University of Debrecen
Faculty of Science and Technology
Institute of Biotechnology

BIOTECHNOLOGY BSC PROGRAM

2024

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DEAN'S WELCOME

Welcome to the Faculty of Science and Technology!

This is an exciting time for you, and I encourage you to take advantage of all that the Faculty of Science and Technology UD offers you during your bachelor's or master's studies. I hope that your time here will be both academically productive and personally rewarding.

Being a regional centre for research, development and innovation, our Faculty has always regarded training highly qualified professionals as a priority. Since the establishment of the Faculty in 1949, we have traditionally been teaching and working in all aspects of Science and have been preparing students for the challenges of teaching. Our internationally renowned research teams guarantee that all students gain a high quality of expertise and knowledge. Students can also take part in research and development work, guided by professors with vast international experience.

While proud of our traditions, we seek continuous improvement, keeping in tune with the challenges of the modern age. To meet our region's demand for professionals, we offer engineering courses with a strong scientific basis, thus expanding our training spectrum in the field of technology. Recently, we successfully re-introduced dual training programmes in our constantly evolving engineering courses.

We are committed to providing our students with valuable knowledge and professional work experience, so that they can enter the job market with competitive degrees. To ensure this, we maintain a close relationship with the most important companies in our extended region. The basis for our network of industrial relationships are in our off-site departments at various different companies, through which market participants - future employers - are also involved in the development and training of our students.

Prof. Dr. Ferenc Kun
Dean

UNIVERSITY OF DEBRECEN

Date of foundation: 1912 Hungarian Royal University of Sciences, 2000 University of Debrecen

Legal predecessors: Debrecen University of Agricultural Sciences; Debrecen Medical University; Wargha István College of Education, Hajdúböszörmény; Kossuth Lajos University of Arts and Sciences

Legal status of the University of Debrecen: non-profit non-public university with legal personality

Founder of the University of Debrecen: Count István Tisza Foundation for the University of Debrecen

Supervisory body of the University of Debrecen: Ministry of Culture and Innovation

Number of Faculties at the University of Debrecen: 13

Faculty of Agricultural and Food Sciences and Environmental Management

Faculty of Child and Special Needs Education

Faculty of Dentistry

Faculty of Economics and Business

Faculty of Engineering

Faculty of Health Sciences

Faculty of Humanities

Faculty of Informatics

Faculty of Law

Faculty of Medicine

Faculty of Music

Faculty of Pharmacy

Faculty of Science and Technology

Number of students at the University of Debrecen: 30,899

Full time teachers of the University of Debrecen: 1,597

210 full university professors and 1,262 lecturers with a PhD.

FACULTY OF SCIENCE AND TECHNOLOGY

The Faculty of Science and Technology is currently one of the largest faculties of the University of Debrecen with about 2,500 students and more than 200 staff members. The Faculty has got 6 institutes: Institute of Biology and Ecology, Institute of Biotechnology, Institute of Chemistry, Institute of Earth Sciences, Institute of Physics and Institute of Mathematics. The Faculty has a very wide scope of education dominated by science and technology (12 Bachelor programs and 14 Master programs), additionally it has a significant variety of teachers' training programs. Our teaching activities are based on a strong academic and industrial background, where highly qualified teachers with a scientific degree involve students in research and development projects as part of their curriculum. We are proud of our scientific excellence and of the application-oriented teaching programs with a strong industrial support. The number of international students of our faculty is continuously growing (currently ~790 students). The attractiveness of our education is indicated by the popularity of the Faculty in terms of incoming Erasmus students, as well.

THE ORGANIZATIONAL STRUCTURE OF THE FACULTY

Dean: Prof. Dr. Ferenc Kun, Full Professor
E-mail: ttkdekan@science.unideb.hu

Vice Dean for Educational Affairs: Prof. Dr. Gábor Kozma, Full Professor
E-mail: kozma.gabor@science.unideb.hu

Vice Dean for Scientific Affairs: Prof. Dr. Sándor Kéki, Full Professor
E-mail: keki.sandor@science.unideb.hu

Consultant on External Relationships: Prof. Dr. Attila Bérczes, Full Professor
E-mail: berczesa@science.unideb.hu

Consultant on Talent Management Programme: Prof. dr. Tibor Magura, Full Professor
E-mail: magura.tibor@science.unideb.hu

Dean's Office
Head of Dean's Office: Mrs. Katalin Kozma-Tóth
E-mail: toth.katalin@science.unideb.hu

English Program Officer: Mrs. Alexandra Csatáry
Address: 4032 Egyetem tér 1., Chemistry Building, A/101, E-mail:
acsatary@science.unideb.hu

DEPARTMENTS OF INSTITUTE OF BIOTECHNOLOGY

Head of Institute	Position	E-mail	Room
Mr. Dr. Dávid Domonkos, PhD, senior research fellow	Director of Institute	domonkos.david@science.unideb.hu	Campus Hotel (Kassai Street Campus), floor 3, A310

Department of Biochemical Engineering
4032 Debrecen, Egyetem tér 1, Chemistry Building

Head of Department	Position	E-mail	Room
Mr. Prof. Dr. Levente Karaffa, PhD, habil, DSc	University Professor, Head of Department	levente.karaffa@science.unideb.hu	Chemistry Building D-8 (ground floor)

Department of Genetics and Applied Microbiology
4032 Debrecen, Egyetem tér 1, Life Science Building

Head of Department	Position	E-mail	Room
Mrs. Dr. Ida Miklós, PhD, habil	Associate Professor, Head of Department	miklos.ida@science.unideb.hu	LSB 2.503

Department of Molecular Biotechnology and Microbiology
4032 Debrecen, Egyetem tér 1, Life Science Building

Head of Department	Position	E-mail	Room
Mr. Prof. Dr. István Pócsi, PhD, habil, DSc	University Professor, Head of Department	pocsi.istvan@science.unideb.hu	LSB 1.105

ACADEMIC CALENDAR

General structure of the academic semester (2 semesters/year):

Study period	1st week	Registration	1 week
	2nd – 15th week	Teaching period	14 weeks
Exam period	directly after the study period	Exams	7 weeks

*Usually, registration is scheduled for the first week of September in the fall semester, and for the first week of February in the spring semester.

For further information please check the following link:
https://www.edu.unideb.hu/tartalom/downloads/University_Calendars_2023_24/University_calendar_2023-2024-Faculty_of_Science_and_Technology.pdf

THE BIOTECHNOLOGY BACHELOR PROGRAM

Information about the Program

Name of BSc Program:	Biotechnology BSc Program
Specialization available:	
Field, branch:	Science
Qualification:	Biotechnology
Mode of attendance:	Full-time
Faculty, Institute:	Faculty of Science and Technology Institute of Biotechnology
Program coordinator:	Prof. Dr. István Pócsi, Head of Department of Molecular Biotechnology and Microbiology
Student advisor:	Dr. Éva Leiter, associate professor
Duration:	6 semesters
ECTS Credits:	180

Objectives of the Biotechnology BSc program

Biotechnology is a dynamically developing discipline whose main goal is to find biologically based solutions to various industrial, agricultural, and biomedical challenges. The Biotechnology BSc course at the University of Debrecen is based on the following pillars: (i) completion of a broad-spectrum natural science and IT module, (ii) acquisition of basic skills in molecular biology, and (iii) transfer of basic knowledge of natural science, IT and molecular biology in the rich repertoire of biotechnology subjects. It is important that we provide students with a large number of laboratory practices, with the help of which students can become familiar with the main branches of modern biotechnology.

Professional competences to be acquired

A Biotechnologist:

a) Knowledge:

- Have a knowledge of the history and recent most important areas and their direction of development of biotechnology
- Acquired the theoretical and practical background of white (applied microbiology, fermentation technology, bioenergy, biotechnological and biorefinery processes), red (pharmaceutical and medical biotechnology, development of diagnostics, therapeutic devices and biopharmacones with biotechnological methods) and green (plant, animal and food biotechnology methods and products) as well as environmental (bioremediation technologies, waste water treatment) biotechnology and of biotechnology related sciences, *e.g.* chromatographic techniques and bioanalytics
- Have a basic knowledge of molecular biotechnology (gene technology) required for the implementation of different biotechnological areas
- Have essential knowledge of informatics, bioinformatics, omics (genomics, transcriptomics, proteomics, metabolomics) required for the molecular approach-based biotechnological research
- Have a basic natural scientific knowledge of the disciplines of biology (biochemistry, biophysics, cell biology, physiology, immunology, microbiology, genetics, molecular biology, molecular ecology), chemistry (inorganic chemistry, organic chemistry, physical chemistry, analytical chemistry), mathematics and physics.
- Have a knowledge how to evaluate, discuss and present experimental results
- To be aware of legal, ethical, economic, quality assurance and safety regulations of the biotechnological activities
- To be aware of public (national and international) perception of the biotechnological activities

b) Abilities:

- able to perform subtasks in the introduction, operation and development of biotechnological processes according to professional instructions, to plan, implement, evaluate and discuss simple laboratory experiments in the areas of biotechnology including white (carrying out basic fermentation procedures), red (application of the most important, biotechnology based diagnostics, therapeutics, production of biopharmacons), green (micropropagation of plants, production of probiotics, animal cell fermentation technologies) and environmental (monitoring of pollutants, application of basic phytoremediation and waste water treatment technologies).
- to be able to apply simple chromatographic techniques and bioanalytical methods under professional supervision
- to be able to genetically modify, work and maintain bacteria (above all *Escherichia coli*), yeasts (*Saccharomyces cerevisiae*) and other GM organisms.
- to be able to analyse informatics, bioinformatics and genomic data, furthermore to search for Hungarian and English databases and scientific literature, to extract, interpret and organize data required for work on its own.
- to be able to expand his/her professional knowledge
- to be able to perform team work with experts from other scientific areas (biologists, environmental scientists, engineers, bioengineers, agronomists, medical doctors and pharmacists)
- to be able to work according to the applicable legal, ethical, economic, quality assurance and safety regulations relating to biotechnological activities.

c) Attitude:

- to be open to acquire new scientific knowledge, try for the continuous learning of the most current biotechnological achievements
- to be constructive, precise in his/her work, try for building professionally and humanly correct, positive and balanced connections/relationships
- try for work with his/her expertise precisely and independently as far as possible
- try for better understanding the activities and demands/needs of his/her company, research organisation and the national biotechnological sector.
- try for increase of his/her scientific knowledge, including further education in MSc program and participation in professional training.
- is committed to environmentally conscious behaviour in and outside of workplace

d) Autonomy and responsibility

- to have the ability to cooperate and contact with leaders and coworkers constructively
- feels responsible for the work of his/her own and of team mates. (Felelősséget érez mind a saját, mind munkatársai munkájával kapcsolatban.)
- to be able to work after acquirement of professional practice, contributes with his/her work consciously and purposefully to fulfil tasks of the team
- follows and enforces the legal, ethical, economic, quality assurance and safety regulations relating to biotechnological activities responsibly
- expresses opinion about professional questions with professionals and non-professionals.
- encourages to follow environmentally conscious behaviour in and outside of work.

Completion of the BSc Program

The Credit System

Majors in the Hungarian Education System have generally been instituted and ruled by the Act of Parliament under the Higher Education Act. The higher education system meets the qualifications of the Bologna Process that defines the qualifications in terms of learning outcomes: statements of what students know and can do on completing their degrees. In describing the cycles, the framework uses the European Credit Transfer and Accumulation System (ECTS).

ECTS was developed as an instrument of improving academic recognition throughout the European Universities by means of effective and general mechanisms. ECTS serves as a model of academic recognition, as it provides greater transparency of study programs and student achievement. ECTS in no way regulates the content, structure and/or equivalence of study programs.

Regarding each major, the Higher Education Act prescribes which professional fields define a certain training program. It contains the proportion of the subject groups: natural sciences, economics and humanities, subject-related subjects and differentiated field-specific subjects.

During the program students have to complete a total amount of 180 credit points. It means approximately 30 credits per semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which takes into account the prerequisite(s) of each subject. You can find the recommended list of subjects/semesters in chapter “Guideline”.

Curriculum for Biotechnology BSc students

Abbreviations: E: oral or written examination; P: practical; S: seminar, SI: signature

Subject/lecturer	Code	Prerequisites	Hours/week in semesters						Credit	Type of examination
Genearal Subjects			**1**	**2**	**3**	**4**	**5**	**6**		
General and Biotech Economic and Management Skills, Communication Seminar Dr. Dávid Domonkos	TTBBG1101_BT_EN		0+2+0						2	G
Bioethics Seminar Dr. János Kristóf Bodnár	TTBBG1102_BT_EN			0+2+0					2	G
The History and Structure of the European Union Lecture Dr. Klára Czimre	TTTBE0030_EN		1+0+0						1	K
Basic Science Subjects										
Physics I. Lecture. Prof. Dr. Zoltán Erdélyi	TTBBE1001_BT_EN		2+0+0						2	K
Physics I. Practical Dr. Petra Pál	TTBBL1001_BT_EN		0+0+1						1	G
Physics II. Lecture Prof. Dr. Zoltán Erdélyi	TTBBE1002_BT_EN	TTBBE1001_BT TTBBL1001_BT		2+0+0					2	K
Physics II. Practical Dr. Petra Pál	TTBBL1002_BT_EN	TTBBE1001_BT TTBBL1001_BT		0+0+1					1	G
Biophysics Lecture Dr. Ferenc Papp	TTBBE1003_BT_EN	TTBBE1002_BT TTBBL1002_BT TTBBG1011_BT				1+0+0			1	K
Biophysics Practical Dr. Ferenc Papp	TTBBL1003_BT_EN	TTBBE1002_BT TTBBL1002_BT TTBBG1011_BT				0+0+2			2	G
General Chemistry Lecture Dr. József Kalmár	TTBBE1004_BT_EN		3+0+0						4	K
General Chemistry Seminar Prof. Dr. Katalin Várnagy	TTBBG1004_BT_EN		0+2+0						0	A
General Chemistry Practical Dr. Annamária Sebestyén	TTBBL1004_BT_EN		0+0+3						3	G
Analytical Chemistry Lecture Prof. Dr. István Fábián	TTBBE1005_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT			2+0+0				2	K
Analytical Chemistry Practical Dr. Csilla Kállay	TTBBL1005_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT			0+0+4				3	G
Organic Chemistry Lecture Prof. Dr. Tibor Kurtán	TTBBE1006_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT		2+0+0					2	K
Organic Chemistry Seminar Prof. Dr. Tibor Kurtán	TTBBG1006_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT		0+1+0					1	G
Organic Chemistry Practical Dr. Juhászné Dr. Éva Tóth	TTBBL1006_BT_EN	TTBBE1006_BT TTBBG1006_BT TTBBL1004_BT			0+0+3				2	G
Inorganic Chemistry Lecture Prof. Dr. Katalin Várnagy	TTBBE1007_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT		2+0+0					2	K
Inorganic Chemistry Practical Dr. Norbert Lihi	TTBBL1007_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT		0+0+2					2	G
Physical Chemistry Lecture Győrváriné Dr. Henrietta Horváth	TTBBE1008_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT		2+0+0					2	K
Physical Chemistry Seminar Győrváriné Dr. Henrietta Horváth	TTBBG1008_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT		0+1+0					1	G
Physical Chemistry Practical Dr. Ferenc Krisztián Kálmán	TTBBL1008_BT_EN	TTBBE1004_BT TTBBG1004_BT TTBBL1004_BT		0+0+2					2	G
Mathematics I. Lecture Prof. Dr. Zoltán Muzsnay	TTBBE1009_BT_EN		4+0+0						4	K
Mathematics I. Practical Prof. Dr. Zoltán Muzsnay	TTBBG1009_BT_EN		0+2+0						2	G
Mathematics II. Lecture and Seminar Prof. Dr. Zoltán Muzsnay	TTBBE1010_BT_EN	TTBBE1009_BT TTBBG1009_BT		1+1+0					2	K

Design and Analysis of Experiments Practical Dr. Borbála Fazekas	TTBBG1011_BT_EN	TTBBE1009_BT TTBBG1009_BT		0+0+2					2	G
Basic Profess Subjects										
Informatics Lecture Dr. Gergő Pál	TTBBE2001_BT_EN		2+0+0						2	K
Informatics Practical Dr. Gergő Pál	TTBBG2001_BT_EN		0+0+2						2	G
Bioinformatics Lecture Prof. Dr. Mátyás Sipiczki	TTBBE2002_BT_EN	TTBBE2001_BT TTBBG2001_BT			2+0+0				2	K
Bioinformatics Practical Dr. Hajnalka Csoma	TTBBG2002_BT_EN	TTBBE2001_BT TTBBG2001_BT			0+0+2				2	G
Introduction to Omics and Systems Biology Lecture and Seminar Dr. András Mádi	TTBBE2003_BT_EN	TTBBG1011_BT TTBBE2002_BT TTBBG2002_BT TTBBE3003_BT TTBBL3003_BT					2+1+0		3	K
Cell Biology Lecture Dr. Gábor Szemán-Nagy	TTBBE2004_BT_EN			2+0+0					2	K
Cell Biology Practical Dr. Gábor Szemán-Nagy	TTBBL2004_BT_EN	TTBBE2004_BT			0+0+2				2	G
Cell Physiology I. Lecture Dr. Péter Szentesi	TTBBE2005_BT_EN	TTBBE2004_BT			2+0+0				2	K
Cell Physiology II. Lecture Dr. Péter Szentesi	TTBBE2006_BT_EN	TTBBE2005_BT				2+0+0			2	K
Biochemistry I. Lecture and Seminar Dr. Teréz Barna	TTBBE2007_BT_EN	TTBBE1006_BT TTBBG1006_BT TTBBL1006_BT TTBBE2004_BT			2+1+0				3	K
Biochemistry Practical Dr. Teréz Barna	TTBBL2007_BT_EN	TTBBE1006_BT TTBBG1006_BT TTBBL1006_BT			0+0+2				2	G
Biochemistry II. Lecture and Seminar Prof. Dr. Gyöngyi Gyémánt	TTBBE2008_BT_EN	TTBBE2007_BT				2+1+0			3	K
Microbial Metabolism Seminar Prof. Dr. Tamás Emri	TTBBG2009_BT_EN	TTBBE2007_BT TTBBE2010_BT				0+2+0			2	G
Microbial Metabolism Practical Prof. Dr. Tamás Emri	TTBBL2009_BT_EN	TTBBE2007_BT TTBBL2007_BT TTBBE2010_BT TTBBL2010_BT				0+0+2			2	G
General and Applied Microbiology Lecture Prof. Dr. István Pócsi	TTBBE2010_BT_EN		2+0+0						2	K
General and Applied Microbiology Practical Dr. Valter Pfliegler	TTBBL2010_BT_EN	TTBBE2010_BT		0+0+2					2	G
Genetics I. Lecture Dr. Gyula Gábor Batta	TTBBE2011_BT_EN			3+0+0					3	K
Genetics I. Practical Dr. Gyula Gábor Batta	TTBBG2011_BT_EN	TTBBE2011_BT			0+0+2				2	G
Genetics II. Lecture Dr. Gyula Gábor Batta	TTBBE2012_BT_EN	TTBBE2011_BT			2+0+0				2	K
Immunology Lecture Dr. Attila Gábor Szöllősi	TTBBE2013_BT_EN	TTBBE2004_BT			2+0+0				2	K
Immunology Practical Dr. Árpád Lányi	TTBBL2013_BT_EN	TTBBE2013_BT				0+0+2			2	G
Physiology of Experimental Animals Lecture Dr. Szentandrássyné Dr. Mónika Gönczi	TTBBE2014_BT_EN	TTBBE2004_BT TTBBL2004_BT TTBBE2005_BT				2+0+0			2	K
Physiology of Experimental Animals Lecture Dr. Szentandrássyné Dr. Mónika Gönczi	TTBBL2014_BT_EN	TTBBE2004_BT TTBBL2004_BT TTBBE2005_BT				0+0+2			2	G
Physiology of Model Plants Lecture Prof. Dr. Csaba Máthé	TTBBE2015_BT_EN	TTBBL2007_BT TTBBE2008_BT					2+0+0		2	K
Physiology of Model Plants Practical Prof. Dr. Csaba Máthé	TTBBL2015_BT_EN	TTBBE2015_BT						0+0+2	2	G
Molecular, Microbial Ecology Lecture Prof. Dr. Tibor Magura	TTBBE2016_BT_EN	TTBBE2010_BT TTBBL2010_BT				2+0+0			2	K

Molecular, Microbial Ecology Practical Prof. Dr. Tibor Magura	TTBBL2016_BT_EN	TTBBE2010_BT TTBBL2010_BT				0+0+2			2	G
Special Courses										
Bioanalytics Lecture Prof. Dr. Gyöngyi Gyémánt	TTBBE3001_BT_EN	TTBBE1005_BT TTBBL1005_BT TTBBE2007_BT TTBBE2008_BT					2+0+0		2	K
Bioanalytics Practical Prof. Dr. Gyöngyi Gyémánt	TTBBL3001_BT_EN	TTBBE1005_BT TTBBL1005_BT					0+0+1		1	G
Separation Techniques Lecture Dr. István Lázár	TTBBE3002_BT_EN	TTBBE1004_BT TTBBE1005_BT TTBBG1006_BT TTBBE1007_BT					1+0+0		1	K
Separation Techniques Practical Prof. Dr. Attila Gáspár	TTBBL3002_BT_EN	TTBBE1005_BT TTBBL1005_BT					0+0+3		3	G
Methods in Molecular Biology and Gene Technology I. Lecture Dr. Krisztina Tar	TTBBE3003_BT_EN	TTBBE2007_BT TTBBE2011_BT TTBBG2011_BT TTBBE2012_BT				2+0+0			3	K
Methods in Molecular Biology and Gene Technology I. Practical Dr. Krisztina Tar	TTBBL3003_BT_EN	TTBBE2007_BT TTBBE2011_BT TTBBG2011_BT TTBBE2012_BT				0+0+1			1	G
Methods in Molecular Biology and Gene Technology II. Lecture and Seminar Dr. Ida Miklós	TTBBE3004_BT_EN	TTBBE3003_BT TTBBL3003_BT					2+1+0		3	K
Methods in Molecular Biology and Gene Technology II. Practical Dr. László Attila Papp	TTBBL3004_BT_EN	TTBBE3003_BT TTBBL3003_BT					0+0+3		4	G
Synthetic Biology Lecture Dr. Zsigmond Benkő	TTBBE3005_BT_EN	TTBBE3004_BT TTBBL3004_BT						2+0+0	2	K
Synthetic Biology Practical Dr. Zsigmond Benkő	TTBBL3005_BT_EN	TTBBE3004_BT TTBBL3004_BT						0+0+2	2	G
Industrial and Environmental Biotechnology Lecture Prof. Dr. Levente Karaffa	TTBBE3006_BT_EN	TTBBE2007_BT TTBBL2007_BT TTBBE2010_BT TTBBL2010_BT				2+0+0			2	K
Industrial and Environmental Biotechnology Practical Prof. Dr. Levente Karaffa	TTBBL3006_BT_EN	TTBBE2007_BT TTBBL2007_BT TTBBE2010_BT TTBBL2010_BT				0+0+3			3	G
Pharmaceutical Biotechnology Lecture Prof. Dr. Gábor Halmos	TTBBE3007_BT_EN	TTBBE2006_BT TTBBE2013_BT TTBBL2013_BT TTBBE2014_BT TTBBL2014_BT					1+0+0		1	K
Pharmaceutical Biotechnology Practical Prof. Dr. Gábor Halmos	TTBBL3007_BT_EN	TTBBE2006_BT TTBBE2013_BT TTBBL2013_BT TTBBE2014_BT TTBBL2014_BT					0+0+2		2	G
Medical Biotechnology and Cell Culture Lecture Dr. Csaba Matta	TTBBE3008_BT_EN	TTBBE2006_BT TTBBE2013_BT TTBBL2013_BT TTBBE2014_BT TTBBL2014_BT					1+0+0		1	K
Medical Biotechnology and Cell Culture Practical Dr. Csaba Matta	TTBBL3008_BT_EN	TTBBE2006_BT TTBBE2013_BT TTBBL2013_BT TTBBE2014_BT TTBBL2014_BT					0+0+2		2	G
Microbial Pharmaceuticals Lecture Prof. Dr. István Pócsi	TTBBE3009_BT_EN	TTBBG2009_BT TTBBL2009_BT						2+0+0	2	K
Microbial Pharmaceuticals Practical Prof. Dr. István Pócsi	TTBBL3009_BT_EN	TTBBG2009_BT TTBBL2009_BT						0+0+2	2	G
Agricultural and Food Biotechnology Lecture Prof. Dr. Judit Dobránszki	TTBBE3010_BT_EN	TTBBE2014_BT TTBBL2014_BT TTBBE2015_BT TTBBL2015_BT						2+0+0	2	K

Agricultural and Food Biotechnology Practical Prof. Dr. Judit Dobránszki	TTBBL3010_BT_EN	TTBBE2014_BT TTBBL2014_BT TTBBE2015_BT TTBBL2015_BT						0+0+3	3	G
Quality Assurance, Risk Assessment and Safety in Biotechnology Seminar Dr. Dávid Domonkos	TTBBG3011_BT_EN				0+3+0				3	G
Scientific Method and Analysis Seminar Dr. Valter Péter Pfliegler	TTBBG3012_BT_EN		0+1+0						1	G
Thesis, Internship, Free Optional Subjects										
Free Optinal Subjects								+	9	K
Internship (6 weeks) Dr. Éva Leiter	TTBBG3013_BT							+	4	G
Institutional Visit Practical Dr. Éva Leiter	TTBBG3014_BT			0+0+2					1	G
Thesis I.	TTBBG0001_BT						0+0+3		3	G
Thesis II.	TTBBG0002_BT							0+0+9	9	G
										35 exams/ 6 semesters
total hours/practical hours/semester examination/practical grade number of credits: (lecture/practical)			27/13 6/7 15/11 (26)	28/16 7/9 15/14 (29)	31/19 6/7 13/16 (29)	30/18 7/8 15/16 (31)	27/16 7/6 13/15 (28)	23/18 3/5 6/18 (24)		

Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen each student has to complete the online course for work and fire safety. Registration for the course and completion are mandatory for graduation. For MSc students, the course is only necessary if their BSc diploma has been awarded outside of the University of Debrecen.
Registration in the Neptun system by the subject: MUNKAVEDELEM.
Students have to read an online material until the end to get the signature on Neptun for the completion of the course. The link of the online course is available on webpage of the Faculty.

Internship

Students majoring in the Biotechnology BSc have to carry out a 6 weeks internship involved in the model curriculum. The internship course must be signed up for previously via the NEPTUN study registration system in the spring semester (4^{th} semester). Its execution is the criteria requirement of getting the pre-degree certificate (absolutorium).
The professional internships cover many branches of biotechnology, so students have a greater choice, which will also facilitate the choose of the MSc specialization in Biotechnology for the students, who apply for. In the framework of the professional practice, student acquires the ability to work independently and develop tasks. The professional practice can be carried out at the University of Debrecen and in institutions and companies belonging to the University.

Physical Education

According to the Rules and Regulations of University of Debrecen each student has to fulfil at least two semesters of Physical Education during his/her Bachelor's training. Our University offers a wide range of facilities to carry them out. Further information is available from the Sport Centre of the University, its website is: http://sportsci.unideb.hu.

Pre-degree Certification

A pre-degree certificate is issued by the Faculty after completion of the bachelor's (BSc) program. The pre-degree certificate can be issued if the student (1) has successfully completed the study and exam requirements as set out in the curriculum, (2) the requirements relating to

Physical Education as set out in Section 10 in Rules and Regulations– with the exception of preparing thesis – and (3) gained the necessary credit points (180). The pre-degree certificate verifies (without any mention of assessment or grades) that the student has fulfilled all the necessary study and exam requirements defined in the curriculum and the requirements for Physical Education. Students who obtain the pre-degree certificate can submit their theses and take the final exam.

Thesis

The thesis is based on an independent project work summarizing research by the student conducted under the supervision of a university professor. It serves to prove that students are able to collect and interpret literature information related to a specific problem and solve biological problems through data collection, analysis and interpretation. The Topics of the thesis has to be selected in the 4th semester at the latest, however, students may join any research activity at the departments earlier. Thesis courses have to be completed in semesters 4, 5 and 6 with the total credit points of 10. The minimum length of the thesis is 15-20 typewritten pages, composed with A/4 paper size, 2.5 cm margins, 12 points Times New Roman letter size and type, and 1.5 spacing, respectively. The following chapters need to be included: Title page, Table of Contents; Introduction and review of literature; Objectives; Materials and Methods; Results; Discussion; Summary; Acknowledgements; Bibliography. The literature review should cover a very minimum of 10 scientific articles (a scientific article is a piece of literature that is indexed in the scientific databases Web of Science, PubMed or Scopus). There are no further formal requirements, but the supervisor may make additional recommendations specific to the particular field of study.

