Module Catalogue for the Master Degree Programme Molecular Life Sciences

Status: 2016

Faculty of Biology and Pharmacy

List of abbreviations

ср	credit point(s)
	1 4

L Lecture
S Seminar
E Exercise

P Practical course

Ex Excursion

SS Summer Semester
WS Winter Semester
hpw hours per week
Mc Module coordinator

Curriculum Master Molecular Life Sciences

1. General overview according to academic years

1st acad	lemic year	2nd aca	demic year
ws	SS	ws	SS
MMLS.G1 7 hpw Molecular Developmental Biolog	MMLS.A1 7 hpw yMol. Devel. of Model Systems	MMLS.T1 Specialisation Module MMLS	MMLS.T3 Master Thesis MMLS
MMLS.G2 7 hpw Molecular Genetics	MMLS.A2 7 hpw Evol. Devel. Biology	MMLS.T2 Project Module MMLS	
MMLS.G3 6 hpw Molecular Cell Biology	1 hpw		
	MMLS.A3 7 hpw Developmental Control Gene		
	MMLS.A4 7 hpw Gene Regulation		
	MMLS.A5 7 hpw Theoretical Systems Biology		
	MMLS.A6 7 hpw Applied Systems Biology		
	MMLS.A7 7 hpw Signal transduction		
	MMLS.A9 7 hpw Biological Clock and Temporal Gene Expression		
	MMLS.A10 7 hpw Mol. Med. of Ion Transport		
	MMLS.A17 7 hpw Genome Integrity, Tumors and Ageing		
	MMLS.A12 7 hpw Organelles: Devel. a. Function		
	MMLS.A13 7 hpw Cellular Networks		
	MMLS.A14 8 hpw Systematic Neurobiology		
	MMLS.A15 8 hpw Development and Plasticity of Nervousl System II		
	MMLS.A16 7 hpw Symbiosis, Signalling and Metabolism		

Basic modules (compulsory)

Advanced modules (compulsory elective)

Interdisciplinary module:

Modules from other degree programmes will be included after mandatory mentors advise if they particularly enhance the interdisciplinary character of the study course. Examples could be – aside from other life science subjects (e. g. offered within the Master programme Biochemistry, Molecular Medicine or Microbiology) – specifically Ethics, Scientific English, Nanotechnologies, Photonics. Also an internship at external research institutions can be accredited after previous student advisory service within the scope of an advanced module.

International mobility / Mobility window

Study stays abroad within the Master degree programme Molecular Life Sciences are possible and desired. For the support of students, who want to go abroad, a special entry on the website publishes links to the International Office, the Erasmus Programme, the networking amongst Coimbra Universities, current links (such as RISE) and the offer of an individual mentoring.

To make the recognition of achievements easier, a "Learning Agreement" about the planned study programme should be arranged with the responsible professor of the degree programme and should be provided to the Study and Examination Office. Possibilities of a degree programme related mobility can be given by the responsible professor of the degree programme as well as the Study and Examination Office.

2. General Overview According to Subject-Related Semesters and Credit Points

Module number	Module name	Credit points
1st Semester	3 Basic modules	
MMLS.G1	Basic module "Molecular Developmental Biology"	10
MMLS.G2	Basic module "Molecular Genetics"	10
MMLS.G3	Basic module " Molecular Cell Biology "	10
2nd Semester	3 Advanced modules ¹	
MMLS.A1	Advanced module "Molecular Developmental Biology of Model Systems "	10
MMLS.A2	Advanced module "Evolutionary Developmental Biology"	10
MMLS.A3	Advanced module "Developmental Control Genes"	10
MMLS.A4	Advanced module "Gene Regulation"	10
MMLS.A5	Advanced module "Theoretical Systems Biology"	10
MMLS.A6	Advanced module "Applied Systems Biology"	10
MMLS.A7	Advanced module "Signal Transduction"	10
MMLS.A9	Advanced module "Biological Clock and Temporal Gene Expression"	10
MMLS.A10	Advanced module "Molecular Medicine of Ion Transport"	10
MMLS.A17	Advanced module "Genome Integrity, Tumors and Ageing"	10
MMLS.A12	Advanced module "Organelles: Development and Function"	10
MMLS.A13	Advanced module "Cellular Networks"	10
MMLS.A14	Advanced module "Systematic Neurobiology"	10
MMLS.A15	Advanced module "Development and Plasticity of Nervous System II"	10
MMLS.A16	Advanced Module "Symbiosis, Signalling and Metabolism"	10
3rd Semester	2 Modules	
MMLS.T1	Specialisation Module	10
MMLS.T2	Project Module	20
4th Semester	Master thesis	
MMLS.T3	Master thesis	30

¹ The Advanced modules can be freely chosen.

