Master of Science
Molecular Plant Science

22 March 2023

Learning outcomes:
The English-language master's program "Molecular Plant Science" (MoPS) is designed as a research-oriented course of study building on basic knowledge in molecular biology. Graduates have acquired advanced knowledge in molecular biological, physiological, biochemical and imaging methods for research on plants and are able to apply them independently. They have the ability to formulate hypotheses based on problems and design experiments to investigate these hypotheses based on their knowledge of methods. They also have extensive experience in conducting experiments, as well as in analysing and correcting errors, and can present and critically discuss experimental results in a scientific context. Graduates have gained extensive practical experience in university research operations and have learned about alternative career paths. They are familiar with the current discussion on molecular biology methods and can contribute to the discourse in the social context through their professional knowledge.

Curriculum

Semester				
1	Introduction to Molecular Plant Science	Introduction to lab methods A: Basic Molecular Biology and Protein Biochemistry	Introduction to lab methods B: Plant Stress Responses	Introduction to lab methods C: Molecular and Cellular Analyses of Phenotypes
2	Ethics in Biology	compulsory elective: lab rotation modules		
3	Introduction to job	compulsory elective: lab rotation modules		
4	Master thesis			

Inhalt

Abbreviation: hrs=hours, P=presence, S=self-study, EP= exam preparation

Title:	**Introduction to Molecular Plant Science**				
Module number:	MoPS-01				
Semester:	Winter				
Applicability, type of module, and curricular area	• Compulsory module				
Prerequisites for participation:	none				
Module coordinator:	Prof. Dr. Stefan Hoth, Phone: 42816 582, stefan.hoth(at)uni-hamburg(dot)de				
Instructors:	All Instructors				
language	English				
Intended learning objectives:	The students are familiar with current topics in molecular plant sciences, in particular plant physiology, developmental biology, genetics and infection biology.				
Contents	Current concepts of Molecular Plant Science, with special emphasis on plant physiology, plant development, genetics and infection biology				
Course types and forms of instruction:	• L: Introduction to Molecular Plant Science • S: Introduction to Molecular Plant Science				2 SEM./HRS 2 SEM./HRS
Workload (module components and total):		*credits*	P (hrs)	S(hrs)	EP (hrs)
	• L: Introduction to Molecular Plant Science		*28*	*41*	*12*
	• S: Introduction to Molecular Plant Science		*28*	*41*	
	Total Workload	*5*	*56*	*82*	*12*
Coursework and examinations:	Formal requirements for examinations: Talk examinations: Written exam (graded; 100%)				
Duration	one semester				
Module frequency:	annual				
Literature:	Handed out at the beginning of the lecture				

Title:	**Introduction to Lab Methods A- Basic Molecular Biology and Protein Biochemistry**
Module number:	MoPS-02
Semester:	Winter
Applicability, type of module, and curricular area	• Compulsory module
Prerequisites for participation:	none
Module coordinator:	Prof. Dr. Julia Kehr, Phone: 42816 312, julia.kehr(at)uni-hamburg(dot)de
Instructors:	Prof. Dr. Stephan Hoth Prof. Dr. Julia Kehr Dr. Anna Ostendorp Prof. Dr. Arp Schnittger Dr. Magdalena Weingartner
language	English
Intended learning objectives:	The students have practical knowledge of current investigation methods in molecular biology, protein biochemistry, and mass spectrometry. In addition, they acquire the skills to develop hypothesis-based experimental concepts and to statistically analyze data sets. They will be able to adequately document and present their results
Contents	Heterologous protein expression, protein purification from bacteria and plant samples, 1D- and 2D-PAGE; protease digest, sample preparation & MALDI-TOF mass spectrometry, protein identification from spectra using computational tools.
Course types and forms of instruction:	• P: Lab methods in Molecular Plant Science – course A1 — 4 SEM./HRS • P: Lab methods in Molecular Plant Science – course A2 — 4 SEM./HRS

Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• P: Lab methods in Molecular Plant Science – course A1		52	65	33
	• P: Lab methods in Molecular Plant Science – course A2		52	65	33
	Total Workload	10	104	130	66

Coursework and examinations:	Formal requirements for examinations: Active working examinations: Two Protocols (graded; each 50%)
Duration	one semester
Module frequency:	annual
Literature:	Handed out at the beginning of the course

Title:	**Introduction to Lab Methods B - Plant Stress Responses**				
Module number:	MoPS-03				
Semester:	Winter				
Applicability, type of module, and curricular area	• Compulsory module				
Prerequisites for participation:	none				
Module coordinator:	Prof. Dr. Stefan Hoth, Phone: 42816 582, stefan.hoth(at)uni-hamburg(dot)de,				
Instructors:	Dr. Maren Heese Prof. Dr. Stephan Hoth Prof. Dr. Julia Kehr Prof. Dr. Arp Schnittger Dr. Magdalena Weingartner				
language	English				
Intended learning objectives:	The students have practical knowledge of the current investigation methods of molecular plant physiology and developmental biology. In addition, they acquire the skills to develop hypothesis-based test concepts and to statistically analyze data sets. You will be able to adequately document and present your results.				
Contents	DNA and RNA isolation, PCR, qPCR for detection of gene expression, genotyping and phenotyping of transgenic plants, transient plant transformation, analysis of promoter reporter gene constructs, confocal laser scanning microscopy to determine intracellular localization of proteins tagged with fluorophors, isolation and purification of recombinant proteins, immuno cytochemistry, Immune detection of proteins, western blot				
Course types and forms of instruction:	• P: Lab methods in Molecular Plant Science – course B1 • P: Lab methods in Molecular Plant Science – course B2				4 SEM./HRS 4 SEM./HRS
Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• P: Lab methods in Molecular Plant Science – course B1		52	65	33
	• P: Lab methods in Molecular Plant Science – course B2		52	65	33
	Total Workload	10	104	130	66
Coursework and examinations:	Formal requirements for examinations: Active working examinations: Two Protocols (graded; each 50%)				
Duration	one semester				
Module frequency:	annual				
Literature:	Handed out at the beginning of the course				

Title:	**Introduction to Lab Methods C - Molecular and Cellular Analyses of Phenotypes**				
Module number:	MoPS-04				
Semester:	Winter				
Applicability, type of module, and curricular area	• Compulsory module				
Prerequisites for participation:	none				
Module coordinator:	Prof. Dr. Arp Schnittger, Phone: 42816 502, arp.schnittger(at)uni-hanburg(dot)de				
Instructors:	Dr. Maren Heese Prof. Dr. Arp Schnittger				
language	English				
Intended learning objectives:	The students gain practical knowledge of current research methods in cell- and molecular biology as well as genetics to study Arabidopsis and Zea mays. In addition, they acquire the skills to develop hypothesis-based test concepts and to statistically analyze data sets. They will be able to adequately document and present their results.				
Contents	Crossing and genetic analysis of Arabidopsis, analysis of Arabidopsis mutants with fertility problems, analysis of the meiotic process by DNA spreads of Maize meiocytes, standard cloning methods, e.g. recombination based cloning methods such as SLiCE and Gateway.				
Course types and forms of instruction:	• P: Lab methods in Molecular Plant Science – course C				8 SEM./HRS
Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• P: Lab methods in Molecular Plant Science – course C		52	65	33
	Total Workload	5	52	65	33
Coursework and examinations:	Formal requirements for examinations: Active working examinations: Protocol (graded; 100%)				
Duration	one semester				
Module frequency:	annual				
Literature:	Handed out at the beginning of the course				