Final Exam

(a) requirements for admission to the final examination;

Registration for the Final Exam requires that the student has already obtained the required 180 credits and submitted his/her thesis.

(b) final examination;

At the final exam the obtained knowledge is evaluated in an oral exam using Topicss covering the core material. Defending the thesis is part of the final exam in the form of a short presentation of the results summarized in the thesis work. Calculation of exam results is based on the Rules and Regulations. The final exam has to be taken in front of the Final Exam Board. If a candidate does not pass his/her final exam by the termination of his/her student status, he/she can take the final exam after the termination of the student status on any of the final exam days of subsequent academic years according to existing requirements on the rules of the final exam.

Final Exam Board

The Board chair and members are selected from the acknowledged internal and external experts of the professional field. Traditionally, it is the chair and in case of his/her absence or indisposition the vice-chair who will be called upon, as well. The board consists of – besides the chair – at least two

members (one of them is an external expert), and questioners as required. The mandate of a Final Examination Board lasts for one year.

Repeating a failed Final Exam

If any part of the final exam is failed it can be repeated according to the rules and regulations. A final exam can be retaken in the forthcoming final exam period (typically the next semester). A repeated final exam can be taken twice on each subject.

Diploma

The diploma is an official document decorated with the coat of arms of Hungary which testifies the successful completion of studies in the Biotechnology Bachelor Program. It contains the following data: name of HEI (higher education institution); institutional identification number; serial number of diploma; name of diploma holder; date and place of his/her birth; level of qualification; training program; specialization; mode of attendance; place, day, month and year issued. Furthermore, it has to contain the rector's (or vice-rector's) original signature and the seal of HEI. The University keeps a record of the diplomas issued.

In Biotechnology Bachelor Program the diploma grade is calculated as the average grade of the results of the followings:

− Weighted average of the overall studies at the program (A)

− Average of grades of the thesis and its defense given by the Final Exam Board (B)

− Average of the grades received at the Final Exam for the two subjects (C)

Diploma grade = (A + B + C)/3

Classification of the award on the bases of the calculated average:

Excellent 4.81 – 5.00

Very good 4.51 – 4.80

Good 3.51 – 4.50

Satisfactory 2.51 – 3.50

Pass 2.00 – 2.50

Course Descriptions of Biotechnology BSc Program

Title of course: **General and Biotech Economic and Management Skills, Communication Seminar** **Code: TTBBG1101_BT_EN**	**ECTS Credit points**: 2
Evaluation: practical grade	
Type of teaching, contact hours: - lecture: - - practice: 2 hours/week - laboratory: -	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it:-	
Topics of course:	
Students acquire general and biotechnological economic and management knowledge, as well as the basics of business communication, which are relevant to the industry. The knowledge gained will help shed light on the trends of the industries related to the behavior of the players, and their goals. In addition, we want to provide a professional basis for the similar courses of the subsequent master's degree courses, especially the Biotechnology MSc and Molecular Biology MSc, Bioengineering MSc courses.	
Literature	
Mandatory literature: Departmental teaching aid. Lecture slide show.	
Schedule: *1st week*: biotech background and specialities *2nd-5th week*: biotech economical background *6th-8th week*: biotech pharma background *9th-14th week*: management & communication seminar	
Requirements: written exam, passed exam: above 50%	
Person responsible for course*:* Dr. Dávid Domonkos, PhD, head of Biotechnology Institute	
Lecturer:	

Title of course: **Bioethics Seminar** Code: TTBBG1102_BT_EN	**ECTS Credit points**: 2

Evaluation: final exam

Type of teaching, contact hours:

- lecture: 2 hours/week
- practice: -
- laboratory: -

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 62 hours

Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

The aim of the course is to provide the students with an introduction to the debates surrounding current biotechnology, the main ethical and philosophical questions, and their foundational legal, policy-related and legislative documents. It is also aiming to foster their ethical sensitivity and ethical responsibility underlying their professional duties through presenting current social and scientific affairs to them. Via this course the students will be able to master and reflect on the basic and more advanced concepts and theories to discuss and investigate such ethical questions of the biotechnology, and thus to grasp a thorough picture of the problematic legal, social, political, ideological and ethical aspcects of recent biotechnology.

Literature

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Veatch, J. - Guidry-Grimes B. – The Basics of Bioethics. Massachusets – NYP 2019

Schedule:

1st week: Introduction and technical debriefing
2nd week: General ethics introduction 1. (Basic concepts)
3rd week: General ethics introduction 2. (Metaethics 1.)
4th week: General ethics introduction 3. (Metaethics 2.)
5th week: General ethics introduction 4. (Normative ethics 1.)
6th week: General ethics introduction 5. (Normative ethics 2.)
7th week: Applied ethics – bioethics
8th week: Current bioethics debates
9th week: Animal ethics

10th week: Student presentations 1. *11th week*: Student presentation 2. *12th week*: Student presentation 3. *13th week*: Student presentation 4. *14th week*: Consultation session
Requirements: The students need to create 1. a presentation based on topics and sources discussed during the lectures 2. write a simple choice question written exam in the examination period. Making a propre presentation is the necessary requirement to write the exam. The final grade is an avarage of the two grades. If either is a failing grade, the whole grade is a failing one. The students can prepare for their exam from the lecture and seminal materials, indicated chapters of the course reader
Person responsible for course*:* Dr. János Kristóf Bodnár, assistant professor, PhD
Lecturer:

Title of course: **The History and Structure of the European Union Lecture** Code: TTTBE0030_EN	**ECTS Credit points**: 1

Evaluation: final oral exam

Type of teaching, contact hours:
- lecture: 1 hour/week
- practice: -
- laboratory: -

Workload (estimated), divided into contact hours:
- lecture: 14 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 76 hours

Total: 90 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

The aim of the course is to provide information and create an awareness for the students about the history of the European Community, the operation of its institutional system, the enlargement processes and the most important fields of cooperation within the integration. This includes an introduction to the development of international integrations in general, the discussion of the milestones in the history of the European integration process. The uniqueness of the institutional structure is analysed focusing on the network system of the Community which has been the basis of the success in many respects. At the level of policies, the issues of agriculture, regional policy, the Economic and Monetary Union and the Schengen Area are discussed in more details. The goal is to enable students to gain realistic knowledge about the operation of the European Union, and to provide information about the international background of the EU membership of Hungary.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Berend, T.I. (2016) the history of the European integration: a new perspective, Abingdon:Routledge, ISBN: 978-113865491-4

Gilbert, M. (2021) European integration: a political history, Lanham: Maryland: Rowman & Littlefield Publishers, ISBN 978-1-538-10680-8

Troitiño, D.R., Kerikmäe, T., La Guardia, R.M. and Sánchez, G.Á.P. (eds.) (2020) The EU in the 21st Century: challenges and opportunities for the European integration process, Springer Cham, Switzerland, ISBN 978-3030383992

Wiener, A. and Diez, T. (eds.) (2009) European integration theory, Oxford : Oxford University Press, ISBN: 978-019922609-2

Schedule:

1st week:

Introduction to the course.

2nd week:

History of the integration. Integration theories, stages of integration around the world. Specific features of the integration process before the Second World War.

3rd week:

Impacts of the Second World War on the history of the integration. Predecessors, impacts of the European Coal and Steel Community (ECSC) on the foundation of the European Economic Community. Steps towards the European Union.

4th week:

Process of the enlargement of the organisation. Preconditions of the enrollment of new members. Events of the period prior to the First Enlargement (1973). Steps, principles, causes and consequences of the Enlargements. Relationships between the decision-making mechanism and the Enlargement.

5th week:

Specific features of the enlargements after the turn of the millennium. Transformation of East Central Europe, and the unique features of its membership. Copenhagen criteria, pre-accession funds, prolonged negotiation process. Special cases in the enlargement processes. Future enlargements.

6th week:

History and principles of the creation of the institutional system. Taking-over the institutional system of the European Coal and Steel Community. Tasks of the most important institutions, operational mechanism, democratic deficit. Reform process of the institutional system, concepts laid down in the Constitutional Treaty. Decision-making in the EU.

7th week:

Main EU policies and programmes. Policies, instruments and competences. Internal policies *versus* external policies. Main actors in the EU policy management.

8th week:

EU budget: general features. History of the EU budget. Components of the EU budget and recent changes in the proportions. Budget revenues: duties, value-added tax (VAT), gross national product (GNP) sources. Expenditures: agricultural policy; structural funds; external aid; research and development; pre-accession assistances; administrative expenditures, etc. Economic characteristics. Budget procedure.

9th week:

Funding opportunities within the European Union. EU funding programmes managed by the European Commission and the EU in general. Types of funding. Funding instruments and programming

10th week:

Agricultural policy. History of the development of the CAP. The most important tools and sources of the funds. Horizontal measures. Current state of the common agricultural policy and its expected future. Reform attempts in agriculture. Hungary and common agricultural policy. Sharing the fish stocks of the seas.

11th week:

Regional policy in the European Union. History of the regional policy. Regionalism – regionalisation in the EU Member States. General features of the regional policy. NUTS nomenclature. Regional disparities in the Community. Funds and main objectives. Decision-making in regional policy. Hungary and the EU regional policy.

12th week:

Economic and Monetary Union (EMU). History of the European monetary co-operation. The European Monetary System (EMS). Role of the Maastricht Treaty in the monetary co-operation. Stages on the development of the Monetary Union. Convergence criteria. The euro and the currency market. Hungary and the Monetary Union.

13th week:

History of co-operations in home affairs. Schengen Convention. Regulations related to crossing state

borders. Border checks. Checks between state borders, migration policy. Migration and the European Union. Theoretical background to the migration crisis in 2015 and its practical consequences. History of the migration routes and movements. Natural and social (political) causes contributing to the crisis situation.
14th week:
External relations. Principles of the common foreign trade policy. Autonomous import and export regulation. Issues related to the impediment to trade. External relations: African, Caribbean and Pacific Group of States (ACP), Global Mediterranean Policy, associated countries.

Requirements:
- *for a signature*

Attendance at lectures is **recommended but not compulsory.**

- *for a grade*
The course ends in a written examination. The grade for the examination is given according to the following Table:

Score (%)	Grade
0-40	fail (1)
41-56	pass (2)
57-68	satisfactory (3)
69-84	good (4)
85-100	excellent (5)

If the score of the test is below 40%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Dr. Klára Czimre, assistant professor, PhD

Lecturer:

Title of course: **Physics I. Lecture** Code: TTBBE1001_BT_EN	**ECTS Credit points**: 2

Evaluation: final oral exam

Type of teaching, contact hours:
- lecture: 2 hours/week
- practice: -
- laboratory: -

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 62 hours

Total: 90 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

Objectives of the course:
The aim of the course is for the students to become familiar with basic physical quantities and to know the connections between kinematics and dynamics. They should understand the force laws and gas laws, they can see this in a system and interpret the observations with their help.

Brief description of the course:
Physical quantities, force laws, Newton's axioms, types of energy, conservation of energy, deformable bodies, thermodynamics, basic statistical physical distributions

Course structure:
Basic knowledge of natural sciences.

Literature:

Mandatory literature:
Physics by James Walker, 5th edition, ISBN-13: 9780137576968

Recommended literature:
Physics for Scientists and Engineers: Foundations and Connections, Volume 1 1st Edition
by Debora M. Katz ISBN-13 978-0534466756

Schedule:

1st week:

Physical quantities (scalar and vector quantities)

2nd week:

Different force laws

3rd week:

Newton’s axioms I

4th week:

Newton’s axioms II

5th week:
Work and Energy
6th week:
Different types of energy
7th week:
Conservation of energy
8th week:
About deformable bodies (Hook's law))
9th week:
Gas laws
10th week:
The laws of thermodynamics I.
11th week:
The laws of thermodynamics II.
12th week:
Basic statistical and physical distributions I.
13th week:
Basic statistical and physical distributions II.
14th week:
Consultation

Requirements:
- for a signature
Attendance at lectures is **recommended but not compulsory.**

- for a grade
The course ends in an oral or written examination. The grade for the examination is given according to the following Table:

Score (%)	Grade
0-50	fail (1)
51-64	pass (2)
65-76	satisfactory (3)
77-88	good (4)
89-100	excellent (5)

If the score of the test is below 50%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Prof. Dr. Zoltán Erdélyi, full professor, doctor of the Hungarian Academy of Sciences (physics)

Lecturer:

Title of course: **Physics I. Practical** Code: TTBBL1001_BT_EN	**ECTS Credit points**: 1

Evaluation: practical grade

Type of teaching, contact hours:
- lecture:
- practice: -
- laboratory: 1 hour/week

Workload (estimated), divided into contact hours:

- lecture: -
- practice: - 14 hours
- laboratory:
- home assignment: 14 hours
- preparation for the exam: 28 hours

Total: 56 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s):-

Further courses built on it:-

Topics of course:

The aim of the course is for the students to become familiar with basic physical quantities and to know the connections between kinematics and dynamics. They should understand the force laws and gas laws, they can see this in a system and interpret the observations with their help.

Literature:

Mandatory literature:
Physics by James Walker, 5th edition, ISBN-13: 9780137576968

Recommended literature:
Physics for Scientists and Engineers: Foundations and Connections, Volume 1 1st Edition
by Debora M. Katz ISBN-13 978-0534466756

Schedule:

1st week:

Physical quantities (scalar and vector quantities)

2nd week:

Different force laws

3rd week:

Newton's axioms I

4th week:

Newton's axioms II

5th week:

Work and Energy

6th week:

Different types of energy

7th week:

Conservation of energy

8th week:

Test no. 1.

9th week:

Deformable bodies

10th week:

Gas laws

11th week:

The laws of thermodynamics I.

12th week:

The laws of thermodynamics II.

13th week:

Test no. 2.

14th week:

Retake test

Requirements:

- for a signature

Attendance at practical is **compulsory.**

- for a grade

The grade for the practical is the sum of two midterm tests according to the following Table:

Score (%)	Grade
0-50	fail (1)
51-64	pass (2)
65-76	satisfactory (3)
77-88	good (4)
89-100	excellent (5)

If the score of the test is below 50%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Petra Pál, PhD, assistant lecturer

Lecturer:

Title of course: **Physics II. Lecture** Code: TTBBE1002_BT_EN	**ECTS Credit points**: 2

Evaluation: final oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 62 hours
Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Physics I. Lecture and Practical

Further courses build on it: -

Topics of course:

The aim of the course: the students can understand the relationships between electricity and magnetism in a complex way, and know the main results of modern physics. They should be aware of the physical basis of detection, the operating principle of nuclear power plants. In the last hours, we deal with the origin of the universe and the physical foundations of other Topicss that affect thinking people, without being held accountable.

Brief description of the course:
Electrostatic charge, Coulomb's law, field strength, voltage, potential energy. Physical concepts related to current, direct current, alternating current. Capacitor, resistance i, Ohm's law, Kirchoff's law. RC circuit properties, filters. Work and performance of circuit elements. Induction, impedance, RLC circuits. Coil, transformer, electric motor. Basic physical concepts of power plant operation. Types of electromagnetic waves and their practical application. Modern physics. Atomic physics, nuclear physics, particle physics.

Literature:

Mandatory literature:
Physics by James Walker, 5th edition, ISBN-13: 9780137576968

Recommended literature:
Physics for Scientists and Engineers: Foundations and Connections, Volume 1 1st Edition
by Debora M. Katz ISBN-13 978-0534466756

Schedule:
1st week:
Electrostatic charge
2nd week:
Coulomb's law, electric field, capacitor
3rd week:

Potential and voltage

4th week:

Physical concepts related to current (direct as well as alternating current)

5th week:

Ohm's law and electrical resistance

6th week:

Kirchoff's laws

7th week:

Alternating current and RC circuit properties, filters

8th week:

Induction, impedance, RLC circuit

9th week:

Coil, transformer, electric motor

10th week:

Electromagnetic waves and their practical application.

11th week:

Modern physics, the basic concepts of quantum mechanics.

12th week:

Atomic, nuclear and particle physics.

13th week:

Basic physical concepts of power plant operation.

14th week:

Consultation

Requirements:

- for a signature

Attendance at lectures is **recommended but not compulsory.**

- for a grade

The course ends in an oral or written examination. The grade for the examination is given according to the following Table:

Score (%)	Grade
0-50	fail (1)
51-64	pass (2)
65-76	satisfactory (3)
77-88	good (4)
89-100	excellent (5)

If the score of the test is below 50%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Prof. Dr. Zoltán Erdélyi, full professor, doctor of the Hungarian Academy of Sciences (physics)

Lecturer:

Title of course: **Physics II. Practical** Code: TTBBL1002_BT_EN	**ECTS Credit points**: 1

Evaluation: practical grade

Type of teaching, contact hours:
-lecture:
-practice: -
-laboratory: 1 hour/week

Workload (estimated), divided into contact hours:
-lecture: hours
-practice: -14 hours
-laboratory
-home assignment: 14 hours
-preparation for the exam: 28 hours
Total: 56 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Physics I. Lecture and Practical

Further courses build on it: -

Topics of course:

The aim of the course:
The students can understand the relationships between electricity and magnetism in a complex way and know the main results of modern physics. They should be aware of the physical basis of detection, the operating principle of nuclear power plants. In the last lectures, we deal with the origin of the universe and the physical foundations of other Topicss that affect us.

Literature:

Mandatory literature:
Physics by James Walker, 5th edition, ISBN-13: 9780137576968

Recommended literature:
Physics for Scientists and Engineers: Foundations and Connections, Volume 1 1st Edition
by Debora M. Katz ISBN-13 978-0534466756

Schedule:
1st week:
Electrostatic charge
2nd week:
Coulomb's law, electric field, capacitor
3rd week:
Potential and voltage
4th week:
Physical concepts related to current (direct as well as alternating current)
5th week:
Ohm's law and electrical resistance

6th week:
Kirchoff's laws
7th week:
Test No.1.
8th week:
Alternating current and RC circuit properties, filters
9th week:
Induction, impedance, RLC circuit
10th week:
Coil, transformer, electric motor
11th week:
Electromagnetic waves and their practical application (reflection, retraction, total reflection).
12th week:
Modern physics, the basic concepts of quantum mechanics.
13th week:
Test no.2.
14th week:
Retake

Requirements:
- for a signature

Attendance at practical is **compulsory.**
- for a grade
The grade for the practical is the sum of two midterm tests according to the following Table:

Score (%)	Grade
0-50	fail (1)
51-64	pass (2)
65-76	satisfactory (3)
77-88	good (4)
89-100	excellent (5)

If the score of the test is below 50%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Dr. Petra Pál, PhD, assistant lecturer

Lecturer:

Title of course: **Biophysics Lecture** Code: TTBBE1003_BT_EN	**ECTS Credit points**: 1

Evaluation: final oral exam

Type of teaching, contact hours:
-lecture: 1 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 14 hours
-practice: -
-laboratory -:
-home assignment: 14 hours
-preparation for the exam: 62 hours
Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Physics II. Lectures and Practical, Design and Analysis of Experiments Practical

Further courses built on it:-

Topics of course:

Objectives of the course:
To provide an adequate theoretical background for understanding the basic principles of physics applied in molecular and cell biology and medicine and their role in living systems (e.g. diffusion, electrical properties of cells, etc.). Introduction to (bio)physical techniques applied in molecular and cell biology and medicine, e.g. electrophoresis, sedimentation methods, microscopy, imaging (PET, SPECT, MRI) and basic drug discovery methods.

Short description of the course:
The course will provide students with a quantitative description of the physical principles relevant to the key Topicss in molecular, cellular and biomedical biology.

Course structure:

Basic knowledge in natural science.

Physical principles of molecular and cellular biology methods (e.g. microscopy, electrophysiology, X-ray, fluorescence techniques, radioactive radiation, etc.).

Medical physics (e.g. the physical basis of diagnostic and therapeutic procedures and drug discovery methods).

Molecular biophysics (e.g. diffusion, membrane biophysics).

Literature:

Mandatory literature:
Lecture materials and practical guides (materials posted on the website)
Medical Biophysics (2nd edition, ed. by Sándor Damjanovich, Judit Fidy, János Szöllősi, Medicina, 2006, ISBN: 963-226-024-4);

Biophysical Measurements (Debreceni University Note, 2001)

Recommended literature:
Medical Biophysics (1st edition, ed. by Sándor Damjanovich, László Mátyus, Medicina, 2000, ISBN: 963-242-653-3);
Supplementary material available on the Institute's e-learning platform.
Teaching website address: biophys.med.unideb.hu and the Moodle link (e-Learning) provided there.

Schedule:
1st week:
Introduction to the course. Generation and absorption of X-rays. X-ray contrast materials
2nd week:
Fluorescence spectroscopy, fluorescence techniques
3rd week:
Lasers and their biomedical applications. Photodynamic therapy.
4th week:
Optical and electron microscopy.
Stat1: Set theory. Random events. Conditional probability, marginalization. Independent events. Descriptive statistics.
5th week:
Ionizing radiations and their interaction with materials. Dosimetry, tissue effects, detection of radiation. Stat2: Random variable. Cumulative distribution function, distribution function of random variable. Discrete probability distributions: binomial and Poisson-distribution.
6th week:
Research, diagnostic and therapeutic application of stable and radioactive isotopes. Contrast materials, radiopharmacons.
Stat 3: Continuous probability distribution. Normal distribution. Standard normal distribution. Sampling.
7th week:
Medical imaging (CT, PET, SPECT, MRI)
Stat4: Hypothesis testing. Null hypothesis. Statistical significance. One- and two tailed tests. The z-test. One sample t-test.
8th week:
Diffusion at the molecular level, statistical interpretation. Fick's 1st law. Thermodiffusion. Osmosis.
Stat5: Paired t-test. F-test. Unpaired t-test.
9th week:
Structure of biological membranes. Membrane transport
Stat6: Screening tests. Epidemiologic investigations: odds ratio and relative risk. The Kaplan-Meier curve.
10th week:
Pharmacology of ion channels (gating, selectivity). Patch clamp technique.
Stat7: Consultation.
11th week:
Origin of membrane potential Resting potential, action potential, electric excitbility.
12th week:
Fluid mechanics, blood circulation. Newtonian fluids, viscosity, creams and emulsions
Biostatistics final test
13th week:
Methods of pharmacological research. Gel electrophoresis, isoelectric focusing, blotting. Detecting molecular interactions (SPR, FCS, FRET)
14th week:
Biophysics of drug delivery. Nanotechnology approach.
Biophysics grade offering exam (electronic exam)

Requirements:

Condition for signature:
- All labs have done (if one missed, only one repetition option is available)
- Lab exam attended (no make-up is available)
- Minimally 5 out of 6 biostatistics seminars attended (no make-up is available)
- Signing up for the electronic course PHARM-Biophysics at the exam.unideb.hu website by the end of week 3 (the site can only be reached from inside the University network)
- Lecture attendance is strongly recommended

Exams and grading:
- Lab exam (see the actual timetable) – 10+1 points max
- Final exam in biostatistics (see the actual timetable) – 20 points max
- Exemption test (electronic) in biophysics, or written exam (electronic) in the final exam - 70 points max

Total: 100 points.

Grades:
- 50< pass (2)
- 60< satisfactory (3)
- 70< good (4)
- 80< excellent (5)
- Please note that lab and biostatistics work during the semester constitutes a compulsory part of the final score, which cannot be changed during the exam period, so take your studies seriously throughout the semester.

Repeaters The signature obtained for the subject earlier is making students exempted from attending labs and biostatistics seminars.

Exempted students can choose to keep their scores from last year or to take the exams together with the rest of the class during the semester. Exemption-related decisions must be made before the end of the 3rd week of education, and the study advisor at biophysedu@med.unideb.hu notified about it. In the absence of written notification, we automatically assume that the last year's score is kept, and no further changes will be possible later. Biostatistics and Lab exemptions, scores, exams are independent of each other.

Person responsible for course*:* Dr. Ferenc Papp, assistant professor, PhD (theoretical medicine)

Lecturer: Dr. Zsolt Fazekas, assistant professor, PhD; Dr. Péter Hajdu, associate professor, PhD; Dr. Ferenc Papp, assistant professor, PhD; Prof. Dr. György Panyi, full professor, PhD, DSc; Dr. György Vámosi, senior research fellow, PhD; Dr. Zoltán Varga, associate professor, PhD, DSc; Prof. Dr. György Vereb, full professor, PhD, DSc.

Title of course: **Biophysics Practical** Code: TTBBL1003_BT	**ECTS Credit points**: 2

Evaluation: practical exam

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 28 hours
-home assignment: 14 hours
-preparation for the exam: 14 hours
Total: 56 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Physics II. Lecture and Practical; Design and Analysis of Experiments Practical

Further courses built on it:-

Topics of course:

Objectives of the course:

Practical demonstration of some of the methods taught in the Biophysics Theory course, carrying out simple measurements on these Topicss, and an introduction to how to design, carry out and evaluate measurements.

Course structure:

- Introduction.
- Perform exercises.

Literature:

Mandatory literature:
- the materials (practical descriptions) on the eLearning page of the course.

Recommended literature:
- Biophysical measurements (University of Debrecen, 2001)
- Medical Biophysics (1st v. 2nd edition, ed. by Sándor Damjanovich, László Mátyus, Medicina, 2000, ISBN: 963-242-653-3 or 963-242-847-1).

Education website address:
biophys.med.unideb.hu
eLearning platform (https://elearning.med.unideb.hu/).

Schedule:
3rd week:
Spectrofluorimetry

4th week: Refractometry *5th week*: Light microscope. Optical measurements *6th week*: Measuring the attenuation of gamma radiation with a GM counter *7th week*: Definition of diffusion constant *8th-9th weeks*: Practice Exam
Requirements: Students write a short quiz (may contain test questions and short calculation problem(s)) before each lab topic. At least 50% must be earned in this test to be eligible for doing the lab. Students failing the quiz need to repeat it then do the practicals within the frame of spare practicals. In the laboratory practical, a laboratory logbook (into a booklet with stable pages) should be written to make the conditions of the measurements accomplished repeatable according to the notes. Students must be prepared for the lab. One part of this preparation is a summary of the theoretical part of the lab exercises to be performed. Each lab is graded from 1 to 5. The average score of 4 or 5 of all labs is rewarded with a +1 exam point. That is added to the laboratory practical exam result. In case of unpreparedness, the lab exercise should be repeated, where a maximum of 2 points can be obtained for the make-up lab. An immediate organization of the make-up lab is the student's responsibility by obtaining written permission from the tutor at the end of the logbook.
Person responsible for course*:* Dr. Ferenc Papp, assistant professor, PhD (theoretical medicine)
Lecturer: Dr. Zsolt Bacsó, associate professor, PhD; Dr. Tibor Szantó G., assistant professor, PhD; Dr. Gábor Mocsár, research fellow, PhD; Dr. Árpád Szöőr, assistant professor, PhD; Dr. Andrea Dóczy-Bodnár, senior research fellow, PhD.

Title of course: **General Chemistry Lecture** Code: TTBE1004_BT_EN	**ECTS Credit points**: 4

Evaluation: final oral exam

Type of teaching, contact hours:
-lecture: 3 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 42 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 68 hours
Total: 110 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

History and development of chemistry and its relation to other natural sciences. Development of atomic and molecular theory. The structure of atom. Basics of radioactivity. Discovery of the periodic table and periodically changing properties. Introduction to quantum chemistry. Primary and secondary chemical bonds. Description of gaseous, liquid and solid states of matter. Phase changes. Chemical equilibrium. Acid-base theories. Basics of thermochemistry, reaction kinetics and electrochemistry.

Literature:

- John McMurry, Robert C. Fay: Chemistry, 7th ed., Prentice Hall ISBN: 0321943171.
- Darrell D. Ebbing: General Chemistry, 9th ed. Belmont, CA, ISBN: 1439049829
- James E. Brady, Gerard E. Humiston: General chemistry: principles and structure, 3rd ed., New York, Wiley, ISBN: 0471808164

Literature:

Schedule:

1st week:

Classification of natural sciences, history and development of chemistry. The concept of chemical change. The SI system of units, the most important physical quantities and units. Conservation of mass and energy. The law of definite proportions, the law of multiple proportions, law of combining gas volumes, Avogadro's law. Dalton's atomic theory. Relative atomic and molecular weights. Amount of substance and the definition of mole. Notations for elements and compounds, symbol, empirical formula, molecular formula, structure, isomerism.