Record sheet Master Molecular Life Sciences

Module	Work performed	Grade	Signature
Basic module 1	Lectures		
	Seminar		
Basic module 2	Lectures		
	Seminar		
Basic module 3	Lectures		
	Seminar		
Advanced module 1 (can be freely chosen from the range			
of the courses offered in Molecular Life Sciences)			
Advanced module 2 (can be freely chosen from the range			
of the courses offered in Molecular Life Sciences)			
,			
Advanced module 3 (can be freely chosen from the range			
of the courses offered in Molecular Life Sciences)			
Specialisation module			
Project module			
Master thesis			

Module Overview for the Master's Programme Molecular Life Sciences (MMLS)

- G
- Basic module (compulsory module) Advanced module (compulsory elective module) Thesis (Master thesis)

1st Semester:

MM	LS.G1: Molecular Developmental Biology	(Mc: Theißen)	WS/SS	hpw	ср
L	Molecular Developmental Biology I	Theißen, Damen	WS	2	
L	Molecular Developmental Biology II	Olsson, Englert, Baniahmad	WS	2	
L	Gene Regulatory Networks	Theißen, Damen	WS	1	
S	Comparative and Evolutionary Developmental Biology	Damen, Olsson, Theißen	WS	2	
				7	10

MM	MLS.G2: Molecular Genetics (Mc: Baniahmad)		WS/SS	hpw	ср
L	Molecular Genetics I	Baniahmad, Heinzel, Theißen	WS	2	
L	Molecular Genetics II	Baniahmad, Saluz, Damen	WS	2	
L	Systems Biology	Schuster, Platzer, Dittrich	WS	1	
S	Molecular Genetics	Baniahmad	WS	2	
				7	10

MM	LS.G3: Molecular Cell Biology (Mc: Sasso)		WS/SS	hpw	ср
L	Molecular Cell Biology I	Jungnickel, Hemmerich	WS	2	
L	Molecular Cell Biology II	Oelmüller, Sasso	WS	2	
L	Molecular Cell Biology III	Mittag	WS	2	
S	Molecular Cell Biology	Hemmerich, Oelmüller, Sasso, Mittag	WS/SS	1	
				7	10

2nd Semester: 3 advanced modules can be freely chosen

MM	LS.A1: Molecular Developmental Biology of I	Model Systems (Mc: Englert)	WS/SS	hpw	ср
S	Molecular Developmental Biology of Model Systems	Englert, Theißen, Damen	SS	2	
Р	Molecular Developmental Biology of Model Systems	Englert, Theißen, Damen	SS	5	
				7	10

MM	LS.A2: Evolutionary Developmental Biology (Mc: Theißen)	WS/SS	hpw	ср
S	Evolutionary Developmental Biology	Theißen, Damen	SS	2	
Р	Evolutionary Developmental Biology	Theißen, Damen	SS	5	
				7	10

MM	MLS.A3: Developmental Control Genes (Mc: Theißen)		WS/SS	hpw	ср
S	Developmental Control Genes	Theißen, Damen	SS	2	
Р	Developmental Control Genes	Theißen, Damen	SS	5	
				7	10

MM	IMLS.A4: Gene Regulation (Mc: Baniahmad)			hpw	ср
S	Gene Regulation	Baniahmad	SS	2	
Р	Gene Regulation	Baniahmad, Heinzel, Englert, NN	SS	5	
				7	10

MM	LS.A5: Theoretical Systems Biology (Mc	: Schuster)	WS/SS	hpw	ср
L	Analysis of Gene Expression	Guthke	SS	2	
L	Metabolic and Regulatory Networks	Schuster	SS	2	
Е	Metabolic and Regulatory Networks	Schuster	SS	1	
Р	Metabolic and Regulatory Networks	Schuster	SS	2	
				7	10

MM	MMLS.A6: Applied Systems Biology (Mc: Mittag)		WS/SS	S hpw	ср
Р	Applied Systems Biology	Mittag, Saluz	SS	5	
S	Applied Systems Biology	Mittag	SS	2	
				7	10

MM	MMLS.A7: Signal Transduction (Mc: Liebmann)		WS/SS	hpw	ср
S	Signal Transduction	Spänkuch, Heinzel, Wetzker	SS	2	
Р	Signal Transduction	Spänkuch, Heinzel, Wetzker	SS	5	
				7	10

MML	MLS.A9: Biological Clock and Temporal Gene Expression (Mc: Mittag)			hpw	ср
	Current Topics on Molecular Mechanisms of Circadian Clocks and Temporal Gene Expression	Mittag	SS	2	
	Molecular Chronobiology - Temporal Gene Expression	Mittag and members of staff	SS	5	
				7	10

MM	MMLS.A10: Molecular Medicine of Ion Transport (Mc: Heinemann)			hpw	ср
L	Ion Transport and Disease	Heinemann, Schönherr	SS	2	3
	Current Topics on the Structure and Function of Ion Channels and Transporters	Heinemann	SS	1	2
Р	Membrane Processes and Transport	Heinemann and members of staff	SS	4	5
				7	10

