QBio201: Molecular Mechanism of the Cell

Module Responsible: Prof. Dr. Ilka Axmann	**Version:** 02/01/2021
Module Organizer: Prof. Dr. Ilka Axmann	**Type:** Compulsory

Lecturer:
Prof. Dr. Ilka Axmann, Prof. Dr. Matias Zurbriggen, Prof. Dr. Markus Pauly, Dr. Vicente Ramírez

Total Working Time	**Credit Points**	**Contact Time**	**Self Study**	**Duration**
360 h	12 CP	150 h	210 h	1 Semester

Course Components		**Group Size**	**Frequency**
Lecture :	5 SWS	P: 40	Every Summer Semester
Exercise:	3 SWS	P: 40	
Practical :	2 SWS	P: 20	

Learning Competencies:
The students have basic knowledge of the fundamental molecular mechanisms of the cell. Knowledge on cellular structures as well as processes involved in the flow of information in a cell, e.g. transcription, translation, replication, cell cycle, gene regulation and signalling.
After completing the module, students are able to

- reproduce comparatively the structure of a cell as well as the process of gene expression of pro- and eukaryotes (gene organization and regulation, transcription, translation and post-translational modifications of proteins).
- explain processes of the cell cycle, cell division and replication.
- explain selected molecular biological methods (see content) and name their areas of application.
- deal under supervision with the basic measuring instruments and apparatus of molecular biology and to explain how they work.

Content:

1. The cell
   - Prokaryotes and eukaryotes; Components of prokaryotic and eukaryotic cells; Structural features of cells; Multicellularity and cell specialization; Cell division, Cell cycle, Mitosis, Meiosis
   - Cell membranes and their dynamics: structure of biological membranes; Recognition and adhesion of cells; Membrane transport; Endo- and exocytosis; Endomembrane system, glycosylation, cytoskeleton, chemical syntheses and information processing
   - energy conversion in chloroplasts and mitochondria [-> QBio301: Cell Bioenergetics]
2. Genes
   - Gene expression in prokaryotes and eukaryotes: gene organization; Transcription (promoters, RNA polymerases and their auxiliary factors); genetic code; Translation

(ribosomes, tRNAs, translation process); Transport and post-translational modification of proteins
- Regulatory RNAs: RNAi, microRNAs, CRSPR-Cas
- Replication of DNA: Enzymatic DNA Synthesis; Meselson Stahl experiment; Chemism of enzymatic DNA synthesis;
- How DNA polymerases work; Replication mechanism. Leader strand + follower strand, strand polarity, okazaki fragments, polymerase processivity, clamp protein, replisome. Origin of replication in prokaryotes and eukaryotes. Telomeres + telomerase. Replication accuracy: Proofreading. Mismatch repair.
- DNA mutations: genotype, phenotype, selection. Mutation types. Direct repair, base and nucleotide excision repair, linking of non-homologous strand ends.
- Homologous recombination: Holliday structure, splice + patch recombinants. SOS response + cell cycle control
- Epigenetics: histone modifications, DNA methylation
- Mobile genetic elements: insertion element, transposon, transposon replication

3. Microbes and viruses [-> QBIO101: Network of Life]
   - Genome diversity, structure, general replication cycle, lysis + lysogeny, retrovirus, transcription + replication, viroid, prion
   - bacteria: cellular structure, morphology, cell division, growth control, pathogenicity, virulence factors, DNA exchange through transduction, transformation, conjugation, F-plasmid, resistance mechanisms.
   - Gene regulation: end product inhibition, lac operon, substrate induction, antibiotic effect, antibiotic resistance and mechanisms. Resistance plasmid.
   - Genome, essential genes, restriction and modification (restriction enzymes).
4. Molecular Biology Applications
   - DNA sequencing, polymerase chain reaction (PCR), DNA mapping, sequencing, DNA fingerprinting, recombinant DNA technology, recombinant DNA technology: cloning, mapping, restriction and ligation, cDNA cloning, gene inactivation. Heterologous gene expression.
   - Biotechnology
   - Monogenic diseases
   - Stem cells (types and concepts), mitosis, cell cycle, cell communication and signal chains, apoptosis, cancer development

Conditions of Participation:
Enrolled in Quantitative Biology

Examination:
Learning portfolio consisting of
- Written exams based on the content of the lectures (50% of the final grade)
- Exercises (25% of the final grade)
- Protocol (25% of the final grade)

Prerequisites for Awarding Credits for this Module:
- Passing Exercises (50 % of Exercise Sheets)
- Passing Written Exam
- Successful Participation at The Lab Course

Factor for the Overall Grade: The grade is weighted according to the credit points (CP) in the overall grade.
Language: English
Literature: Molekulare Genetik Knippers Molecular Biology 3rd Edition Authors: David Clark Nanette Pazdernik Michelle McGehee 2018 Molecular Biology of the Cell (Sixth Edition) by Bruce Alberts 2014 Molecular biology principles and practice (Cox and Doudna)
Further Information: