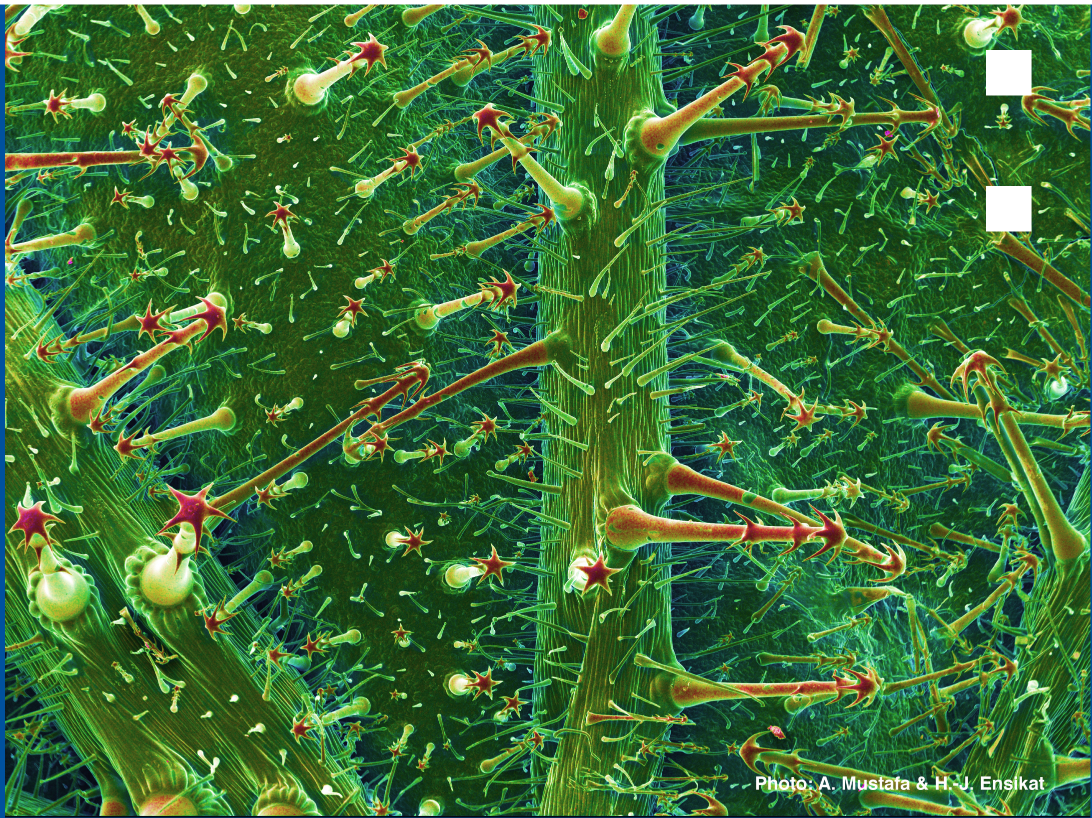
M.Sc. Plant Sciences

Module description



Rheinische
Friedrich-Wilhelms-
Universität Bonn

Due to changes of faculty members, the list of modules and the content of modules is ocassionally modified.

This version is currently under revision but in most cases it can give you an impression about the content of the modules.

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Description

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Plant Biochemistry, Physiology & Molecular Biology 1

Module Code	Workload	Credit Points	Duration	Semester
PBPM1	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Dorothea Bartels

Institute
IMBIO

Participating teachers
Prof. Dr. Dorothea Bartels
Prof. Dr. Volker Knoop
Prof. Dr. Lukas Schreiber

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**1**

Learning goals
Students should gain a solid understanding of the physiological processes in plants on the basis of a well-founded, current knowledge of the molecular structures, reactions and processes in plant cells and tissues.

Key competencies
Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant molecular biochemistry, biology, genetics and physiology.

Content
The lecture will address all major topics of plant biochemistry, physiology and molecular biology including: biochemical pathways of primary and secondary metabolism, photosynthesis, respiratory chain, carbohydrates, plant hormones, membrane and storage lipids, membranes, long-distance and membrane transport, cell wall biosynthesis and external biopolymers, nitrogen and sulfur assimilation, abiotic and biotic environmental interactions, physiological stress, plant-microbe interactions and plant pathogens, plant genomes and gene expression, model organisms in plant research, gene technology and transgenic plants.

The accompanying seminar will demonstrate the scientific impact of the vast amount of new information on gene sequence and expression data as well as on protein and metabolite data. This information which has been gathered over the last two decades has had a major effect on the understanding of plant metabolism and physiology. Examples will be discussed using very recent literature.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecure – Plant Biochemistry, Physiology & Molecular Biology	**3**	**210 h**	**7**
Seminar - Plant Biotechnology	**2**	**90 h**	**3**

Evaluation

Written Examination (3 h)	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
2. Taiz L, Zeiger E (2006) Plant Physiology. Sinauer Associates Inc., Sunderland, MA

Plant Biochemistry, Physiology & Molecular Biology 2

Module Code	Workload	Credit Points	Duration	Semester
PBPM2	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Volker Knoop

Institute
IZMB

Participating teachers
Prof. Dr. Dorothea Bartels
Prof. Dr. Volker Knoop
Prof. Dr. Lukas Schreiber

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**1**

Learning goals
Students should gain a solid understanding of the physiological processes in plants on the basis of a well-founded, current knowledge of the molecular structures, reactions and processes in plant cells and tissues.

Key competencies
Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant molecular biochemistry, biology, genetics and physiology.

Content
The lecture will address all major topics of plant biochemistry, physiology and molecular biology including: biochemical pathways of primary and secondary metabolism, photosynthesis, respiratory chain, carbohydrates, plant hormones, membrane and storage lipids, membranes, long-distance and membrane transport, cell wall biosynthesis and external biopolymers, nitrogen and sulfur assimilation, abiotic and biotic environmental interactions, physiological stress, plant-microbe interactions and plant pathogens, plant genomes and gene expression, model organisms in plant research, gene technology and transgenic plants.

The accompanying specific seminar on transgenic plants in PBPM2 will focus on up-to-date literature on new developments in basic and applied research using transgenic plant approaches.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecure – Plant Biochemistry, Physiology & Molecular Biology	**3**	**210 h**	**7**
Seminar - Transgenic Plant Research	**2**	**90 h**	**3**

Evaluation

Written Examination (3 h)	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
2. Taiz L, Zeiger E (2006) Plant Physiology. Sinauer Associates Inc., Sunderland, MA

Plant Biochemistry, Physiology & Molecular Biology 3

Module Code	Workload	Credit Points	Duration	Semester
PBPM3	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Lukas Schreiber

Institute
IZMB

Participating teachers
Prof. Dr. Dorothea Bartels
Prof. Dr. Volker Knoop
Prof. Dr. Lukas Schreiber
Prof. Dr. Rochus Franke

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**1**

Learning goals
Students should gain a solid understanding of the physiological processes in plants on the basis of a well-founded, current knowledge of the molecular structures, reactions and processes in plant cells and tissues.