ММ	MMLS.A17: Genome Integrity, Tumors and Ageing (Mc: Jungnickel)			hpw	ср
V	Genomic Instability and Tumor Biology	Jungnickel, Grosse	SS	2	
S	Genetic and Cellular Plasticity	Jungnickel	SS	2	
Р	Genetic and Cellular Plasticity	Jungnickel	SS	4	
				8	10

MM	MMLS.A12: Organelles: Development and Function (Mc: Oelmüller)			hpw	ср
S	Organelles: Development and Function	Oelmüller	SS	2	
Р	Organelles: Development and Function	Oelmüller	SS	5	
				7	10

MM	MMLS.A13: Cellular Networks (Mc: Jungnickel)		WS/SS	hpw	ср
S	Cellular Networks	Jungnickel	SS	2	
Р	Cellular Networks	Jungnickel	SS	5	
				7	10

MM	MMLS.A14: Systems Neurobiology (Mc: Bolz)		WS/SS	hpw	ср	
L	Systems Neurobiology	Bolz		SS	2	
S	Systems Neurobiology	Bolz		SS	2	
Р	Systems Neurobiology	Bolz		SS	4	
					8	10

ΜM	MLS.A15: Development and Plasticity of Nervous System II (Mc: Bolz)			hpw	ср
L	Development and Plasticity of Nervous System II	Bolz, Lehmann	SS	2	
S	Development and Plasticity of Nervous System II	Bolz, Lehmann	SS	2	
Р	Development and Plasticity of Nervous System II	Bolz, Lehmann	SS	4	
		·		8	10

MM	MMLS.A16: Symbiosis, Signaling and Metabolism (Mc: Sasso)			hpw	ср
L	Symbiosis, Signaling and Metabolism	Sasso, Mahlow	SS	1	
S	Symbiosis, Signaling and Metabolism	Sasso	SS	1	
Р	Symbiosis, Signaling and Metabolism	Sasso	SS	5	
			·	7	10

3rd Semester:

	LS.T1 : Specialisation Module MMLS ranced modules of the Master program	WS/SS	hpw	ср	
Р	Current Methods MMLS	according to agreement	WS		
					10

	MMLS.T2: Project module MMLS (Mc: All persons responsible for Basic and Advanced modules of the Master programme MLS)			hpw	ср
Р	Project laboratory course MMLS	according to agreement	WS		
	1	'	ı	ı	20

4th Semester:

	MLS.T3 : Master thesis MMLS vanced modules of the Master	(Mc: All persons responsible for Basic and programme MLS)	WS/SS	hpw	ср
Р	Master thesis MMLS	according to agreement	SS		
					30

Module descriptions

Module number	MMLS.G1
Module name	Molecular Developmental Biology
Module coordinator	Theißen
Admission requirements	none
Usability (required for)	Requirement for further modules
Type of module (compulsory,	Compulsory module, Basic module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, WS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	L: 5 hpw
exercise, practical course)	S: 2 hpw
	·
Credit points (ECTS credits)	10 ср
Workload in hours:	
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation)	
Contents	Based on the module BB 3. MLS 1 (Developmental Genetics) of the Bachelor degree programme the module provides in-depth basics in Developmental Biology on the broad base, particularly in Molecular Biology, Genetics, Evolutionary Biology, Molecular Medicine. The focus is on lectures of text book knowledge about the development of model organisms, whereby animals (e.g. <i>Drosophila</i>) and plants (e.g. <i>Arabidopsis</i>) are handled comparatively. Particular attention is paid to the methods of the Molecular Developmental Genetics and the role of Gene Regulatory Networks in the development.
Admission requirements for the module examination	Deepening of basics in Developmental Biology; basic knowledge for essential research directions in <i>Molecular Life Sciences</i> ; deepened overview of the subject area as whole; Presentation of the scientific results giving a lecture; dealing with English scientific literature. <i>Regular participation in the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.</i>
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written examination on the contents of all lectures (70 %), Seminar presentation (30 %)

Module number	MMLS.G2
Module name	Molecular Genetics
Module coordinator	Baniahmad
Admission requirements	None
Usability (required for)	Requirement for further modules
Type of module (compulsory,	Compulsory module, Basic module
compulsory elective module)	Comparisory module, Basic module
Frequency of offer (module cycle)	Yearly, WS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	L: 5 hpw
exercise, practical course)	S: 2 hpw
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Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation) Contents	The fearer of the leaders in an the atmost man of account of
Contents	The focus of the lectures is on the structure of genomes of
	different organisms, chromatin structure and modification,
	epigenetics, tumor genetics, structure of genome,
	transposons, immuno genetics, comparative genetics and analysis of genome. Furthermore basics in systems
	biology are provided. Current literature on the scientific
	field and the newest techniques are discussed in the
	seminar.
Learning and qualification objectives	Acquirement of a wide perspective at the meaning of
g and quannounen expectives	molecular genetics for the organisms, mechanisms of the
	gene regulation, genomics; introduction to systems
	biology; learning about the newest molecular genetic
	techniques in theory as well as importance of the
	epigenetics and chromatin; acquisition of a scientific style
	in giving a speech and presentations. Regular participation
	in the seminar is required to reach the study objectives of
	the module. The teaching staff will inform about further
	details at the beginning of the courses.
Admission requirements for the	
module examination	
Requirements for the award of	Written examination on the contents of all lectures (70 %),
credit points (forms of examination,	Seminar presentation (30 %)
weighting of grades in %)	

