differ in grain anatomy like rice, wheat and sorghum.

The proposed thesis research will focus on grain and plant tissue analyses from flowering onwards. The experiments will have to be sown well in advance hence the need to make early appointments.

Title: Ecology of insect behaviour

Group: Entomology (ENT)

Supervisor(s): Joop van Loon, Marcel Dicke, Willem Takken, Peter de Jong

Contact information: joop.vanloon@wur.nl ; tel.: 82791

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity; Organismal and Developmental Biology, Human and Animal Health Biology

Deadline for application for the project: 1 month before the start of the thesis project

Type of research project: experimental lab-work

Description: Every animal is under selection to make decisions about where to forage, how long to forage etc. These decisions will be based upon characteristics of the availability and quality of food sources, competitors and enemies. To effectively make decisions animals depend on information. Insects live in a chemical world and odours such as pheromones, food odours, odours from their enemies play a decisive role in behavioural decisions. In this thesis project you will be able to work on an insect species that is cultured at the Laboratory of Entomology, ranging from cabbage white butterflies to malaria mosquitoes to ladybird beetles. There is ample choice of the behaviour to be investigated, including e.g. hitch-hiking by parasitic wasps, exploiting SOS-odours by parasitic wasps and predators, pollination by bumble bees or aggregation of ladybird beetles. A wide range of modern bioassays to investigate the behaviour of insects, related to *e.g.* pheromones or other infochemicals is available e.g. wind tunnels, olfactometers, flight tents, 3D-flight tracking.

Title: Does oviposition by cabbage white butterflies prime or induce cabbage plants to produce infochemicals for egg and larval parasitoids?

Group: Entomology (ENT)

Supervisor(s): Nina Fatouros, Joop van Loon

Contact information: joop.vanloon@wur.nl ; tel.: 82791

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity; Organismal and Developmental Biology

Deadline for application for the project: 1 month before the start of the thesis project

Type of research project: experimental lab-work

Description: Plant volatiles induced by herbivore feeding play an important role in the foraging behaviour of carnivorous arthropods. The carnivores are able to use these odours to locate their prey. In addition to feeding damage by herbivores, egg deposition may also induce such defensive responses in plants. To compare the mechanisms and functions of the defensive responses of plants induced by either herbivore feeding or egg-deposition, we want to evaluate the egg-induced defence in the well-known system of cabbage plants and its herbivores and parasitoids. In the present project the mechanisms of the egg-induced defensive response of balc mustard plants (*Brassica nigra*) in connection with the behavioural responses of egg parasitoid wasps and larval parasitoids will be examined. The project will involve behavioural studies on parasitoid responses and collection and chemical analysis of plant volatiles.

Title: Associative learning in parasitoid wasps: differences in learning abilities analysed from molecule to behaviour

Group: Entomology (ENT)

Supervisor(s): Hans Smid, Louise Vet

Contact information: hansm.smid@wur.nl; tel.: 82791

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity; Organismal and Developmental Biology, Cell and molecular biology

Deadline for application for the project: 1 month before the start of the thesis project

Type of research project: experimental lab-work

Description: Two closely related species are selected as a model system, the generalist *Cotesia glomerata* and the specialist *Cotesia rubecula*, which are different in their use of associative learning for host location. They lay their eggs into caterpillars of cabbage white butterflies, *Pieris brassicae* (L.) and *P. rapae* (L.). Both wasp species can learn to associate plant odors of a particular plant species with the presence of hosts, after having encountered suitable host caterpillars on that plant. However, *C. glomerata* can learn very fast, it forms long term memory (protein-synthesis-dependent) after a single learning experience, whereas *C. rubecula* learns slowly; it needs several repeated experiences before it forms long term memory. The research goes from behaviour to molecule, and combines neurobiology with evolutionary ecology. You can participate by doing either behavioural, molecular, or neurobiological work, or combinations. Main research

questions are:

* Which differences in memory formation occur when wasps are given standardized learning events? The memory structure of the wasps is determined using a behavioural test for memory retention, a windtunnel test where wasps can fly to the plants on which they previously have found hosts

* Which differences in the brains of *C. glomerata* and *C. rubecula* are involved in the observed difference in learning? We focus on a set of reward sensitive neurons (based on studies on the honeybee), the ventral median unpaired neurons (VUM neurons).

* Which genes are involved in the difference in learning between *C. glomerata* and *C. rubecula*? We currently focus on the expression of a transcription factor known to play a key role in long term memory formation, cAMP-responsive element binding protein (CREB).

Depending on the question studied you will use (1) behavioural techniques *e.g.* windtunnel assays, memory training of wasps, effects of various treatments on memory such as specific chemical blocking of memory phases (short- median-or long term memory); varying the strength/duration of the reward stimulus etc. (2) neurobiological techniques: Scanning Electron Microscopy, light microscopy, confocal laser scanning microscopy, detection of neurotransmitters and other neuro-active substances (octopamine, nitrogen oxide, PKA/PKC, CREB); analysis of neuronal pathways involved in learning, electrophysiology in combination with Gas chromatography of plant odour composition; (3) molecular biology: gene cloning, real time quantitative PCR, in-situ hybridization.

Title: Gourmet or gourmand – feeding behaviour of larval mosquitoes

Group: Entomology (ENT)

Supervisor(s): Willem Takken

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Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity; Organismal and Developmental Biology, Human and Animal Health Biology

Deadline for application for the project: 1 month before the start of the thesis project

Type of research project: experimental lab-work

Description: Mosquito larvae live in water and feed on the microorganisms that float in the water. It is known that food is a factor in limiting mosquito growth and size, but we do not yet know a) how much food a mosquito larva consumes and b) where in competition with other larvae, larvae start eating faster. In this study you will investigate the amount of food a mosquito larva consumes during its life time, and to determine the effects on growth of density of larvae. In this way you will obtain an energy budget of the insect as well as gain insight on density dependent effects on development.

Title: Effect of fungus treatment of breeding site on oviposition behavior of the malaria vector mosquitoes *Anopheles gambiae* and *An. stephensi*

Group: Entomology (ENT)

Supervisor(s): Willem Takken, Tullu Bukhari, Sander Koenraadt

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Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity; Human and Animal Health Biology

Deadline for application for the project: 1 month before the start of the thesis project

Type of research project: experimental lab-work

Description: This research is a part of a project that aims to determine the potential of entomopathogenic fungi when applied at the aquatic breeding sites of mosquitoes. Entomopathogenic fungi are known to effectively kill malaria mosquito larvae and are useful microbial control agents. Mosquito larvae complete their development at breeding sites. The adult female mosquitoes also visit these breeding sites to lay eggs. It is therefore likely that the ovipositing females are affected by these entomopathogenic fungi. Oviposition behavior can be differentiated into pre-oviposition and oviposition. Pre-oviposition includes all the behaviors involved in attraction or repellence to a breeding site. Oviposition is the actual deposition of eggs on the substrate. The main objective of this research is to determine the effect of the fungal treatment on

the oviposition behavior of *Anopheles gambiae* and *An. stephensi*, both important malaria vectors. Whether formulated and unformulated fungal spores attract or repel the ovipositing females, if there is a difference in the number of eggs laid on the treated and untreated sites and if the female mosquitoes pick up an infection while settled on the water surface to lay eggs are some of the research questions that will be addressed. The results of this research will make an important contribution in developing a biological control agent against malaria mosquitoes.

Title: Do plants affect the outcome of parasitoid competition?

Group: Entomology (ENT)

Supervisor(s): Erik Poelman, Marcel Dicke

Contact information: erik.poelman@wur.nl ; tel.: 854333)

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity; Organismal and Developmental Biology

Deadline for application for the project: 1 month before the start of the thesis project

Type of research project: experimental lab-work

Description: Parasitoids often compete for herbivore hosts that they exploit to rear offspring. Generally, a single host species is exploited by more than one parasitoid species and hence competition between parasitoids for host and larval competition within a host are common features in nature. Co-existence of parasitoid species has resulted in species radiation of reproductive strategies of parasitoids that include variation in clutch size, larval traits, patch exploitation, learning capability and in-flight discrimination of odours derived from plant-herbivore complexes. These differences in host exploitation strategies of parasitoid species are fundamental to species co-existence. Typically, outcomes of competition are affected by the set of biotic and abiotic conditions of the arena where competition takes place. Herbivore host - parasitoid interactions predominantly take place in a background of an insect community with non-host herbivores that simultaneously feed on the same plant or neighbouring plants. Those host and non-host herbivores alter plant quality when feeding on a plant and may thereby affect the outcome of parasitoid competition.

We study whether plant quality affects competition among parasitoids and focus on 1) in-flight avoidance of competition, 2) host patch exploitation strategies under competition, 3) indirect competition of parasitoid larvae on the host plant, 4) direct competition of parasitoid larvae inside the herbivore host. The basis of most of the experiments that can be designed in this topic are measurements of insect behaviour and their performance. Behavioural measurements include choice tests, patch exploitation behaviour and adult as well as larval interactions among parasitoid species. The performance tests include measurements on adult body mass as well as reproductive success in number of eggs and their distribution over hosts.

Title: Stress-induced mutagenesis

Group: Laboratory of Genetics (GEN)

Supervisor: Merijn Salverda, Arjan de Visser

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Period(s) in which subject is available: all periods

Project is intended for specialization(s): Ecology and biodiversity, Cell and molecular biology

Deadline for application for the project: two weeks before the start.

Type of research project: data analysis/ experimental work: fluctuation tests under various conditions

Description: Mutations are said to occur in a non-directed way. This means that they arise irrespective of their possible benefit under the given environmental conditions. However, the frequency with which random mutations occur may not always be independent of environmental conditions. For instance, it is known that some bacteria produce more mutations under conditions of stress. We will study the effect of several stress conditions on the mutation rate of the bacterium *Escherichia coli*. For this, we will grow populations of *E. coli* under various stress conditions, such as low antibiotic concentrations, nutrient starvation and increased temperature, and measure the frequency with which they produce resistance mutations to certain antibiotics.

We will then compare estimates of the mutation rate under various stresses with those estimated under control conditions.

Title: Natural Variation in Photosynthesis

Group: Plant Science Group, Lab of Genetics (GEN)

Supervisor(s): Pádraic Flood

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Period(s) in which subject is available: all

Project is intended for specialization(s): Organismal and developmental biology

Deadline for application for the project: 2 weeks before the start of the course

Type of research project: data analysis/experimental work

Description: Natural variation is the raw material which fuels evolution. Photosynthesis is the source of almost all biological energy on the planet, in other words, it is the fuel of life. Therefore the importance of studying both natural variation and photosynthesis cannot be underestimated, yet the natural variation within a species for its photosynthetic characteristics is greatly understudied. This project will combine phenotypic screening of natural accessions of *Arabidopsis* with analysis of the generated data, with the aim being to quantify some of the variation present for specific photosynthetic traits. It is hoped that studying the natural variation of photosynthesis will provide us with insights into the regulation of the process and possible methods by which it may be modified to improve crop productivity.

Title: Long-term evolution in the fungus *Aspergillus nidulans*

Group: Laboratory of Genetics (GEN)

Supervisor: Arjan de Visser, Fons Debets

Contact information: arjan.devisser@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Ecology and biodiversity, Cell and molecular biology

Deadline for application for the project: two weeks before the start.

Type of research project: data analysis/ experimental work: competition experiments, molecular-genetic analyses of evolved changes

Description: In early 2010, we started a long-term evolution experiment with the fungus *Aspergillus nidulans*. Every week, 1% of the asexual spores of each of 12 populations – all started with the same strain – is being transferred to a bottle with fresh growth medium, where glucose is limiting growth. We are interested in analyzing the progress of adaptation to this simple laboratory environment, as well as in identifying the fungal competitive strategies involved (e.g. faster spore production, production of anti-competitor toxins, morphological changes). In addition to these phenotypic analyses, we aim to find the genetic causes of the observed evolutionary changes.

Title: Predicting the evolution of antibiotic resistance

Group: Laboratory of Genetics (GEN)

Supervisor: Merijn Salverda, Arjan de Visser

Contact information: arjan.devisser@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Ecology and biodiversity, Cell and molecular biology

Deadline for application for the project: two weeks before the start.

