Course descriptions:	
Department/Code	KBB/MBBRE
Title	Molecular Cell Biology of Plants
Accredited / Credits	2
Time requirements – (hours/year)	Lecture 3 hours/week
Timetable	Yes
Minimum (B + C) students	Not set
Substituted course	None
Preclusive courses	None
Prerequisite courses	None
Informally recommended courses	None
Courses depending on this Course	None
Academic Year	2018/2019
Form of course completion	Exam
Type of completion	Combined
Course credit prior to examination	No
Included in study average	Yes
Language of instruction	English
Repeated registration	No
Semester taught	WS
Optional course	None
Internship duration	N/A

Course objectives (annotation):
The aim of the course is to teach students on the molecular structure and functional organization of plant cells, principles of cell organelles and compartments. Attention will also be given on the ontogenesis and differentiation of plant cells and their organization into tissues and organs. The subject summarizes the knowledge of molecular cell biology, genetics, structural molecular biology, biochemistry and physiology.

Course content (syllabus)
1. Introduction to plant cell biology, endosymbiotic theory, brief overview of plant cells, structural and functional compartmentalization of plant cells, semiautonomous and other organelles, cell

compartments, vesicles, plant cell specifics - plastids, cytoskeleton, cell wall
2. Cell wall in plants, structure, ontogenesis and function, cell plate development, primary and secondary cell wall, molecular components - cellulose, pectin, hemicelluloses, glycoproteins and proteoglycans, lignin, suberin, concept of continuum / interaction cell wall - plasma membrane - cytoskeleton in plants
3. Plasma membrane, structure, structural proteins, receptors, pumps, channels, structural lipids and phospholipids, interactions with the environment
4. Vesicular transport I: vesicular secretion, endoplasmic reticulum (ER), Golgi, trans-Golgi network, vacuoles, vesicles, structure and function with emphasis on molecular aspects, chaperones (BiP, calreticulin), ER stress, adaptor proteins, coat proteins COPI, COPII, SNARE proteins, VSR (vacuolar sorting receptors), Rab GTPase, Exocyst complex, SCAMP
5. Vesicular transport II: endocytosis, molecular structure and function of endosomes and endocytosis in plants, clathrin, adaptor proteins, dynamin, Rab GTPases, sorting nexin, Escort complex, Retromer complex
6. Plant cytoskeleton, tubulin, microtubules, microtubule associated proteins (MAPs), kinesin motor proteins, actin, actin cytoskeleton, actin binding proteins (ABPs), myosin motor proteins, organization and dynamic cytoskeleton changes during cell ontogenesis, cytoskeletal mutants, interactions between microtubules and actin
7. Signalling, signal transmission, plasma membrane receptor kinases, interactions of signal molecules with cytoskeleton and vesicular transport, protein kinase with emphasis on plant mitogen-activated protein kinase, their localization, substrates and functions, secondary signal transducers in plants - Ca, ROS, NO, PI
8. Ontogenesis and differentiation of plant cells, stem cells, cell division and growth, mitosis and meiosis, plant cell specificity (cell division and phragmoplast), totipotency of plant cells and derived biotechnological aspects, biodiversity and specialized plant cell types, symmetrical and asymmetric divisions, plant polarity
9. Cell nucleus, nucleolus, structure, dynamics, molecular structure and function, nuclear membrane, nuclear pores, heterochromatin, euchromatin, transcription, chromosomes
10. Plastids, types of plastids - proplastids, chloroplasts, amyloplasts, leucoplasts, chromoplasts, molecular structure and functions, molecular basis of photosynthesis, dynamics and movement of plastids
11. Mitochondria, peroxisomes, glyoxisomes, liposomes, structure and function, molecular basis of respiration, division of mitochondria, dynamics and movement of mitochondria and peroxisomes
12. Intercellular interactions, plasmodesmata, development of cells in tissues and organs, polarity, molecular aspects of polar growth, interactions of plant cells with microorganisms (symbiosis, mycorrhiza)

Requirements on students
70% test in the scope of the subject.

Guarantors and lecturers
Guarantors: prof. RNDr. Jozef Šamaj, DrSc. **Lecturer:** prof. RNDr. Jozef Šamaj, DrSc.

Literature
Recommended: Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. *Molecular biology of the cell. 5th edition*. Tailor & Francis, 2007. **Recommended:** Gunning BES. *Plant cell biology on DVD*. Springer, 2009. **Recommended:** Šamaj, Baluška, Menzel. *Plant Endocytosis*. Springer, pp. 314, 2006.