2nd week:

Valency and oxidation number. Oxidation number in inorganic compounds. Types of chemical reactions. Latin names of compounds. Experimental background of the atomic theory, discovery of the nucleus. Discovery and basic properties of subatomic particles (electron, proton, neutron). Isotopes.

3rd week:

Types and properties of radioactive radiation. Laws of radioactive decay, decay series. Medical and other practical importance of radioactive isotopes. The mass defect. Einstein's equation on mass-energy equivalence. Nuclear energy, nuclear fission and fusion. Quantized changes in the energy states of atoms. The photon hypothesis. The Bohr model of the atom. Characteristics of electromagnetic radiation, atomic line spectra, X-ray radiation.

4th week:

The dual nature of matter. Heisenberg's uncertainty principle. Schrödinger's equation and its application for the hydrogen atom. Quantum numbers and their importance. The shape of atomic orbitals. Characterization of polyelectronic atoms. Principles of the periodic table.

5th week:

Electronegativity, ionization energy, electronaffinity, atomic and ionic radii and their change across the periodic table. The ionic bond. Calculation of the lattice energy. Metallic bonding.

6th week:

The covalent bond. Basic characteristics of the molecular orbital (MO) theory and its application for diatomic molecules. The valence shell electron pair repulsion (VSEPR) model. The shape of molecules, bond angles, bond orders, hybridization. Polarity of covalent bonds, polar and nonpolar molecules.

7th week:

Intermolecular forces. London forces, dipole-dipole interaction. Hydrogen bond and its importance in inorganic and organic chemistry. General characterization of molecular, ionic, metallic, and network atomic solids.

8th week:

Classification and structure of chemical systems. General characterization of different states of matter. The kinetic molecular theory of gases, ideal and real gases. Gas laws: Boyle's law, Charles's law, the ideal gas law. Gas mixtures, partial pressure. General characterization of liquids, surface tension, viscosity. General characterization and classification of solids. Changes of state: melting, freezing, evaporation, condensation, sublimation.

9th week:

Classification of multicomponent systems, properties of solutions and mixtures. Solubility and units of concentration. Vapor pressure, freezing and boiling point of solutions. Osmosis pressure. Determination of molecular weight. Phase diagrams, critical temperature and pressure. Thermodynamic temperature.

10th week:

Basics of thermochemistry. Heat of reaction, Hess's law. The importance of heat of formation. Heat of reaction and bond energies. The direction of spontaneous chemical reactions: internal energy, enthalpy, free energy and entropy.

11th week:

Dependence of reaction rates on concentrations and the temperature. Order of reactions. Activation energy. Catalysts, homogeneous and heterogeneous catalytic reactions. Enzymes. Photochemical processes. The equilibrium condition and the equilibrium constant. Possibilities to shift the composition of equilibria. Dependence of the equilibrium constant on temperature and pressure. Le Chatelier's principle.

12th week:

Solubility equilibria, solubility product. Temperature dependence of solubility. Gas-liquid and liquid-liquid equilibria. Extraction. Different theories of acid-base reactions (Arrhenius, Brønsted, Lewis). Characterization of aqueous solutions, electrolytic dissociation. Strength of acids and bases. Super acids. Dissociation constant and degree of dissociation.

13th week:

Self-ionization of water. Ionic product of water. The definition and calculation of pH. Amphoteric substances. Buffer solutions and acid-base indicators. Acid-base properties of salts. Complex ion equilibria. Pearson's hard-soft theory.

14th week:

Basics of electrochemistry. Galvanic cells and the concept of electrode potential. Standard electrode potentials, oxidizing and reducing agents. Water as a redox system. Electrolysis, voltage needed in electrolytic cells, overvoltage. Quantitative laws of electrolysis. Galvanic cells and batteries.

Requirements:

- *for a signature:*

Attendance at lectures is recommended, but not compulsory. The General Chemistry Seminar course have to be completed with at least a pass(2) final mark.

- *for a grade:*

The course ends in an examination. The result of the examination determines the final grade.
The minimum requirement for the examination single choice test is 65%. Based on the score of the exam, the grade is given according to the following table:

Score	Grade
0-64	fail (1)
65-69	pass (2)
70-79	satisfactory (3)
80-84	good (4)
85-100	excellent (5)

If the case of failure, students can retake exam(s) in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Dr. Kalmár József, associate professor, PhD

Lecturer:

Title of course: **General Chemistry Seminar** Code: TTBBG1004_BT_EN	ECTS Credit points: **0**

Evaluation: middle-term tests

Type of teaching, contact hours:
-lecture: -
-practice: 2 hours/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 28 hours
-laboratory -:
-home assignment: 2 hours
-preparation for the exam:
Total: 30 hours

Year, semester: 1st year, 1st semester

Its prerequisites(s):-

Further courses built on it:-

Topics of course:

Determination of atomic weight, molecular weight, empirical formula, molecular formula, amount of substance. Determination of empirical formula based on weight percent composition and on elemental analysis. General introduction to the units of concentration. Interconversion of units. Calculation problems connected to solution preparation. Introduction to the SI system. Mass concentration, molarity, mass percent composition, molar percent composition.
Interconversion of concentration units. Density measurements. Mixing equations. Theoretical background of crystallization. Calculation problems of crystallization. Theoretical background of gas and solids. Composition of solid and gaseous mixtures. Introduction to basic chemical equations. Stoichiometric calculations based on chemical equations. Preparation of salts, calculation of theoretical and percent yield. Dissolving of metal mixtures in acids. Acid-base equilibria. Theory of acid-base reactions and titrations. Determination of molar weight based on titration results. Introduction to basic gas laws. Laboratory preparation of gases. Calculation problems connected to evolution of gases based on chemical equations. Theory of redox reactions. Balancing of redox reactions. Calculations based on redox reactions. Preparation of salts from its metal. Definition of pH. Theoretical background of pH calculation. Introduction to water ionisation constants. Relationship between the K_w and H^+. Calculation of pH of strong acids and strong bases. Calculation of pH of weak acids and weak bases. Determination of dissociation rate. Theoretical background of buffer systems. Calculation problems regarding the pH of buffer systems. Fundamental of galvanic cells (Daniell cell). The concept of electromotive force, redox potential, standard redox potential. Nernst equation.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:

1. J.McMurray, R.C. Fay, Chemistry, Pearson Education, Inc., New Yersey, 2004.
2. S.S. Zumdahl, Chemistry, D.C. Heath and company, Lexington MA, 1993.
3. J. W. Hill, R. H. Petrucci, General Chemistry, Prentice Hall, ISBN-10:0130334456, ISBN-13: 9780130334459
4. F. A. Cotton, G. Wilkinson: Basic Inorganic Chemistry, John Villay and Sons (1976)
5. D. D. Ebbing: General Chemistry, Houghton M. Company (1984)

Schedule:

Schedule: The seminar will be held in 11 weeks.

1st week:

Determination of atomic weight, molecular weight, empirical formula, molecular formula,amount of substance. Determination of empirical formula based on weight percent composition and on elemental analysis.

2nd week:

General introduction to the units of concentration. Interconversion of units. Calculation problems connected to solution preparation. Introduction of the SI system. Mass concentration, molarity,mass percent composition, molar percent composition.

3rd week:

Review exercises concerning on the first two weeks. Interconversion of concentration units. Density measurements. Mixing equations.

4th week:

Theoretical background of crystallization. Exercises calculation problems of crystallization. Exercises calculation problems of crystallization.

5th week:

Theoretical backgrounds of gas and solids. Composition of solid and gas mixtures. Introduction to basic chemical equations. Stoichiometric calculations based on chemical equations.Preparation of salts, calculation of theoretical and percent yield. Dissolving of metal mixtures in acids.

6th week:

Acid-base equilibria. Theory of acid-base reactions and titrations. Exercises based on acid-base titrations. Stoichiometric calculations based on chemical equations. Determination of molar weight based on titration results.

7th week:

Review exercises in stoichiometry and concentration calculations.

8th week:

Introduction to basic gas laws. Laboratory preparation of gases. Calculation problems connected to evolution of gases based on chemical equations.

9th week:

Theory of redox reactions. Balancing of redox reactions. Calculations based on redox reactions.Preparation of salts from its metal.

10th week:

Review exercises in balancing of redox and acid-base reactions.

11th week:

Definition of pH. Theoretical background of pH calculation. Introduction to water ionisation constants. Relationship between the K_w and H^+.

12th week:

Calculation of pH of strong acids and strong bases.

13th week:

Calculation of pH of weak acids and weak bases. Determination of dissociation rate. Theoretical

background of buffer systems, buffer capacity. Calculation problems regarding the pH of buffer systems.

14th week:

Electrochemical exercises. Fundamental of galvanic cells (Daniell cell). The concept of electromotive force, redox potential, standard redox potential. Nernst equation. Review exercises of pH calculations.

Requirements:

Students are required to write two general tests (after week 6 and after week 11) which are based on the course material for weeks 1-7 and 8-14, respectively. Each general test is worth 50 points. The sum of scores frome both tests must be at least 50 % to get the signature and the students are eligible to regiser for the theoretical exam. The students with low test results (the socre of both tests are between 20 and 40 %) can take a comprehensive test (Test III) int he examination period and the passing level is 60 %. Test III will be organized only once in the examination preiod. If the score of the individual tests is less than 20 %, teh student's lecture book won't be signes and the student has to retake the course next year.

Person responsible for course*:* Prof. Katalin Várnagy, full professor, DSc

Lecturer: Dr. Petra Herman, assistant professor, PhD

Title of course: **General Chemistry Laboratory Practical** Code: TTBBL1004_BT_EN	**ECTS Credit points**: 3

Evaluation: middle-term tests and final test

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 3 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 42 hours
-home assignment: 42 hours
-preparation for the exam: 6 hours
Total: 90 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course

General introduction to the laboratory rules and laboratory work. Safety training. Introduction to laboratory pieces of equipment. The use of gas burners. Overview of pieces of the received laboratory equipment. Mass and volume measurements: weighing on analytical and standard laboratory balances; introduction to volume measurement devices (pipette, burette, volumetric flask). Calibration of volumetric measuring equipment (pipette or volumetric flask). Calculation the standard error between the measured and nominal values. Introduction to solution preparation: grinding, use of mortar, pestle, volumetric flask. Preparation of a standard solution from a crystalline salt. Introduction to a density measurement. The use of the pycnometer. Determination of the density of the prepared solution by the help of volumetric flask. Calculating the weight percent composition of the prepared solution. Introduction to separation methods: decantation, centrifuging, filtration. Purification of solids. Theoretical background of heating, cooling and the use of hot water bath. Preparation of a salt using basic laboratory procedures. Determination of the composition of a mixture of two compounds. Different methods used to temperature measurements. Introduction to the measurements of melting point of the solid substances. Determination of the melting point of a compound. Practice of acid-base titration. Concentration determination of a solution by acid-base titration. Determination of the molar weight of a solid acid by acid-base titration. Laboratory work with gases: introduction to the use of gas cylinders, simple gas generator, Kipp's apparatus. Studying the chemical and physical properties of gases. Demonstration of hydrogen preparation. The hydrogen explosion test. Preparation of oxygen in a laboratory gas generator and burning of sulphur in oxygen. Study of the observations during the reaction (oxidation product of sulphur). Determination of molecular weight based on the ideal gas law. Practice the basic laboratory techniques considering the preparation of a salt. Studies of reactions involving gas formation and precipitation. Quantitative study of a precipitation reaction to determine the stoichiometric composition of water insoluble precipitates using the method of continuous variation. Dependence of reaction rate on concentration of reactants. Studying factors affecting the reaction rates. Determination of the reaction rate and the rate law of the studied reaction. Theoretical background of liquid-liquid extractions and demonstration of the separation techniques. Introduction to buffer systems, buffer capacity by studying a particular buffer system (acetic acid/acetate ion buffer; ammonium ion/ammonia buffer). Hydrolysis of salts to study the acid-base properties of ionic and covalent compounds in aqueous

solutions or in reactions with water. Writing of the ionic equations based on the observed chemical reactions. General introduction to electrochemistry. Study of redox reactions. Prediction of the direction of spontaneous processes based on standard potentials. Factors affecting the order of the deposition of different metals during electrolysis (study of Daniell cell).

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
1. J.McMurray, R.C. Fay, Chemistry, Pearson Education, Inc., New Yersey, 2004.
2. S.S. Zumdahl, Chemistry, D.C. Heath and company, Lexington MA, 1993.
3. J. W. Hill, R. H. Petrucci, General Chemistry, Prentice Hall, ISBN-10:0130334456, ISBN-13: 9780130334459
4. F. A. Cotton, G. Wilkinson: Basic Inorganic Chemistry, John Villay and Sons (1976)
5. D. D. Ebbing: General Chemistry, Houghton M. Company (1984)

Schedule:

The laboratory practice will be held in 11 weeks.

1st week:

General introduction to the laboratory rules and laboratory work. Safety training. Introduction to laboratory pieces of equipment. The use of gas burners. Overview of pieces of the received laboratory equipment.

2nd week:

Mass and volume measurements: weighing on analytical and standard laboratory balances; introduction to volume measurement devices (pipette, burette, volumetric flask). Calibration of volumetric measuring equipment (pipette or volumetric flask). Calculation the standard error between the measured and nominal values.

3rd week:

Introduction to solution preparation: grinding, use of mortal, pestle, volumetric flask. Preparation of a standard solution from a crystalline salt. Introduction to a density measurement. The use of the pycnometer. Determination of the density of the prepared solution by the help of the pycnometer. Calculating the weight percent composition of the prepared solution.

4th week:

Introduction to separation methods: decantation, centrifuging, filtration. Purification of solids. Theoretical background heating, cooling and the use of hot water bath. Purification of a benzoic acid sample contaminated with sodium chloride. Preparation of a double salt from simple salts and basic laboratory procedures.

5th week:

Writing the general mid-term test based on the studied material of the laboratory practice and seminar until week 4. Determination of the composition of mixture of potassium chloride and potassium chlorate. Review of different methods used to temperature measurements. Introduction to the measurements of melting point of the solid substances. Determination of the melting point of the purified benzoic acid sample. Determination of the contamination percentage of the purified benzoic acid sample.

6th week:

Demonstration of acid-base titration. Preparation of a standard solution of NaOH. Concentration determination of the standard NaOH solution by acid-base titration. Determination of the molar weight of the recrystallized sample of benzoic acid by acid-base titration. Comparing the result with the literature value and calculating the standard error between the given and measured data. Purified benzoic acid due in.

7th week:

Laboratory work with gases: introduction to the use of gas cylinders, simple gas generator, Kipp's apparatus. Studying the chemical and physical properties of gases. Demonstration of hydrogen preparation. The hydrogen explosion test. Preparation of oxygen in a laboratory gas generator and burning of sulphur in oxygen. Study of the observations during the reaction (oxidation product of sulphur). Determination of molecular weight based on the ideal gas law.

8th week:

Practice the basic laboratory techniques considering the preparation of a salt. Preparation of salts from its metal. Studies of reactions involving gas formation and precipitation.

9th week:

Quantitative study of a precipitation reactions to determine the stoichiometric composition of water insoluble precipitates using the method of continuous variation. Dependence of reaction rate of concentration of reactants. Studying the factor affecting the reaction rates. Determination of the reaction rate and the rate law of the studied reaction. Metal salts preparations due in.

10th week:

Theoretical background of liquid-liquid extractions and demonstration of the separation techniques. Introduction to buffer systems, buffer capacity by studying a particular buffer system (acetic acid/acetate ion buffer; ammonium ion/ammonia buffer). Hydrolysis of salts to study the acid-base properties of ionic and covalent compounds in aqueous solutions or in reactions with water. Writing of the ionic equations based on the observed chemical reactions.

11th week:

General test from week 5 to week 10. General introduction to electrochemistry. Study of redox reactions. Prediction of the direction of spontaneous processes based on standard potentials. Factors affecting the order of the deposition of different metals during electrolysis (study of Daniell cell). Return of the received pieces of laboratory equipment.

Requirements:

Each week the laboratory session begins with a short test (not more than 20 minutes) based exclusively on the preparatory material of that week and the previous week and the results of the experiments carried out the previous week. With each short test a student can collect 25 points. Altogether there are eight short tests during the semester. Students are also required to write two general tests (week 5 and week 11) which are based on the course material for weeks 1-4 and 5- 10, respectively. Each general test is worth 50 points. Grading is based on a five-level scale: 1 (fail), 2 (pass), 3 (average), 4 (good), 5 (excellent). The final course grade is given based on the results of these tests, the quality of the laboratory notes and the quality of laboratory work. The average score from both the short tests and the general tests must be above 50 % to avoid a 'fail' final course grade. In order to pass the laboratory practice, a student should collect minimum 100 points from the short tests and minimum 50 points from the general tests. Students with 'fail' final course grade due to inadequate laboratory work have to retake the course the next year. Students with 'fail' final course grade due to low test results can re-take a comprehensive test exam in the examination period. Those students, whose results are lower than 25% either from the short test or from the general test, cannot write a final exam, they will receive a 'fail' final course grade. It is not allowed to miss any laboratory practices/seminars. If a student misses one or two lab practices, medical certification is needed. If a student misses three lab practices/seminars even for any medical reasons, the student's lecture book won't be signed and she or he has to retake the course next year. It is not possible to miss short tests at the beginning of the laboratory practice. If a student misses more than two short tests, the laboratory practice will not be accepted for him or her. The students cannot miss either of the general tests, otherwise no signature and final grade is given to the student.

Person responsible for course*:* Prof. Katalin Várnagy, full professor, DSc

Lecturer: Dr. Petra Herman, assistant professor, PhD

Title of course: **Analytical Chemistry Lecture** Code: TTBBE1005_BT_EN	**ECTS Credit points**: 2
Evaluation: oral or written exam	
Type of teaching, contact hours: -lecture: 2 hours/week -practice: - -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 28 hours -practice: - -laboratory -: -home assignment: - -preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): General Chemistry Lecture, Seminar and Practical	
Further courses built on it:-	
Topics of course and Schedule:	
The students will acquire basic knowledge of analytical chemistry according to the following schedule: *1st week:* Introduction to analytical chemistry. Measurements. Basic equations of equilibrium calculations. *2nd week:* Acids and bases, acid-base theories. The Broensted equation. Buffers. *3rd week:* Basic terms related to titrations. Practice of acid-base titrations. *4th week:* Basics of complexometry. Complexometric titrations. *5th week:* Solubility equilibria. Precipitation titrations, argentometry. *6th week:* Redoxi equilibria. Permanganometry. *7th week:* Chromatometry. Bromatometry. Iodometry. *8th week:* Simple separation techniques I. Gravimetry. *9th week:* Simple separation techniques II. Extraction. *10th week:* Chromatographic separations and techniques. *11th week:* Classification of instrumental analytical methods. Evaluation of analytical chemical results. *12th week:* Spectroscopy I. Atomic spectroscopy.	

13th week:
Spectroscopy II. UV-Vis spectroscopy.
14th week:
Potentiometry and conductometry.

Literature:

Mandatory literature:
1) Syllabus provided by the tutor
2) Daniel C. Harris: Quantitative Chemical Analysis, 7th Ed., 2007, Freeman and Co.
3) Vogel's Qualitative Inorganic Analysis, (ed. Gy. Svehla), Longmann, 2007
Recommended literature:
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Requirements:
written or oral exam. Level of acceptance is 40 %. The marks are proportional above 40 %.

Person responsible for course*:* Prof. Dr. István Fábián, full professor, DSc of the Hungarian Academy of Sciences (chemistry)

Lecturer: Prof. Dr. Buglyó Péter, full professor, PhD (chemistry)

Title of course: **Analytical Chemistry Practical** Code: TTBBL1005_BT_EN	**ECTS Credit points**: 3

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 4 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 56 hours
-home assignment: 34
-preparation for the exam: -
Total: 90 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): General Chemistry Lecture, Seminar, Practical

Further courses built on it:-

Topics of course:

Acid-base, complexometric, argentometric and redox titrations, quantitative determination unknown samples.

Literature:

Mandatory literature:
Study Aids on the website
Recommended literature:
Daniel C. Harris: Quantitative Chemical Analysis
R. Kellner, J.-M. Mermet, M. Otto, H. M. Widner: Analytical Chemistry, Wiley, 1997

Schedule:
1st week:
Introduction to the Quantitave Analytical Chemistry Laboratory.
Laboratory Safety Information.
Review of lab equipment.
2nd week:
Preparation of ~0.1 M HCl titrant (250 ml).
Determination of the exact concentration of the HCl titrant solution using potassium hydrogen carbonate stock solution.
Preparation of ~0.1 M NaOH titrant by the Sörensen (500 ml) and determination of its exact concentration.
3rd week:
Determination of borax content of a solid sample (unknown sample).
Simultaneous determination of sulfuric acid and boric acid in a mixture (unknown sample).
4th week:
Determination of oxalic acid (unknown sample).
Determination of Na2S2O3 by measuring the acid formed in the oxidation reaction of Na2S2O3 with

bromine.
5th week:
Preparation of 0.02 M potassium bromate titrant (250.00 ml).
Determination of ascorbic acid active ingredient content of vitamin C tablet (unknown sample).
Determination of the composition of KCl-KBr mixture using 0.05 M silver nitrate stock solution (unknown sample).
6th week:
Determination of the exact concentration of the potassium permanganate titrant solution using sodium oxalate stock solution.
Determination of ferrous oxalate by permanganometric titration (unknown sample).
Determination of hydrogen peroxide (unknown sample).
7th week:
Preparation of 0.02 M sodium thiosulfate titrant (250 ml) and determination of its exact concentration using 0.003 M potassium iodate stock solution.
Determination of iodide ion (unknown sample).
8th week:
Redetermination of the exact concentration of the prepared 0.02 M sodium thiosulfate titrant
Determination of copper(II) (unknown sample).
9th week:
Preparation of 0.01 M Na2EDTA titrant solution (250.00 ml).
Simultaneous determination of calcium(II) and magnesium(II) ions (unknown sample).
Determination of Bi(III) (unknown sample).
10th week:
Simultaneous determination of copper(II) and zinc(II) ions (unknown sample).
11th week:
Quantitative description of precipitation equilibria. Solubility product and solubility.
12th week:
Determination of Al(III) (unknown sample).
13th week:
Lab equipment return.
14th week: Evaluation

Requirements:
- *for a signature:*
Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than one during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Being late is equivalent with an absence. In case of absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.
Each week the laboratory session begins with a short test (not more than 15 minutes) based exclusively on the preparatory material and calculations of that week.
Students are required to determine “unknown samples”.
- *for a grade:*
The grade is calculated from the results of the tests (50%) and the unknown samples (50%). Both averages have to be to be minimum 2.00 in order to successfully complete the course. Otherwise the final grade will be fail (1). Students with fail (1) final course grades thanks to unacceptable test results can take once a comprehensive test exam during the examination period.

Person responsible for course*:* Dr. Csilla Kállay, associate professor, PhD

Lecturer:

Title of course: **Organic Chemistry Lecture** Code: TTBBE1006_BT_EN	**ECTS Credit points**: 2

Evaluation: exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 62 hours
Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry Lecture, Seminar and Practical

Further courses built on it:-

Topics of course:

Students acquire the basic concepts and theories necessary to understand organic chemistry, as well as the synthesis, physical and chemical properties of organic compounds containing different functional groups.
Topicss of the course:
- Summary of basic concepts of organic chemistry
- Brief description and comparison of chemical bonding and bonding theories
- Discussion of the most important bond types found in organic compounds
- Isomerism and basic concepts of stereochemistry
- Classification of chemical reactions
- Functional groups, nomenclature of organic compounds
- Synthesis, physical and chemical properties of organic compounds containing different functional groups: hydrocarbons, halogenated compounds, hydroxy derivatives of hydrocarbons, oxo compounds, nitrogen-containing organic compounds, sulfur-containing organic compounds, the most important heterocyclic compounds, carbohydrates, amino acids, peptides, proteins, nucleosides, nucleotides, nucleic acids.

Literature:

Mandatory literature:
Lecture slides.
Recommended literature:
T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder; Organic Chemistry, 12th edition, John Wiley & Sons, Inc., 2016.
John McMurry; Organic Chemistry, 8th edition, Brooks/Cole, 2011.
Herbert Meislich, Estelle Meislich, Jacob Sharefkin; 3000 Solved Problem in Organic Chemistry, 1994.

Schedule:

1st week:
A brief history of organic chemistry. Chemical bonding theories: Lewis-Kossel method, VB, MO method, hybridization theory.
2nd week:
Classification of chemical reactions. Classification of organic compounds. Basic concepts of isomerism.
3rd week:
Nomenclature of organic compounds. Origin of chemical names. Bonding in alkanes, conformation, reactions, industrial importance.
4th week:
Bonding in alkenes and alkynes, geometric isomerism, reactions, industrial significance.
5th week:
Structure of benzene, aromatic electrophilic substitution, substituent effects. Important representatives of aromatic compounds and their industrial importance.
6th week:
Structure of alkyl halides, their reactions, industrial importance. Their impact on the environment. Properties of alcohols, their synthesis, reactions, detection methods.
7th week:
Structure of phenol, reactions, industrial importance. More important phenols. Sulfur-containing compounds: thiols, sulfonic acid derivatives.
8th week:
Properties and importance of nitro compounds. Synthesis of amines and their most important reactions, azo compounds.
9th week:
Aldehydes and ketones: structure, synthesis, most important reactions, detection.
10th week:
Carboxylic acids: acidity, description of carboxylic acid derivatives and their interconversions. Detergents and soaps.
11th week:
Biological role and identification of amino acids. Description of some important peptides. Structure of proteins.
12th week:
Structure and detection of carbohydrates. Description of the most important mono-, di- and polysaccharides.
13th week:
Bonding in five- and six-membered heterocyclic compounds, their biological significance. Some important natural compounds.
14th week:
Structure of nucleosides, nucleotides, DNA reproduction, role of RNA in protein synthesis.

Requirements:
understanding properties and reactivities of organic compounds, written exam with the following scoring:
100%-85% excellent
85%-75% good
75%-60% average
60%-50% pass
below 50% fail

Person responsible for course*:* Prof. Dr. Tibor Kurtán, head of department, full professor, DSc

Lecturer:

Title of course: **Organic Chemistry Seminar** Code: TTBBG1006_BT_EN	**ECTS Credit points**: 1

Evaluation: in term written test

Type of teaching, contact hours:
-lecture: -
-practice: 1 hour/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 14 hours
-laboratory -:
-home assignment: 76 hours
-preparation for the exam:
Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry Lecture, Seminar and Practical

Further courses built on it:-

Topics of course:

The aim of the seminar is to practice the concepts and theories necessary to understand organic chemistry, as well as the synthesis, physical and chemical properties of organic compounds.
Topicss of the course:
- Summary of basic concepts of organic chemistry
- Brief description and comparison of chemical bonding and bonding theories
- Discussion of the most important bond types found in organic compounds
- Isomerism and basic concepts of stereochemistry
- Classification of chemical reactions
- Functional groups, nomenclature of organic compounds
- Synthesis, physical and chemical properties of organic compounds containing different functional groups: hydrocarbons, halogenated compounds, hydroxy derivatives of hydrocarbons, oxo compounds, nitrogen-containing organic compounds, sulfur-containing organic compounds, the most important heterocyclic compounds, carbohydrates, amino acids, peptides, proteins, nucleosides, nucleotides, nucleic acids.

Literature:

Mandatory literature:
Lecture slides.

Recommended literature:
T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder; Organic Chemistry, 12th edition, John Wiley & Sons, Inc., 2016.
John McMurry; Organic Chemistry, 8th edition, Brooks/Cole, 2011.
Herbert Meislich, Estelle Meislich, Jacob Sharefkin; 3000 Solved Problem in Organic Chemistry, 1994.

Schedule:

1st week:

A brief history of organic chemistry. Chemical bonding theories: Lewis-Kossel method, VB, MO method, hybridization theory.

2nd week:

Classification of chemical reactions. Classification of organic compounds. Basic concepts of isomerism.

3rd week:

Nomenclature of organic compounds. Origin of chemical names. Bonding in alkanes, conformation, reactions, industrial importance.

4th week:

Bonding in alkenes and alkynes, geometric isomerism, reactions, industrial significance.