Type of research project: data analysis/ experimental work: *in vitro* mutagenesis, *in vivo* selection, MIC assays, sequence analysis

Description: Evolutionary biology is a largely descriptive science, providing explanations for past evolution by looking back (albeit in increasing detail!), but is unable to predict the outcome of future evolution. We use *in vitro* evolution experiments with the enzyme β -lactamase to test factors that affect the predictability of short-term evolution. β -lactamases break down certain antibiotics and are a major cause of insensitivity of pathogenic bacteria to medical antimicrobial treatment. We will use *in vitro* evolution protocols, involving error-prone PCR followed by *in vivo* selection of enzyme variants with increased antibiotic resistance, to study how certain factors cause evolution

to repeatedly use the same sequence of mutations. Factors that we would like to manipulate include the population size, the mutation rate and the strength of selection.

Title: Population genetic analysis of domestic cats in The Netherlands

Group: Laboratory of Genetics (GEN)

Supervisor: Fons Debets

Contact information: Fons.Debets@wur.nl

Period(s) in which subject is available: period 2,3

Project is intended for specialization(s): Ecology and Biodiversity, Organismal and Developmental Biology

Deadline for application for the project: 2 weeks before the start of the period

Type of research project:

- 1) analysis of available data from students in the first year Genetics course
- 2) set up questionnaire/web-based input programme to collect new data during the course with the help of first year students (BBI, BDW, BPW)
- 3) compare owned pets to unwanted cats (asielkatten)

Description: Little data are available on gene frequencies in domestic cat (*Felis catus*) in the Netherlands, only some studies have been carried out in a few cities in the seventies (e.g. Lloyd 1982). Studying the cat population not only gives unique scientific information (allele frequencies, Hardy-Weinberg equilibria, isolation by distance) but can also aid in understanding genetic principles (Christensen 2000). Since 2001 we have collected data from domestic cats in The Netherlands during the first year genetics course. We want to critically evaluate these data and set up a new and improved questionnaire for students and preferably a web-based input programme for gathering new data as part of our genetics course.

Title: Testing a genetic model for handedness in The Netherlands

Group: Laboratory of Genetics (GEN)

Supervisor: Fons Debets

Contact information: Fons.Debets@wur.nl

Period(s) in which subject is available: period 2,3

Project is intended for specialization(s): Ecology and Biodiversity, Organismal and Developmental Biology, Human and Animal Health Biology

Deadline for application for the project: 2 weeks before the start of the period

Type of research project:

1. analysis of available data from students in the first year Genetics course
2. set up an improved questionnaire/web-based input programme to collect new data during the course with the help of first year students (BBI, BDW, BPW)

Description: By far most people are right handed. Only less than 10% is left handed. It is unclear to what extent handedness is genetically determined or results from environmental factors. We know that the environment can have an influence, for example forced writing with the right hand. Nevertheless most people have a natural preference for using one hand over the other. Klar (2003) proposed a genetic model, in which he assumed a correlation between *handedness* and *scalp hair-whorl direction*. Most people can be categorized in one of two groups: clockwise or counterclockwise. A minority of less than 10% is counterclockwise. Klar assumed the existence of a single locus, with two alleles (*R* and *r*), that simultaneously influences handedness and scalp hair-whorl direction. This model can be put to the test by collecting and analyzing reliable data from a large number of individuals.

Title: Is the fungal *het-s* prion present in natural populations or is it a lab artifact

Group: Laboratory of Genetics (GEN)

Supervisor: Fons Debets

Contact information: Fons Debets

Period(s) in which subject is available: period 1 and 6

Project is intended for specialization(s): Cell and Molecular Biology, Ecology and Biodiversity

Deadline for application for the project: 3 weeks before the start of the period

Type of research project:

1. collection of fungi from the field
2. detection of prion containing strains (bio-assay)
3. molecular characterization of het-S/s locus

Description: Prion manifestations have up to now only been recorded in mammals (humans and life stock like cows, sheep and goats) as neurodegenerative diseases and in fungi (yeasts and the ascomycete *Podospora anserina*) under laboratory conditions (NAKAYASHIKI *et al.* 2005; PRUSINER 1998; UPTAIN and LINDQUIST 2002; WICKNER 1999). Though some fungal prions are considered as a disease ([URE3] and [PSI⁺] in yeast), the prion [HET-s] in *Podospora* has been suggested to be advantageous. If this is true, it is to be expected that the prion is present in natural strains.

Title: Characterization of an Alcohol Dehydrogenase

Group: Laboratory of Microbiology (MIB)

Supervisors: Mark Levisson and Servé Kengen

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Period(s) in which subject is available: All periods

Project is intended for specialization(s): Cell and Molecular Biology

Deadline for application for the project: 2 weeks in advance

Type of research project: Experimental work

Description: Alcohol dehydrogenases catalyze the interconversion of alcohols, aldehydes and ketones. They display a wide variety of substrate specificities and are involved in many metabolic processes. This makes them attractive biocatalysts for different industrial applications. Recently, we solved the crystal structure of an alcohol dehydrogenase from *Shewanella denitrificans*. However, we do not know anything about its properties. We would like to understand its catalytic mechanism and investigate the substrate specificity and optimal reaction conditions. Therefore, the aim of this project is to investigate the biochemical and structural properties of this alcohol dehydrogenase.

Title: Find the Binder

Group: Laboratory of Microbiology (MIB)

Supervisors: Mark Levisson and Servé Kengen

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Period(s) in which subject is available: All periods

Project is intended for specialization(s): Cell and Molecular Biology

Deadline for application for the project: 2 weeks in advance

Type of research project: Experimental work

Description: Nowadays, peptides, proteins and oligosaccharides are more and more used as a medicine or food additive. However, most of these products are produced in low concentrations and selective separation from a complex mixture is laborious and often results in low yields. Therefore, new technologies, based on molecular affinity, are required to reduce the number of purification steps. Highly specific molecular affinity is one of the fundamental functions of proteins. A novel approach is, therefore, applying binding proteins as a scaffold in affinity purification. A scaffold refers to a protein framework that is essentially invariant and provides positions that can

accommodate extensive sequence variations (e.g. antibodies). These scaffold proteins can then be covalently coupled to a matrix and used for the isolation of industrially valuable molecules. The aim of this project is to develop novel binding proteins that are highly stable and have a high affinity for selected target molecules using modern techniques such as phage display and rational and directed evolution techniques.

Title: Evolution of Rhizobium symbiosis

Group: Molecular biology (MOB)

Supervisor: Rene Geurts

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Period(s) in which subject is available: period 1

Project is intended for specialization(s): Cell and molecular biology, Organismal and developmental biology

Deadline for application for the project: august 15

Type of research project: (data analysis/ experimental work)

Description: Legumes comprise one of the most important agricultural taxa worldwide providing a major source of proteins for humans and animals, and nitrogen for soil improvement. Legumes have the unique ability to establish a symbiosis with nitrogen fixing *Rhizobium* bacteria. These bacteria are hosted in newly formed organs; the root nodules. The formation of nodules requires developmental reprogramming of root cortical cells as well as infection of the plant root by the bacterium. Both processes are induced by bacterium-produced signal molecules, called Nod factors. Forward genetics in legume model species like *Medicago truncatula* and *Lotus japonicus* has resulted in the identification of a small symbiotic network essential for Nod factor perception and signaling. To understand why the Nod factor signaling network is functional in legumes, but not in closely related species, and how these genes have evolved, the function of closely related genes in non-nodulating plant species is studied.

Title: Dwarf shrubs outcompete graminoids in Siberian tundra?

Group: Nature conservation and plant ecology (NCP)

Supervisor: Dr. Ir. Monique Heijmans

Contact information: monique.heijmans@wur.nl, Lumen room 1.302, 0317-484167, www.ncp.wur.nl/uk/staff/heijmans

Period(s) in which subject is available: 1, 2/3

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the project: end of august for period 1, half September for period 2/3

Type of research project: lab measurements (period 1 or 2), data analysis, or model simulation (other periods)

Description: In Siberian tundra we observe that the shrub species *Betula nana* (dwarf birch) seems to outcompete the graminoid species *Eriophorum vaginatum* (cottongrass). This contrasts with the general theory that graminoids are better competitors than small shrubs. In period 1 or 2, you will study the competition between these plant species, by performing measurements on plant characteristics, such as specific leaf area and nutrient allocation, influencing the competitive relationships. In other periods, you may use the data on plant characteristics in a model simulation of competition. A tundra ecosystem model will be used to explore under which conditions the dwarf shrub or the graminoid wins competition.

Title: Unravelling R gene mediated plant immunity

Group: Nematology (NEM)

Supervisor: Erik Slootweg, Anna-Finkers-Tomczak, Erin Bakker, and/or Aska Goverse

Contact information: Aska.Goverse@wur.nl

Period(s) in which subject is available: all

Specialisation: Cell and molecular biology

Deadline application: two weeks prior the start of a period

Type research project: experimental work

Description: Plants have evolved a sophisticated defence system based on so called *R* genes, encoding immune receptors which are able to recognize cognate effector molecules released by invading pathogens. This leads to the activation of a resistance response that blocks the pathogen from further spreading. Co-evolution between pathogen and host has resulted in the presence of a whole arsenal of *R* genes in the plant genome and a pallet of highly diverse effector molecules in various pathogens. We want to understand a) how plant immune receptors are able to recognize these pathogen effector molecules, b) how plant immune receptors are able to provoke a resistance response and c) how co-evolution between pathogens and plants results in immune receptor and effector diversity. This will be achieved by performing structure-function analyses, protein-protein interaction studies (CoIP, FRET, etc), cellular localisation studies and bioinformatics.

Title: The secrets of secretions in host-parasite interactions revealed

Group: Nematology (NEM)

Supervisor: Wiebe Postma, Jose Lozano, Anna Finkers-Tomczak, and/or Geert Smant

Contact information: geert.smant@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Cell and molecular biology, Human and animal health biology

Deadline for application for the project: two weeks prior to start of a period

Type of research project: experimental work in molecular and cell biology

Description: Helminth parasites live inside host plants and animals for a long time, seemingly untouchable by the immune system of the host. Inside their host these parasites bring about amazingly complex transformations in host cells. These transformed host cells are so fundamentally different from normal cells that all alarm bells alerting for intruders in the host should go off. This doesn't happen though as the parasites release molecules to suppress and/or evade host innate immunity. We want to develop molecular and cellular assays a) to determine whether proteins secreted by parasites indeed suppress innate immunity of the host, and b) to understand the molecular mechanism of immune suppression. The project will make use of cell death assays, proteomics, transcriptomics, gene silencing and overexpression analyses.

Title: On the role of lateral gene transfer in the evolution of plant parasitic nematodes

Group: Nematology (NEM)

Supervisor: Kasia Rybarczyk (PhD), Hans Helder

Contact information: Hans.Helder@wur.nl - (4)83136

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology, Ecology and biodiversity

Deadline for application for the project: At least two weeks before the start of the course

Type of research project: experimental work

Description: How to become a (plant) parasite? This is a central question underlying this BSc subject. One of the main challenges for a nematode to use plants as a food source is the penetration of the plant cell wall, a major physical barrier. Plant parasitic nematodes produce cell wall degrading enzymes (CWDEs), and we have various (so far non conclusive) indications that the corresponding genes were acquired from bacteria by lateral gene transfer. So far mainly high impact plant parasites have been investigated, and in this BSc topic you will be looking for the origin of the plant cell wall degrading enzymes by investigating their distribution and nature of these CDWEs in basal ('primitive') plant parasites. The research will include the PCR amplification, cloning and sequencing of CDWEs, and the phylogenetic analysis of the resulting data.