Title:	**Ethics in Biology**				
Module number:	MoPS-05				
Semester:	summer				
Applicability, type of module, and curricular area	• Compulsory module				
Prerequisites for participation:	none				
Module coordinator:	Dr. Susanne Stirn, Phone: 42816 533, Susanne.stirn(at)uni-hamburg(dot)de				
Instructors:	Dr. Susanne Stirn				
language	English				
Intended learning objectives:	Students are familiar with different ethical concepts as a key to understand, why people differ in evaluations of scientific and technical innovations. They are able to develop their own qualified position, to understand societal governance processes and ways to actively participate in societal decision making.				
Contents	Global challenges; ethical concepts; perceptions of scientific and technical innovations in the sciences and the public; preconditions in and consequences for society and the environment; criteria for evaluating innovations; international comparison of government options to regulate innovations				
Course types and forms of instruction:	• V: Ethics in Biology • S: Ethics in Biology				2 SEM./HRS 2 SEM./HRS
Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• V: Ethics in Biology		28	56	
	• S: Ethics in Biology		28	56	12
	Total Workload	6	56	112	12
Coursework and examinations:	Formal requirements for examinations: Active participation examinations: Paper (graded; 100%)				
Duration	one semester				
Module frequency:	annual				
Literature:	Handed out at the beginning of the lecture				

Title:	**Lab course A - Molecular Plant Physiology**				
Module number:	MoPS-06				
Semester:	Summer and winter				
Applicability, type of module, and curricular area	• Compulsory elective module				
Prerequisites for participation:	Modules MoPS-02 to MoPS-04 have to be successfully passed				
Module coordinator:	Prof. Dr. Stefan Hoth, Phone: 42816 582, stefan.hoth(at)uni-hamburg(dot)de				
Instructors:	Prof. Dr. Stefan Hoth				
language	English				
Intended learning objectives:	The graduates have deeper knowledge of experimental techniques and research procedures and are able to apply their knowledge in scientific research. They have advanced understanding in molecular physiology and modern plant science in general. The graduates can develop scientific problems, raise hypothesis, and design the required experiments to test hypothesis and finally solve a problem. They are able to document their experimental work and actively present their scientific work. The graduates have knowledge of molecular mechanisms in plant immunity, stress response and/or cell function as well as in the dynamics and function of membraneless condensates and/or key components of signaling pathways.				
Contents	Content of teaching are molecular biology, biochemistry, molecular genetics, imaging, and molecular physiology in plant research. Fundamental and advanced techniques of the different disciplines will be applied to solve a current research problem in plant development (for instance meristem function, senescence, root hair development, auxin signaling) and/or plant stress response (for instance immune responses, abiotic stresses, cell death). In this context, the function of membraneless condensates and other compartments may be studied. Techniques cover for instance DNA, RNA, and protein isolation, DNA construct design and production for different purposes (for instance reporter gene constructs, GFP fusions, inducible gene knock-out, gene overexpression), production of recombinant proteins, stable and transient plant transformation, protein detection, protein interaction experiments (for instance yeast-two-hybrid, BiFC, CoIP, MST), crossing of transgenic lines to genetically dissect signaling pathways, different kinds of bioassays , imaging techniques such as confocal laser scanning microscopy to look into cells in 3-D and non-invasively, and different staining techniques for cells and tissues.				
Course types and forms of instruction:	• S: Seminar to lab course A • P: Lab course A				2 SEM./HRS 14 SEM./HRS
Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• S: Seminar to lab course A		28	28	48
	• P: Lab course A		196	300	120
	Total Workload	24	224	328	168
Coursework and examinations:	Formal requirements for examinations: Active working Examinations: Repeated oral presentations of the research project, proper documentation of the experimental work in a lab journal of the scientific progress (graded, 40%). Presentation of the results of the project and discussion of the results within the state-of-the-art in the research area (graded 60%).				
Duration	One semester				
Module frequency:	Usually each semester				