5th week:

Structure of benzene, aromatic electrophilic substitution, substituent effects. Important representatives of aromatic compounds and their industrial importance.

6th week:

Structure of alkyl halides, their reactions, industrial importance. Their impact on the environment. Properties of alcohols, their synthesis, reactions, detection methods.

7th week:

Structure of phenol, reactions, industrial importance. More important phenols. Sulfur-containing compounds: thiols, sulfonic acid derivatives.

8th week:

Properties and importance of nitro compounds. Synthesis of amines and their most important reactions, azo compounds.

9th week:

Aldehydes and ketones: structure, synthesis, most important reactions, detection.

10th week:

Carboxylic acids: acidity, description of carboxylic acid derivatives and their interconversions. Detergents and soaps.

11th week:

Biological role and identification of amino acids. Description of some important peptides. Structure of proteins.

12th week:

Structure and detection of carbohydrates. Description of the most important mono-, di- and polysaccharides.

13th week:

Bonding in five- and six-membered heterocyclic compounds, their biological significance. Some important natural compounds.

14th week:

Structure of nucleosides, nucleotides, DNA reproduction, role of RNA in protein synthesis.

Requirements:

understanding properties and reactivities of organic compounds, evaluation is based on the short written tests and achievement at the seminar

Person responsible for course*:* Prof. Dr. Tibor Kurtán, head of department, full professor, DSc

Lecturer: Dr. Sándor Kun, senior lecturer, PhD (chemistry)

Title of course: **Organic Chemistry Practical** Code: TTBBL1006_BT_EN	**ECTS Credit points**: 2

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 3 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 42 hours
-home assignment: 28 hours
-preparation for the exam: -
Total: 70 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Organic Chemistry Lecture, Organic Chemistry Seminar and General Chemistry Practical

Further courses built on it:-

Topics of course:

The purpose of the laboratory practice is to learn basic organic chemistry laboratory techniques, to apply theoretical knowledge in practice, to learn about the reactivity of functional groups through the synthesis of simple preparations and test tube experiments. Our further goal is for the students to acquire adequate knowledge of materials, as well as to get to know and apply purification and identification techniques as typical organic chemical activities.

Content and Topicss of the course
- Presentation and application of basic organic chemistry techniques: recrystallization, extraction, distillation, column chromatography
- Presentation and application of organic chemical identification methods: thin layer chromatography, melting point measurement
- Synthesis of simple preparations
- Detection of functional groups using test tube experiments

Literature:

Mandatory literature:
Laboratory manual, which contains the necessary theoretical knowledge and the instructions for performing the preparations and isolations

Recommended literature:
1. James W. Zubrick (2015) The Organic Chem Lab Survival Manual: A Student's Guide to Techniques Hoboken, NJ, John Wiley & Sons, Inc., ISBN 978-1-118-87578-0
2. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder; Organic Chemistry, 12th edition, John Wiley & Sons, Inc., 2016.
3. John McMurry; Organic Chemistry, 8th edition, Brooks/Cole, 2011.
4. Herbert Meislich, Estelle Meislich, Jacob Sharefkin; 3000 Solved Problem in Organic Chemistry, 1994.

Schedule:
1st week:
Description of tasks, handover of equipment, accident prevention training. Description of the operation of the rotary vacuum evaporator
2nd week:
Presentation of the apparatus required for recrystallization. Presentation of the gravity and vacuum filter equipment. Recrystallization of acetanilide from water
3rd week:
Presentation of thin layer chromatography (TLC). Presentation of melting point determination. Checking the purity of the compound recrystallized in the previous exercise using melting point measurement and VRK. Calculation of the recrystallization yield.
4th week:
Presentation of liquid-liquid extraction. Checking the purity of the compound recrystallized in the previous exercise by measuring the melting point. Calculation of the recrystallization yield. Application of liquid-liquid extraction to the separation of a mixture of m-dinitrobenzene and m-nitroaniline.
5th week:
Presentation of the equipment used in atmospheric pressure distillation. Distillation of acetone from KMnO4 at atmospheric pressure.
6th week:
Presentation of equipment used in distillation under reduced pressure. Distillation of water in vacuum.
7th week:
Test tube reactions of hydrocarbons and halogenated hydrocarbons: Reaction of hydrocarbons with bromine. Reaction of hydrocarbons with bromine in the presence of UV light. Friedel-Crafts test for aromatic hydrocarbons. Baeyer's test for unsaturated hydrocarbons. Beilstein and alcoholic silver nitrate test of halogen derivatives. Identification of unknown sample.
8th week:
Presentation of steam distillation. Isolation of carvone from cumin and preparation of its 2,4-dinitrophenylhydrazone derivative
9th week:
Presentation of the apparatus used for reactions carried out in multi-necked flasks. Preparation of benzamide and recrystallization of the product from water
10th week:
Checking the purity of benzamide by measuring the melting point and using VRK. Test tube reactions of hydroxy derivatives of hydrocarbons. Solubility relations of alcohols and phenols. Lucas test of alcohols. Oxidation of alcohols with Jones reagent. Reaction of diols and poliols with copper(II) ions. Complex formation of phenols and enols with iron(III) ions. 2-Alkanols iodoform test. Identification of unknown sample
11th week:
Presentation of column chromatography. Column chromatographic separation of a mixture of acetanilide and m-dinitrobenzene
12th week:
Test tube reactions of oxo derivatives of hydrocarbons: Detection of aldehydes with 2,4-dinitrophenylhydrazine test. Oxidation of oxo compounds with potassium permanganate and Jones reagent. Reaction of oxo compounds with Tollens reagent. Iodoform test for oxo compounds. Identification of unknown sample
13th week:
Test tube reactions of carbohydrates, amino acids and proteins. Examination of the reducing properties of carbohydrates with the Fehling and Tollens tests. Complexation reactions of amino acids and proteins (Biuret test). Detection of α-Amino acids (Ninhydrin test). Detection of proteins containing α -amino acids with an aromatic ring (Xantoprotein reaction)
14th week:
Completion of missed identification tasks (melting point, VRK) yield calculation.

Equipment cleaning and handover, announcement of results
Requirements: Attendance at laboratory practice is compulsory. Before starting the laboratory work, students must write a short written test on their theoretical organic chemistry and practical knowledge as well as on the safety rules about the previous laboratory practice (20-30 minutes). Grades of short written tests: excellent (5): 90%; good (4): 75%; satisfactory (3): 60%; pass (2): 50%; fail (1): below 50%. Grades of unknowns: • **5** if the result is good for the first presentation and the justification is good • **3** if the result is good for the second presentation and the justification is good • **1** if the result is not good even after a second presentation or the justification is unacceptable The term mark consists of the marks obtained for the identification of the unknowns, the marks of the written tests, and your overall performance on the laboratory practices. A prerequisite for successful laboratory practice is the synthesis of all preparations. The final grade will be determined based on the average of the grades of tasks. A weighted average of the grades of subtasks will be calculated in the following manner: • Short written test (65%) • Activity in laboratory practice (15%) • Identification of unknown compounds (20%)
Person responsible for course*:* Éva Dr. Juhászné Dr. Tóth, assistant professor, PhD
Lecturer:

Title of course: **Inorganic Chemistry Lecture** Code: TTBBE1007_BT_EN	**ECTS Credit points**: 2

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 32 hours
Total: 60 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry Lecture, Seminar, Practical

Further courses built on it:-

Topics of course:

Elements in the periodic table. Classification of the elements. Production of the elements by separation and by chemical (metallurgical) methods. Preparation of the metallic and non-metallic elements. Hydrogen. Atomic and physical properties, abundance, chemical properties. Deuterium and tritium. Production and uses. The Noble gases. (Group 18). Atomic and physical properties, distribution, chemical properties. Production and uses. The halogens. (Group 17) Atomic and physical properties, distribution, chemical properties of the halogens. Hydrogen halides, oxides and oxoacids. Structure and acidity of the oxoacids. Preparation and uses. The chalcogens. (Group 16). Atomic and physical properties, distribution, chemical properties of the chalcogens. Compounds with hydrogen and halogens. Water and softening of water. Oxides and oxoacids of chalcophylic elements. Sulphur-nitrogen compounds. Production and uses of the elements. Nitrogen and phosphorus (Group 15). Atomic and physical properties, distribution, chemical properties of the elements. Typical compounds of nitrogen and phosphorous, preparation and uses of ammonia. Structure, chemical properties of the phosphorous oxoacids. Production and uses of the elements. Carbon, silicon, germanium, tin and lead (Group 14). Atomic and physical properties, distribution, chemical properties of the elements. Chemistry of carbon and silicon. Important compounds of carbon and silicon. Production and uses of the elements. Atomic and physical properties, distribution, chemical properties of the elements of aluminum. Oxides and related compounds. Production and uses of the aluminum. S-block elements (Group 1 and 2): Atomic and physical properties, distribution, chemical properties and uses of the alkali and alkaline earth metals. Dissolution of Na in liquid ammonia. Covalent and coordination compound of the alkali metal elements. Crown ethers and cryptands. Compounds of alkaline earth metals: hydrides, halogenides, oxides, hydroxides, salts with strong acids, complexes. Transition metals (d-block elements, Group 3 -12): General trend in the d-block. Atomic and physical properties, distribution, chemical properties and uses of the transition metals. Important compounds of d-block: hydrides, halogenides, oxides, hydroxides, salts with strong acids, complexes. Acid-base properties and redoxy reactions. Transition metal ions in aqueous solutions: hydrated cations, oxocations and oxoanions. Iso- and heteropolyacids. The

characterization of the most important transition metals and their compounds: chromium, manganese, iron, cobalt, nickel, platina-group, copper, silver, gold, zinc, cadmium, mercury. f-block elements. Electronic structure, the lanthanide contraction. Some important complexes of Gd. Important uranium compound related to the atomic energy industry. Biological functions of alkali and alkaline earth metal ions. Transition metals and other elements. Transport, storage and activation of oxygen. Role and metabolism of iron. Copper containing proteins and metabolism of copper. Biological role of zinc in activation of enzymes. Importance of Mo, Se and silicon. Medical applications: diagnosis and therapy. Toxicity of metal ions.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
1) N. N. Greenwood and A. Earnshaw, Chemistry of the elements, Pergamon press, Oxford, New York, Seoul, Tokyo, 1994.
2) Geoff Rayner-Canham, Tina Overton: Descriptive Inorganic Chemistry (5th Edition), W. H. Freeman and Company, New York, 2010, ISBN-13: 978-1-4292-2434-5 (or later edition)
3) Glen E. Rodgers, Descriptive Inorganic, Coordination and Solid-Phase Chemistry, (3rd Edition), Brooks/Cole, 2012, ISBN-13: 978-0-8400-6846-0 (or later edition)

Schedule:

1st week:

Elements in the periodic table. Classification of the elements. Production of the elements by separation and by chemical (metallurgical) methods. Preparation of the metallic and non-metallic elements. Hydrogen. Atomic and physical properties, abundance, chemical properties.

2nd week:

The hydrogen: Atomic and physical properties, occurrence, chemical properties. Deuterium and tritium. The production and use of hydrogen.

The Noble gases (Group 18): Atomic and physical properties, distribution, chemical properties. Production and uses.

3rd week:

The halogens (Group 17:) Atomic and physical properties, distribution, chemical properties of the halogens. Hydrogen halides, oxides and oxoacids. Structure and acidity of the oxoacids. Preparation and uses.

The chalcogens. (Group 16). Atomic and physical properties, distribution, chemical properties of the chalcogens. The production and use of oxygen and sulphur.

4th week:

Hydrogen compunds of oxygen and Sulphur. Water and softening of water. Complexes of oxygen, their biolgogical importance. General characterization of oxides and oxoacids.

5th week:

Oxygen compounds and oxoacids of sulphur.

Nitrogen and phosphorus (Group 15): Atomic and physical properties, distribution, chemical properties of the elements. Production and uses of nitrogen, Sulphur and ammonia.

6th week:

Nitrogen oxides and oxoacids: structure, chemical properties, practical significance. General characterizaion of the phosphorous oxoacids.

7th week:

The carbon group (Group 14): Atomic and physical properties, distribution, chemical properties of the elements. Chemistry of carbon and silicon. Important compounds of carbon and silicon. Uses of the elements.

8th week:

Atomic and physical properties, distribution, chemical properties of the elements of aluminum. Oxides and related compounds. Production and uses of the aluminum.

9th week:

S-block elements (Group 1 and 2): Atomic and physical properties, distribution, chemical properties and uses of the alkali and alkaline earth metals. Dissolution of Na in liquid ammonia. Covalent and coordination compound of the alkali metal elements. Crown ethers and cryptands. Compounds of alkaline earth metals: hydrides, halogenides, oxides, hydroxides, salts with strong acids, complexes. The role of alkali metal and alkaline earth metal ions in biological systems.

10th week:

Transition metals (d-block elements, Group 3 -12): General trend in the d-block. Atomic and physical properties, distribution, chemical properties and uses of the transition metals. Acid-base properties, complex formation and redoxy reactions. The basics of the hard-soft acid-base (HSAB) theory. Transition metal ions in aqueous solutions: hydrated cations, oxocations and oxoanions. Iso- and heteropolyacids.

11th week:

Important compounds of d-block: hydrides, halogenides, oxides, hydroxides, salts with strong acids. The characterization of the most important transition metals and their compounds: physical properties, distribution, chemical properties and uses of chromium, molybdenum and manganese. The biological role of molybdenum and manganese.

12th week:

Physical properties, distribution, chemical properties and uses of iron, cobalt, nickel, platina-group. The biological role of iron. The role of platinum metals in medicine.

13th week:

Physical properties, distribution, chemical properties and uses of, copper, silver, gold, zinc, cadmium, mercury. The role of copper and zinc in biological systems, the medicinal applications of silver and gold.

14th week:

f-block elements. Electronic structure, the lanthanide contraction. Some important complexes of Gd. Important uranium compound related to the atomic energy industry. The use of rare earth metals and other radioactive isotopes in medicine: diagnosis and therapy.

Requirements:

- *for a signature*:

Attendance at lectures is recommended, but not compulsory.

- *for a grade*:

The course ends in an examination. The minimum requirement for the examination is 40 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-39	fail (1)
40-55	pass (2)
56-70	satisfactory (3)
71-85	good (4)

86-100 excellent (5) If the score of any test is below 40, students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
Person responsible for course*:* Prof. Katalin Várnagy, full professor, DSc
Lecturer: Dr. Norbert Lihi, associate professor, PhD

Title of course: **Inorganic Chemistry Practical** Code: TTBBL1007_BT_EN	**ECTS Credit points**: 2

Evaluation: middle term and final exams

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 28 hours
-home assignment: 32 hours
-preparation for the exam:
Total: 60 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry Lecture, Seminar and Practical

Further courses built on it:-

Topics of course:

The objective of the laboratory practice is to introduce the students to laboratory work of inorganic chemistry, the use of basic laboratory equipment, simple laboratory operations and measurements. In addition, students are expected to prepare certain simple chemicals and run various basic experiments in the field of inorganic chemistry to familiarize themselves with chemical laboratory work.
We aim to impart the following knowledge:
Identification and separation of inorganic anions and cations
Laboratory scale preparation of hydrogen and chlorine, reaction of chlorine with metals.
Reactions of alkali-chlorides, -bromides and iodides, identification of bromide and iodide ions coexisting in solution.
Oxygen group: detection and identification of hydrogen peroxide, preparation of hydrogen sulfide and its aqueous solution, detection of hydrogen sulfide, identification of sulfite and sulfate ions.
The analysis of ammonia and ammonium ions. Reactions of nitrite and nitrate ions.
Detection of orthophosphate ions from aqueous solutions.
Interaction of metals with acids and bases. Reactions of alkali and alkaline earth metals. Oxidation states of transition metal ions in aqueous solution. Formation of transition metal hydroxides and hidroxo complexes, transition metal hydroxides and ammine complexes. Formation and investigation of transition metal sulfides.

Literature:

Mandatory literature:
Inorganic Chemistry Laboratory Manual
Written by József Emri, Béla Győri, István Lázár
Department of Inorganic and Analytical Chemistry, University of Debrecen, Debrecen, 2020

Recommended literature:
Vogel's Qualitative Inorganic Analysis – Fifth Edition
G. Svehla (reviser)
Longman Scientific & Technical, John Wiley & Sons, Inc., New York, 1994. ISBN 0-582-

45090-X. ISBN 0-470-20710-8
Chemistry of the Elements
N.N. Greenwood and A. Earnshaw, Second edition, 1997

Schedule:

Practice 1.

1. General rules of laboratory work, requirements of laboratory practice
2. Safety training
3. Light a Bunsen-burner
4. Laboratory preparation of hydrogen with the use of Kipp's apparatus and combustion of hydrogen
5. Inventory check of laboratory equipment

Practice 2.

1. Laboratory scale preparation of chlorine
2. Reaction of chlorine with metals
3. Burning of hydrogen in chlorine
4. Detection of fluoride ions
5. Formation and dissolution silver halides
6. Detection of bromide and iodide ions next to each other by using chlorine water
7. Detection of chloride ion next to bromide and iodide ions (Berg reaction)
8. Purity test with chemical methods (Ph. Hg. VII. I/186-189. reading)
9. Purity test: Investigation of bromate impurity in potassium bromide (Ph. Hg. VII. II/1066–1067. [12])
10. Unknown sample: Detection of two anions from the following ones: F^-, Cl^-, Br^-, I^-.

Practice 3.

1. Electrolytic preparation, detection and oxidizing ability of ozone
2. Detection of hydrogen peroxide
3. Preparation of hydrogen sulfide and its aqueous solution, detection of H_2S.
4. Differentiation of sulfite and sulfate ions
5. Formation of nitrogen by synproportionation
6. Detection of ammonia and ammonium ions
7. Identification of nitrite ions
8. Identification of nitrate ions
9. Identification of nitrite and nitrate ions with Griess-Ilosvay reagent
10. Identification of orthophosphate ions
11. Preparation and properties of carbon monoxide
12. Unknown sample: Detection of two anions from the following ones: S^{2-}, SO_3^{2-}, PO_4^{3-}, SO_4^{2-}, Cl^-, NO_2^-, NO_3^-, NH_4^+

Practice 4.

1. Interaction of lead with acids
2. Chemical reactions of aluminum with acids and bases
3. Crown ether complexes of alkali metal ions
4. Preaparation of one of the following complexes:

– potassium [tetracyanonickelate(II)]
– ammonium [octaeicozaoxa-decavanadate(V)] hydrate (1/6)
– [tris(2,4-pentanedionato)iron(III)]
– Bis(2,4-pentanedionato)vanadium(IV) oxide

5. Purity test: Investigation of lead impurity in boric acid (Ph. Hg. VII. II/668-669. [5] and I/189. C.7.1.2., standard solution: I/597.)

Practice 5.

1. Reaction of Ag^{+}; Cd^{2+}; Hg^{2+}; Hg_2^{2+}; Pb^{2+}; Bi^{3+} and Cu^{2+} on filter paper with iodide ions (demonstration)
2. Oxidation states of 3d transition metals in aqueous solution
3. Aluminothermic preparation of transition metals
4. Formation of transition metal hydroxides and hidroxo complexes
5. Transition metal hydroxides and ammine complexes
6. Formation and investigation of transition metal sulfides
7. Detection of a few ions with organic reagents
8. Due in of the preparations
9. Unknown sample: Detection of two cations from the following ones: Cu^{2+}, Cd^{2+}, Hg^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Fe^{3+}, Cr^{3+}

Practice 6.

1. Preaparation of one of the following complexes:
   - $(NH_4)_3[Cr(SCN)_6]\cdot 4H_2O$
   - cis-$K[Cr(C_2O_4)_2(H_2O)_2]$
   - $[Cr(OCN_2H_4)_6]Cl_3\cdot 3H_2O$
   - [μ-Hidroxo-bis{pentaammin-cromine(III)}]-chloride
2. Classification of cations. Reactions of group cation group IV and V.
3. Study of poorly water soluble alkali metal salts
4. Low-solubility alkaline earth metal salts
5. Flame tests and flame emission spectra of the alkali metals

Practice 7.

1. Due in of the preparations
2. Purity test:. Investigation of silver impurity in “bismuth subnitrate, heavy” (Ph. Hg. VII. II/819. [4] and [6])
3. Unknown sample: Detection of two cations from the following ones: Na^{+}, K^{+}, NH_4^{+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+} (One component is a cation of group IV., and the other one is from cation group V.)

Inventory and return of laboratory equipment

Requirements:

The final grade for the course is determined by the average result of the short tests and that of the unknown samples. The quality of the laboratory reports will be assessed to decide uncertain grades. The average score from the short tests have to be above 50 % to earn “pass (2)” grade. In addition, the average grade earned for analyzing unknown
samples have to be minimum 2.00 in order to successfully complete the course.

Person responsible for course*:* Dr. Norbert Lihi, assistant professor, PhD

Lecturer: Dr. Attila Forgács, research fellow, PhD

Title of course: **Physical Chemistry Lecture** Code: TTBBE1008_BT_EN	**ECTS Credit points**: 2

Evaluation: written tests

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 84 hours
Total: 112 hours

Year, semester: 2nd semester

Its prerequisite(s): General Chemistry Lecture, Seminar an Practical

Further courses built on it:-

Topics of course:

The series of lectures are based on the Topicss of chemical thermodynamics, equilibrium studies, electrochemistry and reaction kinetics. It reviews the fundamental relations of physical chemistry. The course helps to build and strengthen the concepts of physical chemistry in the student's scientific view. In this way the basic concepts and phenomena learned, especially in the General Chemistry course (prerequisite) will be placed into more exact and mathematically wellestablished surrounding. Application of the approach of physical chemistry in engineering is discussed through examples.

Literature:

Mandatory literature:
- Lecture notes and teaching material available via the e-learning system.
- P. W. Atkins, J. de Paula (2004 or any later edition): Elements of physical chemistry, 4 th edition, Oxford University Press
- P. W. Atkins, J. de Paula (2008 or any later edition): Physical Chemistry, 8th edition, Oxford University Press
Recommended literature:
- P. W. Atkins, J. de Paula (2006): Physical chemistry for life sciences, Oxford University Press
- R. Chang (1977): Physical chemistry with applications to biological systems, MacMillan, New York

Schedule:

1st week:
General information
2nd week:
Basic notions of thermodynamics
3rd week:
First Law of thermodynamics
4th week:
Second and Third Laws of thermodynamics

5th week:
Phase transitions
6th week:
Mixture
7th week:
Chemical equilibrium
8th week:
Transport processes
9th week:
Electrical conductance
10th week:
Galvanic cells
11th week:
Reaction kinetics 1.
12th week:
Reaction kinetics 2.
13th week:
Colloids
14th week:
Interfacial phenomena

Requirements:
1. The lecture is optional (it is not compulsory), but who does not attend the lectures min. 30% of them are not allowed to apply for the exam.
2. The semester ends with a written colloquium.

Person responsible for course*:* Dr. Henrietta Horváth, associate professor, PhD

Lecturer: -

Title of course: **Physical Chemistry Seminar** Code: TTBBG1008_BT_EN	**ECTS Credit points**: 1
Evaluation: mark of written tests	
Type of teaching, contact hours: -lecture: - -practice: 1 hour/week -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: - -practice: 14 hours -laboratory -: -home assignment: - -preparation for the exam: 40 hours Total: 54 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): General Chemistry Lecture, Seminar, Practical	
Further courses built on it:-	
Topics of course:	
The series of seminars are based on the Topicss of chemical thermodynamics, equilibrium studies, electrochemistry and reaction kinetics. It reviews the fundamental relations of physical chemistry. The course helps to build and strengthen the concepts of physical chemistry in the student's scientific view. In this way the basic concepts and phenomena learned, especially in the General Chemistry course (prerequisite) will be placed into more exact and mathematically wellestablished surrounding. Application of the approach of physical chemistry in engineering is discussed through examples.	
Literature:	
Mandatory literature: - Lecture notes and teaching material available via the e-learning system. - P. W. Atkins, J. de Paula (2004 or any later edition): Elements of physical chemistry, 4 th edition, Oxford University Press - P. W. Atkins, J. de Paula (2008 or any later edition): Physical Chemistry, 8th edition, Oxford University Press Recommended literature: - P. W. Atkins, J. de Paula (2006): Physical chemistry for life sciences, Oxford University Press - R. Chang (1977): Physical chemistry with applications to biological systems, MacMillan, New York	
Schedule: *1st week:* General information *2nd week:* Basic notions of thermodynamics *3rd week:* First Law of thermodynamics *4th week:* Second and Third Laws of thermodynamics *5th week:*	

Phase transitions
6th week:
Mixture
7th week:
Chemical equilibrium
8th week:
Transport processes
9th week:
Electrical conductance
10th week:
Galvanic cells
11th week:
Reaction kinetics 1.
12th week:
Reaction kinetics 2.
13th week:
Colloids
14th week:
Interfacial phenomena

Requirements:

1. Mandatory participation in seminars. A duly justified absence is possible up to 2 times (advance notice to the seminar leader or medical certification required). In the case of a higher number of absences, the semester cannot be accepted.
2. Effective writing of closed-ended essays. During the semester, you will have to demonstrate your mastery of the computational tasks by writing a seminar exam. For biotechnology students, the seminar mark is the average of the marks obtained in these final papers.

0-40% - 1
41-52% - 2
53-66% - 3
67-79% - 4
80-100% - 5

Person responsible for course*:* Dr. Henrietta Horváth, associate professor, PhD

Lecturer: -

Title of course: **Physical Chemistry Practical** **ECTS Credit points**: 2
Code: TTBBL1008_BT

Evaluation: marks of laboratory notebooks and written tests

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 28 hours
-home assignment: 28 hours
-preparation for the exam:
Total: 56 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry Lecture, Seminar and Practical

Further courses built on it:-

Topics of course:

This course is intended to stimulate students for independent work, to teach them how to perform basic physical chemistry measurements and to get familiar with measurement planning, data processing and report writing. The tasks detailed here contain mainly thermodynamic, equilibrium and kinetic studies.
Topicss of measurements:
- determination of thermodynamic parameters by spectrophotometry
- study of solubility and its ionic strength dependence by conductivity measurements
- determination of transmission coefficient
– determination of kinetic properties by titrimetric, spectrophotometric and gas volumetric methodes
- study of the phase diagram of two- and three-component mixtures
– study of UV-VIS spectra of metal complexes

Literature:

Mandatory literature:
Departmental laboratory notes and additional teaching materials.

Recommended literature:
P.W. Atkins, J. de Paula: Atkins, Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8, 2006

K. Ősz, A. Bényei: Physical Chemistry Laboratory Measurements (for students of Pharmacy, Chemistry and Chemical Engineering). Debreceni Egyetemi Kiadó, ISBN: 978-963-318-143-0, 2011

Schedule:
One of the measurements listed above (**Topics of course**) per week except the 1st practice (introduction, general information and safety training).

Requirements:

Participation on the laboratory practice is compulsory. The measurements and knowledge of the associated theory are marked and an overall mark will be given. Safety training (1st week) is

mandatory before the first lab practice (2nd week). Everybody should work individually according to the pre-set schedule (which will be provided on the 1st week). Lab practices are 4 hours long every week. Being late or failed mark on the written test from the appropriate measurement is equivalent with an absence. In accordance with the regulations of University of Debrecen, attendance is compulsory with the exception of health or family problems (the reason of absence should be certified). In this case, the students should agree with the teacher on replacement dates for the missed experiments.

Requirements for the grade:

The measurements (regularly) and written tests (occasionally) according to the knowledge of the associated theory are marked and the overall mark will be given based on these.

- All notebooks of the measurements have to be marked as "pass (2)" or better for the successful completion.
- The minimum requirement for the written tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the average of written tests is below 60% the best grade for the course can be only "pass (2)" in any other cases the final mark is given with weighted average by means of the mark of the written tests and notebooks in 1 to 2 ratio.

Person responsible for course*:* Dr. Ferenc K. Kálmán, associate professor, PhD

Lecturer: -

Title of course: **Mathematics I. Lecture** Code: TTBBE1009_BT_EN	**ECTS Credit points**: 4

Evaluation: oral or written exam

Type of teaching, contact hours:
-lecture: 4 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
- lecture: 56 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 34 hours

Total: 90 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and improper integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.