Key competencies
Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant molecular biochemistry, biology, genetics and physiology.

Content
The lecture will address all major topics of plant biochemistry, physiology and molecular biology including: biochemical pathways of primary and secondary metabolism, photosynthesis, respiratory chain, carbohydrates, plant hormones, membrane and storage lipids, membranes, long-distance and membrane transport, cell wall biosynthesis and external biopolymers, nitrogen and sulfur assimilation, abiotic and biotic environmental interactions, physiological stress, plant-microbe interactions and plant pathogens, plant genomes and gene expression, model organisms in plant research, gene technology and transgenic plants.

In the accompanying seminar "Phytochemistry" in PBPM3 recent publications in the field of primary and secondary plant metabolites will be presented and discussed.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecure – Plant Biochemistry, Physiology & Molecular Biology	**3**	**210 h**	**7**
Seminar - Phytochemistry	**2**	**90 h**	**3**

Evaluation

Written Examination (3 h)	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
2. Taiz L, Zeiger E (2006) Plant Physiology. Sinauer Associates Inc., Sunderland, MA

Plant Cell Development and Ultrastructure 1

Module Code	Workload	Credit Points	Duration	Semester
PCDU1	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Ute Vothknecht

Institute
IZMB

Participating teachers
PD Dr. Frantisek Baluska
Prof. Dr. Ute Vothknecht
Dr. Boris Voigt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**1**

Learning goals
Students should be able to understand the fundamental principles of plant cell architecture, function, cell growth and dynamics, the genetic basis of plant development, and basic principles of communication between cells, tissues and organs. They should gain insight into the various strategies by which plants perceive and respond to all sorts of abiotic and biotic stimuli.

Key competencies
Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant cell biology and development.

Content
The lecture will address structure, function and development of plant cells, tissues and organs from the level of microscopic anatomy to the level of macromolecular interactions. The lecture will include: endosymbiont theory and the emergence of plant cell lineages, plastid types, structure and function, endomembrane systems as a dynamically regulated machinery for the secretion of wall material and a means of cell-cell communication, interaction between the cytoskeleton the plasma membrane and the structural framework of the cell wall to create polarity, maintain growth and accomplish cell differentiation, principles of the plant cell cycle, mitosis and cytokinesis, the role of programmed cell death in development and host pathogen interaction, mechanisms and regulation of material transport between cells, tissues and organs. The seminar will focus on new technical and conceptual approaches to understand plant ultrastructure on the basis of recent publications in the field.
In the accompanying seminar "Phytochemistry" in PBPM3 recent publications in the field of primary and secondary plant metabolites will be presented and discussed.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Plant Cell Development and Ultrastructure	**3**	**210 h**	**7**
Seminar - Plant Ultrastructure	**2**	**90 h**	**3**

Evaluation

Written Examination	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular biology of the cell, New York:Garland Science, 2002.
2. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
3. William V. Dashek. Methods in plant electron microscopy and cytochemistry, Humana Press, 2000.
4. A. W. Robards. Dynamic aspects of plant ultrastructure, McGraw Hill, 1974.

Plant Cell Development and Ultrastructure 2

Module Code	Workload	Credit Points	Duration	Semester
PCDU2	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
PD Dr. Ute Vothknecht

Institute
IZMB

Participating teachers
PD Dr. Frantisek Baluska
Prof. Dr. Ute Vothknecht
Dr. Boris Voigt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**1**

Learning goals
Students should be able to understand the fundamental principles of plant cell architecture, function, cell growth and dynamics, the genetic basis of plant development, and basic principles of communication between cells, tissues and organs. They should gain insight into the various strategies by which plants perceive and respond to all sorts of abiotic and biotic stimuli.

Key competencies
Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant cell biology and development.

Content
The lecture will address structure, function and development of plant cells, tissues and organs from the level of microscopic anatomy to the level of macromolecular interactions. The lecture will include: endosymbiont theory and the emergence of plant cell lineages, plastid types, structure and function, endomembrane systems as a dynamically regulated machinery for the secretion of wall material and a means of cell-cell communication, interaction between the cytoskeleton the plasma membrane and the structural framework of the cell wall to create polarity, maintain growth and accomplish cell differentiation, principles of the plant cell cycle, mitosis and cytokinesis, the role of programmed cell death in development and host pathogen interaction, mechanisms and regulation of material transport between cells, tissues and organs. The seminar will focus on the basic paradigms in plant development and the emergence of radically new concepts guiding our understanding of underlying molecular mechanisms.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Plant Cell Development and Ultrastructure	**3**	**210 h**	**7**
Seminar - Plant Development	**2**	**90 h**	**3**

Evaluation

Written Examination	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular biology of the cell, New York:Garland Science, 2002.
2. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.

Plant Cell Development and Ultrastructure 3

Module Code	Workload	Credit Points	Duration	Semester
PCDU3	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Ute Vothknecht

Institute
IZMB

Participating teachers
PD Dr. Frantisek Baluska
Prof. Dr. Ute Vothknecht
Dr. Boris Voigt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**1**

Learning goals
Students should be able to understand the fundamental principles of plant cell architecture, function, cell growth and dynamics, the genetic basis of plant development, and basic principles of communication between cells, tissues and organs. They should gain insight into the various strategies by which plants perceive and respond to all sorts of abiotic and biotic stimuli.

Key competencies
Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant cell biology and development.

Content
The lecture will address structure, function and development of plant cells, tissues and organs from the level of microscopic anatomy to the level of macromolecular interactions. The lecture will include: endosymbiont theory and the emergence of plant cell lineages, plastid types, structure and function, endomembrane systems as a dynamically regulated machinery for the secretion of wall material and a means of cell-cell communication, interaction between the cytoskeleton the plasma membrane and the structural framework of the cell wall to create polarity, maintain growth and accomplish cell differentiation, principles of the plant cell cycle, mitosis and cytokinesis, the role of programmed cell death in development and host pathogen interaction, mechanisms and regulation of material transport between cells, tissues and organs. The seminar will focus on dynamic behavior of cell compartments with special focus on cytoskeleton, endocytosis, endomembranes and intracellular signaling as well as macromolecular interactions and regulatory circuits that govern cell growth and differentiation.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Plant Cell Development and Ultrastructure	**3**	**210 h**	**7**
Seminar - Plant Cell Dynamics	**2**	**90 h**	**3**

Evaluation

Written Examination	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular biology of the cell, New York:Garland Science, 2002.
2. John Bowman. Arabidopsis: An atlas of morphology and development, Springer, 1994.
3. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
4. Barry W. Hicks. Green fluorescent protein: Applications and protocols, Humana Press, 2002.
5. C. J. Staiger, F. Baluska, D. Volkmann, and P. Barlow. Actin: A dynamic framework of multiple plant cell functions, Kluwer, 2000.