Title: DNA barcode-based tools to detect & monitor (parasitic) nematodes

Group: Nematology (NEM)

Supervisor: Paul Mooyman and Hans Helder

Contact information: Hans.Helder@wur.nl - (4)83136

Period(s) in which subject is available: Cell and Mol Biology (tool development) - any period. Monitoring etc. Spring and Summer

Project is intended for specialization(s): Cell and molecular biology, Ecology and biodiversity

Deadline for application for the project: At least two weeks before the start of the course

Type of research project: experimental work and field work

Description: Nematodes are extremely abundant and speciose group of animals, and – although parasitic nematodes receive a lot of attention – these 'bad guys' usually constitute only a small minority. Nematodes have a conserved morphology (they very much look alike), and identification under a microscope is possible but requires substantial training, and is invariably time consuming. As an alternative, DNA characteristics can be used to characterize nematodes. Within our lab we've generated a large database that contains small subunit ribosomal DNA sequences from appr. 2,000 nematode genotypes. Within this BSc project you will design your own PCR primers, test their specificity in the lab, generate calibration lines for quantification, and – as a next step – test your novel assay under field conditions.

Title: DNA based monitoring of nematode assemblages as a proxy for ecological soil condition.

Group: Nematology (NEM)

Supervisor: Jet Vervoort (PhD), Hans Helder

Contact information: Hans.Helder@wur.nl - (4)83136

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the project: At least two weeks before the start of the course

Type of research project: field work and experimental work

Description: Soil is probably the most densely inhabited habitat on our planet; it is teeming with life. For many reasons - ecological, eco-toxicological, agricultural – we would like to make a statement about the health situation of a soil. The overwhelming biodiversity makes it at least impractical to try to make an overall inventory of soil life. Instead we use groups of soil inhabitants that reflect the overall ecological status of a soil. Nematodes are often used for this purpose mainly because of their trophic diversity; different groups feed on bacteria, fungi, protozoa or other nematodes. Therefore, nematode assemblages mirror the conditions of e.g. the bacterial and fungal communities. Within this project you will investigate natural variations in nematode assemblages due to season, rainfall, temperature, changes in vegetation etc. The establishment of a normal operating range (NOR) will allow us to define (undesired) structural changes in soil life. Q-PCR based community analyses will be a central tool in this BSc subject

Title: C. elegans as a model for aging and disease

Group: Nematology (NEM)

Supervisor: Jan Kammenga

Contact information: Jan.Kammenga@wur.nl, tel: 482998

Period(s) in which subject is available: all

Project is intended for specialization(s): Molecular and Cell Biology, Organismal and Developmental Biology, Human and Animal Health Biology

Deadline for application for the project: 4 weeks before the start of the course

Type of research project: experimental work & data analysis

Description: The nematode worm *C. elegans* is a standard model for studying human aging related disease pathways and gene networks. It was in *C. elegans* that the first single-gene mutations increasing lifespan three-fold were isolated. The pathways identified also extend lifespan in other animals, including mammals (e.g. insulin signalling, caloric restriction). The student will be involved in studying the underlying mechanisms of aging and disease stress using advanced genetic tools like gene and expression-QTL mapping. Experimentation includes: gene expression profiling using microarrays, SNP analysis, lifespan analysis and, if required, targeted gene knock-down studies.

Title: Plant produced biopharmaceutical proteins to combat inflammatory and autoimmune diseases

Group: Nematology (NEM)

Supervisor: Ruud Wilbers, Lotte Westerhof and Arjen Schots

Contact information: arjen.schots@wur.nl tel: 485261

Period(s) in which subject is available: all

Project is intended for specialization(s): Human and Animal Health Biology

Deadline for application for the project: 4 weeks before the start of the course

Type of research project: experimental work

Description: The incidence of inflammatory diseases such as Crohn's disease and autoimmune diseases such as Rheumatoid Arthritis and Multiple Sclerosis has increased dramatically over the last 50 years. In a normal anti-inflammatory cytokines lead to a reintroduction of homeostasis once an infection is cleared. Hence, such cytokines hold the promise to be effective to treat these immune diseases. However, efficient production of these labile cytokines is often not easy. Plants have shown to be good production hosts for a variety of proteins. In this project the student will

express cytokines in plants, isolate these and test their biological activity in *in vitro* assays. The research will include gene cloning, transformation, expression studies, protein analysis, tissue culture and immunoassays.

Title: Mushrooms: an old remedy for modern diseases

Group: Nematology (NEM)

Supervisor: Jan van de Velde and Arjen Schots

Contact information: arjen.schots@wur.nl tel: 485261

Period(s) in which subject is available: all

Project is intended for specialization(s): Human and Animal Health Biology

Deadline for application for the project: 4 weeks before the start of the course

Type of research project: experimental work

Description: Mushrooms have been used for thousands of years because of the medicinal properties. The increased incidence of inflammatory diseases, autoimmune diseases and cancer has led to a renewed interest in mushrooms as medicine. Little is known on what compounds of the mushroom do lead to what effects. Most effects operate through an immunological mechanism such as enhanced antigen presentation. In this project the focus will be on testing compounds, isolated from mushroom for their immune effects such as β -glucans from the mushroom cell wall. This will initially be done through *in vitro* assays, but in a later stage it may include the analysis of samples from animal experiments. The research includes the use of cell and tissue culture, immunoassays, flow cytometry, confocal microscopy and possibly sugar chemistry.

Title: Protonemal growth and the involvement of the cytoskeleton under experimental conditions in the moss *Physcomitrella patens*.

Group: Plant Cell Biology (PCB)

Supervisor: dr. André van Lammeren/H. Kieft

Contact information: andre.vanlammeren@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology, Organismal and developmental biology, Human and animal health biology.

Deadline for application for the project: 2 weeks before start of the course but preferable earlier.

Type of research project: data analysis and experimental work

Description: Protonemal cells of the moss *Physcomitrella patens* behave differently under various regimes of growth regulators. Chloronema, caulonema and leafy plantlets develop depending on the conditions. It is aimed to visualize and analyze changes in configuration of the microtubular cytoskeleton under the applied experimental conditions to clarify the role of the cytoskeleton in cell shaping in the early phase of moss development.

Lines of *P. patens* are available that constitutively express GFP-tubulin through which microtubules are visible throughout the cell cycle in living cells. You will visualize the microtubular cytoskeleton with advanced light microscopy (confocal laser scanning microscopy –CLSM) and analyze the effects of environmental conditions on the organization of the microtubular cytoskeleton. In addition, the concomitant changes in cell differentiation will be monitored in life cells under controlled conditions. The project aims at a better insight in the role of MTs in cell morphogenesis in *P. patens*.

Title: Making the right connections between cellular filaments

Group: Plant cell biology (PCB)

Supervisor: Juliane Teapal/prof dr Marcel Janson

Contact information: marcel.janson@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology, Organismal and developmental biology, Human and animal health biology.

Deadline for application for the project: 2 weeks before the start of the course but preferably earlier.

Type of research project: data analysis and experimental work

Description: Cells build networks of microtubules to orchestrate key cellular events like cell division and cell polarization. To understand how these networks are constructed we study proteins that regulate the interactions between microtubules. These include molecular motors that slide microtubules along one another and proteins that bundle microtubules together. In this project you will study these proteins and their function in network construction using GFP-fusions in live fission yeast cells. The yeast is used as a simple and genetic tractable model system for eukaryotic cells. In addition, proteins from the yeast will be expressed and purified to study their interaction with microtubules in well-controlled biochemical assays. Advanced light microscopy and the use of image analysis software will be an integral part of the project. In the lab you may pick up a role in the cloning of genes using PCR, the purification of proteins, or the crossing and isolation of yeast strains.

Title: Deposition of the cell wall component cellulose during and after plant cell growth by cellulose synthase complexes in the plasma membrane

Group: Plant cell biology (PCB)

Supervisor: Ying Zhang / Jelmer Lindeboom / dr. Tijs Ketelaar

Contact information: tijs.ketelaar@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology, Organismal and developmental biology.

Deadline for application for the project: 2 weeks before start of the course but preferable earlier.

Type of research project: experimental work and data analysis

Description: Cellulose microfibrils are the main load bearing structures in the cell walls of plants. They are synthesized by large enzyme complexes in the plasma membrane, the cellulose synthase complexes (CSC). Each complex consists out of 36 CesA proteins. We have produced transgenic Arabidopsis lines in which the CSCs have been labeled with fluorescent proteins, so that we can follow the CSCs over time using Spinning Disc microscopy. In this project, you will look at two classes of CesA proteins, the class that is involved in the synthesis of cell walls of growing cells and the class that is involved in the synthesis of walls of fully grown cells. Questions of interest are amongst others: during what developmental stages and in which cells are the different CesA proteins present? Can they be both present simultaneously in one cell, and in one CSC? Do both classes produce cellulose microfibrils at similar speeds? The experimental work that you will perform will gain insight that will help answering these questions.

Title: Actin organization and developmental effects in plants with mutations in actin bundling proteins

Group: Plant cell biology (PCB)

Supervisor: Hannie van der Honing/ Ying Zhang / Henk Kieft / dr. Tijs Ketelaar

Contact information: tijs.ketelaar@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology, Organismal and developmental biology.

Deadline for application for the project: 2 weeks before the start of the course but preferable earlier.

Type of research project: experimental work and data analysis

Description: Cytoplasmic streaming is the transport of organelles over bundles of actin filaments. These bundles of actin filaments are formed by the activity of amongst others the actin bundling proteins villin and fimbrin. Our research focuses on understanding the role of actin bundling in the organization of the actin cytoskeleton. Problems with actin bundling cause defects in cell and plant morphogenesis, indicating that the actin bundling proteins are essential for plant development. In this project, you will study the actin organization in plants with mutations in actin bundling proteins

and the resulting defects in cell growth and plant development. You will use advanced light microscopy for the analysis of the actin organization over time, combined with genotyping of mutants using PCR and analysis of cell growth and plant growth.

Title: Fine-mapping *DOG2* locus for dormancy and storability gene(s)

Group: Plant physiology (PPH)

Supervisor: Thu Phuong Nguyen and Dr. Leónie Bentsink

Contact information: phuong.nguyenthuphong@wur.nl

Period(s) in which subject is available: October to December 2010 (can be longer)

Project is intended for specialization(s): Seed genetics and physiology

Deadline for application for the project: as soon as possible

Type of research project: experimental work and data analysis

Description: Dormancy and storability are two important seed traits, knowledge on the genetic control of dormancy and storability is essential to be able to improve the seed quality of crops. The quantitative trait loci (QTL) analyses in six *Arabidopsis thaliana* populations lead to the identification of dormancy and storability QTL co-locations (Fig 1), which is interesting to investigate if these 2 traits are controlled by the same genes. One of the found loci (QTLs), *DOG2* (in red circle), was validated for both traits. We now aim to fine map *DOG2* locus and study the genetic inheritance of gene(s) responsible for dormancy and storability phenotypes. Techniques: DNA isolation, PCR, Germination assay, Control deterioration test, genetic analysis of fine-mapping population.

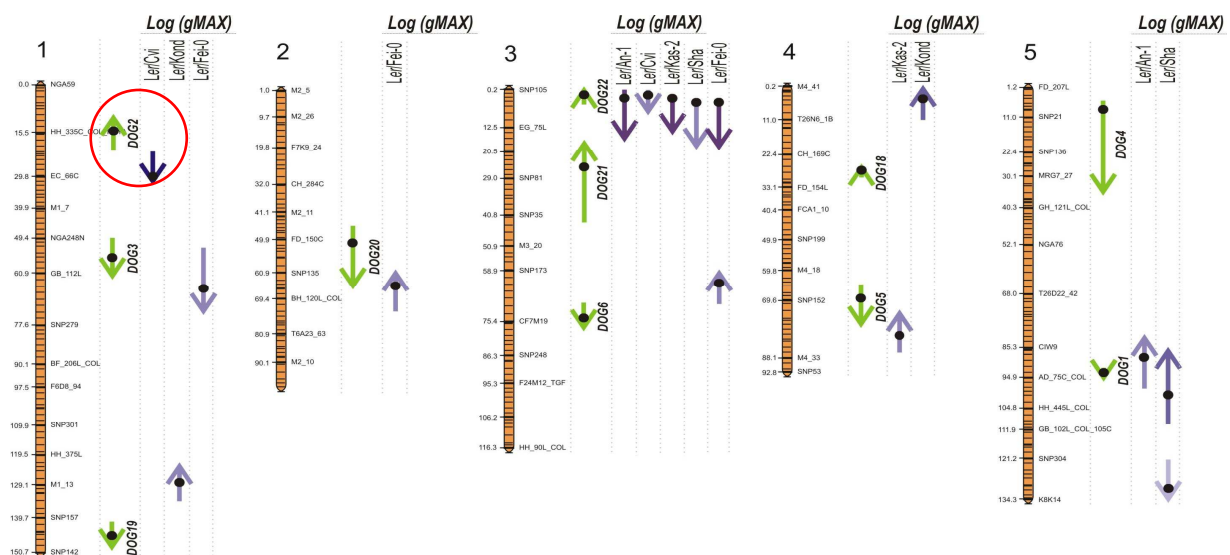


Figure 1: Integrated genetic map showing the genetic location of QTLs controlling seed longevity (Log) represented by parameter gMAX in combination with the *DOG* loci. Arrows indicate the direction of phenotypic effect of *Ler* allele (up increasing, down decreasing). The length of the arrows depicts the 2-LOD support intervals. LOD scores are presented in purple, the darker the more significant the QTL.