Literature:	Handed out at the beginning of the course

Title:	**Lab course B – Molecular Plant Genetics**				
Module number:	MoPS-07				
Semester:	Summer and winter				
Applicability, type of module, and curricular area	• Compulsory elective module				
Prerequisites for participation:	Modules MoPS-02 to MoPS-04 have to be successfully passed				
Module coordinator:	Prof. Dr. Julia Kehr, Phone: 42816- 312, julia.kehr(at)uni-hamburg(dot)de				
Instructors:	Prof. Dr. Julia Kehr				
language	English				
Intended learning objectives:	The graduates will gain deeper knowledge of experimental techniques and research procedures in the field of molecular plant biology and biochemistry. They will be able to apply their knowledge to scientific questions. They will have advanced understanding of modern plant science, especially in the areas of molecular biology, biochemistry, analytics, mass spectrometry, and computational analysis. The graduates will learn to identify scientific problems, raise hypotheses, and design the required experiments to test these hypotheses to finally solve the problems. They will be enabled to document and actively present their scientific work.				
Contents	Content of teaching is molecular biology, biochemistry, molecular genetics, analytical methods and plant physiology. Fundamental and advanced techniques of the different disciplines will be applied to a current research problem in plant research (for example stress response, nutrient allocation, long-distance signaling, RNA storage & transport). Techniques applied include DNA, RNA, and protein isolation, DNA construct design for expression in plants and microorganisms, production and purification of recombinant proteins, stable and transient plant transformation, protein-protein and protein-nucleic acid interaction experiments (e.g. microscale thermophoresis, zone interference gel electrophoresis, affinity chromatography), small RNA analysis (PCR, microarrays, next generation sequencing), mass spectrometry, and *in vitro* and *in vivo* phase separation assays.				
Course types and forms of instruction:	• S: Seminar to lab course B • P: lab course B				2 SEM./HRS 14 SEM./HRS
Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• S: Seminar to lab course B		28	28	48
	• P: lab course B		196	300	120
	Total Workload	24	224	328	168
Coursework and examinations:	Formal requirements for examinations: Active working Examinations: Repeated oral presentations of the research project, proper documentation of the experimental work in a lab journal of the scientific progress (graded, 40%). Presentation of the results of the project and discussion of the results within the state-of-the-art in the research area (graded 60%).				
Duration	one semester				
Module frequency:	Usually each semester				
Literature:	Handed out at the beginning of the course				

Title:	**Lab course C – Plant Biochemistry and Infection Biology**
Module number:	MoPS-08
Semester:	Summer and winter
Applicability, type of module, and curricular area	• Compulsory elective module
Prerequisites for participation:	Modules MoPS-02 to MoPS-04 have to be successfully passed
Module coordinator:	Prof. Dr. Sigrun Reumann, Phone: 42816-743, sigrun.reumann(at)uni-hamburg(dot)de
Instructors:	Prof. Dr. Sigrun Reumann
language	English
Intended learning objectives:	The graduates will gain deeper knowledge of experimental techniques, research procedures and bioinformatics and are able to apply their knowledge in scientific research. They will obtain advanced understanding in molecular biology, biochemistry, protein chemistry, applied bioinformatics and modern plant science in general. The graduates can identify scientific problems, raise hypotheses, and design the required experiments to test these hypotheses to finally solve the problem. They are able to document their experimental work, interpret and critically evaluate research data and actively present their scientific work.
Contents	Content of teaching are molecular biology, biochemistry, protein chemistry, molecular genetics, imaging, bioinformatics and infection biology in plant research. Fundamental and advanced techniques of the different disciplines will be applied to solve a current research problem in organelle biology (e.g. peroxisome biogenesis and degradation, pexophagy), infection biology (plant resistance/susceptibility to pathogens) or abiotic stress tolerance. Wet-lab techniques cover, for instance, DNA, RNA, and protein isolation (e.g. 2DE), DNA construct cloning for different purposes (e.g. GFP fusions, gene knock-out or overexpression, site-directed mutagenesis), production of recombinant proteins, stable and transient plant transformation, protein interaction analyses (e.g. yeast-two-hybrid, BiFC), topology studies on membrane proteins, crossing of transgenic lines to genetically dissect signaling pathways, live cell imaging techniques (e.g. self assembly GFP, photoconvertible fluorescent proteins) and RNA sequencing to study gene expression patterns/ transcriptomics. Computational techniques cover, for instance, BLAST searches, targeting signal analyses, orthology and phylogenetic analyses, primer design, homology modeling and structural analyses.
Course types and forms of instruction:	• S: Seminar to lab course C — 2 SEM./HRS • P: lab course C — 14 SEM./HRS

Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• S: Seminar to lab course C		28	28	48
	• P: lab course C		196	300	120
	Total Workload	24	224	328	168

Coursework and examinations:	Formal requirements for examinations: Active working Examinations: Repeated oral presentations of the research project, proper documentation of the experimental work in a lab journal of the scientific progress (graded, 40%). Presentation of the results of the project and discussion of the results within the state-of-the-art in the research area (graded 60%).
Duration	one semester
Module frequency:	Usually each semester

Literature:	Handed out at the beginning of the course

Title:	**Lab course D – Developmental biology**
Module number:	MoPS-10
Semester:	Summer and winter
Applicability, type of module, and curricular area	• Compulsory elective module
Prerequisites for participation:	Modules MoPS-02 to MoPS-04 have to be successfully passed
Module coordinator:	Prof. Dr. Arp Schnittger, Phone: 42816 502, arp.schnittger(at)uni-hanburg(dot)de
Instructors:	Prof. Dr. Arp Schnittger
language	English
Intended learning objectives:	Guided by case studies, the graduates will be exposed to current topics and question in developmental biology. They will learn hypothesis driven versus unbiased descriptive approaches and will become familiar with state-of-the-art techniques in the field of genetic, molecular and image-based analysis of mitosis and meiosis as well as DNA damage repair and will be able to apply these techniques independently. The graduates learn analytical dissection of scientific question and experimental design. They learn how to proper document as well as present and communicate their data.
Contents	Content of teaching is developmental biology and its interface with plant physiology, pathology, genetics, biochemistry, and evolution. Topics include mitotic cell cycle control, proliferation, the DNA damage response, and growth. In addition, different aspects of meiosis will be studied such as the temporal resolution of the meiotic process as well as homologous recombination. Techniques include cell biological methods, biochemistry, genetics, molecular biology, and bioinformatics which are used to analyze the two model species Arabidopsis thaliana and Zea mays. Cell biology: (live) imaging of proteins by confocal fluorescence microcopy, spreading of chromosomes, immune detection of proteins, etc. Biochemistry: expression and purification of proteins, e.g. kinases, protein-protein interaction assays, etc. Genetics: Crossing schemes, transmission analyses, transformation of Arabidopsis and Maize, etc. Molecular biology: chromatin-immuno precipitation, qRT PCR, generation of fluorescent reporter constructs, etc. Bioinformatics: Analysis of large data sets, identification of functional motifs in DNA and protein, protein structure prediction, etc.
Course types and forms of instruction:	• S: Seminar to lab course D — 2 SEM./HRS • P: lab course D — 14 SEM./HRS

Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• S: Seminar to lab course D		28	28	48
	• P: lab course D		196	300	120
	Total Workload	24	224	328	168

Coursework and examinations:	Formal requirements for examinations: Active working Examinations: Repeated oral presentations of the research project, proper documentation of the experimental work in a lab journal of the scientific progress (graded, 40%). Presentation of the results of the project and discussion of the results within the state-of-the-art in the research area (graded 60%).
Duration	one semester
Module frequency:	Usually each semester
Literature:	Handed out at the beginning of the course