Literature:

Mandatory literature: -
Recommended:
Thomas, Weir & Hass: Thomas' Calculus,
K. A. Stroud: Calculus and Mathematical Analysis,
K. A. Stroud: Engineering Mathematics,
E. Mendelson: Schaum's 3000 Solved Problems in Calculus,

Schedule:

1st week:

Operations with sets, set algebra. Descartes product, relations, functions. Special functions: injectivity, surjectivity, bijectivity. The inverse of a function. Real numbers. Exact lower and upper bounds. Open and closed sets. Bolzano-Weierstrass theorem.

2nd week:

Complex numbers. The algebraic structure of the set of complex numbers. The complex plane. Trigonometric form of complex numbers, multiplication, division, n-th power, n-th root.

3rd week:

Sequences. Convergence and limit of real sequences. Monotonous, bounded, convergent sequences, Cauchy's convergence criteria. Algebraic operations with convergent sequences. Squeezing theorem. The generalization of the notion of limit.

4th week:

Series. The convergence of series. Arithmetic series and geometric series. The harmonic series. Leibniz type series. Convergence tests: ratio and root tests. Power series.

5th week:

Limits and continuity of functions. Properties of continuous functions. Continuity of the composition and the inverse function. Special properties of continuous functions defined on an interval. Elementary functions.

6th week:

Differentiation. The geometric meaning of the derivative. Rules of differentiation. Derivative of a function of a function: the chain rule. The derivative of the inverse function. Relationship of monotonicity and the derivative. Roll's theorem and Lagrange's theorem. Conditions for the existence of extreme values. Derivative of elemental functions.

7th week:

Higher order derivatives. Convexity and the derivatives. Approximating with polynomials, Taylor formula. Conditions for the existence of extreme value.

8th week:

Primitive functions, the indefinite integral. Integration methods. Definite integral. Basic properties of the definite integrals. Integration of a continuous functions. The Newton-Leibniz formula.

9th week:

Improper integrals. Applications.

10th week:

Ordinary differential equations. The solution of separable, homogeneous and linear differential equations.

11th week:

Vector space. Linear dependent and independent system of vectors. Base, dimension. Subspace. Vector space generated by a set of vectors. Rank of a system. Linear maps.

12th week:

Matrices, matrix algebra. Determinants and their calculation. The rank of a matrix. The inverse of a matrix. Matrix representation of linear maps.

13th week:

System of linear equations. Homogeneous and inhomogeneous systems. Gauss elimination, Cramer's rule. Applications.

14th week:

Euclidean spaces. Inner product, standard, angle, distance. Schwarz and Minkowski inequality. Orthogonality. Orthogona projection. Symmetrical and orthogonal transformations.

Requirements:

- for a signature

If the student fails the course Mathematics I practical (TTBBG1009_BT_EN), then the signature is automatically denied.

- for a grade

The course ends in written examination, although it is possible to request an oral examination. The grade is given according to the following table:

Total Score (%)	**Grade**
0 – 49	fail (1)
50 – 64	pass (2)

65 – 74	satisfactory (3)
74 – 84	good (4)
85 – 100	excellent (5)

Person responsible for course*:* Prof. Dr. Zoltán Muzsnay, head of department, full professor, PhD (mathematics), doctor of the Hungarian Academy of Sciences (mathematics)

Lecturer:

Title of course: **Mathematics I. Seminar** Code: TTBBG1009_BT_EN	**ECTS Credit points**: 2

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: 2 hours/week
-laboratory: -

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28 hours
- laboratory: -
- home assignment: -
- preparation for the exam: 28 hours

Total: 56 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and improper integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.

Literature:

Mandatory literature: -
Recommended:
Thomas, Weir & Hass: Thomas' Calculus,
K. A. Stroud: Calculus and Mathematical Analysis,
K. A. Stroud: Engineering Mathematics,
E. Mendelson: Schaum's 3000 Solved Problems in Calculus,

Schedule:

1st week:

Exercises concerning sets, Descartes products, relations, functions.

2nd week:

Exercises concerning complex numbers, trigonometric form of complex numbers, multiplication, division, n-th power, n-th root.

3rd week:

Exercises concerning sequences, convergence and limit of real sequences. Monotonous, bounded, convergent sequences, Algebraic operations with convergent sequences, squeezing theorem.

4th week:

Exercises concerning series, the convergence of series. Arithmetic series and geometric series.

The harmonic series. Leibniz type series. Convergence tests: ratio and root tests. Power series.

5th week:

Exercises concerning limits and continuity of functions. Properties of continuous functions. Continuity of the composition and the inverse function. Special properties of continuous functions defined on an interval. Elementary functions.

6th week:

Exercises concerning differentiation: the rules of differentiation, derivative of a function of a function: the chain rule, the inverse function.

7th week:

Exercises concerning higher order derivatives: convexity, approximating with polynomials, Taylor formula.

8th week:

Test. Exercises concerning the indefinite and definite integrals, integration methods.

9th week:

Exercises concerning improper integrals and applications.

10th week:

Solving ordinary differential equations: the separable, homogeneous and linear differential equations.

11th week:

Exercises concerning vector space: linear dependent and independent system of vectors, base, dimension. Linear maps.

12th week:

Exercises concerning matrices, matrix algebra. Matrix representation of linear maps.

13th week:

Exercises concerning system of linear equations. Homogeneous and in homogeneous systems. Gauss elimination, Cramer's rule. Applications.

14th week:

Test.

Requirements:

- for a signature

Attendance of classes are compulsory with the possibility of missing at most three classes during the semester. In case of further absences, a medical certificate needs to be presented, otherwise the signature is denied.

- for a grade

The course is evaluated on the basis of two written tests during the semester. The grade is given according to the following table:

Total Score (%)	**Grade**
0 – 49	fail (1)
50 – 64	pass (2)
65 – 74	satisfactory (3)
75 – 84	good (4)
85 – 100	excellent (5)

If a student fails to pass at first attempt, then a retake of the tests is possible.
It is not possible to obtain an offered grade in this course.

Person responsible for course*:* Prof. Dr. Zoltán Muzsnay, head of department, full professor, PhD (mathematics), doctor of the Hungarian Academy of Sciences (mathematics)

Lecturer:

Title of course: **Mathematics II. Lecture and Seminar** Code: TTBBE1010_BT_EN	**ECTS Credit points**: 2

Evaluation: exam

Type of teaching, contact hours:

-lecture: 1 hours/week

-practice: 1 hours/week

-laboratory: -

Workload (estimated), divided into contact hours:

- lecture: 14 hours
- practice: 14 hours
- laboratory: -
- home assignment: -
- preparation for the tests: 32 hours

Total: 60 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Mathematics I. Lecture and Seminar

Further courses built on it:-

Topics of course:

Probability. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events. Random variables. Discrete and continuous random variables. Probability distribution, density function. Random variables and cumulative distribution function. Expected value and variance.Elements of statistics. Notable discrete and continuous random variables. Statistical estimators: unbiasedness, efficiency, consistency.

Literature:

Mandatory literature: -
Recommended literature:
J. Bain: Introduction to Probability and Mathematical StatisticsThomas,
Marco Taboga: Lectures on Probability Theory and Mathematical Statistics

Schedule:

1st week:

Probability. Classical and geometrical probability spaces.

2nd week:

Conditional probability. Total probability theorem, Bayes' theorem. Independence of events.

3rd week:

Random variables and cumulative distribution function. Discrete random variables, probability distribution.

4th week:

Continuous random variables, density function.

5th week:

Expected value and variance.

6th week:

Exercises concerning discrete and continuous random variables.

7th week:

Test.

8th week:

Special discrete probability distributions: Bernoulli, binomial, hypergeometric, Poisson, geometric distribution.

9th week:

Special continuous distributions: uniform, exponential and normal distribution.

10th week:

Exercises concerning special distributions.

11th week:

Elements of statistics: estimation of the distribution and density functions and the expected value. Unbiasedness, efficiency, consistency.

12th week:

Estimation of the variance. Estimation of parameters.

13th week:

Hypothesis testing: z-test and t-test.

14th week:

Test.

Requirements:

- for a signature

Attendance of classes are compulsory with the possibility of missing at most three classes during the semester. In case of further absences, a medical certificate needs to be presented, otherwise the signature is denied.

- for a grade

The course is evaluated on the basis of two written tests during the semester. The grade is given according to the following table:

Total Score (%)	**Grade**
0 – 49	fail (1)
50 – 64	pass (2)
65 – 74	satisfactory (3)
75 – 84	good (4)
85 – 100	excellent (5)

If a student fails to pass at first attempt, then a retake of the tests is possible.
It is not possible to obtain an offered grade in this course.

Person responsible for course*:* Prof. Dr. Zoltán Muzsnay, head of department, full professor, PhD (mathematics), doctor of the Hungarian Academy of Sciences (mathematics)

Lecturer:

Title of course: **Design and Analysis of Experiments Practical** Code: TTBBG1011_BT_EN	**ECTS Credit points**: 2

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: 2 hours/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 28 hours
-laboratory:
-home assignment: 32
-preparation for the exam:
Total: 60 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Mathematics I. Lecture and Seminar

Further courses built on it:-

Topics of course:

Students acquire knowledge of statistics and the basic notations and methods of design and analysis of experiments. We aim to impart the following basic knowledge: storage, manipulation and visualization of data with the aid of computer. Statistical analysis of data, testing of hypotheses, statistical tests, regression analysis with the aid of computer. The basics of design of experiments. Factorial designs. Single-factor experimental design: completely randomized design, randomized block design, Latin square design. Two-factor factorial design.

Literature:

Recommended literature:
Montgomery, D.C.: Design and Analysis of Experiments, John Wiley and Sons, New York, 2001., ISBN: 0-471-31649-0
Selvamuthu, D., Das, D.: Introduction to Statistical Methods, Design of Experiments and Statistical Quality Control, Springer, Singapore, 2018., ISBN: 978-981-13-1735-4

Schedule:
1st week:
Basics of the program R: datatypes (numbers, vectors, matrices, lists), simple functions
2nd week:
Basics of the program R: graphics, input and output of data, tables
3rd week:
Basics of statistics with R: mean, variance, correlation, simple statistical tests.
4th week:
Basics of statistics with R: statistical tests (Student's t-test, F-test, Chi-squared test). I.
5th week:
Basics of statistics with R: statistical tests (Student's t-test, F-test, Chi-squared test). II.
6th week:
Test

7th week:

CONSULTATION WEEK

8th week:

Correlation. Regression analysis.

9th week:

Basics of experimental design. Single-factor experimental design. Completely randomized design.

10th week:

Randomized block design.

11th week:

Latin square design.

12th week:

Balanced incomplete block desing.

13th week:

Multifactor experimental design.

14th week:

Test

Requirements:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there are two tests: the mid-term test in the 6th week and the end-term test in the 14th week.

The minimum requirement for the mid-term and end-term tests, respectively is 60%. Based on the score of the tests the grade is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course*:* Dr. Borbála Fazekas, assistant professor, PhD

Lecturer:

Title of course: **Informatics Lecture** Code: TTBBE2001_BT_EN	**ECTS Credit points**: 2

Evaluation: written or oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: 28 hours
-preparation for the exam: 24 hours
Total: 80 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

Introduction to the history of informatics. Basics of informatics. General architecture of computers. Bus systems. Structure and operation of microprocessors. Types of memory (register, cache, RAM, ROM) and their operation. Peripherals and input- and output units. BIOS, interrupts, DMA. Definition and elements of operating systems. Process, scheduler, memory management, file management, interrupt system. Linux and Windows operating systems. Metrics of computer performance; methods for improving performance. Artificial intelligences (AI) and the theory and applications of deep learning. Methods for handling large amounts of data (Big Data).

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Andrew S. Tanenbaum (2006) Structured Computer Organization, Pearson, ISBN 97801132916523
Andrew S. Tanenbaum, Albert S. Woodhull (2007) Operating Systems, Pearson, ISBN 978-0136386773

Schedule:
1st week:
Introduction to the course. History of informatics. General architecture of computers.
2nd week:
Boolean algebra
3rd week:
Structure and operation of microprocessors.
4th week:
Memory types (register, cache, RAM, ROM) and their features

5th week:
Peripherals: storage units (HDD, SSD, ODD)
6th week:
Peripherals: input and output units
7th week:
1st test for proposed mark
8th week:
Definition of operating systems
9th week:
Process, scheduler, memory management
10th week:
File management, interrupt system
11th week:
The Linux operating system
12th week:
The Windows operating system
13th week:
Metrics of computer performance, improving performance
14th week:
2nd test for proposed mark

Requirements:
- for a lecture grade
The course ends in an examination. The requirement for examination is having pass (2) or better practical mark (TTFBL1104-EN).
The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
-an offered grade:
it may be offered for students if the average grade of the two theoretical tests during the semester is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of the theoretical test. Taking the tests is not mandatory.

Person responsible for course*:* Dr. Gergő Pál, assistant professor, PhD

Lecturer:

Title of course: **Informatics Practical** Code: TTBBG2001_BT_EN	**ECTS Credit points**: 2

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: 2 hours/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 28 hours
-laboratory:
-home assignment: 28 hours
-preparation for the exam: 28 hours
Total: 84 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

Students acquire basic knowledge of word-processing, spreadsheets, creating presentations. Basics of technical documentation, rules of creating a laboratory report. Units of measurements in informatics. Numeral systems, number representation. Hardware elements. Boolean logic. Using and handling databases and large amounts of data (BigData). Artificial Intelligence (AI), machine learning (ML), deep learning.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Andrew S. Tanenbaum (2006) Structured Computer Organization, Pearson, ISBN 97801132916523
Andrew S. Tanenbaum, Albert S. Woodhull (2007) Operating Systems, Pearson, ISBN 978-0136386773

Schedule:
1st week:
Introduction to the class and to the requirements
2nd week:
Number systems in informatics, number system conversion
3rd week:
Boolean logic, simplification of logical functions
4th week:
Representation of numbers
5th week:
BCD, ASCII code tables, units in informatics
6th week:
Practice, preparing for the first test

7th week:
First test
8th week:
Word-processing
9th week:
Spreadsheets
10th week:
Technical documentation, measurement report
11th week:
PowerPoint and presentation
12th week:
Practice, preparing for the second test
13th week:
Second test
14th week:
Possibility to redo tests

Requirements:
- for a term grade
Two successful tests are required for completion of this class. Maximum two missed classes are allowed for the semester.
One test is in written form with theoretical questions and calculations. One test is on computer with practical tasks.

0-50 %	failed (1)
51-62 %	pass (2)
63-75 %	satisfactory (3)
76- 87 %	good (4)
88-100%	excellent (5)

Person responsible for course*:* Dr. Gergő Pál, assistant professor, PhD

Lecturer:

Title of course: **Bioinformatics Lecture** Code: TTBBE2002_BT_EN	**ECTS Credit points**: 2
Evaluation: oral exam	
Type of teaching, contact hours: -lecture: 2 hours/week -practice: - -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 28 hours -practice: - -laboratory -: -home assignment: - -preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): Informatics Lecture and Practical	
Further courses built on it:-	
Topics of course:	
Students acquire basic knowledge of bioinformatics: 1. Introduction to bioinformatics 2.1. Introduction to mining scientific literature 2.2. Web of Science 2.3. Research Gate 2.4. PubMed and PubMed Central (PMC) 3.1. Introduction to sequence search 3.2. ENTREZ 3.3. Other sequence search tools 4.1. Introduction to pairwise alignment 4.2. Global vs. local alignment 4.3. Distance and substitution scoring matrices 4.4. Methods of producing pairwise alignments 5. Dot plots for pairwise sequence alignment 6.1 Dynamic programmes for pairwise sequence alignment 6.2. The Needleman-Wunsch algorithm 6.3. The Smith-Waterman algorithm 7.1. Word programming for pairwise sequence alignment 7.2. FASTA 7.3. FASTA Format 7.4. BLAST 8.1. Multiple alignment 8.2. The CLUSTAL algorithm 9.1. Introduction to similarity search 9.2. Sequence databases 9.3. FASTA search 9.4. BLAST searching 9.5. The probability value and the expectation value 10.1. Computational phylogenetics	

10.2. PGMA Pair-Group Method with Arithmetic mean; UPGMA and WPGMA
10.3. Maximum parsimony

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Choudhuri S.: Bioinformatics for beginners: genes, genomes, molecular evolution, databases and analytical tools. Elsevier, 2014

Schedule:
1st week:
1. Introduction to bioinformatics
2.1. Introduction to mining scientific literature
2nd week:
2.2. Web of Science
2.3. Research Gate
3rd week:
PubMed and PubMed Central (PMC)
4th week:
3.1. Introduction to sequence search
3.2. ENTREZ
3.3. Other sequence search tools
5th week:
4.1. Introduction to pairwise alignment
4.2. Global vs. local alignment
6th week:
4.3. Distance and substitution scoring matrices
7th week:
4.4. Methods of producing pairwise alignments
5. Dot plots for pairwise sequence alignment
8th week:
6.1 Dynamic programmes for pairwise sequence alignment
6.2. The Needleman-Wunsch algorithm
9th week:
6.3. The Smith-Waterman algorithm
10th week:
7.1. Word programming for pairwise sequence alignment
7.2. FASTA
7.3. FASTA Format
7.4. BLAST
11th week:
8.1. Multiple alignment
8.2. The CLUSTAL algorithm
12th week:
9.1. Introduction to similarity search
9.2. Sequence databases
13th week:
9.4. BLAST searching
9.5. The probability value and the expectation value
14th week:
10.1. Computational phylogenetics

10.2. PGMA Pair-Group Method with Arithmetic mean; UPGMA and WPGMA 10.3. Maximum parsimony
Requirements: End-of-semester exam: 4-5 assay questions, no time limit, each answer is evaluated individually (five-point scale), final grade is the rounded arithmetic mean of the individual grades (e.g. 3+1+5+4=13, 13:4=3.25 $\Rightarrow$ 3=satisfactory)
Person responsible for course: Prof. Dr. Sipiczki Mátyás, professor emeritus, PhD, DSc
Lecturer:

Title of course: **Bioinformatics Practical** Code: TTBBG2002_BT_EN	**ECTS Credit points**: 2

Evaluation: practical exam

Type of teaching, contact hours:
-lecture: -
-practice: 2 hours/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 28 hours
-laboratory:
-home assignment: 2 hours
-preparation for the exam:
Total: 30 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Informatics Lecture and Practical

Further courses built on it:-

Topics of course:

Finding scientific journals, citations: Pubmed, Medline, Scopus, Agricola. Getting to know NCBI. Genetic diseases in humans and animals: OMIM, OMIA. Database of Hazardous Substances: NCBI-TOXNET.
Identification of DNA and Protein Sequences: ENTREZ, ENSEMBL, GeneDB, Yeastgenome, Pombase Databases. Sequence analysis: Protein and DNA BLAST, pairwise alignment, multiple alignment, and phylogenetic trees. Learn about the Treeview program. Design and control of PCR primers. Restriction digestions, restriction endonucleases. Learn about bioinformatics.org.

Literature:

Mandatory literature: -
Recommended literature: -

Schedule:

1st week:

Molecular biology databases. Explore the NCBI database website; compare field structures. Integrated information search: NCBI-Entrez.

2nd week:

Overview of molecular biology databases. Bibliographic databases PubMed, Medline, EISZ, Scopus, Agricola, EMBL-EBI.

3rd week:

Searching for references and citations: using Scopus, Web of Science.

4th week:

Genetic diseases in humans and animals: OMIM, OMIA.

Familiarisation with PubChem database.

5th week:

Sequence management, different sequence formats. Introduction to computer sequence analysis programs, program packages, how to use them.

6th week:

Search DNA and protein sequences in ENTREZ, ENSEMBL, GeneDB, Yeast Genome, FungiDB, MGI databases.

7th week:

Sequence analysis: local alignment of protein and nucleic acid sequences (BLAST), pairwise alignments. NCBI-BLAST application, interpretation of results.

8th week:

Sequence analysis: global alignment of protein and nucleic acid sequences, pairwise alignments. Application of Needleman-Wunsch algorithm, interpretation of results.

9th week:

Sequence management in EMBOSS.

10th week:

Sequence analysis: protein and DNA BLAST, multiple sequence alignments and phylogenetic trees. Use of Clustel Omega software package. Learning the Treeview program.

11th week:

Introduction to restriction endonucleases and their potential uses. Introduction to bioinformatics.org. Design and control of restriction digestion of nucleotide sequences. Introduction and use of bioinformatics.org/sms2/rest and Restriction Mapper sequence manipulation sites.

12th week:

Design and validation of PCR primers. Using the Primer3 program. Interpreting the parameters obtained during verification.

13th week:

Preparing for a final exam. Revision of practical topics, solving sample tasks.

14th week:

Earning a practical grade, a final examination test.

Requirements:

- for a signature

Participation at practice classes is **compulsory**. A student must attend the practice classes and may not miss during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at practice classes will be recorded by the practice leader. In case of further absences, a medical certificate needs to be presented.

Students are allowed to bring and use their own notebook computer.

- for a grade

The course ends in practical test.

The minimum requirement for the end-term tests respectively is 60%. The grade for the tests is given according to the following table:

Score	Grade
0-10	fail (1)
11-12	pass (2)
13-14	satisfactory (3)
15-17	good (4)

18-20 excellent (5) If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS. *-an offered grade:-*
Person responsible for course*:* Dr. Hajnalka Csoma, assistant professor, PhD
Lecturer: -

Title of course: **Introduction to Omics and Systems Biology, Lecture and Seminar**	ECTS Credit points: 3

Evaluation: exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: 1 hour/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: 14 hours
-laboratory -:
-home assignment: -
-preparation for the exam: 28 hours
Total: 70 hours

Evaluation: written or oral exam

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Design and Analysis of Experiments Practical, Bioinformatics Lecture and Practical, Methods in Molecular Biology and Gene Technology I. Lecture and Practical

Further courses built on it:-

Topics of course:

Introduction to omics testing systems, and knowledge of cell and molecular biology necessary for understanding genomics and transcriptomics experiments. NGS-based transcriptomics is described through selected examples to answer biological questions, and also the mathematical interpretation of omics data compared with traditional mol. biol. methods. Fundamentals of testing methods for epigenetic regulation and their presentation starting in individual cells up to populations. The importance of examining binding sites of transcription factors. Students acquire knowledge of the roles of DNA-protein interactions in transcriptional regulation. The students become familiar with the principles of high-throughput, new-generation sequencing methodologies (RNA and genome sequencing, ChIP-seq, ATAC-seq). They also gain knowledge about the mapping of gene expressions in individual cells (single cells) and why it is important. The students acquire knowledge about what proteomics is, what kind of information it can provide, and in which cases it can be used. The most important proteomics techniques are introduced by presenting real biological problems. Techniques providing structural data are discussed through the presentation of biological problems, and how biologically relevant information can be extracted from proteomics data. In the seminars, the students will learn which processing steps lead to a gene list from raw sequencing data (fastq). They carry out pathway analyses to understand biological processes using the obtained gene lists. They are educated on the use of Reactome, KEGG, and GeneCards databases. During proteomics data analyses, the students learn how biologically relevant information can be obtained from a protein list in practice.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2018) Lewin's Genes XII, Jones &

Bartlett Pub Inc, Burlington, Massachusetts, ISBN 9781284104493

Wyatt Peter (1997) Proteomics: Principles, Techniques and Analysis, Syrawood Pub House, New-York, ISBN 9781682865972

Schedule:
1st week: Introduction
2nd week: Omics and systems
3rd week: Basics of eukaryotic gene expression regulation
4th week: Proteomics basics, why do we need proteomics?
5th week: The epigenetic programme and the possibilities of studying chromatin structure
6th week: Cistromics
7th week: Basics of genomic analysis based on next generation sequencing
8th week: Basic proteomic techniques
9th week: Proteomic techniques that provide structural information
10th week: Beyond oncogenes: gene expression changes in tumour tissue
11th week: From data to biological processes
12th week: What is beyond the proteomic data?
13th week: Summary lecture
14th week: Exam

Requirements:
Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

There is the end-term test in the 14th week. Based on the score of the test, the offered grade is given to the students. The minimum requirement for the end-term test and the offered grade is 60%. Based on the score of the test, the offered grade and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

It is possible to take oral exam(s) in the exam period, if the result of the end-term test is fail or the student wants to improve the offered grade.

Person responsible for course*:* Dr. Andras Mádi, college associate professor, PhD

Lecturer: Prof. Dr. Éva Csősz, full professor, DSc, Dr. Gergely Kalló, assistant professor, PhD, Dr. Beáta Scholtz, associate professor, PhD

Title of course: **Cell Biology Lecture** Code: TTBBE2004_BT_EN	**ECTS Credit points**: 2

Evaluation: written exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: 14
-preparation for the exam: 48
Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

The students acquire general and applied cell biology knowledge, which serve as the foundation for later courses in cell biology practice, cell anatomy, anatomy of experimental animals, immunology, and medical biotechnology and cell culture. Additionally, we aim to professionally base the later master's programs, particularly the Biotechnology MSc and Molecular Biology MSc programs, on cell biology and mammalian cell biotechnology courses. During the course, the student will learn the history and evolution of cell biology, acquire cell anatomy knowledge with a focus on the significance of these in mammalian fermentation technology, and learn the terminology of cell biology. The aim is to impart the following basic knowledge: General characterization and evolution of living systems, general and comparative cell and cell anatomy knowledge, characteristics of surface and intracellular membranes, transport processes and energy of surface and intracellular membranes, prokaryotic and eukaryotic organisms, cytoskeleton and motor proteins, vesicular systems, lysosomes, biology of cell organelles, energy metabolism and mitochondrial function, inter- and intracellular signaling processes, structure and function of the cell nucleus, regulation of the cell cycle, cell pathology, cellular examination methods.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Lodish: "Molecular Cell Biology" 5. kiadása, W. H. Freeman Publishers, 2003

Schedule:

1st week:

General properties of the living systems

Cellular-theory, Chemoton-model, abiogenesis, chemical evolution, ribozymes, molecules of information

2nd week:

Cellular membranes

Composition and formation of cellular and endomembrane systems.

3rd week:

Cellular membrane transport

Transport systems and transport energetics.

4th week:

Prokaryotic and eukaryotic cells

Functional and morphological comparison of pro- and eukaryotic cells.

5th week:

Cytoskeleton and motorproteins

Cellular dynamics and involved proteins.

6th week:

Vesicular systems and lysosomes

Vesicular processes and transport.

7th week:

1. **Midterm exam**

8th week:

Biology of the cellular organelles

Basic function and morphology of the cellular organelles.

9th week:

Mitochondrial function and energy metabolism

Basic cellular metabolism and bioenergetics.

10th week:

Cellular signalling pathways

Signal transduction, receptors and ligands, second messengers.

11th week:

The nucleus

Nuclear structure and functions, chromatin structure.

12th week:

Cell-cycle regulation and pathology

Normal and pathological processes involved in the regulation of cell-cycle.

13th week:

Cellular experimental and investigation methods

Basic methods in cell-biology.

14th week:

Midterm exam

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

During the semester there are two tests: mid-term tests in the 8th week and in the 14th week. Students have to sit for the tests.

- for a grade

Based on the grades of the mid-term tests, the final grade is calculated as an average of them.

The course ends in an **examination if mid-term test results are not reaching 60% each**.

The minimum requirement for the mid-term and examination test respectively is 60%. Based on the score of the tests separately, the grade for the tests **or** the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of **exam** test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:
it may be offered for students if the average grade of the two mid-termtest is at least pass (2) and the mid-term tests reach 60% each.

Person responsible for course*:* Dr. Gábor Szemán-Nagy, associate professor, PhD

Lecturer:

Title of course: **Cell Biology Practical** Code: TTBBL2004_BT_EN	**ECTS Credit points**: 2

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: 2 hours/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 28 hours
-laboratory:
-home assignment: 14 hours
-preparation for the exam: 48hours
Total: 90 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Cell Biology Lecture

Further courses built on it:-

Topics of course:

Students acquire general and applied cell biology knowledge that serves as the foundation for later cell biology practices, Cell Biology, Animal Physiology, Immunology, as well as Medical Biotechnology and Cell Culture courses. Additionally, we aim to professionally establish the foundation for later master's programs, especially the Biotechnology MSc and Molecular Biology MSc programs, with cell biology and mammalian cell biotechnology courses. During the course, the student will become familiar with the basic tools of cell biology. They will learn the basics and limitations of light, fluorescent, and confocal microscopy. They will acquire theoretical knowledge about the operation and limitations of transmission and scanning electron microscopy. The student will learn how to interpret images created with different biological imaging techniques. During the course, students will acquire general knowledge about the biological and physical-chemical background of the most common microscopic staining procedures. Participants will learn how to interpret the results of staining procedures commonly used in cell biology practices. The course focuses on reviewing the physics and toolkit of fluorescent imaging procedures, as well as the biochemical aspects of fluorescent labeling. Furthermore, we will focus on the use of dynamic live-cell imaging technologies in both basic and applied research. During the course, we will introduce the results of biological imaging procedures at a basic level.