Study programmes
Molekulární a buněčná biologie 1515R004
Biochemie 1406T002
Biologie 1501R001
Biofyzika 1702T005

Competences acquired
Student will be able to: - define the main concepts and describe the main approaches used in molecular cell biology of plants

Teaching methods
Monologic Lecture(Interpretation, Training)

Assessment methods
Written exam

Course descriptions:	
Department/Code	KBC/MBIOE
Title	Molecular Biology
Accredited / Credits	3
Time requirements – (hours/year)	3 h lecture +1 h seminar/week, 13 weeks/semester; total 52 h/year
Timetable	Yes
Minimum (B + C) students	Not set
Substituted course	None
Preclusive courses	None
Prerequisite courses	None
Informally recommended courses	None
Courses depending on this Course	None
Academic Year	2018/2019
Form of course completion	Examination
Type of completion	Oral
Course credit prior to examination	No
Included in study average	Yes
Language of instruction	English
Repeated registration	No
Semester taught	WS
Optional course	No
Internship duration	-

Course objectives (annotation):

The subject gives advanced and complex view of molecular processes in cells. Lecturing is based on an international textbook Molecular Biology of the Cell supplemented with newest findings in the field. The lectures are accompanied with instructive animations and videos of molecular and cellular structures and events and seminar discussion. The course includes ten specific topics covering the background and molecular principles of important cellular processes. Two additional topics provide an overview of advanced techniques of molecular biology that made possible to reach the current level of knowledge.

Course content (syllabus)

Lecture topics:

1. **Cells and genomes.** Definition of genome, gene, gene types. DNA, RNA and the central dogma of molecular biology. Evolution of genes and organisms. Tree of Life. Gene and genome sizes. Model organisms.
2. **DNA and chromosomes.**Structure of DNA in prokaryotes and eukaryotes. Structure of eukaryotic chromosomes, chromatin deposition levels. Histones, their function in nucleosomes, replication and transcription. Heterochromatin, euchromatin, centromer and telomeres.
3. **DNA replication, repair and recombination.** The principle of DNA replication, control mechanisms. Replication fork in prokaryotes and eukaryotes, action of DNA polymerase. Auxiliary enzymes, primase, helicase, topoisomerase. Genome replication in prokaryotes and eukaryotes. Errors and DNA damage, DNA repair mechanisms. General and site-specific recombination.
4. **Transcription and translation.** Transcription of gene, RNA polymerase. Formation and processing of mRNA in prokaryotes and eukaryotes. Formation of rRNA. Translation and genetic code. Synthesis of proteins on the ribosome. Protein folding, protein quality monitoring and degradation.
5. **Regulation of gene expression.** Importance of gene expression control, basic principles. Binding of proteins to DNA, types of regulatory proteins. Experimental methods of study of gene expression and its regulation. Regulation of gene expression in prokaryotes. Regulation of gene expression in eukaryotes. Methylation of DNA and its significance for gene expression. Post-transcriptional mechanisms of gene expression regulation. Alternative splicing. Regulated transport and mRNA editing. Gene silencing by interfering RNAs. Translational controls. Riboswitches.
6. **Cellular organization, cytoskeleton.** Biological membranes, composition and structure. Phospholipids and membrane proteins. Cellular filaments – cytoskeleton. Actin filaments, microtubules, intermediate filaments. Motor proteins and their involvement in muscle movement, organelle/vesicle trafficking and in cell division.
7. **Vesicular traffic and protein sorting.** Cellular compartments, different membranes. Types of protein transport. Protein sorting, signal sequences. Pore transport between nucleus and cytosol. Chanel transport into mitochondria and chloroplasts. Transport to other organelles. Transport to endoplasmic reticulum and Golgi apparatus, secretory pathway. Vesicular transport. Endocytosis, pinocytosis and phagocytosis.
8. **Membrane transport.** Permeability of lipid membranes. The importance of membrane transport. Membrane channels, carriers and pumps. Passive and active transport. Types of membrane pumps and transporters. Ion channels and membrane polarization. Propagation of the signal in neuron cells, neuromuscular synaptic junction, spinal cord cells. Energy conversion on membranes. The process of obtaining energy in mitochondria. The process of obtaining energy in chloroplasts.
9. **Signaling.** Cell signaling, basic principles and regulatory mechanisms. Receptor types. Signaling through G-protein coupled receptors. Signaling through tyrosine kinases. Other types of membrane receptors. Signaling through nuclear receptors. Specific signaling pathways in plants.
10. **Cell cycle and apoptosis.** Phases of the cell cycle. Checkpoints and cell cycle control systems, cyclin dependent kinases. Mitosis and meiosis. Apoptosis - programmed cell death. Caspase enzymes. Extrinsic and intrinsic apoptotic pathway. Regulation by survival factors.
11. **Techniques of molecular biology I.** Manipulation of DNA, RNA and proteins. Cell culture types. Cell fractionation. Protein purification and determination of protein structure. Gene cloning, library preparation. DNA sequencing. Determination of genome sequences of whole organisms. PCR method and its applications. Methods of study of protein-protein and protein-DNA interactions. Methods of study of gene expression and function. Genetic manipulation, genome editing by CRISPR/Cas9.
12. **Techniques of molecular biology II.** Visualization of cells and cellular structures. Cell

visualization - light and fluorescence microscopy. Visualization of components in living cells. Observation of cell dynamics. Electron microscopy, types and applications. Particle reconstruction and tomography.