Module number	MMLS.G3	
Module name	Molecular Cell Biology	
Module coordinator	Sasso	
Admission requirements	None	
Usability (required for)	Requirement for further modules	
Type of module (compulsory,	Compulsory module, Basic module	
compulsory elective module)	Compaisory module, Dasie module	
Frequency of offer (module cycle)	Yearly, WS/SS	
Duration of module	2 semesters	
Module composition/ Forms of		
instruction (lecture, seminar,	L: 6 hpw	
exercise, practical course)	S: 1 hpw	
	S. 1p. 1	
Credit points (ECTS credits)	10 cp	
Workload in hours:	10 00	
- in class and	-105 h	
- self-study (incl. examination	-195 h	
preparation)	13311	
Contents	This module will extend the basic knowledge of molecular	
	systems biology, evolution and develop-ment, and molecular medicine from module BB3.MLS9, with a wider scope. The emphasis will be on (a) principles of cell communication and signalling, structure, function and transport processes of selected membranes, organisation of the cell nucleus and the stem cell complex, (b) molecular processes in plants including genetic methods for their modification, genome sequencing and function of small RNAs, and (c) the molecular organisation of biological clocks, particularly the circadian clock of selected organisms of prokaryotes, fungi, plants and animals and the evolution of clock components.	
Learning and qualification objectives	Extension of basic knowledge of molecular cell biology; acquisition of knowledge for important fields in molecular life sciences. Methods for the visualisation of molecules, organelles and cells, and for the manipulation of proteins, DNA and RNA in cells; presentation of scientific knowledge in the form of a talk; reading and discussion of scientific literature (in English) on aspects of the lecture. Regular participation in the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.	
Admission requirements for the		
module examination		
Requirements for the award of	Written examination on the contents of all lectures (70 %),	
credit points (forms of examination,	Seminar presentation (30%)	
weighting of grades in %)		

Module number	MMLS.A1
Module name	Molecular Developmental Biology of Model Systems
Module coordinator	Englert
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module , Project module, Master thesis
Type of module (compulsory, compulsory elective module)	Compulsory elective module, Advanced module
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	P: 5 hpw S: 2 hpw
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	-105 h -195 h
Contents	The module provides knowledge in housing and breeding of different model organisms (e.g. Arabidopsis, Zebrafish, mouse); distinction of different developmental stages and preparation of particular organs; genotyping; expression analysis (RT-PCR and <i>in situ</i> hybridization); immunohistochemical processes; fluorescence microscopy as well as analysis of transgenic plants and animals.
Learning and qualification objectives	Deepening of knowledge in developmental genetics; acquisition and application of methods of developmental genetics and/ or developmental biology; gaining of experience in handling as well as in housing and breeding of experimental animals and plants; writing of a scientific protocol, presentation of data and communication in English. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
Admission requirements for the module examination	Writing of a practical course protocol
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral examination (70%), Seminar presentation (30%), major course assessment for the practical course

Module number	MMLS.A2
Module name	Evolutionary Developmental Biology
Module coordinator	Theißen
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module , Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	P: 5 hpw
exercise, practical course)	S: 2 hpw
	·
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation) Contents	100 11
	The focus of this module is on keeping and culturing of evolutionary biological informative organisms (e.g. shepherd's purse, orchids, frogs, and fishes). Similarities and differences of the classical model organisms (e.g. <i>Arabidopsis, Drosophila,</i> mouse), particularly comparative morphogenetic studies and sequential and gene expression analysis are analysed.
Learning and qualification objectives	Acquirement of experimental skills in developmental biology in an evolutionary biological context; providing of subject-specific terminology, approaches and methods of the evolutionary developmental biology; writing of a scientific protocol; presentation of scientific results and dealing with English scientific literature. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral examination (70%), Seminar presentation (30%), major course assessment for the practical course