Title: QTL analysis for seed storability after controlled deterioration test

Group: Plant physiology

Supervisor: Thu-Phuong Nguyen Dr. Leónie Bentsink

Contact information: phuong.nguyenthuphong@wur.nl

Period(s) in which subject is available: October 2010 to March 2011

Project is intended for specialization(s): Seed genetics and physiology

Deadline for application for the project: as soon as possible

Type of research project: experimental work and data analysis

Description: Seed storability, defined as the longevity of seeds after storage, represents a trait important for the conservation of seed resources. To avoid long time waiting caused by natural ageing, a method for artificial ageing has been developed to evaluate seed storability, so-called controlled deterioration test (CDT). Though CDT are being used by seed companies,

there are still a lot of discussions around if CDT can mimic natural ageing. We target to investigate the reliability of the test by performing CDT on seeds of *Arabidopsis thaliana* population and to perform quantitative trait loci (QTL) mapping for germination ability after this CT treatment. The result will be compared to that of QTL mapping for storability after natural ageing (Fig.1).

Techniques: Controlled deterioration test, germination assay, QTL analysis

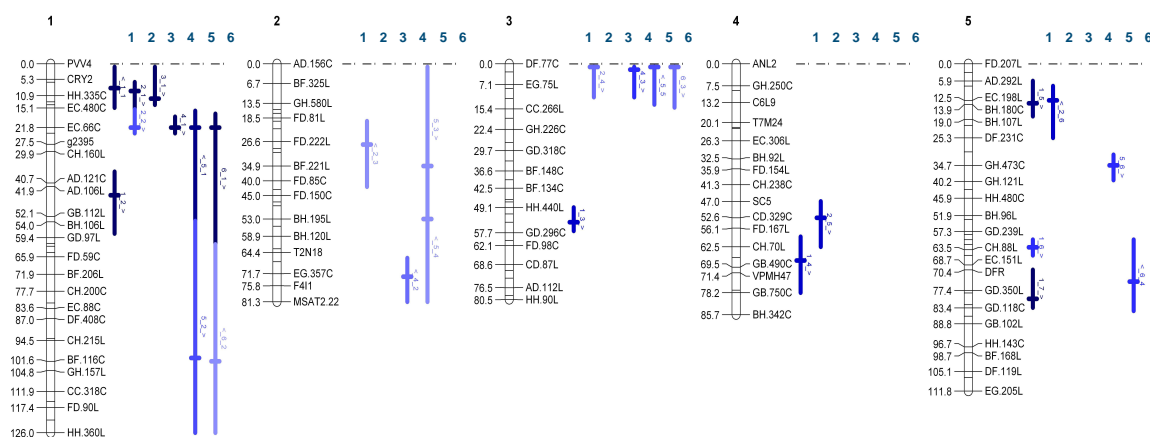


Figure 1: QTL analyses with 95% confidence intervals for seed dormancy-delay of germination loci DOG (1), storability-maximum of germination (Gmax) after CDT (2), storability-Gmax after 4 years of storage (3) (Bentsink et al., 2000), storability after 4 years of storage (currently analyzed) of Gmax (4), of t50 (time required for 50% of germination) (5), of AUC (area under curve) (6). confidence intervals are presented in blue, the darker the stronger the QTL.

Title: Is the enzyme UGPase involved in stress responses in Arabidopsis?

Group: Plant Physiology (PPH)

Supervisors: dr. Dick Vreugdenhil

Contact information: dick.vreugdenhil@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology; Organismal and developmental biology

Deadline for application for the project: 4 weeks before start of the course but preferably earlier.

Type of research project: Experimental work and data analysis

Description: Carbohydrate metabolism is one of the major and essential processes in plants. A way to study the various pathways and enzymatic steps involved is to study mutants that are modified in one or more steps. One of the central steps in carbohydrate metabolism in plants is catalyzed by the enzyme UGPase (UDPGlucose pyrophosphorylase). The model plant *Arabidopsis* has two genes coding for this enzyme.

We recently obtained knock-out mutants for these genes, and also the double mutant was made. Surprisingly, preliminary screening revealed little phenotypic effects on plant growth. However, a pilot experiment suggests that the double mutant has a three fold increase in the stress hormone ABA. Literature data also suggests a role for this enzyme in stress responses. In this project we want to study growth and development of the mutants (single and double knock-outs) under various stress conditions in order to determine if UGPase is of particular interest under certain non-optimal environmental conditions. Time permitting, activities of enzymes, relevant carbohydrates and levels of ABA will be determined.

Activities: literature studies, analysis plant growth and development, enzyme activities, hormone determinations

Title: Natural genetic variation of abiotic multi-stress responses in Arabidopsis

Group: Plant Physiology (PPH)

Supervisors: dr. Dick Vreugdenhil / Myriam Olortegui

Contact information: myriam.olortegui@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology; Organismal and developmental biology

Deadline for application for the project: 2 weeks before start of the course but preferably earlier.

Type of research project: Experimental work and data analysis

Description: Plants, like most living organisms, grow subject to different kinds of biotic and abiotic stresses. The effects of a combination of stress-factors on crops might be more severe than the effects of the same stress, but applied separately. Biotic and abiotic stresses affect plants at the genetic and physiological levels. Plants respond variably to these stresses depending on their genetic background and on gene-environment interactions. Another reason for these different responses could be epigenetics. Epigenetics explain changes in gene function (i.e. activation / inactivation) not due to changes in the DNA sequence of the organism. Elucidating the natural variation in responses and adaptations to the combination of two or more simultaneous biotic and/or abiotic stresses in the model plant *Arabidopsis* will help understanding, predicting and manipulating stress responses in crops. Extensive research on the effects of different single-stress factors to plants has been carried out. However, the bioinformatics tools for analyzing the complex data generated by plant systems biology experiments under multiple stressing conditions are being developed only recently. The aim of this project is to identify and generate information about *Arabidopsis* natural variation responses to selected abiotic stresses.

Using a novel approach for QTL analysis, an epigenetic population named epiRILs, consisting of *Arabidopsis thaliana* recombinant inbred lines (RILs) with different DNA methylation profiles but identical DNA sequence, we aim to identify genes that regulate responses to salt and temperature simultaneous stresses.

The BSc project requires knowledge of at least basic genetics and molecular biology. The project can be adapted to meet the students interests and expectations upon discussion.

Title: Subcellular transport of metabolites

Group: Plant Physiology (PPH)

Supervisors: Dr Sander van der Krol

Contact information: sander.vanderkrol@wur.nl or dick.vreugdenhil@wur.nl

Period(s) in which subject is available: all periods

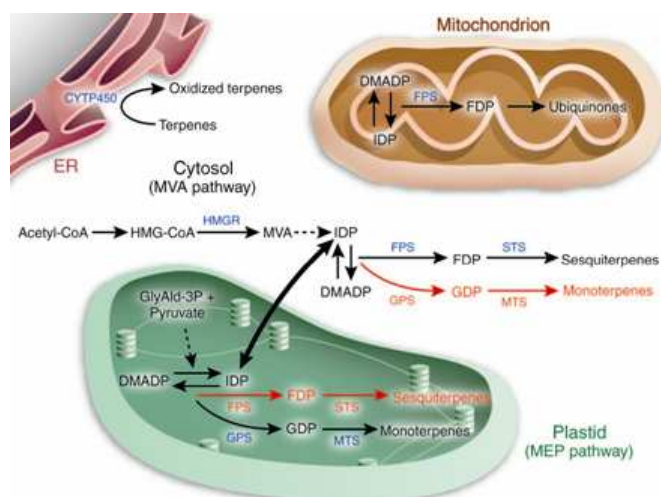
Project is intended for specialization(s): BBI-A, BBI-B, BPW, BML, BBT, BPW

Deadline for application for the project: 4 weeks before start of the course but preferably earlier.

Type of research project

Experimental work and data analysis

Description: A plant does not only have to deal with the integration of processes between different organs (e.g. between leaf, root and flower), but also with integration of processes that take place within different compartments of the cell. For instance, secondary metabolites are made in different subcellular compartments, so the cell has to deal with several transport issues: how do the enzymes get to the right compartment, how are intermediates transported between compartments (e.g. from plastid to ER, from ER to peroxisome) and how are compounds transported over membranes (e.g. from cytosol to vacuole or from cytosol to the extracellular space). Very little



is known about specific proteins involved in the transport of metabolites between compartments and over membranes.

Our approach:

Metabolites: In many plant species, expression of terpene biosynthesis genes coincides

with high expression of lipid transfer protein genes (LTP's). Therefore we are studying the effect of LTP overexpression and LTP mutants on terpene production in plants, while in a complementary approach we change terpene synthesis in plants and monitor how that affects LTP expression. To study the transport over membranes we are analyzing mutants in ABC transporter proteins, while the putative role of vesicles in metabolite transport are investigated in mutants impaired in vesicle transport (e.g. specific SNARE mutants). Candidate genes in terpene biosynthesis or transport are fused to GFP to determine their sub-cellular location. This allows us to map all the steps in the pathway over the different cellular compartments.

Title: Source-sink relation in plants

Group: Plant Physiology (PPH)

Supervisors: Dr Dick Vreugdenhil, Dr Joost Keurentjes

Contact information: harro.bouwmeester@wur.nl or dick.vreugdenhil@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): BBI-A, BBI-B, BPW, BML, BPW

Deadline for application for the project

4 weeks before start of the course but preferably earlier.

Type of research project

Experimental work and data analysis

Description: Plant performance -how does a plant grow under various conditions- depends on the acquisition of raw material (carbon fixation and mineral uptake), the allocation of this material over the plant organs, and the ability to cope with environmental stresses. Although this is a gross oversimplification, it provides a useful scheme to approach plant performance. For total biomass production, photosynthetic carbon dioxide fixation is by far the most important process. However, mineral nutrition, although contributing a much smaller proportion in terms of weight, is also essential for plant growth.

Functionally a plant can be divided into source and sink, sources being the parts where net fixation of carbon dioxide occurs, and sinks being the sites where assimilates are stored or used. Allocation of assimilates between plant parts occurs via transport in the phloem.

Much of the present research uses the model species *Arabidopsis thaliana*, because of its obvious advantages: small size, sequenced genome, availability of mutants, etc. However, in other projects we try to exploit the knowledge, as obtained in *Arabidopsis*, to other species, e.g. tomato and potato.

Our approach:

The understanding of source-sink relations implies research on primary metabolism, i.e. mainly carbohydrate metabolism. Therefore, we focus on metabolites and enzymes involved in this process, including cellular and tissue localization.



To understand the regulation of plant growth and allocation of reserves, insight into the genetic components is essential. QTL analysis, which makes use of existing natural variation within a species, offers such an approach. This approach will be used to gain insight into the various aspects of plant performance, to be studied at the level of primary production, allocation of assimilates, and interaction between mineral nutrition and carbohydrate metabolism.