Title:	**Lab course E – Functional analysis of hormone-mediated growth control in Bryophytes and their closest algal relatives**				
Module number:	MoPS-011				
Semester:	Summer and winter				
Applicability, type of module, and curricular area	• Compulsory elective module				
Prerequisites for participation:	Modules MoPS-02 to MoPS-04 have to be successfully passed				
Module coordinator:	PD. Dr. Klaus von Schwartzenberg, Phone: 42816-599, klaus.von.schwartzenberg(at)uni-hamburg.de				
Instructors:	PD. Dr. Klaus von Schwartzenberg,				
language	English				
Intended learning objectives:	The students will have access to the newest evolutionary findings regarding hormonally mediated growth control of plants belonging to early diverging clades such as bryophytes and conjugating green algae. Training in the setup of experiments in order to assess hormonal actions on a molecular and physiological level will be provided, e.g. bioassays and differential gene expression analysis. The planning and realization of reverse genetic approaches aiming at the attribution of functions of so far undescribed genes will be included when appropriate. Along with the project, in which state of the art techniques will be used, the students learn to independently plan, perform, interpret and adapt their experiments. Emphasis will be placed on exact and comprehensive documentation as well as on and optimal presentation of experimental approaches and results.				
Contents	Experimental and bioinformatic analysis of molecular elements involved in growth control in early divergent plant lineages				
Course types and forms of instruction:	• S: Seminar to lab course E • P: lab course E				2 SEM./HRS 14 SEM./HRS
Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• S: Seminar to lab course E		28	28	48
	• P: lab course E		196	300	120
	Total Workload	24	224	328	168
Coursework and examinations:	Formal requirements for examinations: Active working Examinations: Repeated oral presentations of the research project, proper documentation of the experimental work in a lab journal of the scientific progress (graded, 40%). Presentation of the results of the project and discussion of the results within the state-of-the-art in the research area (graded 60%).				
Duration	one semester				
Module frequency:	Usually each semester				
Literature:	Handed out at the beginning of the course				

Title:	**Introduction to job**				
Module number:	MoPS-12				
Semester:	winter				
Applicability, type of module, and curricular area	• Compulsory module				
Prerequisites for participation:	none				
Module coordinator:	Prof. Dr. Arp Schnittger, Phone: 42816 502, arp.schnittger(at)uni-hanburg(dot)de				
Instructors:	Prof. Dr. Stefan Hoth Prof. Dr. Julia Kehr Prof. Dr. Sigrun Reumann Prof. Dr. Arp Schnittger				
language	English				
Intended learning objectives:	Students have the ability to interpret scientific literature, to integrate their findings into the overall scientific context and to compile them as a publishable scientific presentation. They can conclusively present their scientific findings, while applying various media and technology. They are acquainted with the application for financial and scientific sponsorship. They comprehend the occupational field of molecular biologists.				
Contents	Scientific writing, presentation techniques and writing of grant proposals				
Course types and forms of instruction:	• V: Introduction into job • E: Introduction into job				2 SEM./HRS 2 SEM./HRS
Workload (module components and total):		credits	P (hrs)	S(hrs)	EP (hrs)
	• V: Introduction to job • E: Introduction to job		28 28	56 56	 12-
	Total Workload	6	56	112	12
Coursework and examinations:	Formal requirements for examinations: Active working examinations: Final Exercise (pass)				
Duration	one semester				
Module frequency:	annual				
Literature:	Handed out at the beginning of the lecture				

Title:	**Master thesis**				
Module number:	MoPS-13				
Semester:	*Winter or summer*				
Applicability, type of module, and curricular area	• Compulsory module				
Prerequisites for participation:	All Compulsory elective modules have to be successfully passed				
Module coordinator:	Instructors: of the thesis				
Instructors:	*All* Instructors: s				
language	*English*				
Intended learning objectives:	Students are able to think and work self-containedly in the scientific fields of the MSc Molecular Plant Science Biology. They have gained experience in presentation and evaluation of their own experimental work in the context of the current scientific state of the art and they are able to solve scientific problems.				
Contents					
Course types and forms of instruction:	•				
Workload (module components and total):		*credits*	P (hrs)	S(hrs)	EP (hrs)
	Total Workload	*30*			
Coursework and examinations:	Formal requirements for examinations: Active working examinations: Thesis (graded; 90%), disputation (graded; 10%)				
Duration	one semester				
Module frequency:	annual				
Literature:					