Module number	MMLS.A3
Module name	Developmental Control Genes
Module coordinator	Theißen
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	P: 5 hpw
exercise, practical course)	S: 2 hpw
Credit points (ECTS credits)	10 cp
Workload in hours:	·
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation)	
Contents	Analysis of genes, regulating the developmental
	processes of animals or plants (e.g. homeobox genes,
	MADS box genes) using methods of molecular biology
	(e.g. cloning, sequencing, expression analysis, mutant
	analysis) and molecular evolution (e.g. multiple sequence
Learning and qualification objectives	alignments, phylogenetic trees, test on selection).
Learning and qualification objectives	Acquirement of experimental skills in Developmental
	Genetics and Molecular Biology; deepening of
	understanding the complex interdependence between
	genotype and phenotype; writing of a scientific protocol;
	presentation of scientific results and dealing with English
	scientific literature. Regular participation in the practical course and the seminar is required to reach the study
	objectives of the module. The teaching staff will inform
	about further details at the beginning of the courses.
Admission requirements for the	Writing of a practical course protocol
module examination	withing of a practical course protocol
Requirements for the award of	Oral examination (70%), Seminar presentation (30%),
credit points (forms of examination,	major course assessment for the practical course
weighting of grades in %)	major source account in the practical course
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Module number	MMLS.A4
Module name	Gene Regulation
Module coordinator	Baniahmad
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly , SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	P: 5 hpw
exercise, practical course)	S: 2 hpw
Credit points (ECTS credits)	10 cp
Workload in hours:	·
- in class and	-105 h
 self-study (incl. examination 	-195 h
preparation)	
Contents	The content of the module comprises mechanisms of gene
	regulation, temporally, spatial and hormonal controlled gene regulation of gene expression, expression analysis,
	newest molecular genetic techniques, biological clocks,
	analysis of chromatin and cellular senescence.
Learning and qualification objectives	Practical experience in analysing mechanisms of gene
g and quantication objectives	regulation in different biological systems and on different
	levels, learning to write a scientific protocol, improving
	skills in giving a talk and presentations, data presentation
	and communication in English. Regular participation in the
	practical course and the seminar is required to reach the
	study objectives of the module. The teaching staff will
	inform about further details at the beginning of the
	courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of	Oral examination (70%), Seminar presentation (30%),
credit points (forms of examination, weighting of grades in %)	major course assessment for the practical course

Module number M	IMLS.A5
Module name Tr	heoretical Systems Biology
	chuster
Admission requirements at	t least 1 successfully completed Basic module
Usability (required for) Sp	pecialisation module, Project module, Master thesis
	Compulsory elective module, Advanced module
compulsory elective module)	, , , , , , , , , , , , , , , , , , , ,
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	semester
Module composition/ Forms of L:	: 4 hpw
<u>-</u>	: 2 hpw
exercise, practical course) E:	: 1 hpw
	0 cp
Workload in hours:	
- in class and	105 h
	195 h
preparation)	190 11
ov prince ur (re ex lec ar ar dy mo	the lecture Analysis of Gene Expression provides an verview of chip technologies and their applications; pre- rocessing of data (models of measurement errors and ormalisation); differential gene expression; supervised learning; insupervised learning (cluster analysis); reverse Engineering reconstruction of gene regulatory nets); data bases for gene expression analysis, as well as ethic and legal questions. In the recture Metabolic and regulatory networks the following topics re covered: Enzyme kinetics, balance equations, network analysis (incl. conservation relations and elementary modes), synamic modelling of metabolic and regulatory networks, netabolic control analysis, modelling of enzyme cascades, ultra- rensitivity, bistability, basics in modelling of signal transduction and calcium oscillation. The content of Exercises/ Practical ourse is the analytical/ numeral solution of problems on the cientific area of the lecture (during the practical course by using
Learning and qualification objectives Property the series of the series	rovided programmes). Tractical understanding of the analysis of Microarray data and the interpretation of analysis results; insight into methods of mowledge extraction from the measurement data of molecular iological high-throughput techniques, acquirement of meoretical knowledge about the mathematical modelling of metabolic and (intracellular) regulatory networks, learning about ossibilities of applying linear algebra, convex analysis and differential equation for this modelling; skills to solve exercises on modelling under guidance: application of relevant the rogrammes on simulation of metabolic and regulatory etworks. Regular participation in the practical course and the exercise is required to reach the study objectives of the module. The teaching staff will inform about further details at the reginning of the courses.
<u>-</u>	Vriting protocols for the practical course.
module examination	
	Oral examination in "Analysis of Gene Expr." (30 %), oral or
credit points (forms of examination, wr	ritten examination in "Metabol. and regul. Netw." (70 %), major ourse assessment for the practical course.

Module number	MMLS.A6
Module name	Applied Systems Biology
Module coordinator	Mittag
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module , Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	P: 5 hpw
exercise, practical course)	S: 2 hpw
	·
Credit points (ECTS credits)	10 cp
Workload in hours:	·
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation)	
Contents	The module provides knowledge in the following areas: automated sequencing of DNA, sequence analysis <i>in silico</i> , DNA and RNA fingerprinting, rapid PCR, enrichment of cellular sub-proteomes, preparation of samples for mass spectrometry, mass spectrometry measurements (LC-ESI-MS) and their bioinformatical analysis: "-omics" methods.
Learning and qualification objectives	Theoretical and practical understanding concerning DNA sequence analysis, fingerprinting und rapid PCR; relevance and possibilities of functional genome, proteome and metabolome analysis; independent conduction of simple experiments on topics above including writing of scientific protocols; insight into the newest literature, data presentation and communication in English. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of	Oral examination (70%), Seminar presentation (30%),
credit points (forms of examination,	major course assessment for the practical course
weighting of grades in %)	major course assessment for the practical course
- 3 3 -: 3 -: 2 -: / 0 /	