Plants often have to cope with adverse environmental conditions (stress) and the effect of sub-optimal condition (e.g. drought or salt stress) is studied in several projects.

Title: Genetical genomics of plant stresses

Group: Plant Physiology (PPH)

Supervisors: Dr Dick Vreugdenhil, Dr Joost Keurentjes

Contact information: harro.bouwmeester@wur.nl or dick.vreugdenhil@wur.nl

Period(s) in which subject is available: all periods

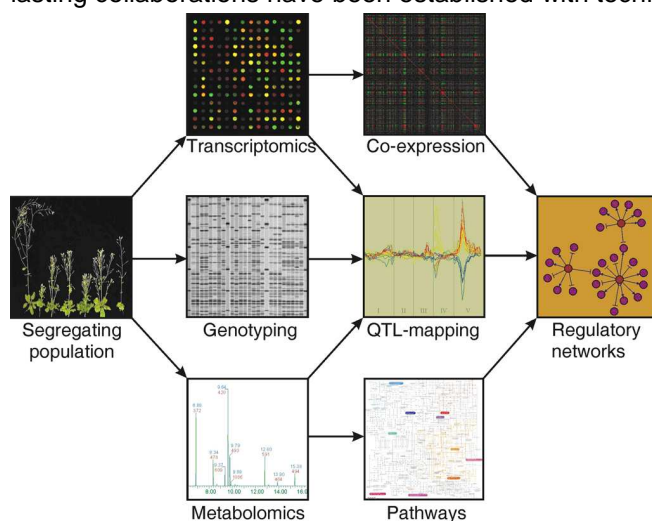
Project is intended for specialization(s): BBI-A, BBI-B, BPW, BML, BBT, BPW

Deadline for application for the project: 4 weeks before start of the course but preferably earlier.

Type of research project: Experimental work and data analysis.

Description: Growth and development of an organism is regulated by a wide range of genes. During the past decade, the use of natural variation and quantitative trait locus (QTL) analysis has been proven to be very fruitful in unraveling genes (and/or more alleles) that play a role in such complex multigenic processes. Shortly, naturally occurring accessions (ecotypes), preferably differing for the trait under investigation, are crossed; the resulting progeny is genotyped by molecular markers, and trait(s) are quantified. Then, marker-trait association are studied using appropriate statistical software, resulting in QTL, being genetic region that significantly affect the trait under investigation. As a follow-up the underpinning genes may be identified, and the (nucleotide) polymorphism, responsible for the variation between the parental accessions, can be revealed.

Initially, QTL analyses focused on single traits. Recently, it was shown that large scale (so-called 'omics' technologies) may be used for large-scale QTL studies, not only revealing loci regulating individual traits, but also networks of interconnected traits. For instance, Keurentjes et al. (2006) showed that combining large-scale untargeted metabolites analyses, in combination with QTL mapping, reveal metabolic networks. Similarly, it was shown that transcriptomic data may be used to build regulatory gene networks (Keurentjes et al., 2007). Collectively, these approaches are named 'genetical genomics' (Jansen and Nap, 2001). Applied approaches include simple correlation analyses but also more sophisticated large-scale QTL analyses and regulatory network construction. Particular attention is given to the role of natural variation in the regulation of traits related to plant adaptation and ecology. An important element of the work involves technological and mathematical improvements for comprehensive analyses of large sample sets (e.g. mapping populations). For this, long lasting collaborations have been established with technology oriented and mathematic research groups.



Title: The role of secondary metabolites in the interaction of plants and insects

Group: Plant Physiology (PPH)

Supervisors: Prof dr Harro Bouwmeester, Dr Carolien Ruyter

Contact information: harro.bouwmeester@wur.nl or dick.vreugdenhil@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): BBI-A, BBI-B, BBI-D, BPW, BML, BBT, BPW

Deadline for application for the project: 4 weeks before start of the course but preferably earlier.

Type of research project: Experimental work and data analysis

Description: Protection of crops against insects can use either direct host plant resistance or biological control. These two approaches are fundamentally different in that host plant resistance depends on direct defence traits of the crop plants (such as trichomes, toxic secondary metabolites or proteins, and repellents), whereas biological control depends on antagonists or enemies of the pest organisms. For the latter it is crucial that the biological control agents are able to find their prey. Hereto, plants – upon herbivory - produce volatiles that are attractive to the natural enemies of the herbivore. The use of predators and parasitoids for biological control is receiving more and more attention and for many years it has been common practice in a number of crops in glasshouse as well as open fields. We are interested in the role of terpenes in this indirect as well as in direct defence.

Our approach:

We focus our work on the cloning and characterisation of genes involved in terpene biosynthesis and the use of these genes to modify terpene production in transgenic plants. We use model plant species such as *Arabidopsis*, tomato, tobacco and cucumber. We use sophisticated engineering approaches through which we also gain insight in regulation of



Calling in the Bodyguards

Plants attacked by herbivorous insect pests can bring out their own chemical defenses, but can also call in "bodyguards," predators that prey on the first round of pests. Volatile compounds are important in this signaling triangle. Kappers *et al.* (p. 2070; see the news story by Pennisi) have now engineered *Arabidopsis* to produce the volatile compounds necessary to call in such bodyguards by targeting terpenoid metabolism.

terpene biosynthesis and subcellular compartmentation and transport. We study the molecular and biochemical consequences of the engineering and the effects on the behaviour of natural enemies as well as pest insects. Our successful modification of *Arabidopsis* to produce an important signalling molecule, hence becoming attractive to predatory mites, was published in *Science* (Kappers *et al.*, 2005). For a review of our other metabolic engineering work see: Aharoni *et al.*, 2005. We are looking for students that want to contribute to these projects that involve many different aspects from gene cloning and plant transformation to chemical and biological characterisation of transgenic plants.

Title: Chemical communication of plants with parasitic plants

Group: Plant Physiology (PPH)

Supervisors: Prof dr Harro Bouwmeester, Dr Iris Kappers

Contact information: harro.bouwmeester@wur.nl or dick.vreugdenhil@wur.nl

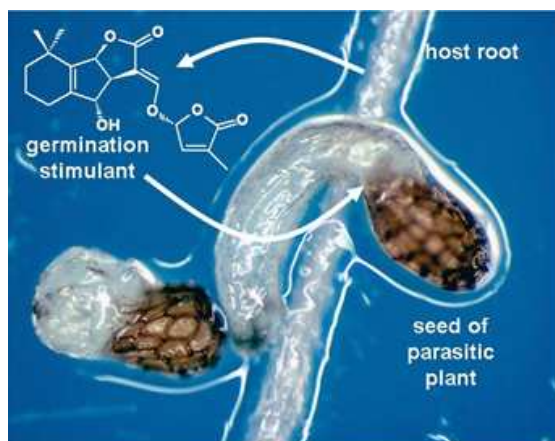
Period(s) in which subject is available: all periods

Project is intended for specialization(s): BBI-A, BBI-B, BBI-D, BPW, BML, BBT, BPW

Deadline for application for the project: 4 weeks before start of the course but preferably earlier.

Type of research project: Experimental work and data analysis

Description: Parasitic plants such as the witchweeds (*Striga spp*) and broomrapes



(*Orobancha spp*) are unusual plants with often very attractive flowers (see pictures). However, their beautiful appearance is misleading, as these plants can be real killers.

They grow on the roots of a host plant and use a special organ called haustorium to

obtain water and nutrients from their host. Parasitic plants are completely dependent upon their host: they have specialised in parasitism and let the host do the work. This specialisation is also risky: if the seeds of a parasite germinate in the absence of a host root, they will die. Therefore the parasites have developed another specialisation: for germination they require a signalling molecule that is exuded by the roots of their host. The seeds of the parasite are extremely sensitive to this compound and can detect the presence in the soil of minute amounts of the chemical.

The question why plants are producing these – apparently non-beneficial - signalling molecules was recently answered by a Japanese group who discovered that the same signalling molecules, called strigolactones, are used by the beneficial arbuscular mycorrhizal (AM) fungi to find their host. AM fungi grow on and in the roots of their host and help the host to obtain water and minerals from the soil. In return they receive assimilates from the plant. Just like the parasitic plants, AM fungi use the strigolactones to detect the presence of their host. Parasitic plants simply abuse the signal intended for the AM fungi to find their host, while the host cannot do without the signal because it needs the AM fungi.

Our approach:

We study the role of the strigolactones in this underground communication between host, parasitic plant and AM fungi and their role in regulating plant development. We work on processes in the transmitter (the host) as well as the receivers of the signals (parasitic plants) and their interaction and the effect of environmental factors, particularly phosphate. We use a combination of disciplines such as chemistry, biochemistry, plant physiology and molecular biology to elucidate the formation and regulation of the chemical signals in the host and their perception in the parasite.

Title: Metabolic engineering of pharmaceutical compounds in plants

Group: Plant Physiology (PPH)

Supervisors: Prof dr Harro Bouwmeester, Dr Sander van der Krol

Contact information: harro.bouwmeester@wur.nl or dick.vreugdenhil@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): BBI-A, BBI-B, BBI-C, BPW, BML, BBT, BPW

Deadline for application for the project

4 weeks before start of the course but preferably earlier.

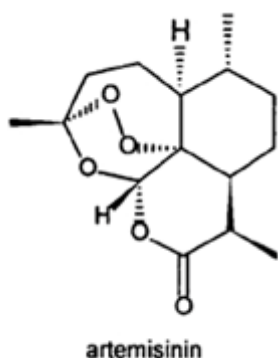
Type of research project: Experimental work and data analysis

Description: Plants produce a wealth of pharmaceutically active compounds and a particularly interesting class of metabolites are the terpenoids. Examples of terpenoid metabolites that have been developed into drugs are artemisinin, the best anti-malarial drug currently available that is extracted from the annual plant *Artemisia annua* and the indolalkaloids (half terpenoid, half alkaloid) vincristine/vinblastine two very potent anti-cancer drugs, extracted from *Catarranthus roseus*. In addition, there are hundreds and hundreds of additional pharmaceutically active terpenoids reported in plants that can potentially be developed into new drugs, for example in the sesquiterpene lactone and diterpene acid chemical groups.

Our approach:

We study the biosynthesis of these pharmaceutically active terpenoids in plants and isolate and characterise the genes that are involved in this biosynthesis. Hereto we use state-of-the-art technologies such as metabolomics, transcriptomics, 454 sequencing and bioinformatics. The genes we isolate can be used for expression in micro-organisms to characterise their biochemical function but also for microbial production of the corresponding metabolites. In addition, these genes can be used for metabolic engineering

where we aim to increase or modify the production of pharmaceutically active terpenoids in homologous or heterologous plant hosts. For this work *Arabidopsis*



and tobacco are used as models but we also work on real production systems. An example of this is our work on the metabolic engineering of artemisinin production. In collaboration with the Belgian pharmaceutical company Dafra, we are engineering industrial chicory for the production of this anti-malarial drug. The aim of this work is to create a better and cheaper supply of this important anti-malarial drug.

Title: Model analyses and Playstations: how can they be combined?

Group: Plant Production Systems

Supervisor: Mark van Wijk

Contact information: 0317-48 6102 mark.vanwijk@wur.nl

Period: Any period

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: modelling and analysis

Description: Model analyses using new statistical techniques ask for a lot of computational power. By building small parallel computer systems the speed at which these analyses can be performed can be increased tremendously. The processors inside a PlayStation 3 are very powerful, and it has been recently shown that they can be coupled easily into a little network using Linux. The topic of this thesis subject is to build such a network and test it for its ease of use for model analyses. The network will then be applied to solve a range of possible interesting questions, depending on your own interests: modelling farmers communities with agent-based models, plant rooting strategies, spatial modeling of plant competition, evolutionary games, etc. And of course, in between the hard work there will be time to play some game.

Title: Roots and shoots: what should plants do in a dry environment?

