M4432 Plant Phenomics for Knowledge-Based Bioeconomy

Coordinator (responsible lecturer)
Prof. Bott (m.bott@fz-juelich.de),

Lecturers
Prof. Bott/ Dr. Frunzke, Prof. Feldbrügge, Dr.Schipper, Prof. Jaeger

Contact and organization
Prof. Bott (m.bott@fz-juelich.de),

Workload	Credits	Contact time	Self-study	Duration
420 h	14 CP	300 h	120 h	1 semester

Course components	Frequency	Group size
Practicals: 18 PPW Lecture: 2 PPW	Summer semester	12

Learning outcomes/skills:
Students can evaluate and independently analyse the regulation of photosynthesis (light and dark reaction, coupling photosynthesis – transpiration and various forms of non-photochemical energy transfer). They are able to quantitatively measure light and dark reactions as well as transpiration using chlorophyll fluorescence and gaseous exchange and use these measurements to make conclusions about the ecophysiological state of the plants. In addition, they can interpret light-dependence curves and Ac_i curves. The students will independently analyse dynamic reactions of plant growth to environmental changes and transfer the results to the biomass accumulation. They can evaluate the biophysical backgrounds to electromagnetic radiation and its interaction with vegetation and carry out hyperspectral reflection measurements, record, evaluate and interpret radiance and reflectance spectra and derive and evaluate the fundamental vegetation indices.
In addition, the students can describe carbon, hydrogen and nitrogen cycles in the plant and in ecosystems, analyse pool sizes and turnover rates of individual materials and evaluate the current scientific and political debates. They will thus be able to evaluate the concept of resource usage efficiency from the scale of individual leaves to entire ecosystems and critically assess the influence of temperature, water and nutrient availability on biomass accumulations and plant ecosystems.

Forms of teaching
Lecture, practical, preparation and delivery of presentations, group work with discussion. One fundamental course concept is the interplay between lecture – planning of own experiments and practical application – presentation and critical appraisal of own results. Measurements will be carried out in the laboratory, greenhouse as well as in the field. Students will be introduced to the theoretical backgrounds during the morning lectures. These will be followed by a practical in which the students split into small groups to apply the various methods to examine defined questions. The students' results will be evaluated and critically discussed during the practical part of the course and during short presentations (seminar period). During the course, the students will be increasingly able to plan their own experiments and develop and expertly work through their own hypotheses. At the end of the course there will be an open final colloquium in which the students will present the results of their experiments in their specialisation.

Content:
Energy transformation and metabolic pathways for the sustainable production of raw materials in plants (nutrients and foodstuffs, biomass, raw materials for industry, molecular farming), the influences of abiotic stress factors on these processes, characterisation of

metabolism, growth and biomass allocation in plants using non-invasive procedures.
The focuses will be on the following subjects:

- Characterisation of photosynthesis and stress recognition
- Endogenous control of primary/secondary metabolism and growth, reactions to the environment
- Substance allocation (within tissue; between organs over long distance transport)
- Improvement of yield from target products (cultivation methods, genetic manipulation, acceleration of modern breeding programmes)
- Deeper understanding of the meaning and relationships between plant-transmitted exchange processes from the leaf to the stock and field
- Role of the plants in local to global material and energy flows.
- Introduction to remote sensing with a focus on remote sensing of plant ecosystems

Practicals:

- Measurement of photosynthesis and associated exchange processes using fluorescence, gaseous exchange and spectrally resolved methods
- Quantification of leaf and root growth as well as the transport and exchange processes
- Phenotyping of the dynamics of biomass accumulation and morphology using imaging procedures
- Chemical, biochemical or physical methods for the determination of sugars, starches, lipids, proteins and pigments
- Examination of biomass allocation between leaf, shoot and root
- Basics of optical remote sensing: hyperspectral reflection measurements, remote sensing of fluorescence, integration of remote sensing data in vegetation modelling

Requirements for admission
Formal: None
With regards to content: None

Examination types
Written examination

Requisites for the allocation of credits
Regular participation in the practical lessons and a pass in the module final exam
Pass in the module final exam, presentations on practical work

Relevant for following study programmes/major (only MSc programme)
M.Sc. Biology
M.Sc. Biology International;

Compatibility with other curricula
None

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
M.Sc. Biology International: 14/44 CP

Course language
English

Additional information
Registration for the practical course is made via the central issuing office (PD Dr. Schumann)
The module will take place in IBG-2 of the Forschungszentrums Jülich (http://www.fz-juelich.de/icg/icg-3/). The course includes a lecture, a practical part and a daily concluding discussion/seminar. Depending on the participants, parts of the course may be carried out in English; the lecture and written exam are in German.