Literature:

Mandatory literature:
Departmental teaching aid. E-learning material.

Recommended literature:
Lodish: "Molecular Cell Biology" 5. kiadása, W. H. Freeman Publishers, 2003

Schedule:

Research methods for the topics of the theoretical courses.

1st week:

General properties of the living systems

Cellular-theory, Chemoton-model, abiogenesis, chemical evolution, ribozymes, molecules of information

2nd week:

Cellular membranes

Composition and formation of cellular and endomembrane systems.

3rd week:

Cellular membrane transport

Transport systems and transport energetics.

4th week:

Prokaryotic and eukaryotic cells

Functional and morphological comparison of pro- and eukaryotic cells.

5th week:

Cytoskeleton and motorproteins

Cellular dynamics and involved proteins.

6th week:

Vesicular systems and lysosomes

Vesicular processes and transport.

7th week:

Midterm exam

8th week:

Biology of the cellular organelles

Basic function and morphology of the cellular organelles.

9th week:

Mitochondrial function and energy metabolism

Basic cellular metabolism and bioenergetics.

10th week:

Cellular signalling pathways

Signal transduction, receptors and ligands, second messengers.

11th week:

The nucleus

Nuclear structure and functions, chromatin structure.

12th week:

Cell-cycle regulation and pathology

Normal and pathological processes involved in the regulation of cell-cycle.

13th week:

Cellular experimental and investigation methods

Basic methods in cell-biology.

14th week:

Midterm exam

Requirements:

- *for a signature*
Attendance at **lectures** is recommended, but not compulsory. A Power Point presentation (10 relevant slide) about a selected topic.

During the semester there are two tests: mid-term tests in the 8th week and in the 15th week. Students have to sit for the tests.

- *for a grade*
Based on the grades of the mid-term tests, the final grade is calculated as an average of them. The course ends in an **examination if mid-term test results are not reaching 60% each**.

The minimum requirement for the mid-term and examination test respectively is 60%. Based on the score of the tests separately, the grade for the tests **or** the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of **exam** test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:
it may be offered for students if the average grade of the two mid-termtest is at least pass (2) and the mid-term tests reach 60% each.

Person responsible for course*:* Dr. Gábor Szemán-Nagy, associate professor, PhD

Lecturer:

Title of course: **Cell Physiology I. Lecture** Code: TTBBE2005_BT_EN	**ECTS Credit points**: 2

Evaluation: written exam

The progress of students will be tested two times during the semester in the form of a written test (simple choice questions). Participation on mid-semester written tests is compulsory.

The first semester is closed by a written end-semester exam (ESE). Students may be exempted for ESE if the average score of the two mid-semester tests is higher than 60% (offered mark). The student can refuse to accept the offered mark based on the results of mid-semester tests and choose to take ESE (written and oral).

Type of teaching, contact hours:

-lecture: 2 hours/week

-practice: -

-laboratory: -

Workload (estimated), divided into contact hours:

-lecture: 28 hours

-practice: -

-laboratory -:

-home assignment: -

-preparation for the exam: 62 hours

Total: 90 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Cell Biology Lecture

Further courses built on it:-

Topics of course:

Cell physiology describes and examines the processes and regulatory mechanisms of the functioning of a healthy organism at the cellular level. The knowledge and perspective acquired during the subject can be used in all areas of the life sciences, so they form the basis of the physiology subjects. Therefore, our goal is to introduce students to the essence of physiological processes and regulatory mechanisms at the basic cellular level.
The structure of mammalian cells and their immediate environment, the regulation of the main membrane transport mechanisms of mammalian cells, the local membrane potential changes and the characteristics of the action potential of mammalian cells, the signaling molecules between mammalian cells, the effects of these signaling molecules on intracellular cell signaling pathways, the regulation of signaling processes, the structure of synapses, short- and long-term regulation of synapse function, steps in the regulation of cell division, different forms of cell death.

Literature:

Mandatory literature:

- Departmental teaching aid
- A. Fonyó: Principles of Medical Physiology; Medicina, 2012.

Recommended literature:

- Sándor Damjanovich, Judit Fidy, János Szöllősi: Medical biophysics.
Medicina, 2006.
- Peter Molnar, James J. Hickman: Patch-clamp methods and protocols. Humana Press Inc, 2007.

Schedule:
1st week: Introduction. Basic sell structures.
2nd week: Transport processes through biological membrans.
3rd week: The resting memnbrane potential of a cell.
4th week: Action potentials I
5th week: Action potentials II
6th week: Communication between cells.
7th week: Signal transduction.
8th week: Self Control Test (SCT I)
9th week: Second messengers.
10th week: Receptors.
11th week: Synapses.
12th week: Membranes and cytoskeleton.
13th week: Cell cycles, cell division, cell death.
14th week: Self Control Test (SCT II)

Requirements:
- *for a signature*:
Attendance at lectures is recommended, but not compulsory.

- *for a grade*:
The progress of students will be tested two times during the semester in the form of a written test (simple choice questions). Participation on mid-semester written tests is compulsory.
The first semester is closed by a written end-semester exam (ESE). Students may be exempted for ESE if the average score of the two mid-semester tests is higher than 60% (offered mark). The student can refuse to accept the offered mark based on the results of mid-semester tests and choose to take ESE (written and oral).

Person responsible for course: Dr. Péter Szentesi, senior research fellow, PhD

Lecturer: Dr. Mónika Gönczi Szentandrássyné, assistant professor, PhD

Title of course: **Cell Physiology II. Lecture**	ECTS Credit points: 2

Evaluation: exam

The progress of students will be tested two times during the semester in the form of a written test (simple choice questions). Participation on mid-semester written tests is compulsory.

The first semester is closed by an written end-semester exam (ESE). Students may be exempted for ESE if the average score of the two mid-semester tests is higher than 60% (offered mark). The student can refuse to accept the offered mark based on the results of mid-semester tests and choose to take ESE (written and oral).

Type of teaching, contact hours:

-lecture: 2 hours/week

-practice: -

-laboratory: -

Workload (estimated), divided into contact hours:

-lecture: 28 hours

-practice: -

-laboratory -:

-home assignment: -

-preparation for the exam: 62 hours

Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Cell Physiology I. Lecture

Further courses built on it:-

Topics of course:

Cell physiology describes and examines the processes and regulatory mechanisms of the functioning of a healthy organism at the cellular level. Our aim is to introduce the students to physiological processes and regulatory mechanisms at the cellular level that are characteristic of different types of cells in the mammalian body.
The knowledge and perspective acquired during the subject can be used in all areas of the life sciences, so they form the basis of the physiology subjects.
Electromechanical properties of skeletal muscle, smooth muscle and cardiac muscle, molecular properties of different neurotransmitters and their receptors, neurotransmitter regulation. The structure, synthesis, metabolism of hormones involved in the regulation of the functioning of the mammalian body, the regulation of their production, the cellular mechanism of action of hormones. Epithelial cells, transport processes through the nephron membrane, the functioning of the absorptive and secretory membranes, the characteristics of the transport of blood gases. The structure of the epidermis, the functions of its cells, the immunological functions of endothelial cells, their role in the regulation of vascular tone and blood coagulation, and the local regulatory factors they produce.

Literature:

Mandatory literature:
- Departmental teaching aid
- A. Fonyó: Principles of Medical Physiology; Medicina, 2012.

Recommended literature:
- Sándor Damjanovich, Judit Fidy, János Szöllősi: Medical biophysics.
Medicina, 2006.

- Peter Molnar, James J. Hickman: Patch-clamp methods and protocols. Humana Press Inc, 2007.

Schedule:
1st week:
Introduction.
2nd week:
General properties of hormones. The mechanism of action of hormones with different chemical structures.
3rd week:
Synthesis and transport of individual hormones, hormone receptors and their associated signaling pathways.
4th week:
Epithelial transport processes. Absorbent and secretory epithelia. Absorption function of intestinal epithelial cells. Secretion in the gastrointestinal system.
5th week:
Transport mechanism in the kidney.
6th week:
The role of red blood cells and the transport of blood gases.
7th week:
Self control test I.
8th week:
The barrier function of the epidermis. The role of keratinocytes and other skin cell types
9th week:
Functions of endothelial cells. The role of the endothelium in the regulation of vascular tone and blood coagulation. Humoral factors produced by endothelial cells. The immunological role of endothelial cells.
10th week:
The skeletal muscle function. The neuromuscular junction. Electro-mechanical coupling in skeletal muscle. The mechanism of muscle contraction
11th week:
Smooth muscle.
12th week:
Electrical and mechanical propertires of the heart muscle.
13th week:
Interneural communication, functioning of nerve-nerve synapses. The different neurotransmitters and their receptors. Possibilities of pharmacological influence on neurotransmission.
14th week:
Self control test II.

Requirements:
Attendance at lectures is recommended, but not compulsory.
- *for a grade:*

The progress of students will be tested two times during the semester in the form of a written test (simple choice questions). Participation on mid-semester written tests is compulsory.
The first semester is closed by a written end-semester exam (ESE). Students may be exempted for ESE if the average score of the two mid-semester tests is higher than 60% (offered mark). The student can refuse to accept the offered mark based on the results of mid-semester tests and choose to take ESE (written and oral).

Person responsible for course: Dr. Péter Szentesi, senior research fellow, PhD

Lecturer: Dr. Mónika Gönczi Szentandrássyné, assistant professor, PhD

Title of course: **Biochemistry I. Lecture and Seminar** Code: TTBBE2007_BT_EN	**ECTS Credit points**: 3
Evaluation: written exam	
Type of teaching, contact hours: -lecture: 2 hours/week -practice: 1 hour/week -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 28 hours -practice: 14 hours -laboratory -: -home assignment: - -preparation for the exam: 48 hours Total: 90 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): Organic Chemistry Lecture, Seminar and Practical, Cell Biology Lecture	
Further courses built on it:-	
Topics of course:	
Students acquire general basic biochemistry knowledge that serves as the basis for the subsequent Biochemistry II, Microbial Metabolism seminar and releated practical courses. In addition, we want to provide a professional basis for the basic biochemical knowledge of the subsequent master's courses, especially the Biotechnology MSc and Molecular Biology MSc. In the framework of the course, the student learns the basics of enzymology, enzyme kinetics, the regulationof the activity of enzymes, then we continue with the mitochondrial metabolic processes (ETC, ATP synthase, termogenin) after that we cover the digestion and absorption mechanism of food components in the field of carbohydrate, lipid, nucleotide and amino acid metabolism, and then their utilization in biosynthetic processes and their final degradation possibilities. In addition we also review anabolic processes, i.e. the biosynthesis and regulation of the body's own carbohydrate, lipid, amino acid, and nucleotide components. Metabolic processes are also reviewed broken down into basic mammalian cell types. The course focuses on the biochemical processes of eukaryotic organisms, and also covers important aspects of human medical biochemistry and human metabolic diseases, defects. At the end of the course in nutritional biochemistry chapter the role of vitamins and the regulation of body weight, apetite, thermogenesis is discussed.	
Literature:	
Mandatory literature:ppt presentation provided by the lecturer Recommended literature: Ferrier, D. R. (2021) Biochemistry (Lippincott's Illustrated Reviews) ISBN-13: 978-1451175622 Devlin, T. M. (2021): Textbook of Biochemistry with Clinical Correlations, ISBN-13: 978-0470281734 Stryer, L. et al (2019) Biochemistry ISBN-13: 978-1319114657	

Schedule:
1st week:
Enzymes. General characterization and classification of enzymes. Principles of the Michaelis-Menten kinetic model and the steady-state kinetic model. Definition and interpretation of kinetic parameters. Reversible and irreversible enzyme inhibition. Principles and visualization of competitive, non-competitive and uncompetitive enzyme inhibition. Regulatory mechanisms of enzymes and their significance.

2st week:
Bioenergetics. Cellular respiration, oxidation of organic compounds in cells. The citric acid cycle and its regulation. Oxidative phosphorylation, the chemiosmotic theory and the ATP sythase. The mithocondrial genome.

3nd week:
Main pathways of the carbohydrate metabolism, central role of glucose. Absorption and transport of monosaccharides. Carbohydrate metabolism in various tissues. Glycolytic pathway. Rapoport-Luebering shunt. Energy production of the glycolytic pathway. Metabolism of galactose and fructose. Shuttle pathways: Cori cycle, glucose-alanine cycle. Gluconeogenesis. Substrates of the gluconeogenesis.

4rd week:
Regulation of the glycolytic pathway in liver and muscle. Regulation of gluconeogenesis. Glycogen in liver and muscle. Degradation and synthesis of glycogen. Regulation of glycogen synthesis and degradation.

5th week:
Pentose phosphate pathway. Synthesis of disaccharides. Metabolism of glucuronic acid. Inherited diseases in the carbohydrate metabolism. Biochemistry of diabetes mellitus. Pyruvate dehydrogenase complex.

6th week:
Organization of lipid structures. Stucture of membranes, membrane transport. Mixed micelles in the digestive tract. Lipoproteins in blood plasma. Covalent interactions between proteins and lipids. Oxidation of fatty acids. Synthesis of fatty acids.

7th week:
Synthesis of triacyl-glycerol. Lipid metabolism during starvation. Ketone bodies.
Steroid hormones. Bile acids. Vitamin D. Eicozanoids. Lipid peroxidation. Synthesis of sphyngolipids and phospholipids

8th week:
The mevalonate metabolic pathway. Synthesis of cholesterol. Cholesterol transport in the body. The LDL receptor and its gene. Excretion of cholesterol. Biochemical explanation of elevated blood cholesterol levels.

9th week:
Comparison of the amino acid metabolism with the carbohydrate and lipid metabolisms. Formation and utilisation of the intracellular amino acid pool. Nitrogen balance. Exogenous amino acid sources, digestion of proteins. Amino acid transports. Structure and function of glutathione. Endogenous amino acid sources: intracellular protein breakdown. Common reactions in the amino acid metabolism: fate of the nitrogen. Transaminations and deaminations. Enzymes containing pyridoxal phosphate cofactors, and their mechanism of action: stereoelectronic control. Formation and

elimination of ammonia in the body. Nitrogen transport between the tissues.

10th week:
The urea cycle and its regulation. Mitochondrial carbamoyl phosphate synthetase. Intracellular glutamine cycle. Decarboxylation and carboxylation reactions in the amino acid metabolism. C1 transfer and transmethylation, related enzyme and vitamin deficiencies. Monooxygenation and dioxygenation reactions. Fate of the carbon skeleton of amino acids: glucogenic and ketogenic amino acids. Degradation of amino acids in the pyruvate pathway. Transport function of alanine. Degradation and synthesis of cysteine. Formation and utilization of PAPS. Degradation and synthesis of serine and glycine. Pathways of threonine degradation. Degradation of amino acids in the α-ketoglutarate pathway. Degradation of histidine, histidinemia.

11th week:
Degradation and synthesis of proline. Degradation and synthesis of arginine and ornithine, their precursor functions: NO, creatine, polyamines. Aspartate and asparagine degradation and synthesis in the oxaloacetate pathway. Degradation of amino acids in the succinyl-CoA pathway. The vitamine requirements and enzyme deficiencies in the propionyl CoA succinyl CoA conversion. Degradation of isoleucine and valine, related enzyme deficiencies. Comparison of leucine degradation with the degradation of isoleucine and valine. Degradation of lysine and tryptophane, their precursor functions. Carnitine synthesis. Degradation of phenylalanine and tyrosine, related enzyme deficiencies and precursor functions. Synthesis and degradation of cathecolamines.

12th week:
Nucleotide pool. Digestion and absorption of nucleic acids. Sources of atoms in purine ring. De novo synthesis of purine nucleotides. Regulation of purine nucleotide synthesis. Salvage pathways for the purine bases. Degradation of purine nucleotides. Diseases associated with purine nucleotide metabolism.

13th week:
De novo synthesis of pyrimidine nucleotides. Regulation of pyrimidine nucleotide synthesis. Salvage pathways for the pyrimidines. Degradation of pyrimidine nucleotides. Nucleoside and nucleotide kinases. Synthesis of deoxythymidilate. Nucleotide coenzyme synthesis (NAD, FAD, CoA). Antitumour and antiviral action of base and nucleoside analogues. Biochemistry of nutrition. Energy requirement. Basic metabolic rate. Energy content of the food. Energy storage and thermogenesis.

14th week:
Biochemical mechanism of obesity. Protein as N and energy source. N balance. Essential amino acids. Protein malnutrition. Vegetarianism. Clinical aspects of protein nutrition. Carbohydrates and lipids. Pathological mechanisms in obesity. Vitamins. Structure, biochemical functions. Relationship between the biochemical functions and the symptoms of deficiency. Essential inorganic elements of the food (metabolism, function, deficiency). Integrated metabolism.

Requirements:
Requirements for getting a signature for the semester: attendance in the seminars. Only those students can get offered grade or take the exam of the theoretical course, who have fulfilled the requirements of the practical course as well. Required knowledge from Biochemistry I. and topics discussed in the seminars. Attendance on the lectures is recommended, but not compulsory. Note that getting points on the seminars will be very difficult without proper understanding of the material, for which the attendance on the lectures is essential. On the seminars the materials of the lectures of the previous week will be discussed. Participation in all seminars is compulsory and can be missed only with medical proofs. In case of more than three absences the Department refuses the signature. In this case the student may ask the Dean for an override, for these requests all medical proofs are necessary.

Person responsible for course*:* Dr. Teréz Barna, assistant professor, PhD
Lecturer: Prof. Dr. István Pócsi, head of department, full professor, candidate of chemical sciences, doctor of the Hungarian Academy of Sciences (biology), Viktor Attila Ambrus, assistant lecturer

Title of course: **Biochemistry Practical** Code: TTBBL2007_BT_EN	**ECTS Credit points**: 2
Evaluation: oral and written assignment	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 2 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 28 hours -home assignment: 30 hours -preparation for the tests: 30 hours Total: 88 hours	
Evaluation: practical grade	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): Organic Chemistry Lecture, Seminar and Practical	
Further courses built on it:-	
Topics of course:	
In the focus of the Biochemistry practical is the study of enzymes related to the main metabolic pathways, introduced/studied in the Biochemistry I lecture series, with special emphasies on the biotechnological relevance of the enzymes. The students are introduced into the principle of enzyme kinetics and protein analytics in a practical aspect. The detailed thematics of the Biochemistry practical I: Detection and quantitation of proteins; Chromatographic separation of proteins; Digestion of dietary starch by alfa-amylase and determination of reducing sugar. Hydrolysis of dietary fat by pancreatic lipase. Quantitative analysis of protease activity. Hydrogen peroxide producig and decomposing enzymes: glucose content determination by glucose oxidase, catalase protects cells from toxic effect of hydrogen peroxide. Determination of Vitamin C content in plant samples. Inhibition of succinate dehydrogenase by malonate.	
Literature:	
Mandatory literature: Departmental teaching aid. Recommended literature: -David L. Nelson and Michael M. Cox : Principle of Biochemistry (8th Edition, 2021) -Hans Bisswanger : Practical Enzymology (3rd edition, 2019) Willey-VCH Verlag GmbH; ISBN: 352734604X. -Rodney Boyen: Biochemistry Laboratory: Modern Theory and Techniques (2nd Edition, 2012), ISBN-10 013604302X, Person Prentice Hall. -Thomas Crowley, Jack Kyte :Experiments in the purification and characterization of enzymes: a laboratory manual; Academic Press (1st edition, 2014) ISBN-10 : 0124095445.	

Schedule:
1st week:
Introduction of the structural properties of proteins describing the relevance to their biological function.
2nd week:
TLC analysis of amino acids.
3rd week:
Introduction of enzyme catalysis the essence of enzyme behaviors.
4th week:
Size-exclusion chromatography of proteins and quantification of protein.
5th week:
The basis of enzyme kinetics.
6th week:
Determining enzyme kinetic parameters in studying an exo-type glycosyl hydrolase.
7th week:
The main feature of enzyme classes, the importance of cofactors. Mid-term test.
8th week:
Quantification of ascorbic acid in different plant samples.
9th week:
Aerob metabolism, ROS formation and the neutralising enzymes.
10th week:
Detection and quantification of catalase activity.
11th week:
Different type of enzyme assays.
12th week:
Glucose determination by glucose oxidase.
13th week:
Detecting and determining oligosaccharide liberation in enzymatic strarch degradation.
14th week:
Discussion of the practical experience and writing the end-term test.

Requirements:
For the signature of the practical, it is required for the students to have at least 75 % of the total attendance for practical work during the term.
The overall grade is evaluated on the basis of two tests written at the first part and the end of the term as well as the individual reports submitted after each practical work.
The minimum requirement for a succesful grade is to achieve more than 50 score (%). The grade is calculated according to the table below:

Score (%)	Grade
0-50	fail (1)
51-60	pass (2)
61-70	satisfactory (3)
71-85	good (4)
86-100	excellent (5)

Person responsible for course*:* Dr. Teréz Barna, assistant professor, PhD

Lecturer: Dr. László Attila Papp assistant professor, PhD, Dr. Zsuzsa Antunovics, assistant professor, PhD

Title of course: **Biochemistry II. Lectures and Seminar** **ECTS Credit points**: 3
Code: TTBBE2008_BT_EN

Evaluation: written exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: 1 hour/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: 14 hours
-laboratory –:
-home assignment: -
-preparation for the exam: 48 hours
Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Biochemistry I. Lecture and Seminar

Further courses built on it:-

Topics of course:

The students acquire the basic knowledge of human cell and organ biochemistry, which serve as necessary basis for the subsequent Medical Biotechnology and Cell Culture plus Pharmaceutical Biotechnology courses. In addition, we want to provide a professional basis of cell and organ biochemistry for the subsequent master's courses, especially for the Biotechnology MSc and Molecular Biology MSc. In the framework of the course, the student learns about the biochemical aspects of the signal transduction processes taking place in eukaryotic cells, the role of kinases, phosphatases, nucleotide cyclases, phosphodiesterases, adapter proteins, etc. in connection with the description of a significant signal transduction pathway selected as an example. We also cover apoptosis and cell cycle regulation. Furhermore, the structure, synthesis and breakdown of the ECM, as well as the role and function of stress proteins, the biochemistry of skeletal muscle contraction and blood coagulation and the related diseses, disorders will also be discussed.

Literature:

Mandatory literature: ppt presentation provided by the lecturer

Recommended literature:
Ferrier, D. R. (2021) Biochemistry (Lippincott's Illustrated Reviews) ISBN-13: 978-1451175622

Devlin, T. M. (2021): Textbook of Biochemistry with Clinical Correlations, ISBN-13: 978-0470281734

Stryer, L. et al (2019) Biochemistry ISBN-13: 978-1319114657

Schedule:
1st week:
Gene expression I. Levels of eukaryotic gene expression. Transcriptional regulation of gene expression. The main features of eukaryotic transcription. The importance of *cis*-acting regulatory

elements and the different transcriptional regulatory proteins.

2nd week:
Regulation of gene expression II. Chromatin structure and transcription activation. Histone post-translational modifications and DNA methylation. Post-transcriptional regulation of gene expression at the level of mRNA. Regulation of gene expression at the level of translation.

3rd week:
Biochemistry of cell proliferation. Biochemical regulation of cell cycle. Cell cycle checkpoints. M-phase kinase. Phosphorylation and proteolysis in the regulation of cell cycle.

4th week:
Biochemistry of cell proliferation and apoptosis. Definition and forms of programmed cell death. Mitotic cascades. Products and biochemical function of protooncogenes. Tumor suppressor genes and their biochemical functions.

5th week:
Biochemistry of cellular stress responses in eukaryotes. The heat-shock response and the function of different heat shock proteins. The unfolded protein response in ER. DNA damage response and the response to oxidative stress.

6th week:
Signal transduction pathways I. Definition of homeostasis. Regulatory strategies at the cell and the organism level. The main components and the feature of cell signaling. Classification of signal transduction pathways. Signaling by nuclear receptors.

7th week:
Signal transduction pathways II. G protein-coupled signal transduction pathways. Sensory transduction in vision, olfaction, and gustation. Phosphoinositide signaling.

8th week:
Signal transduction pathways III. Signaling through transmembrane receptors with tyrosine-specific protein kinase activity. The ras superfamily of monomeric GTPases. Membrane receptors with associated tyrosine kinase activity.

9th week:
Biochemistry of the liver. The central role of liver in metabolism. Biotransformation and detoxification. Biochemical consequences of ethanol consumption.

10th week:
Iron metabolism. Iron transport, storage, and distribution in the human body. Molecular regulation of the iron level in cells: stability of transferrin receptor and ferritin mRNA, IRE binding protein. Risk of the free iron: oxidative stress and adaptive mechanisms.

11th week:
Iron and heme metabolism. Heme biosynhtesis and its regulation. Degradation of heme: formation, conjugation and excretion of bile pigments. Heme bindig proteins. Hemoglobin. The metabolism of erythrocytes.

12th week:
Biochemistry of blood clotting I. Definition and key steps of hemostasis. Cellular, humoral and vascular aspects of blood clotting. Structure, activation, adhesion and aggregation of thrombocytes. The inhibition of thrombocyte activation.

13th week:
Biochemistry of blood clotting II. Classification of blood clotting factors and their role. The initial and the advanced phase of blood clotting. Regulation of blood clotting cascade. Role of thrombocytes and the vascular endothelium. Limiting factors, inhibitors and activators of blood coagulation. Fibrinolysis.

14th week:
Biochemistry of the extracellular matrix. Function and components of ECM. Glycosaminoglycans and proteoglycans. The structure and function of different types of collagens. Synthesis of type I. collagen. Collagenases. Structure and function of elastin. Elastase. Structure and functional domains of fibronectins. Receptors of fibronectins: integrins and other type of receptors. Other adhesion proteins.

Requirements:

Requirements for getting a signature for the semester: attendance in the seminars. Only those students can get offered grade or take the exam of the theoretical course, who have fulfilled the requirements of the practical course as well. Required knowledge from Biochemistry II. and topics discussed in the seminars. Attendance on the lectures is recommended, but not compulsory. On the seminars the materials of the lectures of the previous week will be discussed. Participation in all seminars is compulsory and can be missed only with medical proofs. In case of more than three absences the Department refuses the signature. In this case the student may ask the Dean for an override, for these requests all medical proofs are necessary. Students can't make up a seminar with another group.

Person responsible for course*:* Prof. Dr. Göngyi Gyémánt, full professor, PhD

Lecturer: Prof. Dr. István Pócsi, head of department, full professor, candidate of chemical sciences, doctor of the Hungarian Academy of Sciences (biology), Viktor Attila Ambrus, assistant lecturer, Dr. Teréz Barna assistant professor PhD, Dr. László Attila Papp assistant professor, PhD

Title of course: **Microbial Metabolism Seminar** Code: TTBBG2009_BT_EN	**ECTS Credit points**: 2
Evaluation: practical grade (classroom tests)	
Type of teaching, contact hours: -lecture: 1 hour/week -practice: 1 hour/week -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 14 hours -practice: 14 hours -laboratory: -home assignment: - -preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Biochemistry I. Lecture and Seminar, General and Applied Microbiology Lecture	
Further courses built on it:-	
Topics of course:	
Students will acquire basic knowledge in biochemistry, general and applied microbiology, which will serve as a basis for the subsequent Microbial Ecology, Industrial and Environmental Biotechnology, and Microbial Pharmaceuticals courses. We also provide the professional basis for the microbiology and microbial biotechnology courses of the subsequent Master's degree programs, especially the MSc in Biotechnology and the MSc in Molecular Biology.The course will give students an insight into the biochemical diversity of the microbes and the variety of microbial biochemical metabolic pathways. Students will learn about the most important energy and reducing force producing processes of microorganisms and their importance in microbial biotechnology. We will learn about the glucose degradation pathways of prokaryotes, the possibilities of fermentative utilization of hexoses, pentoses, amino acids and other carbon sources, the alternative respiration of fungi, the structure of the aerobic and anaerobic respiratory electron transport chain in prokaryotes, the specificities of chemolithotrophic metabolism, the biochemical background of photosynthesis in prokaryotes, the ways of utilizing inorganic nitrogen, carbon and sulphur sources as well as the possibilities of utilization of hydrocarbons and single-carbon compounds by microbes.	
Literature:	
Mandatory literature: Departmental teaching aid. Recommended literature: Willey, J.M., Sandman, K.M. és Wood, D.H. (2020) Prescott’s Microbiology, McGraw-Hill Education, New York, ISBN 978-1-260-21188-7 Deacon, J.W. (1997) Modern Mycology, 3rd Edition, Blackwell Science, Oxford, ISBN 978-0632030774	

Schedule:

1st week

An overview of the basic biochemistry required for the course.