Group: Plant Production Systems

Supervisor: Mark van Wijk

Contact information: 0317-48 6102 mark.vanwijk@wur.nl

Period: Any period

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: modelling and analysis

Description: Plants in dry environments can not grow fast. The limited growth they can achieve they can invest belowground in roots, so that they can take up more water, or aboveground so that they can intercept more radiation and grow faster. Somehow they have to balance these investments, because for growth they will need both water and intercepted light. But not only the amount of, for example, root biomass matters, but also how it is distributed, in this case in different soil layers. For this subject we are looking for a student who would like to dig into this interesting problem in which plant ecology and quantitative thinking come together. If you like puzzles and computer games this is a nice subject to start playing games with plants to see what their possibilities are to survive in dry environments. Experience in modeling is not necessary, a willingness to learn about it, for sure is!

Title: Comparison of different crop modelling approaches according to simulation purposes

Group: Plant Production Systems

Supervisors: Myriam Adam; Peter Leffelaar

Contact information: 0317 - 48 35 12 myriam.adam@wur.nl;
0317 - 48 39 18 peter.leffelaar@wur.nl

Period: Any period

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: plant physiological analysis, modelling

Description: Previous development of crop growth and development models has often been the result of a specific question that a modeller wants to address and led to models with strong emphasis on a specific process, and simple descriptions or complete omission of other processes that may be important for other purposes. The level of detail incorporated in a model is often the reflection of its objectives. We target the development of a crop modelling framework that allows a dynamic choice of model algorithms and structures. This framework will comprise different existing crop modelling approaches and a set of guidelines for the users to identify the appropriate models depending on crop type and objective of the simulation.

The aim of the proposed thesis will be to compare different crop modelling approaches and evaluate the adequacy of these approaches according to the simulation objective. Examples of what could be done are:

- ✓ Comparison of the use of a model based on photosynthesis-respiration processes versus a light use efficiency-based model
- ✓ Comparison of photoperiodic responses of short day crops (e.g. millet, sorghum): linear versus quadratic relation to day length
- ✓ Comparison of different approaches to model phenology (determinate vs. indeterminate crops)

Title: The importance of phenological processes in certain crop models

Group: Plant Production Systems

Supervisors: Lenny van Bussel; Myriam Adam; Peter Leffelaar

Contact information:: 0317 - 48 25 36 lenny.vanbussel@wur.nl

0317 - 48 35 12 myriam.adam@wur.nl

0317 - 48 39 18 peter.leffelaar@wur.nl

Period: Any period

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: plant physiological analysis, modelling

Description: The behaviour of living systems, for example agro-ecosystems, is the result of interactions between physical, chemical and physiological processes. To get more insight and understanding in the behaviour of living systems, simplification of the processes with help of systems approaches is one possibility. Systems approaches integrate knowledge about the different processes that determine the behaviour of living systems. Next to enlarging the insight in and understanding of living systems, carrying out predictive studies to support decision making is another important purpose of systems approaches.

The systems approach makes use of mathematical models. Those models are defined by a set of equations, parameters and variables. The quality of a given model is very important, as well as the robustness and reliability of its outcomes. A sensitivity analysis is an often used method to check the quality and the robustness and reliability of the outcomes of a model. With help of a sensitivity analysis the variation in the outcomes of the model can be studied in relation to the variation of different parts of the model. Variation in the outcomes can be detected with help of several model runs with changing input data, values of parameters in general or in certain processes.

The aim of this research is to determine the importance of phenological processes in certain crops models. What is the effect of different levels of detail? What is the best approach to model phenological processes in crop models? Which parameters are most important?

Title: Global change and the functioning of terrestrial ecosystems

Group: Plant Production Systems

Supervisor: Mark van Wijk

Contact information: 0317-48 6102 mark.vanwijk@wur.nl

Period: Any period

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: modelling and analysis

Description: A hot research topic in environmental sciences is the analysis of carbon and energy exchanges between terrestrial ecosystems like forests, tundras and savannas, and the atmosphere. It is important both from an applied science point of view (think of the discussion of carbon sequestration), and from a fundamental research point of view (increasing our knowledge of ecophysiology or land-atmosphere interactions). In recent years, large datasets of CO₂, water and energy fluxes have been collected for different ecosystems. In this topic we want to analyse these flux datasets, to see how they can increase our knowledge regarding the complexity of ecosystem responses to the environment and human management. We will use recently developed analyses techniques, which allow a much more consistent and thorough data analysis and have a large potential in ecosystem and ecophysiology research. Depending on the interests of the students, systems like forests (deciduous, evergreen), tundra or savanna ecosystems can be analysed. The focus of the study is flexible: example topics are ecophysiology, issues in spatial or temporal scaling, or carbon sequestration.

Title: Are peak productions of carbon dioxide, nitrous oxide and methane in soils explainable by drying/wetting and freezing/thawing events?

Group: Plant Production Systems

Supervisor: Peter Leffelaar

Contact information: 0317-48 38018 peter.leffelaar@wur.nl

Period: Any period

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: microbial analysis and modelling

Description: In literature peak emissions of greenhouse gases were found after wetting of dry soil and after thawing of frozen soil. These peaks form probably a large part of the total gas emission from soil during the year. Moreover, these events occur during a short period. Therefore, accurate estimates of these emissions can only be made if good measurement strategies are followed. One strategy would be to measure emissions during the whole of the year (monitoring) with a time resolution that is higher than the frequency of rain showers or freeze/thaw rhythms. However, this will be very expensive. Another strategy could be to take measurements when high emission levels are expected. In this case it is necessary to know how these emissions are affected by the interactions of environmental factors and the underlying microbial processes. The aim of this research is to develop and to test hypothesis, which could explain the enhanced or stimulated activity. The hypotheses mentioned in literature all affect the living circumstances of soil microbes are:

- (i) the disruption of physical bonds between organic materials;
- (ii) the partial sterilization of soil due to dryness or frost and the resulting availability of easily decomposing organic material after wetting or thawing;
- (iii) decrease of gas filled soil porosity (especially when during the day soil pores are filled with water due to partial thawing), by which accumulation of gases will occur under the frozen layer;

- (iv) the possibility of salt accumulation just in front of the frozen layer (the salts will therefore 'freeze out'), by which during thawing an enhanced level of for example nitrate will be present which can be denitrified.

These explanations can be divided in biological (i and ii) and physical (iii and iv) explanations. The approach of this problem will be a thorough literature study and the development of hypotheses, which will be tested in biological (mineralization of organic matter, activity of microbes) and physical (water flow and frost) models. Beside the development of theory, experiments may be proposed to test the theory. In a BSc thesis such experiments can, however, not be executed.

Title: Growing cassava for industrial purposes or for food/feed in Mozambique

Group: Plant Production Systems

Supervisor: Gerrie van de Ven

Contact information: 0317-482696 gerrie.vandeven@wur.nl

Period: Any period (Location Nampula (Mozambique) if for MSc, and Wageningen)

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: plant physiology (cassava) and its susceptibility for pests and diseases

Description: The demand for biofuels has been growing rapidly worldwide. Much research has been done on technology development, but far less on where and how this biomass can be produced. The potentials for production of biomass for fuel are reported to be very large in many parts of the world and especially in Africa. However, these estimates often lack a proper agricultural basis, while the biomass has to be produced by farmers as part of their farming system. Several scenarios exist. On the one hand people advocate that biomass for fuel forms a new perspective for income generation for small holders. On the other hand the fear exists that only large companies will profit and push small farmers out of business.

This research focuses on cassava production in the North of Mozambique in the province Nampula. Here cassava is a major crop used for feed and ethanol and for food in years that maize yields are too low. Cassava production, however, is limited through pests and diseases, shortage of manure, lack of animal traction and high labour demands. Little is known about the local cassava varieties, their yield, inputs used and responses to inputs.

The research will focus on analysing cassava production systems and indicate possibilities for future developments, taking into account the scope for using cassava for fuel. It will describe the existing cassava production systems (cultivars, yields, inputs: nutrients, water, labour, etc.), describe the position of cassava in the farming system, analyse nutrient flows and explain the limitations in cassava production (agro-technical and socio-economic), explore possibilities for improvement, analysis of farm economic issues, such as cost price, and integrate the knowledge gained into sustainable cassava production systems. Specific attention will be paid to the scope that the farming system offers for using the cassava for biofuel, within a food and feed security context.

Title: Multifunctional agriculture as adaptation to global and regional change

Group: Plant Production Systems

Supervisor: Pytrik Reidsma; Martin van Ittersum

Contact information: 0317-48 55 78 pytrik.reidsma@wur.nl

0317-48 23 82 Martin.VanIttersum@wur.nl

Period: Any period

Project intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: 2 weeks before start

Type of research project: knowledge of crop plants and vegetations to assess biodiversity

Description: Agriculture in Europe evolves due to changes in policy, socio-economic and climatic conditions. In the Netherlands, over the past 50 years, the overall number of farms decreased by 75%, while the average farm area increased from 6 to 26 ha. When looking ahead, some rural areas will remain production oriented, others will move to a more multifunctional character. For both types of farming there is a need to identify adaptation strategies that are effective in achieving climate-robust agricultural landscapes, contributing to social, economic and environmental objectives.

A climate-robust, multifunctional rural landscape can only be obtained if farmers contribute to nature targets. However, as biodiversity research has mainly focused on nature areas, and less on the added value of changes in agricultural practices, there is little knowledge on the cross-sectoral effects of adaptation strategies in agriculture and nature. A substantial number of farmers is willing to contribute to biodiversity conservation, but they need economic incentives. Trade-offs between food production, farmer's income and environmental services should be assessed to identify effective and feasible adaptation strategies.

This research will assess the consequences of agricultural adaptation strategies to climate, market and policy changes on different farm types and the implications for nature quality in the rural areas.

Title: Regulation of *NRC1* expression: a key gene of tomato essential for resistance to pathogens

Group: PHP; SOL group, <http://www.php.wur.nl/UK/Research/SOLgroup/>

Supervisor: Daniela Sueldo

Contact information: Daniela.Sueldo@wur.nl; Wladimir.Tameling@wur.nl; Matthieu.joosten@wur.nl.

Period(s) in which subject is available: all

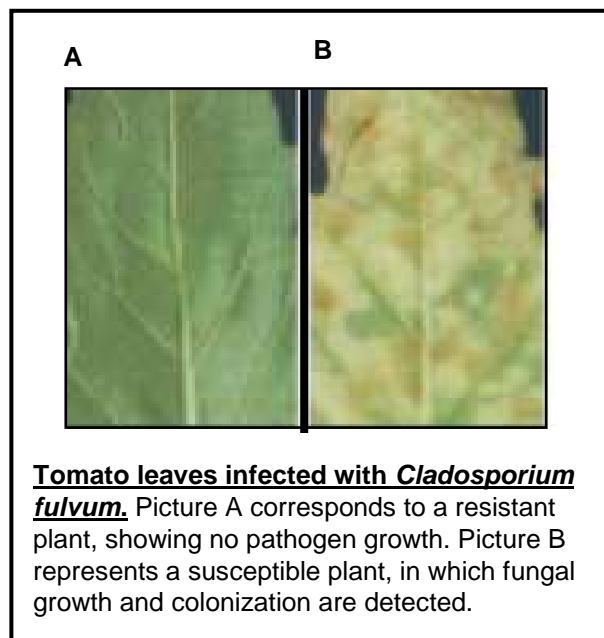
Project is intended for specialization(s): Cell and molecular biology

Deadline for application for the project: 4 weeks in advance of start of the project

Type of research project: experimental laboratory and greenhouse work

Description: *NRC1* is a tomato protein that is required for resistance to the fungal pathogens *Cladosporium fulvum* and *Verticillium dahliae*. *NRC1* was identified through an unbiased screen using tomato plants mounting a synchronized defense response. In general, many genes that are associated with plant immunity are up-regulated during infection by pathogens. Therefore, knowing how *NRC1* expression levels are affected upon infection is very important for understanding its role in this immune system. In this project we aim at characterizing the expression levels of *NRC1* in infected and uninfected tomato plants. You will perform RNA isolation from tomato leaf tissue infected with *Cladosporium fulvum* and you will study *NRC1* mRNA levels through Q-PCR (quantitative real time-PCR). Furthermore,

you will analyze *NRC1* gene expression in tomato seedlings undergoing a synchronized defense response.