Module number	MMLS.A7
Module name	Signal Transduction
Module coordinator	Spänkuch
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module , Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	, ,
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	P: 5 hpw
exercise, practical course)	S: 2 hpw
	'
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation) Contents	
	The selected current problems and research trends in signal transduction of G protein-coupled receptors, cytokine receptors and receptor tyrosine kinases are discussed in the seminar on the basis of original publications and reviews; also the relevance of new scientific findings for molecular medicine and signal transduction therapy is discussed. In the practical course you work at a relevant small project in the context of current projects of the involved research group.
Learning and qualification objectives	Deepening of basic knowledge in the areas: receptors and signal transduction; independent analysis of original literature; seminar presentation on a chosen publication and development of a project proposal on the continuation of the represented scientific problem. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of	Oral examination (70%), Seminar presentation (30%),
credit points (forms of examination, weighting of grades in %)	major course assessment for the practical course

Module number	MMLS.A9
Module name	Biological Clock and Temporal Gene Expression
Module coordinator	Mittag
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	P: 5 hpw
exercise, practical course)	S: 2 hpw
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation)	13511
Contents	The main focuses of the module are cultivation and harvesting of organisms (wild type and clock mutants)
	under circadian conditions; measurement of circadian
	rhythms with the help of reporter genes or automated
	equipment, characterization of clock genes and/ or clock
	proteins at transcriptional, translational and post-
	translational level.
Learning and qualification objectives	Advanced knowledge about physiological and molecular structure of circadian clocks, evolution of clock
	components, chronobiological relevant diseases;
	independent conduction of simple experiments on topics
	above including writing of scientific protocols; insight into
	the newest literature, data presentation and
	communication in English. Regular participation in the
	practical course and the seminar is required to reach the
	study objectives of the module. The teaching staff will
	inform about further details at the beginning of the
Adminator various series for the	courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of	Oral examination (70%), Seminar presentation (30%),
credit points (forms of examination,	major course assessment for the practical course
weighting of grades in %)	

Module number	MMLS.A10
Module name	Molecular Medicine of Ion Transport
Module coordinator	Heinemann
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module , Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 Semester
Module composition/ Forms of	
instruction (lecture, seminar,	L: 2 hpw
exercise, practical course)	P: 4 hpw
	S: 1 hpw
	'
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation)	
Contents	Introduction to symptoms, diagnosis and therapeutic
	approaches for diseases that are related to disorders of
	ion transport. In particular the basics in Molecular
	Medicine and Physiology are provided for comprehension of channels-associated diseases.
	During the practical course membrane transport and the
	function of membrane proteins are analysed with the help
	of modern methods.
	In the seminar current biomedical publications on the topic
	are discussed.
Learning and qualification objectives	Lecture: structure and function of relevant transport
	molecules and their impact on the cellular function. Learn
	about pathophysiological interrelations: diagnosis and
	therapy of diseases, which are caused by defects in ion
	transport.
	Practical course: measurement, quantitative analysis and
	graphical/ written presentation of transport processes.
	Seminar: oral presentation of current publications. Regular
	participation in the practical course and the seminar is
	required to reach the study objectives of the module. The teaching staff will inform about further details at the
	beginning of the courses.
Admission requirements for the	Writing of a practical course protocol.
module examination	Triang of a practical course protocol.
Requirements for the award of	Oral examination concerning contents of the lecture,
credit points (forms of examination,	seminar and practical course (100%)
weighting of grades in %)	. , ,

Module number	MMLS.A17
Module name	Genome Integrity, Tumors and Ageing
Module coordinator	Jungnickel
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	V: 2 hpw
exercise, practical course)	P: 5 hpw
	S: 2 hpw
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
 self-study (incl. examination preparation) 	-195 h
Contents	Object of the lecture are the molecular and cell biological
	basics of genome integrity, tumor biology, stem cell
	biology and of ageing of cells and tissue as well as the
	genetic and epigenetic basics of cellular plasticity in the
	immune system and the nervous system. Regular and
	pathological molecular mechanisms are discussed with
	selected literature and a scientific topic has to be prepared
	independently (with instructions).
	Each student has to attend two seminars of own choice in the field of stem cell biology, ageing, plasticity in the
	immune system or neuronal plasticity and has to take part
	actively with a presentation and discussion.
Learning and qualification objectives	It is the objective of the module to get an overview on
	specific cellular mechanisms which allow plasticity,
	degeneration and regeneration of cells and organs as well
	as developing an understanding of possibilities of
	disorders and effects on the entire organism. Development
	of validated, proofed results and classification into a
	general scientific context. Regular participation in the
	practical course and the seminar is required to reach the
	study objectives of the module. The teaching staff will inform about further details at the beginning of the
	courses.
Admission requirements for the	0001000.
module examination	
Requirements for the award of	Two seminar presentations (50% each), major course
credit points (forms of examination,	assessment for the lecture and practical course
weighting of grades in %)	