Plant Systematics, Biodiversity and Evolution 1

Module Code	Workload	Credit Points	Duration	Semester
PSBE1	**210 h**	**7**	**1 Semester**	**S**

Module Coordinator

Prof. Dr. Maximilian Weigend

Institute

NEES

Participating teachers

Prof. Dr. Maximilian Weigend
Prof. Dr. Dietmar Quandt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**2**
M. Sc. OEP Biology	**Obligatory course**	**2**

Learning goals

At the end of the module students should have a sound overview about the major lineages and families of plants (especially vascular p.), their systematics, morphology, and basic ecology. They will have a good background in morphology, taxonomy, and systematics and have a first overview about the broader field of biodiversity research.

Key competencies

Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant biodiversity.

Content

The lecture teaches the systematics, morphology and ecology of plants. It focuses especially on the systematics and evolution of vascular plants taking up recent insights from the field of molecular systematics. Vascular plants are the most important structural elements and primary producers in almost all non-aquatic ecosystems. They produce food, medicine, and technical products for the over 6 Billion people. The potential of biological structures and functions as models for technical applications in the field of biomimicry (german: "Bionik") is discussed. The lecture is accompanied by a seminar on plant biodiversity, including basic ecological and biogeographical questions.

Participating prerequisites

None

Course Structure

	SWS	Workload	Credit Points
Lecture - Plant Systematics and Biodiversity	**2**	**120 h**	**4**
Seminar - Plant Biodiversity	**1**	**90 h**	**3**

Evaluation

Written Examination	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. JUDD, W.S., CAMPBELL, C.S., KELLOG, E.A. & STEVENS, P.F. (2002): Plant Systematics. A phylogenetic approach. Sinauer Associates, Inc., Massachusetts (USA).
2. KUBITZKI, K. (ed.) (1993 -): The families and genera of vascular plants. Several Volumes. - Springer; Heidelberg.
3. SITTE, P., WEILER, E.W., KADEREIT, J.W., BRESINSKY, A., KÖRNER, C.: Strasburger Lehrbuch der Botanik. - G. Fischer; Stuttgart.

Plant Systematics, Biodiversity and Evolution 2

Module Code	Workload	Credit Points	Duration	Semester
PSBE2	**210 h**	**7**	**1 Semester**	**S**

Module Coordinator
Prof. Dr. Dietmar Quandt

Institute
NEES

Participating teachers
Prof. Dr. Maximilian Weigend
Prof. Dr. Dietmar Quandt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**2**
M. Sc. OEP Biology	**Obligatory course**	**2**

Learning goals
At the end of the module students should have a sound overview about the major lineages and families of plants (especially vascular p.), their systematics, morphology, and basic ecology. They will have a good background in morphology, taxonomy, and systematics and have a first overview about the broader field of biodiversity research.

Key competencies
Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant biodiversity.

Content
The lecture teaches the systematics, morphology and ecology of plants. It focuses on the systematics and evolution of vascular plants taking up recent insights from the field of molecular systematics. Vascular plants are the most important structural elements and primary producers in almost all non-aquatic ecosystems. They produce food, medicine, and technical products for the over 6 Billion people. The potential of biological structures and functions as models for technical applications in the field of biomimicry (german: "Bionik") is discussed. In the seminar major emphasis is put to provide an introduction to the rapidly developing methods in the field of molecular systematics, both in the laboratory and at the computer. Sources of information are presented from the sequence to the genome level.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Plant Systematics and Biodiversity	**2**	**120 h**	**4**
Seminar – Evolution & Molecular Systematics	**1**	**90 h**	**3**

Evaluation

Written Examination	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Judd, W.S., Campbell, C.S., Kellog, E.A. & Stevens, P.F. (2002): Plant Systematics. A phylogenetic approach. Sinauer Associates, Inc., Massachusetts (USA).
2. Kubitzki, K. (ed.) (1993 -): The families and genera of vascular plants. Several Volumes. - Springer; Heidelberg.
3. Sitte, P., Weiler, E.W., Kadereit, J.W., Bresinsky, A., Körner, C.: Strasburger Lehrbuch der Botanik. - G. Fischer; Stuttgart.
4. D. Hillis, C. Moritz and B. Mable: Molecular Systematics. Sinauer.
5. D. Soltis, P. Soltis and J Doyle: Molecular Systematics of Plants II (DNA Sequencing). Kluwer.
6. K. Weising et al. DNA fingerprinting in plants and fungi
7. R. Page & E. Holmes: Molecular Evolution - A Phylogenetic Approach. Blackwell.

Plant Systematics, Biodiversity and Evolution 3

Module Code	Workload	Credit Points	Duration	Semester
PSBE3	**210 h**	**7**	**1 Semester**	**S**

Module Coordinator Prof. Dr. Maximilian Weigend

Institute NEES

Participating teachers Prof. Dr. Maximilian Weigend
Prof. Dr. Dietmar Quandt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Obligatory course**	**2**
M. Sc. OEP Biology	**Obligatory course**	**2**

Learning goals At the end of the module students should have a sound overview about the major lineages and families of plants (especially vascular p.), their systematics, morphology, and basic ecology. They will have a good background in morphology, taxonomy, and systematics and have a first overview about the broader field of biodiversity research.

Key competencies Searching, reading and understanding of scientific literature and databases. Skills for visual and oral presentation of scientific data. Advanced understanding of plant biodiversity.

Content The lecture teaches the systematics, morphology and ecology of plants. It focuses on the systematics and evolution of vascular plants taking up recent insights from the field of molecular systematics. Vascular plants are the most important structural elements and primary producers in almost all non-aquatic ecosystems. They produce food, medicine, and technical products for the over 6 Billion people. The potential of biological structures and functions as models for technical applications in the field of biomimicry (german: "Bionik") is discussed. Aspects of biodiversity conservation are discussed within the seminar.

Participating prerequisites None

Course Structure

	SWS	Workload	Credit Points
Lecture - Plant Systematics and Biodiversity	**2**	**120 h**	**4**
Seminar - Biodiversity and Conservation	**1**	**90 h**	**3**

Evaluation

Written Examination	Graded (70%)
Oral presentation (30 min)	Graded (30%)

Recommended reading

1. Judd, W.S., Campbell, C.S., Kellog, E.A. & Stevens, P.F. (2002): Plant Systematics. A phylogenetic approach. Sinauer Associates, Inc., Massachusetts (USA).
2. Kubitzki, K. (ed.) (1993 -): The families and genera of vascular plants. Several Volumes. - Springer; Heidelberg.
3. Primack: Essentials of Conservation Biology.Sinauer.
4. Sitte, P., Weiler, E.W., Kadereit, J.W., Bresinsky, A., Körner, C.: Strasburger Lehrbuch der Botanik. - G. Fischer; Stuttgart.

Plant Proteomics

Module Code	Workload	Credit Points	Duration	Semester
PLPR	**300 h**	**10**	**1 Semester**	**W,S**

Module Coordinator
Prof. Dr. Dorothea Bartels

Institute
IMBIO

Participating teachers
Prof. Dr. Dorothea Bartels
Dr. Horst Röhrig

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 2 or 3**

Learning goals
The students will learn protein purification methods, separation of protein mixtures by one and two-dimensional electrophoresis as well as expression, purification and enzymatic assays of recombinant proteins. The students will study protein phosphorylation patterns and will discuss the implications of dynamic changes in the phosphorylation status. The students will identify proteins by using immunocytochemistry. The students will become acquainted with protein identification approaches using mass spectrometry and data bank searches of protein sequences.