Title: Colony Collapse Disorder in Honeybees

Group: Resource Ecology Group / Bees@ WUR

Supervisor(s): dr. Frank van Langevelde and dr. Coby van Dooremalen

Contact information: frank.vanlangevelde@wur.nl or coby.vandooremalen@wur.nl

Description: Starting in late 2006, commercial migratory beekeepers along the East Coast of the United States began reporting sharp declines in their honey bee colonies. Because of the

severity and unusual circumstances of these colony declines, scientists named this phenomenon colony collapse disorder (CCD). Nowadays, honey bees all over the world decline. The cause or causes of the syndrome are not yet fully understood, although many authorities attribute the problem to biotic factors such as the parasitic mites (*Varroa destructor*) and insect diseases (i.e., pathogens including *Nosema apis* and Israel acute paralysis virus). At Bees@wur we are currently trying to unravel the causes of CCD and to develop methods in which beekeepers can keep healthy bees. Using existing data, we investigate the role of environmental factors such as food availability, insect diseases or interactions between factors on the fitness of honeybees.

Title: Competition and Facilitation structuring communities of large vertebrates

Group: Resource Ecology Group (REG)

Supervisor: Dr. Fred de Boer

Contact information: fred.deboer@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the project: two weeks in advance

Type of research project: literature analyses

Description: Interspecific competition is often referred to as an important species interaction that structures species assemblages. However, if you look at the literature relatively little evidence is found for the existence of competition under field situations, especially not for the larger vertebrates. How does competition affect diet or habitat choice? And what evidence is there that competition structures species assemblages? This work could be extended looking at positive species interactions.

Title: Forage biomass and forage quality influencing species co-existence of large herbivores

Group: Resource Ecology Group (REG)

Supervisor: Dr. Fred de Boer

Contact information: fred.deboer@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the project: two weeks in advance

Type of research project: literature analyses

Description: Each species has its own requirements in terms of forage intake and forage quality, which is assumed to depend partly on body size. These assumptions are often based on allometric scaling laws, but how much evidence is there from the field that species occurrence is determined by differences in availability and quality of vegetation?

Title: Spatial Ecology: the influence of movements and distribution of foraging success

Group: Resource Ecology Group (REG)

Supervisor: Dr. Fred de Boer

Contact information: fred.deboer@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

two weeks in advance two weeks in advance

Type of research project: literature analyses

Description: There is recently a lot of attention on spatial aspects of foraging. But how important is this for differences in foraging success? Are mathematical models able to predict species distribution and movements based on calculations that aim at optimizing intake?

Title: Trees in savannas: their strategies to cope with fire, herbivory and drought

Group: Resource Ecology Group (REG)

Supervisor: Dr. Frank van Langevelde

Contact information: frank.vanlangevelde@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the project: two weeks in advance

Type of research project: literature analyses

Description: Savannas cover a large part of the global land surface. They are characterised by high species richness, and millions of people and their livestock live in these savannas. Trees determine to a large extent the functioning of savannas. However, surprisingly little is known about the ecology of savanna trees. Studies so far concentrated on single tree species in local conditions. With the set up of a worldwide experiment on tree seedling recruitment, we think that it is now time to generalize knowledge from these different studies. Experiments in 5 continents are set up (Africa, Asia, Australia, North America and South America) and provide plenty of opportunities for BSc and MSc students.

Title: Diseases in natural populations: the genetic viewpoint

Group: Resource Ecology Group (REG)

Supervisor: Dr. Pim van Hooft

Contact information: pim.vanhooft@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s):

Deadline for application for the project: two weeks in advance

Type of research project: literature analyses

Description: Spread of infectious diseases (like avian influenza, bovine tuberculosis and swine fever) is an increasing threat to many ecosystems. Studying the role of molecular processes (genes and their expression) herein in their ecological context provides a perspective that is crucial for understanding disease spread. Especially the new field of ecogenomics is expected to provide major new insights. In this thesis you will evaluate the role genetics can play in studying disease spread in natural populations

Title: Ecogenomics: where are we now and where are we going?

Group: Resource Ecology Group (REG)

Supervisor: Dr. Pim van Hooft

Contact information: pim.vanhooft@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Cell and molecular biology

Deadline for application for the project: two weeks in advance

Type of research project: literature analyses

Description: Most genomic studies to date rely on model species. However, genome sequence information, new technological and bioinformatics platforms and reducing costs now enable comprehensive surveys of adaptive genetic variation in natural populations, better known as ecogenomics. In this thesis you will analyze what is the current state of affairs and what are the potentials for future research and applications.

Title: The role of population genetics in conservation management

Group: Resource Ecology Group (REG)

Supervisor: Dr. Pim van Hooft

Contact information: pim.vanhooft@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the project: two weeks in advance

Type of research project: literature analyses

Description: Technical advances in areas such as high-throughput sequencing, microsatellite analysis and non-invasive DNA sampling have led to a much-expanded role for genetics in conservation. Two important areas in this respect are conservation genetics and landscape genetics. In this study you will investigate to what extent these research areas are and can be used in landscape-based decision-making processes.

Title: Identification and characterization of Cf-4-interacting proteins

Group: SOL-group, Phytopathology (PHP) http://www.php.wur.nl/UK/Research/SOL_group

Supervisor: ir. Thomas Liebrand, Dr. ir. Matthieu Joosten

Contact information: Thomas.liebrand@wur.nl; Matthieu.Joosten@wur.nl

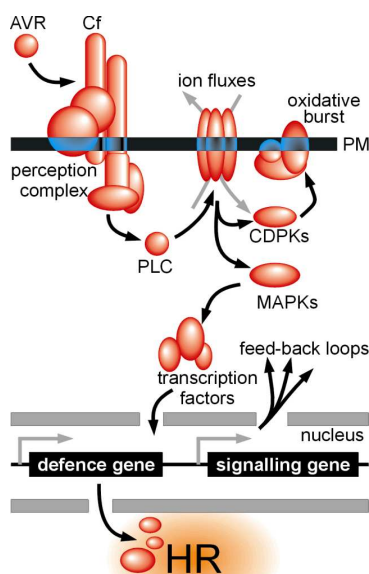
Period(s) in which subject is available: all

Project is intended for specialization(s): Cell and molecular biology

Deadline for application for the project: 4 weeks in advance of start

Type of research project: experimental laboratory and greenhouse work, combined with data analysis

Description: To resist harmful pathogens plants have evolved immune-receptors. At Phytopathology we study the interaction between tomato and its pathogen, the fungus *Cladosporium fulvum*. The Cf-4 immune-receptor of tomato recognizes the Avr4 effector protein of *C. fulvum*. Upon recognition of Avr4 by Cf-4, a defense response is mounted resulting in resistance against *C. fulvum*. Cf-4 is a so-called Receptor-Like Protein (RLP) and is localized to the plasma membrane. It contains an extracellular Leucine-Rich Repeat domain, which is believed to mediate recognition of Avr4, and an intracellular domain without any known signaling domains. We study the Cf-4 receptor in a yeast-two hybrid system to identify Cf-4-interacting proteins and so we expect to learn more about how Cf-4-mediates defense responses. By screening Cf-4 against a tomato cDNA library, interaction of Cf-4 with all expressed tomato proteins is studied. You can participate in identifying new Cf-4-interacting proteins and/or study the role of identified interactors in Cf-4 signaling by 1 to 1 candidate yeast-two hybrid assays or Virus-Induced Gene Silencing (VIGS) in Cf-4 tomato and *N. benthamiana* plants. In addition, bioinformatic tools will be used to further characterize Cf-4-interacting proteins.



*Model for extracellular pathogen perception and defence activation in resistant tomato. In this model, the signal transduction chain that leads to a hypersensitive response (HR) is initiated by the recognition of the effector (Avr protein; AVR) that is secreted by *C. fulvum* upon entering the intercellular spaces of the tomato leaves. The extracellular domain of the Cf receptor-like protein (Cf, residing in the plasma membrane (PM)) senses the presence of the effector either directly or indirectly through interaction with the virulence target (red ball) of the effector. Subsequently, phospholipase C (PLC), ion channels, calcium-dependent protein kinases (CDPKs), mitogen-activated protein kinases (MAPKs) and transcription factors are activated. Eventually, activation of defence genes results in the HR and associated resistance responses.*

Title: Mutational analysis of NRC1, a key-regulator in plant defense signaling

Group: SOL group, phytopathology, WUR

Supervisor: dr. ir. Patrick E.J. Smit

Contact information: Patrick.smit@wur.nl, Matthieu.joosten@wur.nl.

Period(s) in which subject is available: all

Project is intended for specialization(s): all, the student should have interest in molecular manipulation combined with a phenotypic analysis of the results.

Deadline for application for the project: 4 weeks in advance of start

Type of research project: experimental laboratory work

Description: Tomato *NRC1* encodes a nucleotide binding, leucine-rich repeat containing protein that is essential to plant defense against pathogens. It was first identified in tomato, and current nucleotide database analysis suggests that asterids and closely related species contain an *NRC1*,

but it is not present in rosids, monocots, and other more distantly related angiosperm plants. Alignment of the amino acid sequences indicates that there are amino acids in NRC1 and orthologous proteins that are strictly conserved. You will investigate if these conserved amino acids are important to the function of NRC1. You will mutate the conserved codons in the coding DNA, confirm this by sequencing, transform these mutated genes into plants, and observe whether the defense response (programmed cell death) is altered by the mutations.

Title: Genome mining in Oomycetes

Group: Phytopathology (PHP)

Supervisor: Dr. Harold Meijer

Contact information: harold.meijer@wur.nl / phone 0317 483 138

Period(s) in which subject is available: all

Project is intended for specialization(s): Cell and molecular biology

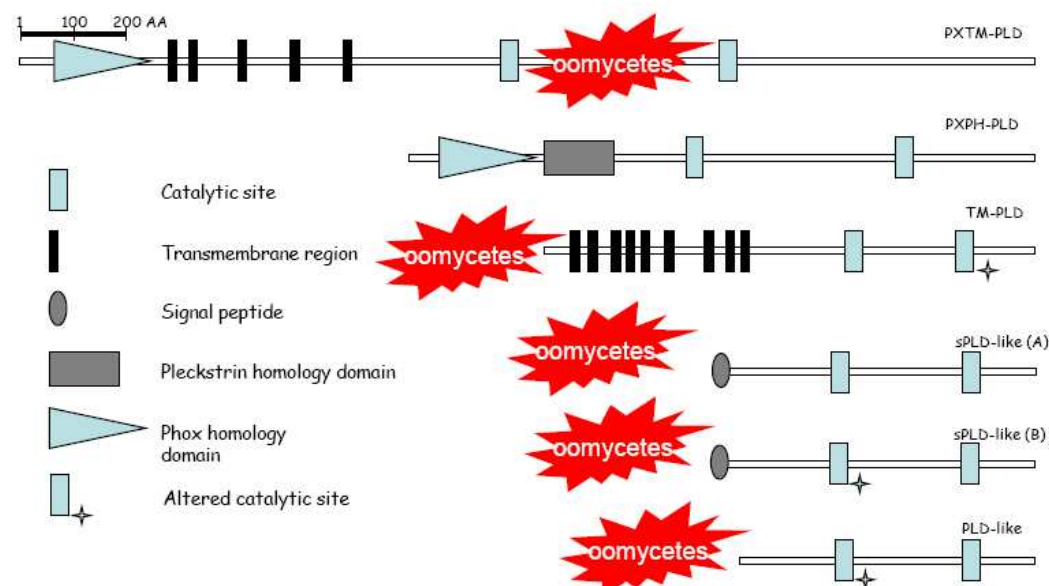
Deadline for application for the project: two weeks before the start of the course

Type of research project: data analysis

Description: Oomycetes are fungus-like organisms that are pathogenic on a wide variety of plants and animals and form a distinct lineage within the 'tree-of-life'. The most notorious oomycete is *Phytophthora infestans*, the causal agent of potato late blight. Comparative genomics of three *Phytophthora* species has revealed genes encoding proteins with *Phytophthora*-specific domain combinations several of which function in signal transduction (for example phospholipase D as shown in the figure). The aim of this project is to investigate gene-innovations in the oomycete *Saprolegnia parasitica*, one of the most important fish pathogens worldwide, especially on catfish, salmon and trout species. It causes millions of dollar losses to the aquaculture industry and has also been linked to declining wild fish stocks and amphibian populations around the world.