2nd week

Thermodynamic and kinetic characterization of transport processes. Transmembrane transport of microbes. Special transport processes of microbes.

3rd week

Significance and variations of glycolysis/gluconeogenesis, oxidative pentose-phosphate shunt, Entner-Doudoroff pathway, phosphoketolase pathway, tricarboxylic acid cycle in microbes.

4th week

Fermentation. Biotechnological and microbiological significance of fermentations. Classical fermentation processes, fermentation of pentoses and amino acids, fermentative utilization of ethanol and lactic acid.

5th week

written test

6th week

Respiration. Respiratory electron transport chain of fungi, alternative oxidase. Aerobe respiration of bacteria. Anaerobic respiration.

7th week

Chemolithotrophy I. An overview of chemolitotrophy. ATP and reducing force generation in chemolithotrophic bacteria. Reverse electron transport. Aerobe and anaerobe iron oxidizing bacteria. Ammonia and nitrite oxidizing bacteria and their ecological and practical significance.

8th week

Chemolithotrophy II. Sulphide oxidizing bacteria, methanogens, acetogens and their ecological and practical significance. Carboxydotrophs.

9th week

Photosynthesis. The aerobe photosynthesis of Cyanobacteria. Anaerobe photosynthesis. Photosynthesis of Green and Purple bacteria

10th week

written test

11th week

CO_2 fixation in bacteria. Utilization of organic one carbon compounds by bacteria and fungi. Utilization of inorganic nitrogen and sulphur. N_2 fixation of bacteria.

12th week

Utilization of hydrocarbons. Aerobe degradation of aromatic and/or heterocyclic hydrocarbons. Anaerobe degradation of hydrocarbons.

13th week

Consultation

14th week

written test

Requirements:

- for a signature

Attendance of classes are compulsory with the possibility of missing at most four classes during the semester. In case of further absences, a medical certificate needs to be presented, otherwise the signature is denied.

- for a grade

The course is evaluated on the basis of three written tests during the end of the semester. The grade is

given according to the following table:

Total Score (%)	Grade
0 – 50	fail (1)
51 – 60	pass (2)
61 – 75	satisfactory (3)
76 – 85	good (4)
86 – 100	excellent (5)

If a student fails to pass at first attempt, then a retake of the tests is possible.

Person responsible for course*:* Prof. Dr. Tamás Emri, full professor, doctor of the Hungarian Academy of Sciences (biology)

Lecturer:

Title of course: **Microbial Metabolism Practical** Code: TTBBL2009_BT_EN	**ECTS Credit points**: 2
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 2 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice:- -laboratory: 28 hours -home assignment: 28 hours -preparation for the exam: Total: 56 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Biochemistry I. Lecture and Seminar, General Micobiology Lecture and Practical	
Further courses built on it:-	
Topics of course:	
Students will acquire practical basic knowledge related to microbial metabolism, which complements the Microbial Metabolism seminar and also serves as a basis for the Industrial and Environmental Biotechnology, Biomolecular Analytics, Pharmaceutical Biotechnology, Agricultural and Food Biotechnology, and Microbial Pharmasuticals courses. We also provide the professional basis for the microbiology and microbial biotechnology courses of the subsequent Master's degree programs, especially the MSc in Biotechnology and the MSc in Molecular Biology. Students will learn about the main biochemical-physiological characteristics of the most important laboratory and industrial microorganisms (e.g. species used in pharmaceutical production, industrial enzyme production, food production, bioremediation). They will learn about the detection of the utilization and transformation of carbon and nitrogen sources, the respiration of microorganisms, the detection of secondary metabolites (e.g. mycotoxins, penicillins and echinocandins), and the measuring intra- and extracellular enzyme activities. They will learn about some biochemical tests used in medical microbiology.	
Literature:	
Mandatory literature: Departmental teaching aid. Recommended literature: Willey, J.M., Sandman, K.M. és Wood, D.H. (2020) Prescott’s Microbiology, McGraw-Hill Education, New York, ISBN 978-1-260-21188-7 Deacon, J.W. (1997) Modern Mycology, 3rd Edition, Blackwell Science, Oxford, ISBN 978-0632030774	

Schedule:
1st week:
Investigation of yeast sugar assimilation and fermentation
2nd week:
Detection of products resulting from protein degradation: detection of indole and hydrogen sulfide
3rd week:
Lactose fermentation in bacteria
4th week:
Microbial nitrate reduction
5th week:
Investigation of oxidoreduction enzymes: Catalase test, reduction of methylene blue, Oxidase reaction
6th week:
Detection of mycotoxins
7th week:
Detection of penicillin and echinocandin. Mid-term test.
8th week:
Examination of extracellular enzymes: amylase, gelatin-degrading exoenzyme („gelatinase")
9th week
Examination of extracellular enzymes: Casein hydrolysis, esterase
10th week:
Study of chemotaxis
11th week:
Investigation of the impact of microorganisms on blood cellular elements
12th week:
Study of the composition of the cell wall and cell membrane: Gram staining
13th week:
Study of the composition of the cell wall and cell membrane: Spore staining
14th week:
Discussion of the practical. End-term test

Requirements:
For the signature of the practical, it is required for the students to have at least 75 % of the total attendance for practical work during the term.
The overall grade is evaluated on the basis of two tests written at the first part and the end of the term as well as the individual reports submitted after each practical work.
The minimum requirement for a succesful grade is to achieve more than 50 score (%). The grade is calculated according to the table below:

Score (%)	Grade
0-50	fail (1)
51-60	pass (2)
61-70	satisfactory (3)
71-85	good (4)
86-100	excellent (5)

Person responsible for course*:* Prof. Dr. Tamás Emri, full professor, doctor of the Hungarian Academy of Sciences (biology)

Lecturer: Viktor Attila Ambrus, assistant lectures

Title of course: **General and Applied Microbiology Lecture** Code: TTBBE2010_BT_EN	**ECTS Credit points**: 2
Evaluation: oral exam	
Type of teaching, contact hours: -lecture: 2 hours/week -practice: - -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 28 hours -practice: - -laboratory -: -home assignment: - -preparation for the exam: 72 hours Total: 100 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it:	
Topics of course:	
Students acquire basic knowledge of general and applied microbiology, which serves as the basis for the subsequent General and Applied Microbiology Practice, Microbial Ecology, Microbial Metabolism, Industrial and Environmental Biotechnology, and Microbial Basic Pharmaceutical Products courses. Furthermore, we want to provide a professional basis for the microbiology and microbial biotechnology courses of the MSc programs based on Biotechnology BSc training, especially the Biotechnology MSc and Molecular Biology MSc courses. Within the frame of the subject, the student learns about the history of the origin and development of microbiology, acquires the basic knowledge of microbiological physiology, especially focusing on their importance in fermentation technology, and acquires the basic concepts of microbiological taxonomy as well. We aim to impart the following basic knowledge: General characterization and evolution of microorganisms. Microbes of the domains Archaea, Bacteria and Eukarya - general and comparative cytology and microbial physiology. The most important bacterial phyla in the domains Archaea (especially methanogenic bacteria) and Bacteria (especially Cyanobacteria, Spirochaetes, Proteobacteria, Firmicutes and Actinobacteria), including and emphasizing the most industrially important genera and species. The most important human and plant pathogenic viruses, as well as bacteriophages, and the practical use of the latter. The most important human pathogenic prions and protozoa. Practically significant genera of true fungi (Kingdom Fungi) and fungi-like organisms (classified in the main taxonomic groups Excavata, Amoebozoa, Rhizaria and Chromalveolata). Thallus organization and reproduction types of fungi, symbiont fungus-plant relationships (lichen and mycorrhiza) and fungal parasites of plants. In addition to the presentation of industrially important microbial species (e.g. those used in the production of pharmaceutics, bioconversion processes, industrial enzyme production, food production, bioremediation and bioenergy production), the course also puts emphasis on the presentation of the most important plant, insect and human pathogenic microorganisms, as well as the most widely used laboratory model microorganisms. Furthermore, the subject also covers the most important diseases caused by human pathogenic microorganisms and their medical treatment.	

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Willey, J.M., Sandman, K.M. és Wood, D.H. (2020) Prescott's Microbiology, McGraw-Hill Education, New York, ISBN 978-1-260-21188-7

Deacon, J.W. (1997) Modern Mycology, 3rd Edition, Blackwell Science, Oxford, ISBN 978-0632030774

Saxena, S. (2015) Applied Microbiology, Springer India, New Delhi, ISBN 978-81-322-2258-3

Schedule:

1st week:
Introduction, the history of the origin and development of microbiology
2nd week:
Basics of microbiology: growth of microorganisms, environmental factors affect growth rate, culture media
3rd week:
Bacterial cell structure: essential and non-essential cell components, bacterial motility, biofilms, bacterial endospores
4th week:
Archaea: archaeal cell structure, phylogeny and most important taxons of Archaea. History of microbial taxonomy, numerical taxonomy, phylogenetic taxonomy
5th week:
Microbial interactions. Bacterial virulence factors. Exo-and endotoxins. Antigens
6th week:
Microbial taxonomy. Non-proteobacterial Gram-negative bacteria including Cyanobacteria, Chlamydiota, Spirochaetota, Bacteroidota
7th week:
Phylum Pseudomonadota, classis Alphaproteobacteria, Betaproteobacteria, Gammaproteobacteria, Phylum Thermodesulfobacteriota, Bdellovibrionota, Myxococcota, Campylobacterota
8th week:
Gram-positive bacteria. Phylum Mycoplasmatota, Bacillota, classis Clostridia. Phylum Actinomycetota. Immunization against bacteria.
9th week:
Plasmids. Eukaryotic cell structure. Protozoa: superphylum Excavata, phylum Metamonada. superphylum Discicristata. superphylum Amoebozoa
10th week:
Myxomycota, supergroup Stramenopiles, Alveolata, Rhizaria. Infrakingdom: Stramenopila (Heterokonta). Pseudofungi, classis Hyphochytriomycetes, Oomycetes, phylum Bigyra
11th week:
Mycology. Structure and growth of hypha. Blastocladiomycota, Chytridiomycota, Neocallimastigomycota.
12th week:
Glomeromycota. Ascomycota, subphylum Taphrinomycotina, Saccharomycotina, Pezizomycotina. Basidiomycota: subphylum Pucciniomycotina, Ustilaginomycotina, Agaricomycotina. Fungi-plant interactions. Mycorrhizal fungi.
13th week:
General virology. Virion structure. Viral lifecycles. Bacteriophages.

14th week:
Human viral diseases caused by DNA and RNA viruses. Plant viral diseases.Viroids. Prions.

Requirements:
- *for a grade*:
The course ends in an examination. The minimum requirement for the examination is 50 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-50	fail (1)
51-60	pass (2)
61-70	satisfactory (3)
71-85	good (4)
86-100	excellent (5)

If the score of any test is below 40, students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Prof. Dr. István Pócsi, head of department, full professor, candidate of chemical sciences, doctor of the Hungarian Academy of Sciences (biology)

Lecturer: Dr. Éva Leiter, associate professor, PhD

Title of course: **General and Applied Microbiology Practical** Code: TTBBL2010_BT_EN	**ECTS Credit points**: 2

Evaluation: written test

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice:-
-laboratory: 28 hours
-home assignment: 22 hours
-preparation for the exam: 10 hours
Total: 60 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General and Applied Microbiology Lecture

Further courses built on it:-

Topics of course:

Students acquire general and applied knowledge that ensures the conditions for sterile and safe work with microbes. Students will learn the preparation, use, and sterilization of culture media, the storage and plating of microbial cultures, the production of isolated colonies, the counting of colony-forming units, the use of pipettes, glass spreading rods, inoculums, and Bunsen burners. In the framework of the subject, students learn about microscopic identification of microbes, colony morphologies, measurement of extracellular enzyme production, metabolic tests and their evaluation, using bacteria and yeast species. In addition, genomic DNA is isolated from microbes, with which PCR is performed. DNA is cloned into a plasmid, thereby learning the process of gene cloning, and then sequence analysis is performed. During the lab, the protease gene of a bacterium that produces high amounts of extracellular protease is amplified and cloned, thus simulating a work process relevant to biotechnology.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Stuart Hogg: Essential Microbiology, 2nd ed. 2013. Wiley. ISBN: 978-1-119-97890-9
Nina Parker, Mark Schneegurt, Anh-Hue Thi Tu, Philip Lister, Brian M. Forster: Microbiology. Openstax. ISBN-10: 1-947172-23-9

Schedule:
1st week:
Lab safety, fire safety, working with microbial cultures. How to write lab notes.
2nd week:
Media for microbes, types, sterilization, preparation, categories of media according to use. Preparing media and pouring Petri dishes.

3rd week:
Choosing species to work with, microscopy.
4th week:
Isolating colonies. Extracellular enzyme tests.
5th week:
CFU determination. Image analysis. Data visualization (colony size distributions via image analysis).
6th week:
Metabolic tests.
7th week:
Isolating colony DNA. Introduction to PCR.
8th week:
PCR, gel electrophoresis.
9th week:
Ligation of DNA into plasmids, theoretical background.
10th week:
Preparations for Sanger-sequencing of plasmid inserts.
11th week:
Species identifications, using the novel sequences for BLAST analysis.
12th week:
Reviewing results, discussions.
13th week:
Test.
14th week:
Test retake, lab note evaluation.

Requirements:

- for a signature
Attendance of at least 75% of the practices. Presenting written lab notes.

- for a grade
The course ends in a presentation of the lab notes which are graded, and a graded test from the laboratory methods and underlying theoretical knowledge, where at least 60% must be reached. The final grade comes from the mean of the two grades (lab notes and test results).

Person responsible for course*:* Prof. Dr. István Pócsi, head of department, full professor, candidate of chemical sciences, doctor of the Hungarian Academy of Sciences (biology)

Lecturer: Dr. Valter Péter Pfliegler, assistant professor, PhD

Title of course: **Genetics I. Lecture** Code: TTBBE2011_BT_EN	**ECTS Credit points**: 3

Evaluation: written or oral exam

Type of teaching, contact hours:
-lecture: 3 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 42 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 84 hours
Total: 126 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

Introduction to the field of Genetics and the overview of its historical milestones. DNA and RNA as genetic material and the experimental proof for their role in it. Prion - a special form of inheritance-related protein.
Presentation of DNA structure and its higher level of organization, both in prokaryotes and eukaryotes: from the double helix to metaphase chromosomes. Highlighting the significance of euchromatin and heterochromatin structure: basics of chromatin level epigenetics. The demonstration of the major types of chromosomal sets among eukaryotes (euploidy and aneuploidy), and the significance of human chromosomal numerical aberrations and prenatal genetic diagnostics. Structural alteration of chromosomes and their roles in disease and evolution.
Introduction to the major events of DNA replication mechanisms in viruses, prokaryotes, and eukaryotes. Also, the telomere and telomerase structure and function will be discussed in both healthy and tumor cells. Presentation of DNA damages and possible ways of repairing the faulty DNA and their relation to human health.
The events and significance of mitotic cell division, and the significance of its regulation. The phenomenon of non-disjunction and its consequences.
The expression of genetic information: steps of gene expression – transcription and translation – and its correlation with phenotype. The genetic code and its alteration: mutations and consequences. The detailed events of meiotic cell division and the significance of neocombination. Life cycles and alternations of generations among eukaryotes. Demonstrations of Mendel's experiments and laws and their correlation with neocombination; Mendelian and non-Mendelian inheritance patterns. Sex determination and sex-linked inheritance patterns in humans and other organisms. The phenomenon of meiotic recombination and its consequence, and its use in genetic mapping – morbid map of the human genome.
Mitotic recombination in somatic cells and their role in disease.

Literature:

Mandatory literature:
Departmental teaching aid.
Recommended literature:

Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick: Lewin's GENES XII 12th Edition (2018) ISBN 9781284104493
Daniel L. Hartl: Essential genetics and genomics 7th edition (2018) ISBN 9781284152685

Schedule:
1st week: Introduction: genetics as a science field; historical overview. The nature of genetic material. DNA and RNA as genetic material. Prions.

2nd week: Structure of DNA. Superhelicity of DNA. The organization of prokaryotic genome.

3rd week: DNA organisation of eukaryotes: chromatin structures – euchromatin and heterochromatin. Basics of epigenetics.

4th week: Structure of chromosomes. Telomere and telomerase. Chromosome sets – euploidy and aneuploidy. Human chromosomal aberrations. Prenatal diagnostics.
5th week: DNA replication mechanisms. Polymerase chain reaction (PCR). DNA repair mechanisms.

6th week: The mitotic cell division and its significance. Nondisjunction and its significance.
7th week: The first step of gene expression: transcription in prokaryotes and eukaryotes.
8th week: Regulation of transcription. Posttranscriptional modifications.
9th week: The second step of gene expression: translation and the genetic code. The change of genetic code – point mutations.
10th week: Meiotic cell division, neocombination. Life cycles. The generation of human gametes.

11th week: Laws of Mendel. Mendelian inheritance – dominant and recessive autosomal inheritances. Nonmendelian inheritances.

12th week: Multifactorial inheritances. Sex determination and sex linked inheritances.
13th week: Meiotic recombination and its use in genetic mapping. Somatic recombination.
14th week: Consultation

Requirements:
The exam is composed of

- 10 keyword/definitions: each meaning maximum 2 points → all together 20 points. But partial points are available if some parts are good.
- 1 long essay: 10 points, partial points are available
- 3 short essays: altogether 12 points, 4 points each, partial points are available. Short essay questions can come from any part of the lecture, except for those that I emphasize that are not needed for the exam.

The maximum points you can reach is 42 points.

Both long and short essays must be in essay formula: with full sentences, explanations, and logical coherence, simply putting the definitions/keywords after each other is not enough. Bullet points are not accepted. Biological significance should be emphasized not just the processes. Correct scientific terms must be used.

Written exam in exam period
<60 % - fail (1)
60-69.99 % - pass (2)
70-79.99 % - satisfactory (3)
80-89.99 % - good (4)
≥90 % - very good/excellent (5)

Person responsible for course*:* Dr. Gyula Gábor Batta, assistant professor, PhD

Lecturer:

Title of course: **Genetics I. Practical** Code: TTBBG2011_BT_EN	**ECTS Credit points**: 2

Evaluation: practice grade with test

Type of teaching, contact hours:
-lecture: -
-practice: 2 hours/week
-laboratory:

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 28 hours
-laboratory: -
-home assignment: - 14 hours
-preparation for the exam: - 14 hours
Total: 56 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Genetics I. Lecture

Further courses built on it:-

Topics of course:

Reviewing the basic keywords for the genetic calculations. First, the single-gene autosomal inheritance patterns will be analyzed and practiced, with human and non-human examples. This part includes dominant-recessive, codominance, and incomplete dominance type inheritance pattern problems. Some of these analyzed genes are related to characteristics of an organism, while others that we analyze are related to human diseases. After, we analyze inheritance problems that involve two or more genes, which are not linked. In this part, we also have a look at gene interactions, such as epistasis, alternating genes, etc. Some inheritances are sex chromosome-linked, thus we also solve problems relating to those. There will be inheritance patterns that involve lethal disease-related genes, these will be also analyzed during the class. Family trees (pedigrees) will also be discussed and used for problem solving, which still have roles in medical/ clinical genetics, but also in breeding. Furthermore, several recombination-related and gene mapping (2-point and 3-point) problems will be solved during the practicals.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick: Lewin's GENES XII 12th Edition (2018) ISBN 9781284104493
Daniel L. Hartl: Essential genetics and genomics 7th edition (2018) ISBN 9781284152685

Schedule:
1st week: Reviewing the basic keywords, meiosis and the mendelian laws required for the genetic calculations
2nd week: Autosomal single-gene inheritance patterns I: dominant recessive
3rd week: Autosomal single-gene inheritance patterns II: incomplete dominance and co-dominance

4th week: Inheritance of 2 or more genes *5th week:* Gene interactions *6th week:* Test 1 *7th week:* Inheritance of lethal genes *8th week:* Sex-linked inheritances *9th week:* Reviewing theoretical background for genetic linkage *10th week:* Linkage examples *11th week:* Genetic mapping *12th week:* Test 2 *13th week:* Make up and correction tests *14th week*: Consultation
Requirements: Each test is composed of 5 problems to be solved. Each problem is worth 5 points maximum. Total points that can be earned is 25 points. Two written tests in the semester, tests are graded as seen below <50 % - fail (1) 50-69.99 % - pass (2) 70-79.99 % - satisfactory (3) 80-89.99 % - good (4) ≥90 % - very good/excellent (5) Final grade is decided ont he avarage of the two tests No failed test is acceptable x.5 will result in the better grade – e.g., „4.5” avarage is a „5”

Person responsible for course*:* Dr. Gyula Gábor Batta, assistant professor, PhD
Lecturer:

Title of course: **Genetics II. Lecture** Code: TTBBE2012_BT_EN	**ECTS Credit points**: 2

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 56
Total: 84 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): Genetics I. Lecture

Further courses built on it:

Topics of course:

The aim of the course is to introduce special genetic Topicss not discussed in the basic genetics course.
Molecular mechanism of genetic recombination: detection of crossing over, gene conversion and post-meiotic segregation. Molecular models of genetic recombination. Mobile genetic elements: insertion sequences, transposons, inversion elements, retro sequences. The mechanisms of conservative, replicative and retro-transposition. Horizontal gene transfer events. Genetic transformation. Generalized transduction. Specialized transduction. Bacterial conjugation. R-factors and other plasmids. Extrachromosomal inheritance: the construction of chondriome and plastome, mitochondrial inheritance.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:

Schedule:

1st week:

Description the course themes and requirements.

Review of the processes of mitosis and meiosis.

2nd week:

Molecular mechanism of genetic recombination I: detection of crossing over, gene conversion and postmeiotic segregation.

3rd week:

Molecular mechanism of genetic recombination II: molecular models.

4th week:

Mobile genetic elements I: insertion sequences, transposons.

5th week:

Mobile genetic elements II: retro sequences, retro elements, retrons, retroposones, retroviruses, pararoviruses.

6th week:

Mobile genetic elements III: the mechanisms of conservative, replicative and retro-transposition.

7th week:

Genetic transformation.

8th week:

Transduction in bacteria: generalized and specialized transduction.

9th week:

Conjugation in bacteria. R-factors and other plasmids.

10th week:

Extrachromosomal inheritance I: the structure of chondriome and inheritance associated with mitochondria.

11th week:

Extrachromosomal inheritance II: pollensterility and phylogenetic aspects.

12th week:

Extrachromosomal inheritance III: the plastome and eukaryotic plasmids.

13th and 14th week:
Consultation.

Requirements:
- for a signature
Attendance at lectures is recommended, but not compulsory.
- for a grade
The course ends in an examination.
The minimum requirement for the examination respectively is 60%.
<60 % - fail (1)
60-69.99 % - pass (2)
70-79.99 % - satisfactory (3)
80-89.99 % - good (4)
≥90 % - very good/excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
-an offered grade:-

Person responsible for course*:* Dr. Gyula Gábor Batta, assistant professor, PhD

Lecturer:

Title of course: **Immunology Lecture**
Code: TTBBE2013_BT_EN

ECTS Credit points: 2

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 56 hours
Total: 84 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Cell Biology Lecture

Further courses built on it:

Topics of course:

In the basic immunology course we will discuss the components and basic mechanisms of the immune system, such as immunological recognition and effector functions. We will detail the function of the natural immune system, B and T cells. We will characterize the main mechanisms of action against intracellular, extracellular pathogens immunological reactions. Summarise the main causes and mechanisms of autoimmunity and allergy.

Literature:

Mandatory literature:
Gogolak P., Koncz G. Short textbook of Basic Immunology; electronic textbook found on the department's online

Recommended literature:
Parham, P. The Immune System, Fifth Edition
Abbul K. Abbas Basic Immunology, Sixth Edition

Schedule:
1st week:
Elements of the immune system and their role in defense against pathogens. Components, characteristics and function of the innate response. Components, characteristics and function of the acquired immune response.
2nd week:
Characteristics of the acquired immune response. T-lymphocytes. B- lymphocytes.
3rd week:
An introduction to antibody structure and function. The structure of lymphoid tissues and organs, tissue stem cells. Lymphatic circulation, immune surveillance by re-circulation of immunocytes within the immune system.

4th week:
Recognition and elimination of pathogens by the innate arm of the immune system. Inflammation and the acute phase response. The complement system.
5th week:
Molecular basis of antigen recognition by antibodies and B-cells. Generation of B-cell receptor diversity. Antigen-independent differentiation of B lymphocytes.
6th week:
Self Control Test
7th week:
Structure and function of proteins encoded by the major histocompatibility (MHC) gene complex. Genetics of MHC. Processing and presentation of antigens.
8th week:
Professional antigen presenting cells. The molecular basis of antigen recognition by T-lymphocytes. T-cell development central tolerance.
9th week:
Requirements and consequences of T-cell activation. Activation and function of cytotoxic T lymphocytes.
10th week:
Antigen-dependent differentiation of B lymphocytes. B-cell activation, Production of various antibody isotypes and their functions. The function of regulatory T-cells.
11th week:
Mechanisms of peripheral tolerance. The primary and secondary immune response. The development of immunological memory.
12th week:
Allergy. Hypersensitivity reactions (Type I, II, III, IV). Autoimmunity.
13th week:
Consultation
14th week:
Self Control Test

Requirements:
To follow the progress of students two self control test (SCT) will be organised (weeks 6 and 14). Student need to score 70% or higher to qualify for the next SCT. Students who score an average of 51% or above on the second SCT will be offered a grade that they may accept as a grade for their end-term exam.
The course ends in an examination. The minimum requirement for the examination is 50 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-50	fail (1)
51-60	pass (2)
61-70	satisfactory (3)
71-85	good (4)
86-100	excellent (5)

If the score of any test is below 50, students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Dr. Attila Gábor Szöllősi, assistant professor, MD, PhD

Lecturer: Prof. Attila Bácsi, full professor; Dr. Gábor Koncz associate professor, PhD; Dr. Árpád

Lányi, associate professor, PhD; Dr. Kitti Linda Pázmándi, research fellow, PhD

Title of course: **Immunology Practical** Code: TTBBL2013_BT_EN	**ECTS Credit points:** 2
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 2 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 28 hours -home assignment: 28 hours -preparation for the exam: Total: 56 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Immunology Lecture	
Further courses built on it:	
Topics of course:	
The immunology practice course is based on the basic immunology course. Students in possession of the theoretical knowledge acquired during the practices will learn the theorectical background and the steps of basic immunological methods used in clinical practice. This will include methods based on antigen/antigen-specific antibody interaction including ELISA, Western blot, flow cytometry, cell separation methods and approaches to study lymphocyte activation and differentiation.	
Literature:	
Mandatory literature: Gogolak P., Koncz G. Short textbook of Basic Immunology; electronic textbook found on the department's online Recommended literature: Parham, P. The Immune System, Fifth Edition Abbul K. Abbas Basic Immunology, Sixth Edition	
Schedule: *1st block*: ELISA *2nd block:* Western blot *3rd block*: flow cytometry *4th block*: cell separation methods *5th block*:	

study of lymphocyte activation and differentiation
Requirements: - *for a signature* Attendance of at least 75% of the practices. Presenting written lab notes. - *for a grade* The course ends in a presentation of the lab notes which are graded, and a graded test from the laboratory methods and underlying theoretical knowledge, where at least 60% must be reached. The final grade comes from the mean of the two grades (lab notes and test results).
Person responsible for course*:* Dr. Árpád Lányi, deputy head of department, Ph.D. associate professor
Lecturer: Dr Péter Gogolák, senior researcher, PhD., Dr. Adrienn Gyöngyösi, research fellow, Ph.D.