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
After the complete genome of Arabidopsis thaliana has been sequenced, the research interests are directed towards the functional analysis of the expressed genes. An important contribution towards the functional analysis is expected from protein analysis. This course will give an introduction into the different aspects of functional protein analysis. Proteins will be purified from different plant tissues and will be biochemically characterized. Proteins will be separated in one and two dimensional electrophoresis. Immunological protein detection assays will be performed as well as enzymatic reactions. Proteins will be expressed in E. coli, purified and their activities will be characterized in vitro.

Participating prerequisites
Any PBPM module

Course Structure

	SWS	Workload	Credit Points
Lab Course - Plant Proteomics	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. Taiz L, Zeiger E (2002) Plant Physiology. Sinauer Associates Inc., Sunderland, MA

Plant Molecular Stress Physiology

Module Code	Workload	Credit Points	Duration	Semester
PMSP	**300 h**	**10**	**1 Semester**	**W,S**

Module Coordinator
Prof. Dr. Dorothea Bartels

Institute
IMBIO

Participating teachers
Prof. Dr. Dorothea Bartels / N.N.

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 2 or 3**
M. Sc. OEP Biology	**Optative Lab course**	**1, 2 or 3**

Learning goals
The students will learn that adaptations to environmental cues (in particular dehydration) will be possible by a specific gene expression program. The students will learn to analyze expression patterns on the transcriptional and translational level including RNA blots, protein blots and promoter reporter gene studies. This module offers an introduction to basic approaches in plant molecular biology including the generation of transgenic plants.

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
Plants respond to adverse environments with a specific gene expression program. The stress responsive genes allow the plants to adapt and /or to tolerate the stress situation. Model plants showing extreme stress tolerance and A. thaliana will be used to analyze and to understand the changes which take place during abiotic environmental stress conditions. During the course the students will investigate stress responses on the transcriptional and translational level as well as analyse regulatory sequences involved in stress specific gene expression.

Participating prerequisites
Any PBPM module

Course Structure

	SWS	Workload	Credit Points
Lab Course - Plant Stress Physiology	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. Taiz L, Zeiger E (2002) Plant Physiology. Sinauer Associates Inc., Sunderland, MA

Physiological and Chemical Ecology

Module Code	Workload	Credit Points	Duration	Semester
PCE	**300 h**	**10**	**1 Semester**	**W, S**

Module Coordinator
Prof. Dr. Lukas Schreiber

Institute
IZMB

Participating teachers
Prof. Dr. Lukas Schreiber
PD Dr. Rochus Franke

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 2 or 3**

Learning goals
In this course students learn to use a variety of different techniques used to analyze plant environment interactions. This includes methods and experimental design in analytical chemistry (gas chromatography and mass spectrometry), molecular biology (gene expression and reporter gene fusion) and transport physiology (water and herbicides transport across leaf surfaces).

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
In the lab course, relevant examples of plant environment interactions on the molecular level will be studied. *Arabidopsis thaliana* will mostly be employed as a model organism but crop species such as barley, corn or potato will also be used. Experiments will deal with water and salt stress, effect of xenobiotics on plants, plant micro organism interaction and secondary plant metabolites. Experimental approaches include measurement of chlorophyll fluorescence, porometry, measurement of cuticular transpiration and uptake of xenobiotics in leaves, chemical analytics and analysis of gene expression in response to environmental stimuli.

Participating prerequisites
Any PBPM module

Course Structure

	SWS	Workload	Credit Points
Lab Course – Physiological and Chemical Ecology: Methods of Chemical Analytics and Transport Physiology	**8**	**300 h**	**10**

Evaluation
Oral and/or poster presentation — Graded

Recommended reading

1. Taiz L, Zeiger E (2006) Plant Physiology. Sinauer Associates Inc., Sunderland, MA
2. Schulze ED, Beck E, and Müller-Hohenstein K. Plant Ecology, Heidelberg: Springer, 2005

Transgenic Plants

Module Code	Workload	Credit Points	Duration	Semester
TRPL	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Volker Knoop

Institute
IZMB

Participating teachers
Prof. Dr. Volker Knoop

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 3**

Learning goals
By the end of the course students should have obtained a good understanding in theory and practice for molecular biological techniques, of plant genomes, gene structures, the biology of plant transformation via Agrobacterium, the use of indicator genes and strategies of gene inactivation and subsequent physiological analyses.

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
The lab course will deal with all experimental steps in construction and analyses of transgenic lines in the model plant Arabidopsis thaliana: Creation of DNA constructs for transformation, PCR, cloning in the GATEWAY system and sequence analyses, transformation of Escherichia coli, Agrobacterium tumefaciens and Arabidopsis, analysis of GFP- and GUS-reporter gene fusions and T-DNA and RNAi knockout plants. Students will get hands-on experience in these molecular lab techniques including enzymatic treatments, electrophoresis and blotting procedures as well as the physiological analysis of transgenic Arabidopsis lines.

Participating prerequisites
Any PBPM module

Course Structure

	SWS	Workload	Credit Points
Lab Course - Transgenic Plants: construction & analyses	**8**	**300 h**	**10**

Evaluation

Oral presentation	Graded (60%)
Lab performance	Graded (40%)

Recommended reading

1. John Bowman. Arabidopsis: An atlas of morphology and development, Springer, 1994.
2. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
3. Frank Kempken and Renate Kempken. Gentechnik bei Pflanzen, Heidelberg:Springer, 2006.
4. Slater, Scott, Fowler: „Plant Biotechnology, OUP (2003)

Plant Molecular Cell Physiology and Biotechnology

Module Code	Workload	Credit Points	Duration	Semester
MCPB	**300 h**	**10**	**1 Semester**	**S**

Module Coordinator	Prof. Dr. Peter Dörmann
Institute	IMBIO
Participating teachers	Prof. Dr. Peter Dörmann

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**

Learning goals

The students will learn techniques of modern plant biochemistry, molecular biology and genetics.

Key competencies

Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content

The lab course includes modern techniques of biochemistry, molecular biology and genetics employing the model plant Arabidopsis thaliana. In this course, we will work on mutant lines of Arabidopsis deficient in specific steps of lipid or carbohydrate metabolism. The mutant lines which are derived from ongoing research projects will be biochemically characterized employing different analytical methods (thin-layer chromatography, HPLC, GC-MS, CE). Mutations derived from chemical mutagenesis will be mapped to the Arabidopsis genome using different PCR based markers (CAPS, SSLP).