Gene innovations in oomycetes

Genes encoding phospholipase D (PLD)



Title: Food limitation as a cause for hibernation diapause in earthworm species

Group: Soil Quality (SOQ)

Project type: Experimental study

Supervisor(s): Ingrid Lubbers, Jan Willem van Groenigen

Contact info: Ingrid Lubbers (Ingrid.Lubbers@wur.nl)

Periods in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity

Deadline for application for the projects: 1 month prior to the start of the bsc thesis

Type of research project: experimental: mesocosm experiment with maximal two earthworm species, different food types and amounts and two food placement treatments.

Description:

Nearly all earthworms have the ability to go into a resting stage (diapause), in response to worsening habitat conditions. During these resting periods earthworms retreat deep into the soil where they become motionless and do not feed. They are tied up in a knot in a little hole that is lined with a slimy substance to avoid moisture loss.

There are several reasons for earthworms to revert to diapause. Reasons can be climatic conditions such as drought or low soil temperatures, reactions to toxicity such as accumulation of heavy metals or pesticides, or food limitation.

Previous laboratory experiments in our research group have shown certain earthworm species to revert to diapause even though climatic conditions were optimal and the soil was non-toxic. Food limitation must therefore have been the main reason for the earthworms to enter a resting stage. The aim of this project is to find out how food limitation causes earthworms to revert to diapause. Factors to be tested are food quantity, food quality and food placement within the soil profile.

Title: The nematode Maturity Index; a good indicator of soil quality?

Group: Sub-department of Soil Quality (SOQ)

Supervisor: Karst Broelsma, Ron de Goede and Ellis Hoffland

Contact information: Karst Broelsma (Karst.Broelsma@wur.nl)

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and Biodiversity

Deadline for application for the project: At least two weeks before the start of the thesis

Type of research project: literature study and meta-analysis

Description: The ecological condition of soils can be monitored by the study of soil organisms and the ecological processes in which they participate. The analysis of the composition of the nematodes fauna is a widely applied bio-indicator. One square metre of soil can contain over a million nematodes and more than 50 nematode species can be present in a single handful of soil. A bio-indicator which describes the nematode community in the soil is the Maturity Index (MI). The calculation of the MI is based on the classification of nematode taxa into so called colonizers and persisters classes, i.e. stress tolerant and stress sensitive taxa, respectively. Based on existing literature, we would like to investigate the quantitative relationship between the nematode MI and (disturbed, i.e. for example tillage, fertilisation, pollution) soil conditions. To do so, you are asked to do a literature research followed by a meta-analysis. A meta-analysis is a statistical analysis of the results of several independent studies (publications) which focus on a common research question.

Title: Relevance of toxic effects on fish population development

Group: Environmental toxicology (TOX)

Supervisor(s): Tinka Murk

Contact information: Tinka.Murk@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity, Human and animal health biology

Deadline for application for the project: At least two weeks before the start of the course, but preferably as soon as possible

Type of research project: literature analysis and data analysis (modeling)

Description: In (eco) toxicological research effects of many types of environmental contaminants have been studied on fish. These effects concern e.g. reproductive outcome, survival of different life stages, growth, etc. It remains, however, to be studied what the consequences of these effects will be at the population level for fish with different population strategies and in interaction with additional stressors. Especially in the marine environment there is a big difference between very big fish that can become very old, such as tuna fish, and e.g. herring. Also fishing pressure is a very important stressor for several fish species. Currently models are being developed to study

the population effects of toxic compounds on fish species in interaction with fisheries. This BSc-project will focus on the different toxic effects that have been described for all fish life stages, the relation with realistic exposure concentrations and the possible consequences for the fish populations.

Title: Possible (environmental) toxicological consequences of climate change

Group: Environmental toxicology (TOX)

Supervisor(s): Tinka Murk

Contact information: Tinka.Murk@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity, Human and animal health biology

Deadline for application for the project: At least two weeks before the start of the course, but preferably as soon as possible

Type of research project: literature review and data analysis

Description: Climate change may influence the availability and fate of toxic compounds and the direct and indirect (eco) toxicological effects. For example release of historical toxic compounds deposited decades ago after atmospheric transport, increased UV levels changing bioactivation of compounds, changed transport because of changing oceanic currents, etc. etc. In literature bits and pieces of the puzzle have been reported. This BSc-thesis aims at reviewing the available information and elaborating on this by following an conceptual approach also resulting in a hypothesis and suggestions for further research.

Title: Ecotoxicological effects of TBT substitutes in antifouling paint

Group: Environmental toxicology (TOX)

Supervisor(s): Diana Slijkerman (IMARES) & Tinka Murk

Contact information: Tinka.Murk@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity, Human and animal health biology

Deadline for application for the project: At least two weeks before the start of the course, but preferably as soon as possible

Type of research project: literature review and data analysis (risk assessment)

Description: Large ships need to reduce the fouling of the ships skin with organisms (epiphyton, barnacles, etc.) as this will slow down the ships and increase the energy costs. For decades tributyltin (TBT) has been mixed in the in paint. This biocide was very effective, but also caused severe adverse environmental effects including imposex in mollusks. Recently TBT was prohibited in Europe, and because of the need of antifouling paints alternatives are being applied such as Irgarol and copper. It is, however, hardly known what the adverse effects of these new biocides can be for the environment.

This BSc-thesis aims at finding out what products currently are being offered by the industry, what the active compounds are, and what the qualities and ecotoxicological risks of these compounds are.

Title: Effectiveness and adverse environmental effects of chlorination as ballast water

Group: Environmental toxicology (TOX)

Supervisor(s): Klaas Kaag (IMARES) & Tinka Murk

Contact information: Tinka.Murk@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Ecology and biodiversity, Human and animal health biology

Deadline for application for the project: At least two weeks before the start of the course, but preferably as soon as possible

Type of research project: literature review and data analysis (risk assessment)

Description: In international shipping it is an obligation to prevent import of new species via the ballast water of ships. Therefore it has to be treated before releasing the ballast water, with physical or chemical means to kill potentially invasive species. One of the promising, effective, treatments is chlorination of the water killing all living cells present. Chlorination of natural water, however, also induces formation of chlorinated organic compounds that can be very toxic and persistent. This has been studied in other fields of application of chlorination, but not yet for the marine environment. When the treated ballast water is released in the new environments ecotoxicological adverse effects could be induced. In addition, indications exist that the effectiveness and adverse effects of chlorination greatly depends on environmental factors such as temperature and salinity.

This BSc-thesis aims at understanding the mechanisms of intended and adverse effects of chlorination and includes its environmental risk assessment.

Title: Beneficial health effects of PPAR- δ activation

Group: Toxicology (TOX)

Supervisor(s): Linda Gijsbers

Contact information: Linda.Gijsbers@wur.nl

Period(s) in which subject is available: all

Project is intended for specialization(s): Cell and molecular biology; Human and animal health biology

Deadline for application for the project: at least 2 weeks before the start of the course

Type of research project: literature research

Description: Peroxisome Proliferator-Activated Receptors (PPARs) are ligand-activated transcription factors: the ligand binds to and thereby activates the PPAR. PPAR activation results in modulation of the expression of target genes. There are three PPAR isoforms; PPAR- α , PPAR- δ and PPAR- γ . PPAR- α plays a role in the regulation of fat metabolism and has anti-inflammatory properties. PPAR- γ has anti-inflammatory effects and is known for its role in adipogenesis and lipid metabolism in adipose tissue. The role of PPAR- δ is not completely understood, but it seems to be linked to wound healing and to fetal and early postnatal development. In this BSc thesis the student will perform a literature study to discover 1) which compounds can (specifically) activate PPAR- δ and 2) what effects PPAR- δ activation exerts on human health.

Title: The risk of estrogens in the human body

Group: Toxicology (TOX)

Supervisor: Nynke Evers (PhD)

Contact information: nynke.evers@wur.nl

Period(s) in which subject is available: All periods

Project is intended for specialization(s): Cell and molecular biology, Human and animal health biology

Deadline for application for the project: At least two weeks before the start of the course, but preferably as soon as possible

Type of research project: Literature research

Description:

Estrogens are needed for normal developmental, physiological and reproductive processes in vertebrates. Estrogens stimulate cell proliferation in normal developing breast tissues and may prevent osteoporosis by increasing bone mineral density. However, several studies also suggest that estrogens may stimulate the growth of for example a large proportion of estrogen receptor positive breast cancers.

What is the normal level of estrogen circulating in the body? At what levels does it become a health risk and is there an increased risk for cancer? And can these risk levels be reached easily just from exposure to environmental estrogens or would you have to be exposed to a lot of estrogenic compounds in for example drugs to reach these levels? These are the questions that should be answered after performing the literature study.

Title: Metabolism of the anti-breast cancer drugs tamoxifen and fulvestrant

Group: Toxicology (TOX)

Supervisor: Nynke Evers (PhD)

Contact information: nynke.evers@wur.nl

Period(s) in which subject is available: All periods

Project is intended for specialization(s): Cell and molecular biology, Human and animal health biology

Deadline for application for the project: At least two weeks before the start of the course, but preferably as soon as possible

Type of research project: Literature research, possibly experimental work and data analysis

Description: The compounds tamoxifen and fulvestrant are used in breast cancer treatment for estrogen receptor positive breast cancers. Estrogens are generally thought to positively influence cell proliferation, therefore stimulating the tumor to grow. Tamoxifen and fulvestrant have anti-estrogenic actions, by blocking or breaking down the estrogen receptors, leading to a decrease in cell proliferation. However, these compounds could be metabolized by the body, meaning that not tamoxifen or fulvestrant itself is responsible for the observed effects, but their metabolites. The literature research will provide information on the way tamoxifen and fulvestrant are metabolized and what influence these metabolites have on cancer cells, with special focus on breast cancer.

If it has your preference to do experimental work, it might also be possible to expose breast cancer cells to 4-hydroxytamoxifen (the major metabolite of tamoxifen) and fulvestrant to check for formed metabolites (possibility to do experimental work first needs to be checked with Nynke Evers).

Title: Effects of nanoparticles on macrophage cells

Group: Toxicology

Supervisor: Merel van der Ploeg/ Laura de Haan/ Ivonne Rietjens

Contact information: merel.vanderploeg@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology, Human and animal health biology

Deadline for application for the project: 2 weeks before the start of the course but preferable earlier.

Type of research project: theoretical and/or experimental work and data analysis

Description: Nanotechnology is a fast growing field, with nanoparticles being implemented in many products, such as paints, cosmetics, clothes and electronics. However, hazards of these particles are not well-known, both in humans and on the environment. In this project you will study effects and mechanisms of different nanoparticles on (cultured) cells. Depending on your preference, you can choose to do a theoretical study on the mechanisms behind nanoparticle exposure effects or you can do cytotoxicity tests; exposing macrophage cells to nanoparticles.

Title: Effect of nanoparticles in soil

Group: Toxicology (TOX)/ Alterra

Supervisor: Merel van der Ploeg/ Annemariet van der Hout/ Nico van den Brink

Contact information: merel.vanderploeg@wur.nl

Period(s) in which subject is available: all periods

Project is intended for specialization(s): Cell and molecular biology, Human and animal health biology

Deadline for application for the project: 2 weeks before the start of the course but preferable earlier.

Type of research project: experimental work and data analysis

Description: Nanotechnology is a fast growing field, with nanoparticles being implemented in many products, such as paints, cosmetics, clothes and electronics. However, hazards of these particles are not well-known, both in humans and on the environment. In this project you will study effects and mechanisms of different nanoparticles on earthworms, a much used animal in ecotoxicology studies. Depending on your preference, you can choose to do more biochemical

work (nanoparticles in the soil) or you can choose to work with the earthworms; looking at the effects of nanoparticle exposure on the earthworms.