Requirements on students
The subject is intended for master students of biochemistry and related disciplines
Activities linked with the course (e-learning, etc.)
None

Guarantors and lecturers
prof. RNDr. Ivo Frébort, CSc., Ph.D.

Literature
Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P: Molecular Biology of the Cell. 6th edition. Garland Science, 2015.

Study programmes
1406T002 Biochemie
1406T012 Biotechnologie a genové inženýrství
1702T005 Biofyzika

Time Requirements	
Activities (Attendance, etc.)	**Time requirements for activity [h]**
Attendance	48
Preparation for the exam	50

Competences acquired
Abilities to define main concepts and describe main approaches used in molecular and cell biology.

Teaching methods
Lecture, dialogic lecture (discussion, dialog, brainstorming)

Assessment methods
Oral examination

Course descriptions:	
Department/Code	KBF/BISE
Title	Biological Experiments In Silico
Accredited / Credits	Yes/2
Time requirements – (hours/year)	2 hours per week
Timetable	Yes
Minimum (B + C) students	Not set
Substituted course	KBF/BEIS, KBF/BIS, KBF/BIOKY
Preclusive courses	None
Prerequisite courses	None
Informally recommended courses	None
Courses depending on this Course	None
Academic Year	2018/2019
Form of course completion	Examination
Type of completion	Combined
Course credit prior to examination	No
Included in study average	Yes
Language of instruction	English
Repeated registration	No
Semester taught	SS
Optional course	Yes
Internship duration	-

Course objectives (annotation):

Obtaining basic general knowledge about in silico biology, i.e., about studying of biological organisms and processes by means of computer modelling and simulations.

Course content (syllabus)

- Introduction (mathematics in biology, purpose of modelling, motivating example – AIDS/HIV research)
- Basic mathematics (linear, exponential and other functions, differential equations)

- Descriptive models and basic data analysis (linear and exponential regressions, χ^2 method)
- Estimation of model parameters (different methods)
- Model validation and verification (Kullback-Liebler divergence, Occam's razor principle, Akike information criterion)
- Chemical reaction kinetics and its modelling (types of reactions, reaction order, law of mass action, master equations, Markov chain)
- Michaelis-Menten and Hill enzymatic kinetics
- Transition state rate theory and rate of electron tunneling
- Modelling of oscillating chemical/biological systems (phase space, criteria for oscillations, Lotka-Voltera model, Brusselator, Belousov-Zhabotinsky reaction, Oregonator, glycolysis in yeast, photosynthetic oscillations)
- Metabolic control analysis (assumptions, control and response coefficients, elasticity, summation and connectivity theorems, biological examples)
- Examples of complex models – modeling of photosynthetic processes (different models)

Requirements on students

Passing the oral examination.

Activities linked with the course (e-learning, etc.)

-

Guarantors and lecturers

Guarantor: doc. RNDr. Dušan Lazár, Ph.D.

Lecturer: doc. RNDr. Dušan Lazár, Ph.D.

Literature

- Britton N.F., Essential Mathematical Buiology, Springer, 2003
- Edelstein-Keshet L., Mathematical Models in Biology, Siam, 2005
- Haefner J.W., Modeling Biological Systems, Principles and applications, 2nd Edition, Springer 2005
- Ellner S.P., Guckenheimer J., Dynamic Models in Biology, Princeton University Press, 2006
- Otto S.P., Day T., A Biologist´s Guide to Mathematical Modeling in Ecology and Evolution, Princeton University Press, 2007
- Bisswanger H., Enzyme Kinetics, 2nd Edition, Wiley-Vch, 2008
- Laisk A., Nedbal L., Govindjee (eds.), Photosynthesis In Silico: Understanding Complexity from Molecules to Ecosystems. Springer, 2009
- Roussel M.R., A Life Scientist´s Guide to Physical Chemistry, Cambridge University Press, 2012
- Rubin A., Riznichenko G., Mathematical Biophysics, Springer, 2014

Study programmes

Biofyzika 1702T005

Experimentální biologie rostlin 1501T029

Time Requirements	
Activities (Attendance, etc.)	**Time requirements for activity [h]**
Preparation for the Exam	24
Attendance	30
Total	54

Competences acquired
The student will be able to define, write and solve mathematical models of basic biological processes.

Teaching methods
Lecture

Assessment methods
Grading