Participating prerequisites

Any PBPM module

Course Structure

	SWS	Workload	Credit Points
Lab Course - Plant Molecular Cell Physiology and Biotechnology	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. Chapter 10 (Lipids) of the textbook: Biochemistry and Molecular Biology of Plants (eds. Buchanan, Gruissem, Jones; American Society of Plant Biologists)

Plant Cell Dynamics

Module Code	Workload	Credit Points	Duration	Semester
PLCD	**300 h**	**10**	**1 Semester**	**S**

Module Coordinator
Dr. Boris Voigt

Institute
IZMB

Participating teachers
Dr. Boris Voigt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**

Learning goals
Students will be given a solid introduction into plant cell biology with emphasis on plant cell compartimentation, dynamics, cell polarity and tissue specific cell differentiation in the context of plant growth and development. Principles and applications of GFP-technology will be thoroughly described along with current methods of transient and stable plant transformation techniques. Students will also be trained to apply modern microscopic imaging techniques. The course will demonstrate, how suitable experimental strategies can be developed for addressing specific questions of cellular dynamics by choosing, designing and applying the appropriate experimental tools.

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
Cell shape and tissue-specific cellular functions are highly depend on dynamic interactions between the cytoskeleton, the endomembrane system and the cell wall. Recent advances in confocal microscopy, digital image processing and recombinant fluorescent reporter protein design have created powerful tools to obtain live images of specific cell structures and molecular components in 3D data sets. With these tools the structure and fate of molecular cell components can be analysed over time in the context of cellular morphogenesis and differentiation in wild type and mutant plant lines and in cell culture. Likewise, the reaction of cells and tissues to external stimuli and challenges by stress and pathogen attack can be followed in great detail.

Participating prerequisites
Any PCDU module

Course Structure		SWS	Workload	Credit Points
	Lab Course - Plant Cell Dynamics	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular biology of the cell, New York:Garland Science, 2002.
3. John Bowman. Arabidopsis: An atlas of morphology and development, Springer, 1994.
4. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
5. Barry W. Hicks. Green fluorescent protein: Applications and protocols, Humana Press, 2002.
6. C. J. Staiger, F. Baluska, D. Volkmann, and P. Barlow. Actin: A dynamic framework of multiple plant cell functions, Kluwer, 2000.

Plant Ultrastructure

Module Code	Workload	Credit Points	Duration	Semester
PLUL	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator PD Dr. Frantisek Baluska

Institute IZMB

Participating teachers PD Dr. Frantisek Baluska

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 3**

Learning goals Students will be given a solid basis of plant cell structure and an introduction into the methodology of ultrastructural research. They will be able to apply classic methods of tissue fixation, dehydration, embedment and ultrasectioning, and receive hands on experience on the application of pre- and post-embedding immunogold labeling of antigens in plant tissue sections.

Key competencies Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content The information on the cell‘s ultrastructure and localization of macromolecular components are indispensable for the reconstruction of subcellular architecture. High resolution transmission electron microscopy of fixed and embedded plant material in conjunction with immunogold histochemistry are modern tools to achieve this goal. This module will summarize the contributions of ultrastructural research to understanding plant cell structure and function. The application of immunogold histochemistry will be demonstrated in specific examples.

Participating prerequisites Any PCDU module

Course Structure		SWS	Workload	Credit Points
	Lab Course - Practice in Plant Ultrastructure	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular biology of the cell, New York:Garland Science, 2002.
2. William V. Dashek. Methods in plant electron microscopy and cytochemistry, Humana Press, 2000.
3. A. W. Robards. Dynamic aspects of plant ultrastructure, McGraw Hill, 1974.

Plant Development and Communication

Module Code	Workload	Credit Points	Duration	Semester
PLDE	**300 h**	**10**	**1 Semester**	**S**

Module Coordinator
PD Dr. Frantisek Baluska

Institute
IZMB

Participating teachers
PD Dr. Frantisek Baluska

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**

Learning goals
Students will acquire a solid background of plant development and morphogenesis, with special focus on root apex organogenesis and root development. They will learn the basic principles of microscopic imaging techniques, particularly using root sections allowing three-dimensional reconstruction of extended root tissues. Experimental strategies will be developed for addressing specific questions related to cell-to-cell communication, tissue morphogenesis, and root development.

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
Elongated plant cells assemble into lengthy cell files via their end-poles: adhesive domains enriched with pectins and traversed by abundant primary plasmodesmata. Complex interactions between the actin cytoskeleton and vesicle recycling characterize this synaptic communication along cell files. Individual cell files interact laterally at pectin/callose enriched pit-fields encompassing secondary plasmodesmata to form three-dimensional plant tissues. Recent data identified myosin VIII and plant synaptotagmins as the most critical molecules which organize these plant synapses transporting auxin from cell-to-cell. Auxin regulates morphogenesis and development of plant organs such as roots. On the example of root apices, the basic processes driving plant organogenesis including gravity- related processes will be analyzed and general conclusion will be extracted and discussed.

Participating prerequisites
Any PCDU module

Course Structure		SWS	Workload	Credit Points
	Lab Course - Plant Development	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular biology of the cell, New York:Garland Science, 2002.
2. John Bowman. Arabidopsis: An atlas of morphology and development, Springer, 1994.
3. Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000.
4. Barry W. Hicks. Green fluorescent protein: Applications and protocols, Humana Press, 2002.
5. C. J. Staiger, F. Baluska, D. Volkmann, and P. Barlow. Actin: A dynamic framework of multiple plant cell functions, Kluwer, 2000.

Plant Physiology and Cell Biology

Module Code	Workload	Credit Points	Duration	Semester
PPCB	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Peter Dörmann

Institute
IMBIO

Participating teachers
Prof. Dr. Peter Dörmann

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 3**

Learning goals
Students will acquire basic knowledge on different plant culture systems, and the use of these techniques in plant biotechnology.

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
The practical lab course on plant physiology and cell biology will focus on basic techniques of molecular biology, plant cell culture, plant expression systems and plant physiology. Modern plant biology includes different plant culture techniques including growth of whole plants on soil, plant callus cultures, suspension cell cultures and protoplast preparation. Depending on the plant species and culture system, a range of transformation protocolls are available, and the most relevant techniques will be presented during this lab course.
Preparation of protoplasts from leaves, protoplast fusion, induction of callus growth from leaf discs, suspension cell cultures, biolistic transformation of plants (leaf discs) with reporter constructs, Agrobacterium-mediated transformation, cloning in Escherichia coli and Agrobacterium tumefaciens, screening of transgenic lines, detection of transgenes by PCR

Participating prerequisites
Any PCDU module

Course Structure

	SWS	Workload	Credit Points
Lab Course - Plant Molecular Cell Physiology and Biotechnology	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. Chapter 10 (Lipids) of the textbook: Biochemistry and Molecular Biology of Plants (eds. Buchanan, Gruissem, Jones; American Society of Plant Biologists)

Plant Evolution and Phylogeny Lab

Module Code	Workload	Credit Points	Duration	Semester
PEPL	**300 h**	**10**	**1 Semester**	**S**

Module Coordinator Prof. Dr. Volker Knoop

Institute IZMB

Participating teachers Prof. Dr. Volker Knoop

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**
M. Sc. OEP Biology	**Optative Lab course**	**2**

Learning goals By the end of the course students should have obtained a good understanding of land plant evolution from a molecular genomic point of view. They should be able to answer question on molecular biological techniques as well as on the diversity of land plant clades and the different approaches taken in molecular phylogenetic analyses.

Key competencies Laboratory techniques in molecular biology. Problem oriented planning of experimental strategies. Project-oriented cooperation in small research groups. Skills for documentation and presentation of scientific experiments and data.

Content The lab course will deal with the phylogenetic information stored over 500 million years of land plant evolution, stored in the genomes of living plants. Molecular techniques, mainly DNA and RNA extraction, cDNA synthesis, PCR amplification, cloning and sequencing and computer programs for database analyses and molecular phylogenetic constructions will be used to retrieve this information. Taxonwise, a focus will be the extant representatives of lower land plants, the bryophytes, lycophytes and monilophytes and locuswise a focus will be the mitochondrial DNA of plants with its peculiar mechanisms of gene expression such as RNA editing and trans-splicing.

Participating prerequisites None

Course Structure

	SWS	Workload	Credit Points
Lab Course - Plant Molecular Phylogenetics	**8**	**300 h**	**10**

Evaluation

Written examination	Graded (40%)
Oral presentation (30 min)	Graded (60%)

Recommended reading

1. Dan Graur and Wen-Hsiung Li. Fundamentals of Molecular Evolution, Sunderland, MA:Sinauer Associates, Inc., 2000
2. Volker Knoop and Kai Müller. Gene und Stammbäume, Heidelberg, München:Elsevier Spektrum, 2006.
3. R. D. M. Page and E. C. Holmes. Molecular evolution. A phylogenetic approach., Oxford:Blackwell Science Ltd., 1998.
4. J.-W. Wägele. Grundlagen der phylogenetischen Systematik, München:Verlag Dr. Friedrich Pfeil, 2001.
5. “Phylogenetic trees made easy”, Hall BG, Sinauer Assoc., Sunderland, MA (2001)
6. „The mitochondrial DNA of land plants: peculiarities in phylogenetic perspective“, Knoop V, Curr. Genet. 46:123-139 (2004)

Plant Molecular Evolution and Phylogeny

Module Code	Workload	Credit Points	Duration	Semester
PMEP	**150 h**	**5**	**1 Semester**	**S**

Module Coordinator
Prof. Dr. Volker Knoop

Institute
IZMB

Participating teachers
Prof. Dr. Volker Knoop

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**
M. Sc. OEP Biology	**Optative Lab course**	**2**

Learning goals
Understanding the fundamentals of modern molecular phylogenetics.

Key competencies
Evolutionary-based understanding of modern phylogenetics, taxonomy and cladistics, use of databases and database query searching, understanding concepts and algorithm of phylogenetic software tools for data assembly, alignments and construction of phylogenetic trees.

Content
Molecular data offer a plethora of information to reconstruct the phylogeny of life on earth. After a brief introduction into the basics of molecular biology (genomes, gene structures, exons, introns, genetic codes, nucleotide and protein sequences) as well as cladistics and systematics the lecture will mainly deal with the methods of phylogenetic analyses: Homologies, data base searches, alignments and the concepts of phylogenetic tree construction (distance, parsimony and likelihood methods). Students will be strongly encouraged to gain hand-son experience using WWW accessible resources and freely available software such as MEGA etc.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Molecular Evolution and Phylogenetics	**2**	**120 h**	**4**
Seminar - Plant Phylogeny and Evolution	**1**	**30 h**	**1**

Evaluation

Written examination	Graded (80%)
Oral presentation (30 min)	Graded (20%)

Recommended reading

1. Dan Graur and Wen-Hsiung Li. Fundamentals of Molecular Evolution, Sunderland, MA:Sinauer Associates, Inc., 2000
2. Volker Knoop and Kai Müller. Gene und Stammbäume, Heidelberg, München:Elsevier Spektrum, 2006.
3. R. D. M. Page and E. C. Holmes. Molecular evolution. A phylogenetic approach., Oxford:Blackwell Science Ltd., 1998.
4. J.-W. Wägele. Grundlagen der phylogenetischen Systematik, München:Verlag Dr. Friedrich Pfeil, 2001.
5. “Phylogenetic trees made easy”, Hall BG, Sinauer Assoc., Sunderland, MA (2001)
6. „The mitochondrial DNA of land plants: peculiarities in phylogenetic perspective“, Knoop V, Curr. Genet. 46:123-139 (2004)

Plant Molecular Systematics

Module Code	Workload	Credit Points	Duration	Semester
PMSY	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Dietmar Quandt

Institute
NEES

Participating teachers
Prof. Dr. Dietmar Quandt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**3**
M. Sc. OEP Biology	**Optative Lab course**	**3**

Learning goals
Participants should gain a fundamental understanding of molecular evolutionary processes governing the change of DNA, and the application of this information to phylogenetic and evolutionary analysis. Aims include to develop skills in (1) generating molecular data from plants in the lab, (2) using computers for phylogeny reconstruction (3) estimating parameters such as substitution rates and divergence times, and (4) evaluating specific processes important in plant evolution such as hybridization, polyploidy and reticulate evolution.

Key competencies
Laboratory skills, molecular techniques, statistical methods, skills for the generation, analysis, and presentation of scientific data.

Content
Our understanding of plant relationships and evolution has been revolutionized in the past decade using information from DNA sequences. Major emphasis in the module is put on providing an introduction to the rapidly developing methods in the field, both in the laboratory and at the computer. Sources of information treated range from the nucleotide sequence to the genome level. Case studies deal with important groups such as angiosperms, ferns and bryophytes in greater detail.

Participating prerequisites
PSBE2

Course Structure

	SWS	Workload	Credit Points
Lab Course - Plant Molecular Systematics	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. D. Hillis, C. Moritz and B. Mable (1996): Molecular Systematics (2nd ed.). Sinauer.
2. D. Soltis, P. Soltis and J Doyle (1998): Molecular Systematics of Plants II (DNA Sequencing). Kluwer.
3. Volker Knoop and Kai Müller. Gene und Stammbäume, Heidelberg, München:Elsevier Spektrum, 2006.
4. K. Weising et al. DNA fingerprinting in plants and fungi (stark aktualisierte Neuauflage in 2005)
5. R. Page & E. Holmes (1998): Molecular Evolution - A Phylogenetic Approach. Blackwell.

Plant Biogeography and Conservation

Module Code	Workload	Credit Points	Duration	Semester
PBCO	**300 h**	**10**	**1 Semester**	**W**

Module Coordinator
Dr. Jens Mutke

Institute
NEES

Participating teachers
Dr. Jens Mutke
Prof. Dr. Maximilian Weigend

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 3**
M. Sc. OEP Biology	**Optative Lab course**	**1, 3**

Learning goals
By the end of the module, students should be able to design and perform analyses in the fields of macroecology and biogeography using GIS, spatial data analyses, and statistics.

Key competencies
GIS and geostatistical methods, skills for planning, performing, documentation, and presentation of scientific analyses.

Content
Understanding the spatial distribution of biodiversity is crucial for its further exploration, use, and conservation. This module combines an introduction in spatial data analysis using GIS with theory and exercises from the fields of macroecology and biogeography. A special focus will be conservation biology including priority setting and analyses of the impact of global environmental change on biodiversity.