Module number	MMLS.A12
Module name	Organelles: Development and Function
Module coordinator	Oelmüller
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory, compulsory elective module)	Compulsory elective module, Advanced module
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	P: 5 hpw S: 2 hpw
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	-105 h -195 h
Contents	Basic molecular methods on the development of organelles, the communication among organelles, the gene expression in organelles and the photosynthesis are provided in the practical course and seminar.
Learning and qualification objectives	Understanding of the role of organelles of plant cells and their importance for the metabolism; practical experience in molecular and physiological laboratory techniques for analysis of this context; strategical understanding to be able to solve scientific problems. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral examination (70%), Seminar presentation (30%), major course assessment for the practical course

Module number	MMLS. A 13
Module name	Cellular Networks
Module coordinator	Jungnickel
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	P: 5 hpw
exercise, practical course)	S: 2 hpw
	·
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
 self-study (incl. examination 	-195 h
preparation)	
Contents	Topics are molecular basics in formation, maintenance,
	modulation and interaction of cellular networks in complex
	tissues such as e. g. immune system, nervous system,
	tumor tissue or the stem cell niche. Normal and
	pathological molecular mechanisms will be discussed with
	the help of selected literature and a scientific topic will be
	worked out independently (with instruction).
Learning and qualification objectives	The aim of the module is to provide an overview of specific
	cellular mechanisms, which enable the formation and
	function of complex organ systems as well as to develop a
	comprehension of possible disorders and their impact on
	the entire organism. In the practical course validated and
	verified results should be achieved and classified into a
	general scientific context. Regular participation in the
	practical course and the seminar is required to reach the
	study objectives of the module. The teaching staff will
	inform about further details at the beginning of the
	courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of	Two seminar presentations (50% each), major course
credit points (forms of examination,	assessment for the practical course
weighting of grades in %)	

Module number	MMLS. A 14
Module name	Systems Neurobiology
Module coordinator	Bolz
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	L: 2 hpw
exercise, practical course)	P: 4 hpw
·	S: 2 hpw
	·
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-120 h
 self-study (incl. examination 	-180 h
preparation)	
Contents	What and how we sense, think and feel is also affected by the architecture of our brain. The brain again is solely the product of evolution and therewith formed by incidental mutations and selection. Thus it is no design of engineers or computer scientists. This has important consequences on how we realise the world and how we experience ourselves in this world. The lecture teaches insight to the functional architecture of the brain and is dealing with neuronal mechanisms of cognition, learning and memory processes as well as neuronal biological basics of emotions and awareness. In the seminar current papers on selected topics of the lecture will be presented and discussed by the students. In the practical course, among other things, the students will perform behavioral tests with mice and optical imaging of neuronal activity in the visual cortex.
Learning and qualification objectives	The aim of this module is to get insight into the functional architecture of the brain and the neuronal mechanisms. Realisation of experiments on above mentioned topics, including writing of scientific protocols, presentation of scientific results and dealing with scientific literature. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
Admission requirements for the	Writing of a practical course protocol.
module examination	Muitten avancia tien appanie e actual at the late
Requirements for the award of	Written examination concerning contents of the lecture
credit points (forms of examination,	(70%), seminar presentation (30%), major course
weighting of grades in %)	assessment for the practical course

Module number	MMLS. A 15
Module name	Development and Plasticity of the Nervous System
Module coordinator	Bolz
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module, Project module, Master thesis
Type of module (compulsory, compulsory elective module)	Compulsory elective module, Advanced module
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	L: 2 hpw
exercise, practical course)	P: 4 hpw
,	S: 2 hpw
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Credit points (ECTS credits)	10 cp
Workload in hours:	•
- in class and	-120 h
- self-study (incl. examination	-180 h
preparation)	
Contents	This module provides an overwiew about fundamental processes in development and plasticity of the nervous system. Major points are embryonic development of the nervous system (neuronal migration, formation of specific neuronal connections), postnatal developmental plasticity (experience and activity dependent modifications of neuronal circuits, critical periods) and plasticity in the adult brain (learning induced plasticity, restoration of function in the aging brain). In the practical course different in vitro assays are performed to examine neuronal migration and axon guidance. Furthermore, the analysis of transgenic mice with modified neuronal circuits will also be part of the practical course.
Learning and qualification objectives Admission requirements for the	Overview on molecular and cellular processes of development and plasticity of the nervous system; critical discussion of current publications on this topic; independent use of methodical approach of developmental neurobiology; guided analysis of the collected data with relevant methods. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
module examination	
Requirements for the award of	Protocols for the practical course in a group of two (70%),
credit points (forms of examination,	seminar presentation (30%)
weighting of grades in %)	