Participating prerequisites
Any PSBE

Course Structure

	SWS	Workload	Credit Points
Seminar - Biogeography and Conservation	**1**	**60 h**	**2**
Lab Course - Biogeography and Conservation	**7**	**240 h**	**8**

Evaluation

Oral and/or poster presentation	Graded (20%)
Protocol of the excercises	Graded (80%)

Recommended reading

1. BLACKBURN & GASTON 2003: Macroecology: Concepts and Consequences. Cambridge Univ Press
2. BROWN, J.H., RIDDLE, B.R. & LOMOLINO, M.V. 2005: Biogeography. 3rd Ed.. Sinauer. 752 pp
3. PRIMACK: Essentials of Conservation Biology.Sinauer.
4. SCHULZE, BECK & MÜLLER-HOHENSTEIN 2005: Plant Ecology. Springer. 702 pp

Plant Biodiversity - Systematics and Biology of Seed Plants

Module Code	Workload	Credit Points	Duration	Semester
PBIO	**300 h**	**10**	**1 Semester**	**S**

Module Coordinator
Prof. Dr. Maximilian Weigend

Institute
NEES

Participating teachers
Prof. Dr. Maximilian Weigend

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**
M. Sc. OEP Biology	**Optative Lab course**	**2**

Learning goals
At the end of the module students should have a sound overview about the major lineages and families of vascular plants, their systematics, morphology, and basic ecology. They will be familiar with the most important methods and terminology in the field of morphology, taxonomy, and systematics.

Key competencies
Methods for the documentation and analysis of plant morphology and floral biology, taxonomic methods, Skills for visual and oral presentation of scientific data.

Content
The course gives an overview on the systematics, morphology, and biology (e.g., floral biology) of (vascular) plants based mainly on living material from the botanic garden, as well as on herbarium material. Methods for the documentation and analysis of plant diversity from the field of morphology, taxonomy, and, e.g., floral biology are taught.

Participating prerequisites
Any PSBE

Course Structure

	SWS	Workload	Credit Points
Lab Course - Systematics and Biology of Seed Plants	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Protocol of the excercises	Graded (50%)

Recommended reading

1. JUDD, W.S., CAMPBELL, C.S., KELLOG, E.A. & STEVENS, P.F. (2002): Plant Systematics. A phylogenetic approach. Sinauer Associates, Inc., Massachusetts (USA).
2. KUBITZKI, K. (ed.) (1993 -): The families and genera of vascular plants. Several Volumes. - Springer; Heidelberg.
3. SITTE, P., WEILER, E.W., KADEREIT, J.W., BRESINSKY, A., KÖRNER, C.: Strasburger Lehrbuch der Botanik. - G. Fischer; Stuttgart.

Paleobotany and Palynology

Module Code	Workload	Credit Points	Duration	Semester
PAPA	**150 h**	**5**	**1 Semester**	**S**

Module Coordinator
Prof. Dr. Thomas Litt

Institute
FG Geowissenschaften, IfP

Participating teachers
Prof. Dr. Thomas Litt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**
M. Sc. OEP Biology	**Optative Lab course**	**2**

Learning goals
Participants should gain an understanding of the evolution of land plants based on macro- and micropalaeobotanical data, and the application of this information to phylogenetic and evolutionary analysis. Aims include to develop skills in (1) morphological analysis of fossil plants, (2) introduction into the pollen morphology and pollen analysis (3) using SEM and Confocal Laser-Scanning Microscop (4) evaluation of palaeobotanical data in comparison with current research on ancient DNA and other biomolecular markers.

Key competencies
Obtaining a profound understanding of the plant fossil record and its evolutionary significance.

Content
Palaeobotany and palynology play a fundamental role to understand the evolution of plants from the earliest forms to the development of our present flora. Based on fossil material the plant evolution will be placed in the context of time, climate change and mass extinction. The course focuses on periods when major evolutionary changes occurred and addresses the rates and timing of the evolutionary change seen in the plant fossil records.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Palaeobotany and terrestrial palaeoecology	**2**	**30 h**	**1**
Lab Course - Palaeobotany and Palynology	**6**	**120 h**	**4**

Evaluation

Final written examination	Graded (50%)
Protocol of the lab course	Graded (50%)

Recommended reading

1. Moore, Webb, Collinson: Pollen Analysis
2. Steward, Rothwell: Paleobotany and the Evolution of Plants
3. Taylor, Taylor: The Biology and Evolution of Fossil Plants
4. Willis, McElwain: The Evolution of Plants

Genome Analysis in Plant Breeding

Module Code	Workload	Credit Points	Duration	Semester
GAPB	**180 h**	**6**	**1 Semester**	**S**

Module Coordinator
Prof. Dr. J. Léon

Institute
Landwirtschaftliche Fakultät, INRES - Plant Nutrition-

Participating teachers
Prof. Dr. J. Léon

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**2**
M. Sc. Agrarwissenschaften	**Optative Lab course**	**2**

Learning goals
The students will be introduced to theoretical and practical aspects of the analysis of plant genomes which are relevant to plant breeding.

Key competencies
General and quantitative genetics, molecular biology of crop plants, molecular plant breeding

Content
The genome analysis in plant breeding is focused on the molecular analysis of inheritable traits in crop plants. The field is located at the junction between classical plant breeding and the relatively recent field of molecular biology. The aims are to improve varieties by means of molecular marker techniques. DNA markers are short DNA sequences, which are inheritable and can be characterized in the laboratory. DNA markers are inherited like Mendelian factors and enable the breeders to understand the genetic architecture of each individual in a segregating population. Applications of DNA markers in plant breeding are numerous. During the course of the lecture, (1) the generation of linkage maps, (2) the detection and selection of favorable genes for monogenic and polygenic, i.e. quantitative, traits, (3) the marker-assisted selection of favorable genotypes, (4) the identification and differentiation of varieties and (5) the isolation and utilization of new genes in plant breeding, e.g for pathogen resistance, will be presented.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Genome Analysis in Plant Breeding	**2**	**120 h**	**4**
Lab Course - Genome Analysis in Plant Breeding	**2**	**60 h**	**2**

Evaluation
Written exam — Graded

Recommended reading

1. Lörz, H. and G. Wenzel, 2005: Molecular Marker Systems in Plant Breeding and Crop Improvement. Springer (ISBN 3540206892)
2. Meksem, K, and G. Kahl, 2005: The Handbook of Plant Genome Mapping. Wiley VCH (ISBN 3527311165)

Plant Biodiversity and Conservation

Module Code	Workload	Credit Points	Duration	Semester
PBDT	**210 h**	**7**	**1 Semester**	**W**

Module Coordinator
Prof. Dr. Maximilian Weigend

Institute
NEES

Participating teachers
Prof. Dr. Maximilian Weigend
Dr. Jens Mutke

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 3**
M. Sc. OEP Biology	**Optative Lab course**	**1, 3**

Learning goals
By the end of the module, the students should be able to map the distribution and describe the nature of earth's major terrestrial biomes. They should have a sound understanding of the influence of the abiotic environment on plant communities and structure of the vegetation and have a first overview about conservation biology.

Key competencies
Sound overview on vegetation ecology, overview on approaches, programs, and actors in biodiversity conservation.

Content
The course deals with the field of vegetation ecology and conservation biology. This includes an introduction to the vegetation ecology of the world's major biomes and aspects of biodiversity conservation. The seminar is on Biodiversity and Conservation.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Lecture - Vegetation Geography	**2**	**120 h**	**4**
Seminar - Biodiversity and Conservation	**1**	**90 h**	**3**

Evaluation

Written test	Graded
Oral presentation (30 min)	Graded

Recommended reading

1. BROWN, J.H., RIDDLE, B.R. & LOMOLINO, M.V. 2005: Biogeography. 3rd Ed.. Sinauer. 752 pp
2. FREY, W. & LÖSCH, R. (2004): Lehrbuch der Geobotanik. Elsevier, Spektrum Verlag.
3. SCHULZE, BECK & MÜLLER-HOHENSTEIN 2005: Plant Ecology. Springer. 702 pp
4. WALTER, H. & BRECKLE, S.-W. (1999): Vegetationszonen und Klima. 7. Aufl. UTB, Ulmer, Stuttgart

Vegetation Ecology

Module Code	Workload	Credit Points	Duration	Semester
PBEC	**300 h**	**10**	**1 Semester**	**Varied**

Module Coordinator
Prof. Dr. Maximilian Weigend

Institute
NEES

Participating teachers
N.N.
Dr. Stefan Abrahamzcyk
Dr. Jens Mutke
Prof. Dr. Dietmar Quandt

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**--**
M. Sc. OEP Biology	**Optative Lab course**	**--**

Learning goals
The students will learn methods of inventorying, identifying, and studying plants and vegetation types in relation to ecological factors. They should gain insight in the fieldwork as well as related work in the herbarium and data analyses.

Key competencies
Methods of field biology.

Content
The course deals with the field of vegetation ecology and field biology. This includes fieldwork and related work in the lab, the herbarium, and computer software to study the structure and floristic composition of plant communities. The fieldwork includes one large (up to 2 weeks) or several small field trips.

Participating prerequisites
Any PSBE

Course Structure

	SWS	Workload	Credit Points
Lab Course - Vegetation Ecology (incl. Fieldw. & Excurs.)	**8**	**300 h**	**10**

Evaluation

Oral and/or poster presentation	Graded (50%)
Documentation/protocol	Graded (50%)

Recommended reading

1. BROWN, J.H., RIDDLE, B.R. & LOMOLINO, M.V. 2005: Biogeography. 3rd Ed.. Sinauer. 752 pp
2. FREY, W. & LÖSCH, R. (2004): Lehrbuch der Geobotanik. Elsevier, Spektrum Verlag.
3. SCHULZE, BECK & MÜLLER-HOHENSTEIN 2005: Plant Ecology. Springer. 702 pp
4. WALTER, H. & BRECKLE, S.-W. (1999): Vegetationszonen und Klima. 7. Aufl. UTB, Ulmer, Stuttgart

Phototrophic Prokaryotes

Module Code	Workload	Credit Points	Duration	Semester
PHPR	**300 h**	**10**	**1 Semester**	**W, S**

Module Coordinator
Prof. Dr. Christiane Dahl

Institute
FG Biologie, Institut für Mikrobiologie und Biotechnologie

Participating teachers
Prof. Dr. Christiane Dahl

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 2 or 3**

Learning goals
By the end of the course students should know that phototrophy is not only main trait of plants but of many bacteria that play major roles as primary producers not only in anoxic but also in oxic environments. The students should gain a good understanding of the high versatility of phototrophic organisms and develop a concept of how the complex oxygen evolving photosystem may have developed from anoxygenic origins.

Key competencies
Laboratory techniques in modern plant research. Skills for documentation and presentation of scientific experiments and data.

Content
The module will cover oxygenic and anoxygenic phototrophic prokaryotes. Oxygenic prokaryotes (cyanobacteria and prochlorophytes) will be presented as prototypes for oxygenic photosynthesis performed by chloroplasts in plants. The different groups of anoxygenic prokaryotic phototrophs will be introduced as examples of organisms that are able to use light energy with only one instead of two photosystems. Different light harvesting structures (phycobilisomes, light harvesting complexes from proteobacteria, chlorosomes) and their regulation depending on environmental conditions will be discussed.
Alternative electron donors (reduced sulfur compounds, organic compounds, hydrogen etc.) for photosynthesis and alternative carbon dioxide fixation pathways (reverse TCA cycle, reductive acetyl-CoA pathway, hydroxypropionate pathway) could be subjects for a practical course, a seminar, and/or be presented as parts of a lecture.

Participating prerequisites
None

Course Structure

	SWS	Workload	Credit Points
Seminar - Electron donors and carbon dioxide fixation pathways in phototrophic prokaryotes	**2**	**60 h**	**2**
Lab Course - Phototrophic prokaryotes	**6**	**240 h**	**8**

Evaluation

Written examination	Graded (50%)
Oral presentation, protocol to the excercises	Graded (50%)

Recommended reading
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Colloquium Reports in the Plant Sciences

Module Code	Workload	Credit Points	Duration	Semester
CRPS	**240 h**	**8**	**1- 3 Semester**	**W, S**

Module Coordinator: PD Dr. Rochus Franke, Prof. Dr. Volker Knoop, AOR Dr. Jens Mutke

Institute: All Plant Science Institutes

Participating teachers: Invited guest lecturers

Use of module

Course of studies	Course Type	Semester Number
M. Sc. Plant Science	**Optative Lab course**	**1, 2 or 3**

Learning goals

The CRPS module is intended to motivate active participation in public presentations of novel plant research by invited guest speakers. Student's shall learn a) how to follow an oral scientific presentation in a concentrated manner, b) gain impressions on different styles of presentation and adapt, learn and iumpove their own style of presentation and c) ideally learn to formulate questions or contributions for subsequent discussions and d) summarize oral/visual presentations in the concise abstract-style of scientific publications.

Key competencies

Concise and precise summarizing of scientific facts, results and presentations in precise writing accompanied by additional background and literature searches.

Content

Student's will visit invited guest speakers' presentations on recent novel findings in the modern plant sciences such as those of the Bonn Botanical colloquium series or similar series of invited talks in the area such as the Max-Planck Institute Cologne, Forschungszentrum Jülich, Universities Aachen, Cologne or Düsseldorf.
Each participation will be signed on a student's report card by the inviting scientist at the respective host institute.

Participating prerequisites

None

Course Structure		SWS	Workload	Credit Points
	Visiting a minimum of 8 invited scientific presentations	**--**	**240 h**	**8**

Evaluation

Min. seven written abstract-style summaries of approx. 300 words each, plus one longer elaboration (of ca. 2 pages) on one selected of the above (min. 8) presentations.

Reports will be inspected and independently graded by two academic staff regularly teaching in the Plant Sciences course series.
No further examination

Graded

Recommended reading

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Photo: S. Abrahamczyk