Module number	MMLS.A16
Module name	Symbiosis, signalling and metabolism
Module coordinator	Sasso
Admission requirements	at least 1 successfully completed Basic module
Usability (required for)	Specialisation module , Project module, Master thesis
Type of module (compulsory,	Compulsory elective module, Advanced module
compulsory elective module)	
Frequency of offer (module cycle)	Yearly, SS
Duration of module	1 semester
Module composition/ Forms of	
instruction (lecture, seminar,	V: 1 hpw
exercise, practical course)	P: 5 hpw
	S: 1 hpw
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	-105 h
- self-study (incl. examination	-195 h
preparation) Contents	This good do discuss a selected to is force combined.
	This module discusses selected topics from symbio-sis, signalling and metabolism in plants and microor-ganisms, including the mutualism between leguminous plants and rhizobia, interactions between microalgae and bacteria, G protein-coupled receptors and calci-um signalling, and the metabolism of carbohydrates, phenylpropanoids and terpenes including involved enzymes in land plants. In the practical course, stu-dents can participate in an ongoing project of the re-search group.
Learning and qualification objectives	Basic knowledge and insights into current research questions in the fields mentioned above; molecular and microbiological laboratory methods for unicellular algae; reading and assessment of the scientific prima-ry literature and seminar talk on a selected article. Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.
Admission requirements for the module examination	Writing of a practical course protocol.
Requirements for the award of	Oral or written examination (70%). Seminar presentation
credit points (forms of examination,	Oral or written examination (70%), Seminar presentation (30%), major course assessment for the practical course
weighting of grades in %)	(50%), major course assessment for the practical course (protocol)
	(protocol)

Module number	MMLS.T1
Module name	Specialisation module MMLS
Module coordinator	Supervisor (Theißen, Baniahmad, Jungnickel, Englert, Schuster, Mittag, Sasso, Spänkuch, Görlach, Heinemann, Oelmüller, Bolz, Lehmann)
Admission requirements	at least 2 Basic modules and 2 Advanced modules
Usability (required for)	Master thesis
Type of module (compulsory, compulsory elective module)	Compulsory module
Frequency of offer (module cycle)	Every semester (WS, SS)
Duration of module	1 semester (half of the semester, the whole day)
Module composition/ Forms of	practical course
instruction (lecture, seminar,	
exercise, practical course)	
Credit points (ECTS credits)	10 cp
Workload in hours:	
- in class and	- 230 h
 self-study (incl. examination preparation) 	- 70 h
Contents	The module provides a specialisation in current methods
	on special topics of MLS.
Learning and qualification objectives	Development of special techniques
Admission requirements for the	none
module examination	
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral examination (ca. 15 min) 100%

Module number	MMLS.T2
Module name	Project Module MMLS
Module coordinator	Supervisor (Theißen, Baniahmad, Jungnickel, Englert, Schuster, Mittag, Sasso, Spänkuch, Görlach, Heinemann, Oelmüller, Bolz, Lehmann)
Admission requirements	at least 2 Basic modules and 2 Advanced modules
Usability (required for)	Master thesis
Type of module (compulsory, compulsory elective module)	Compulsory module
Frequency of offer (module cycle)	Every semester (WS, SS)
Duration of module	1 Semester (half of the semester, the whole day)
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	practical course
Credit points (ECTS credits)	20 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	- 470 h - 130 h
Contents	The module deepens knowledge of selected research areas and provides technical preparation of the Master thesis. It is guided research work including the preparation of literature data and experimental work on a special topic of MLS, which is integrated into the current research works of the offering institution.
Learning and qualification objectives	Focus on specific research work; planning experiments; setting up a work schedule; methodology of data collection; analysis of molecular biological data; record-keeping of scientific work
Admission requirements for the module examination	none
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Presentation (100 %)

Module number	MMLS.T3
Module name	Master thesis MLS
Module coordinator	Supervisor (Theißen, Baniahmad, Jungnickel, Englert, Schuster, Mittag, Sasso, Spänkuch, Görlach, Heinemann, Oelmüller, Bolz, Lehmann)
Admission requirements	successful completion of the Modules MMLS.T1 and MMLS.T2
Usability (required for)	-
Type of module (compulsory, compulsory elective module)	Compulsory module
Frequency of offer (module cycle)	Yearly (WS, SS)
Duration of module	1 Semester
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	practical course
Credit points (ECTS credits)	30 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	- 700 h class hours - 200 h self-study
Contents	The Master thesis shall prove that the student is able to handle a scientific problem within 6 months using scientific methods. The topic of the Master thesis is supervised by one of the module-coordinators and has to be agreed with this person. A high value is set particularly on thoroughly data collection, analysis and interpretation. Experience in an independent writing of a scientific work is gained during the module. The module guides to an independent scientific work on own responsibility.
Learning and qualification objectives	Setting up a work schedule; independent experiment planning and analysis as well as writing a scientific paper
Admission requirements for the module examination	None
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Master thesis (100 %)