Title of course: **Physiology of Experimental Animals Lecture** Code: TTBBE2014_BT_EN	**ECTS Credit points**: 2

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: 7 hours
-preparation for the exam: 35 hours
Total: 70 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Cell Biology Lecture and Practical; Cell Physiology I. Lecture

Further courses built on it:

Topics of course:

Students acquire basic knowledge of general and applied physiology, which serves as the basis for the subsequent Pharmacological biotechnology course. Furthermore, we want to provide a professional basis for the physiology and medical biotechnology courses of the Biotechnology MSc and Molecular Biology MSc courses.
In the framework of the course, the student learns about the possibilities of using animals for experiments, acquires basic knowledge of animal physiology and animal anatomy, with a particular focus on the species that are most often used for animal experiments as model organisms. We aim to impart the following basic knowledge: planning animal experiments, main parameters to be tested and their measurement methods.
Main Topicss covered during the semester: physiology of body fluids; physiology of circulatory, respiratory and excretory systems; function and regulation of the digestive system, digestive enzymes. Physiology of muscle function. Hormones, hormonal regulation in the body of animals. Structure of the nervous system, vegetative nervous system, regulation of the motor system. Structure and function of sensory organs.
The structure and functioning of individual organ systems will be studied in more detail in those animal species and groups of animals that are suitable for modeling the functioning of the given organ system in animal experiments. During the course, we deal with model organisms for physiological experiments and also for genetic or developmental biology experiments.

Literature:

Mandatory literature:
Departmental teaching aid.

Karen Hrapkiewicz, Lesley Colby and Patricia Denison: Clinical laboratory animal medicine, An introduction, Wiley Blackwell, 2013 Christopher D. Moyes and Patricia M. Schulte: Principles of animal physiology, Pearson, 2007.

Recommended literature:
Knut Schmidt-Nielsen: Animal physiology, Cambridge University Press, 1997. Animal physiology. Mechanisms and adaptations. W.H. Freeman and Company, 1998.

Schedule:

1st week: Introduction. Homeostasis, cell membranes, transport mechanisms, receptors and ion channels, membrane potential and action potential. Which animals can be used as lab animals?

2nd week: Circulatory systems. Flow of fluid between capillaries and cells. Blood supply of organs. Different parts of blood vessels. Main arteries and veins of organs. Function of heart. Histological and physiological characteristics of cardiac muscle. Pulmonary and systemic circuit. Coronary artery. Adaptation to high altitudes. Conducting pathway of heart. Cardiac adaptation. Cronotrophic, dromotrophic, inotrophic and bathmotrophic effects on heart. Hormonal and neuronal regulation of heart.

3rd week: Anatomy of heart of animals good for circulatory system experiments. Regulation of heart functioning in different laboratory animals. Fish, Amphibia, Reptile circulation systems. Birds and Mammals circulatory systems.

4th week: Anatomy of respiratory system of birds and mammals. Gas exchange across surface of alveoli, role of surface tension. Respiratory movements and their regulation. Respiration in air, water: gill, lung, trachea. Regulation of respiratory system. Oxygen transport. The structure and oxygen equilibrium curve of hemoglobin and myoglobin. Animal models for studying pulmonary diseases and respiratory system infections.

5th week: The human stomach and digestive organs of gastrointestinal tract. Digestive enzymes. Function of pancreas. Regulation of enzyme production Transport. Surfaces for transport of nutrients. Function of liver. Production of bile, its composition and function.

6th week: Compare digestive tract of different lab animals.

7th week: The three main mechanisms of locomotion (amoeboid, ciliary, muscle). Smooth, cardiac and striated muscle. Molecular mechanism of muscle contraction

8th week: Comparing of different animals by their excretory system. Neural and hormonal regulation of kidney.

9th week: Regulation of endocrine system feedback. Hormones and processes regulated by hormones. I. Mechanism of action of peptide and protein hormones. Types of signal molecules, extra- and intracellular receptors. Which type of compounds are the hormones and where are they produced? Opioid peptides (enkephalines, endorphine), serotonine, histamine. Hormone binding to special receptors. Signal transduction. Primary and secundary messengers. The cAMP, a diacyl-glycerol and inositol-1,4,5-triphosphate, as secundary messengers. Hormones of hypothalamus, hypophysis and thyroid gland. Growth hormone. Regulation of calcium level of bone and blood.

10th week: Steroid hormones: progesterone derivatives, glucocorticoides, mineralocorticoides, androgens and estrogenes. Effects of glucocorticoides (not on metabolism). Sexual-hormones and regulation of menstrual cycle. Hormonal disorders. Experimental animal models to study the effects of steroid hormones.

11th week: Hormones and processes regulated by hormones. II. Glucose metabolism in different tissues. Hormonal regulation of blood glucose level. Regulatory effect of catecholamines and glucocorticoides on intermedier metabolism. Experimental animal models to regulate blood

glucose level.

12th week: Structure of the nervous system in experimental animals for nervous system studies. A neuron. Morphological and functional classification of neurons. Direction of impulse transmission, neurites (nerve fibers), fascicules, spinal nerve. Receptors, nerve endings. Mechano- and thermo receptors. Neurotransmitters of peripheral and central nervous system.

13th week: Experimental animal models for studying chemoreceptors for gustatory and olfactory studies. Experimental animal models for studying hearing, equillibrium and nociception. Experimental animal models for studying vision. Structure of sensory organs and their mechanisms of action.

14th week: Experimental animal models for studying neural connections in brain, peripheral nervous system, learning and sleeping. The peripheral nervous system. Pyramidal, extrapyramidal tracts. Vegetative nervous system. Learning, memory and sleeping.

Requirements:
Requirements:
- for a signature:
Attendance at lectures is recommended, but not compulsory.

- for a grade:
Based on the teaching materials presented at the lecture, we provide the students with a set of questions, from which they will choose an item containing questions from three randomly selected sections of material for the exam. In the case of each of these topics, a minimum level of knowledge must be demonstrated in order to successfully complete the exam with an appropriate grade.

Person responsible for course*:* Dr. Mónika Gönczi Szentandrássyné, assistant professor, PhD

Lecturer: Dr. Péter Szentesi, senior research fellow, PhD; Dr. Mónika Sztretye, scientific associate, PhD;

Title of course: **Physiology of Experimental Animals Practical** Code: TTBBL2014_BT_EN	**ECTS Credit points**: 2
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 2 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 28 hours -home assignment: 10 hours -preparation for the exam: 7 hours Total: 45 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Cell Biology Lecture and Practical; Cell Physiology I. Lecture	
Further courses built on it:	
Topics of course:	
Students acquire basic knowledge of general and applied physiology, which serves as the basis for the subsequent Pharmaceutical Biotechnology course. In addition, we want to provide a professional foundation for the future master's degree programs, especially the physiology and medical biotechnology courses of the MSc Biotechnology and MSc Molecular Biology courses. In the framework of the course, the student learns about the possibilities of using animals for experiments, acquires basic knowledge of animal physiology and animal anatomy, with a particular focus on the species that are most often used for animal experiments as model organisms. We aim to impart the following basic knowledge: planning animal experiments, main parameters to be tested and their measurement methods. Main Topicss covered during the semester: physiology of body fluids; examination of the circulatory, respiratory, excretory system; gastrointestinal system, examination of digestive enzymes and hormones that regulate digestion. Examination of sensory organs and examination of reflexes.	
Literature:	
Mandatory literature: Departmental teaching aid (Animal physiology practical book) Karen Hrapkiewicz, Lesley Colby and Patricia Denison: Clinical laboratory animal medicine, An introduction, Wiley Blackwell, 2013 Christopher D. Moyes and Patricia M. Schulte: Principles of animal physiology, Pearson, 2007. Recommended literature: Knut Schmidt-Nielsen: Animal physiology, Cambridge University Press, 1997. Animal physiology. Mechanisms and adaptations. W.H. Freeman and Company, 1998. Mechanisms and adaptations. W.H. Freeman and Company,1998. Christopher D. Moyes and Patricia M. Schulte: Principles of animal physiology, Pearson, 2007.	

Schedule:

1st week: Blood: Evaluation of the size and shape of red blood cells in different vertebrate classes. Studying of red blood cells in smears of different vertebrate species (frog, chicken, rat). Measuring of the diameter of erythrocytes in smears. Red and white blood cells count with Burker chamber in sample blood. Measurement of hemoglobin content of blood with Drabkin reagent/quick test. Measurement of hematocrite. Counting of MCV and MCH.

2nd week: The structure of a mammalian lung, mechanics of respiration. Lung models of Donders's and Müller's. The structure of kidney and transport processes in renal tubules. Detection of the main components of own urine. Determining of density and pH of urine. Detection of glucose, protein and ketone bodies from modified urine.

3rd week: Structure of digestive tract in earth worm and mammals. Characteristics of main digestive enzymes: amylase, pepsine, trypsine and lipase. Characteristics of regulator hormones of blood glucose level. Gustatory and olfactory receptor sin mammals. Studying of earth worm and paramecium digestion. Studying of digestive enzymes from lyophilized porcine pancreas: trypsine, lipase, amilase. Oral glucose tolerance test. Studying of taste and smell in human.

4th week: The structure of conductivity system of heart in amphibia and mammals. The structure of neuromuscular junction, summation and tetanus. Studying the effects of Stannius I-III. ligature and temperature on heart of frog.

5th week: Structure of eye and ear. Structure of visual pathway. Meaning of hearing treshold. Examination of visual field with perimeter. Examination of hearing with audiometer. Phenomenon of contrast, optical illusions. Blind spot. Mechano- and thermoreceptors in mammals. Stretch reflex. Mechanism of action of vestibular system. Examination of stretch reflexes: jerk (patella), achilles, biceps and triceps reflexes. Time of reaction test.

6th week: Remedial lab

7th week: Simulation of the action potential in squid axon.

8th week: Computer simulation of the humoral regulation of the intestinal smooth muscle.

9th week: Investigation of the endothelial function on isolated arterial ring.

10th week: Computer simulation of the glucose tolerance test.

11th week: Computer simulation of the skeletal muscle function.

12th week: Remedial lab.

13th week: Practical exam.

14th week: Repeating practical exam for those who could not pass it previously.

Requirements:

- *for a signature*:

Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than two times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up

for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation in class, the teacher may evaluate his/her participation as an absence.

- *for a grade*:
The course ends in an examination. Students will be asked from individual topics of the semester´s practices. They have to demonstrate either the manual execution of the practical topic or the use of the appropriate part of the computer program, and need to explain the obtained results based on the theoretical background. The grade is given according how the student was able to represent the appropriate topic. If someone cannot get the practical ticket in the first round, they can repeat it at a predetermined time. If one failed to get practical mark at least ″pass″, the student cannot take the exam from the theoretical material.

Person responsible for course*:* Dr. Mónika Gönczi Szentandrássyné, assistant professor, PhD

Lecturer: Dr. Mónika Szentandrássyné Gönczi, assistant professor, PhD; Dr. Péter Szentesi, senior research fellow, PhD; Dr. Mónika Sztretye, scientific associate, PhD; Dr. Andrea Telek_Haberberger, scientific associate, PhD; Dr. Beatrix Dienes, senior research fellow, PhD; Dr. János Fodor, scientific associate, PhD; Dr. Krisztina Deák-Pocsai, scientific associate, PhD; Dr. Gabriella Czifra, scientific associate, PhD; Dr. Zsuzsa Máthéné Szigeti, assistant professor, PhD

Title of course: **Physiology of Model Plants Lecture** Code: TTBBE2015_BT_EN	**ECTS Credit points**: 2

Evaluation: written exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory: -
-home assignment: 48 hours
-preparation for the exam: 72 hours
Total: 148 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Biochemistry Practical, Biochemistry II. Lecture and Seminar

Further courses built on it:

Topics of course:

Students acquire basic knowledge of plant physiology, which serves as the basis for the subsequent Agricultural/Plant Biotechnology Lectures and Practice. Furthermore, we want to provide a professional basis for the further Biotechnology MSc and Molecular Biology MSc studies related to plant biology. We focus on physiological aspects necessary for the proper understanding of further studies regarding plant tissue culture and genetic transformation techniques. As such, more details will be given on the physiology of plant growth and development, featuring the structures, effects, mechanisms of action and practical applications of plant hormones (PGRs). An introductory Topics on basic anatomical and genetical features of model plants is needed. This will be followed by the core Topicss organized in the following way. Topics 1: Water relations, mineral nutrition and water stress tolerance of plants; Topics 2: C-and N- metabolism of plants, featuring photosynthesis; Topics 3 of crucial importance: growth and development of plants- 3a: general features of growth and development, 3b: plant hormones: auxins, cytokinins, gibberellins, brassinosteroids, stress hormones, 3c: photomorphogenesis. Topics 4: responses of plants to pathogens and plant cell death.
BSc students need to acquire basic knowledge on the above Topicss. This is necessary for their further studies including a better understanding of the molecular background of physiological processes closely related to biotechnology techniques.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Jones, R. et al. (Eds.) (2013) The molecular life of plants. Wiley-Blackwell-ASPB.

Taiz, L., Zeiger, E., Moller, I.M., Murphy, A. (2015) Plant physiology and development. Sinauer, USA

Schedule:
1st week: Model plants: their anatomy and genetics I.

2nd week: Model plants: their anatomy and genetics II.
3rd week: Water relations and mineral nutrition.
4th week: Carbon metabolism of plants I.-photosynthesis
5th week: Carbon metabolism of plants II.- oxidative processes and other key metabolic pathways
6th week: Nitrogen metabolism of plants
7th week: General features of plant growth and development
8th week: Plant hormones: auxins and cytokinins, their uses in biotechnology
9th week: Plant hormones: gibberellins and brassinosteroids
10th week: Plant hormones: abscisic acids, ethylene and other stress-related hormones
11th week: Photomorphogenesis in plants
12th week: Theoretical and biotechnological applications of plant hormone effects on growth and development
13th week: How plants cope with biotic and abiotic stresses, practical applications
14th week: Conclusions, closing remarks

Requirements:

- for a signature
Attendance at **lectures** is recommended, but not compulsory.

- for a grade in case of the lecture:
The course ends in an **examination.**

The minimum requirement for both the examination and laboratory grade is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:
it may be offered for students if the average grade of the designing tasks is at least satisfactory (3)

Person responsible for course*:* Prof. Dr. Csaba Máthé, full professor, PhD

Lecturer: Dr. Viktor Oláh associate professor, PhD

Title of course: **Physiology of Model Plants Practical** Code: TTBL2015_BT_EN	**ECTS Credit points**: 2
Evaluation: short examinations on practical knowledge	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 2 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 28 hours -home assignment: 28 hours -preparation for the exam: 48 hours Total: 96 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): Physiology of Model Plants Lecture	
Further courses built on it:	
Topics of course:	
Students acquire basic knowledge of plant physiology, which serves as the basis for the subsequent Agricultural/Plant Biotechnology Lectures and Practice. Furthermore, we want to provide a professional basis for the further Biotechnology MSc and Molecular Biology MSc studies related to plant biology. We focus on practical aspects necessary for the proper understanding of further studies regarding plant tissue culture and genetic transformation techniques. As such, more details will be given on the practical classes (laboratory exercises) regarding physiology of plant growth and development, featuring the structures, effects, mechanisms of action and practical applications of plant hormones (PGRs). The Topicss of practical classes will be closely related to those of the lectures. Firstly, the student will acquire knowledge on the techniques of growing and determination of germination capacities of model plants. This will be followed by the core Topicss organized in the following way. Topics 1: plant cell physiology, viability assays, techniques of detecting plant mitotic cells. Topics 2: assays regarding water relations, mineral nutrition and water stress tolerance of plants; Topics 3: practicals related to C-and N- metabolism of plants, featuring photosynthesis; Topics 4 of crucial importance: growth and development of plants- determination of auxin and gibberellin contents, effects of cytokinins on leaf senescence, basic tissue culture techniques (tobacco callus cultures) to assay the effects of auxin/cytokinin ratios. Topics 4: stress physiology, assays of antioxidant enzyme activities during abiotic and biotic stresses.	
Literature:	
Mandatory literature: Departmental teaching aid. Recommended literature: Jones, R. et al. (Eds.) (2013) The molecular life of plants. Wiley-Blackwell-ASPB. (practical aspects) Taiz, L., Zeiger, E., Moller, I.M., Murphy, A. (2015) Plant physiology and development. Sinauer, USA (practical aspects)	

Schedule:
1st-4th weeks: plant cell physiology- viability assays, measurements of water regime in plant cells, techniques of detecting plant mitotic cells. Mineral nutrition experiments
5th-8th weeks: Practicals related to C-and N- metabolism of plants, featuring photosynthesis and nitrate reductase activities:

- spectral characteristics of photosynthetic pigments
- identification of photosynthetic pigments by TLC
- study of light-dependent chlorophyll biosynthesis
- indirect measurements of photosynthetic oxygen production

9th-12th weeks: practicals related to plant growth and development:

- detection of plant hormones,
- the effects of auxin/cytokinin ratios on plant development,
- the effects of gibberellins on amylase activities during seed germination

13th-14th weeks: plant stress physiology: assays of the activities of ROS scavenging enzymes and of polyphenol oxidases in stressed and non-stressed plants

Requirements:

- for a signature
Participation at **practice classes** is compulsory.

Students are required to read the experimental protocols and understand the tasks during each practice class.

In case of laboratory class there are tests from experimental issues of every main course topic during the semester.

-for a grade in case of the practice class:
The result of tests and teacher's evaluation of participation in the experimental work are involved.

The minimum requirement for both the examination and laboratory grade is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:
it may be offered for students if the average grade of the designing tasks is at least satisfactory (3)

Person responsible for course*:* Prof. Dr. Csaba Máthé, full professor, PhD

Lecturer: Dr. Viktor Oláh associate professor, PhD

Title of course: **Molecular and Microbial Ecology Lecture** **ECTS Credit points**: 2
Code: TTBBE2016_BT_EN

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 62 hours
Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): General and Applied Microbiology Lecture and Practical

Further courses built on it:

Topics of course:

The aim of the course is to introduce the ecology. The course gives knowledge about the history of ecology, main definition, roles and tasks of ecology, population dynamics of population interaction, the interaction between microorganisms and their environment.

Literature:

Mandatory literature:
1. Allen I. Laskin: Microbial Ecology, CRC Press, Boca Raton (2017)
2.Jean-Claude Bertrand, Pierre Caumette, Philippe Lebaron, Robert Matheron, Philippe Normand, Télesphore Sime-Ngando: Environmental Microbiology: Fundamentals and Applications: Microbial Ecology, Springer, New York (2015)

Recommended literature:
Dhananjaya Pratap Singh, Vijai Kumar Gupta, Ratna Prabha: Microbial Interventions in Agriculture and Environment: Volume 1-3, Springer, Singapore (2019)

Schedule:
1st week: Introduction
2nd week: The history of ecology
3rd week: Topic and main definition of ecology
4th week: Population dynamics and interactions
5th week: Quiz
6th week: Soil as indicator, structure, main characteristics
7th week: Soil pollutants, sources and microbial communities
8th week: Microbial activity as indicator
9th week: Quiz
10th week: Bacteria in aquatic habitats, roles of bacteria in aquatic material cycles
11th week: Heterotrophic eukaryotes in aquatic habitats, the microbial loop
12th week: Algal assemblages, interactions of algae with their non-living and living environment
13th week: Consultation

14th week: Quiz
Requirements: The minimum requirement for the exam test is 60%. Based on the score of the test, the grade for the exam is given according to the following table: Score Grade 0-59 fail (1) 60-69 pass (2) 70-79 satisfactory (3) 80-89 good (4) 90-100 excellent (5)
Person responsible for course*:* Prof. Dr. Tibor Magura, Head of Ecology Department, full professor, DSc
Lecturer: Dr. István Bácsi, associate professor, PhD; Dr. Edina Kundrát-Simon, full professor, PhD

Title of course: **Molecular and Microbial Ecology Practical** Code: TTBBL2016_BT_EN	**ECTS Credit points**: 2

Evaluation: practice grade

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 28 hours
-home assignment: - 62 hours
-preparation for the exam:
Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): General and Applied Microbiology Lecture and Practical

Further courses built on it:

Topics of course:

The aim of the course is for students to learn the basics of experimental design procedures suitable for investigating the relationship between microorganisms and their physical-chemical environment, as well as with each other as environmental elements. Using model organisms (cyanobacteria and algae) during the practices, students learn about the possibilities of constructing simple systems suitable for investigating microbial ecological issues, sampling and sample processing methods, and gain insight into the interpretation of complex phenomena with the help of simple experimental results.

Literature:

Mandatory literature:
1. Barton LL, Northup DE (2011) Microbial Ecology. Wiley-Blackwell, New Jersey.

Recommended literature:
1. Sommer U, Worm B (2002) Competition and coegsistence. Springer.
2. Tillman D (1982) Resource competition and community structure.

Schedule:
1st week: Introduction
2nd week: Biological production, oxygen production and consumption 1(start of experiment, initial measurements)
3rd week: Biological production, oxygen production and consumption 2 (stop of experiments, final measurements)
4th week: Test 1; discussion of the first topic and preparation of the report
5th week: Phosphorous consumption 1 (start of experiment, initial measurements)
6th week: Phosphorous consumption 2 (stop of experiments, final measurements)
7th week: Test 2; discussion of the second topic and preparation of the report
8th week: Nitrogen consumption 1 (start of experiment, initial measurements)
9th week: Nitrogen consumption 2 (stop of experiments, final measurements)
10th week: Nitrogen consumption 3 (remaining measurements)
11th week: Test 3; discussion of the second topic and preparation of the report

12th week: Consultation
13th week: Consultation
14th week: Consultation

Requirements:
The minimum requirement for the test is 60%. Based on the score of the test, the grade for the practice is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course*:* Prof. Dr. Tibor Magura, Head of Ecology Department, full professor, DSc

Lecturer: Dr. István Bácsi, associate professor, PhD; Dr. Edina Kundrát-Simon, full professor, PhD

Title of course: **Bioanalytics Lecture** Code: TTBBE3001_BT_EN	**ECTS Credit points**: 2

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 28 hours
Total: 56 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Analytical Chemistry Lecture and Practical, Biochemistry I. and II. Lecture and Seminar

Further courses built on it:

Topics of course:

The students acquire knowledge based on previous biochemical and analytical studies, which are necessary for their later work. Furthermore, we want to provide a professional basis for the courses of the MSc programs, especially the Biotechnology MSc and Molecular Biology MSc courses. In the framework of the course, the students get to know the subject area of bioanalysis, with special focus on the difficulties arising from the complexity of biological systems. Our goal is to provide the following basic knowledge:
Definition of bioanalysis, most important areas, difficulties in the analysis of biological systems.
Analytical methods suitable for testing biomolecules: a) Methods for identification and characterization (MS, DNA and protein sequencing), b) Methods for quantitative determination and monitoring (chromatography, electrophoresis).
Methods based on biochemical reactions: a) DNA-based methods, b) Protein-based methods (enzymatic reactions to determine substrate and enzyme activity, biosensors), c) Immunoanalytical methods (ELISA, immunoblotting)
The course introduces the main bioanalytical procedures used in industry (e.g. pharmaceutical production, bioconversion processes, industrial enzyme production, food production) and research.

Literature:

Mandatory literature:
Departmental teaching aid.
Recommended literature:
Andreas Manz, Nicole Pamme, Dimitri Iossifidis: Bioanalytical Chemistry, https://doi.org/10.1142/p297

Schedule:
1st week: Introduction
2nd week: Definition of bioanalysis, most important areas, difficulties in the analysis of biological systems.
3rd week: Analytical methods suitable for testing biomolecules: a) Methods for identification and

characterization: mass spectrometry
4th week: Analytical methods suitable for testing biomolecules: a) Methods for identification and characterization: DNA and protein sequencing.
5th week: Methods for quantitative determination and monitoring: chromatography of biomolecules
6th week: Methods for quantitative determination and monitoring: electrophoresis of biomolecules
7th week: Methods based on biochemical reactions: a) DNA-based methods,
8th week: Methods based on biochemical reactions: b) Protein-based methods: enzymatic reactions to determine substrate and enzyme activity)
9th week: Methods based on biochemical reactions: b) Protein-based methods: biosensors
10th week: Methods based on biochemical reactions: c) Immunoanalytical methods: ELISA, immunoblotting
11th week: Bioanalytical method development of biosimilars
12th week: Bioanalytical method validation
13th week: Consultation
14th week: Quiz

Requirements:
The minimum requirement for the test is 60%. Based on the score of the test, the grade for the practice is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course*:* Prof. Dr. Gyöngyi Gyémánt, full professor, PhD

Lecturer:

Title of course: **Bioanalytical Practical** Code: TTBBL3001_BT_EN	**ECTS Credit points**: 1
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 1 hour/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 14 hours -home assignment: 14 hours -preparation for the exam: Total: 28 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): Analytical Chemistry Lecture and Practical	
Further courses built on it:	
Topics of course:	
In order to deepen the knowledge of the bioanalytical course and acquire practical knowledge, the students perform laboratory practical tasks. 1. Optimizing the operating parameters of enzymes for the development of method for activity measurement. 2. DNA testing by gel electrophoresis 3. Solving a biochemical analytical task	
Literature:	
Mandatory literature: Departmental teaching aid.	
Schedule: *1st block*: Optimizing the operating parameters of enzymes for the development of method for activity measurement. *2nd block*: DNA testing by gel electrophoresis *3rd block*: Solving a biochemical analytical task	
Requirements: *- for a signature:* Participation at practices is compulsory. A student must attend every practices during the semester. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. *- for a grade:* Grading is given by the average of separate grades: - the average grade of the short tests written at the beginning of the instrumental analysis lab practices (an average of at least 2.0 is necessary to avoid a 'fail' final grade)	

- the average grade of evaluation of the analytical data measured by the instrument, the laboratory notebook prepared by the student and final discussion/conclusion made between the student and the supervisor at the end of the lab practice (an average of at least 2.0 is necessary to avoid a ‘fail’ final grade)
Person responsible for course*:* Prof. Dr. Gyémánt Gyöngyi, full professor, PhD
Lecturer:

Title of course: **Separation Techniques Lecture** Code: TTBBE3002_BT_EN	**ECTS Credit points**: 1

Evaluation: exam

Type of teaching, contact hours:
-lecture: 1 hour/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 14 hours
-practice: -
-laboratory -:
-home assignment: 28
-preparation for the exam: 48
Total: 90 hours

Year, semester: 3rd years, 1st semester

Its prerequisite(s): General Chemistry Lecture, Analytical Chemistry Lecture, Inorganic Chemistry Lecture, Organic Chemistry Seminar

Further courses built on it:

Topics of course:

During the course, students will get the knowledge of the techniques and tools used for the enrichment, separation and extraction of simple and complex, multi-component systems according to their components, and the related analytics with its principles, tools, operating principles and methods of equipment and tools, technical implementation, evaluation of results. The course material to be presented for the subject in more detail: Basic concepts. Procedures for Solvent Removal. concentration, concentration, Partial evaporation; Partial freezing, concentration, Complete evaporation (to dryness), Spray drying, Freeze drying (lyophilization, freeze-drying); Separation of a mixture of solid materials: Sorting, Magnetic separation, Flotation; Centrifugation, Ultracentrifugation; Filtration, microfiltration, nanofiltration; Osmosis, reverse osmosis, dialysis; Extractions, solid phase extraction, solid phase microextraction; Chromatographies; Layer chromatography procedures and their devices; Principle of gas chromatography, gas chromatography separations, analyses; Principle of liquid chromatography, principle of low- and high-pressure liquid chromatography, tools, separations with liquid chromatography; Gel chromatography, gel permeation chromatography; Principle, tools and practice of gel electrophoresis; Affinity chromatography.

Literature:

Mandatory literature:
Dr. István Lázár: Separation Techniques and Instrumental Analysis (Chromatography) for B.Sc. students, 1st English Edition, UD Department of Inorganic and Analytical Chemistry, 2020.

Recommended literature:
Frederick Dechow, Separation and Purification Techniques in Biotechnology; Elsevier, 1989, ISBN: 9780815511977
Tadashi Uragami, Science and Technology of Separation Membranes, Wiley,
2017, ISBN 9781118932544

Schedule:
1st week: Basic principles of separations, classifications
2nd week: Techniques to remove solvents
3rd week: Spray drying, Freeze-drying, other techniques
4th week: Separation of solid mixtures by density, magnetic properties, wettability.
5th week: Removal of solids from fluidic mediums, sedimentation, centrifugation and related techniques
6th week: Filtration from liquids and gases.Basic principles, filtration aids, practical aspects,
7th week: Classifications of filter mediums, devices, pressure, flow direction, electric charge
8th week: Extraction, liquid-liquid, solid-liquid, SPE, SPME
9th week: Reversed osmosis, dialysis, haemodialysis
10th week: Chromatographic techniques in general. Layer chromatographies.
11th week: Column chromatographies in general. Gas chromatography, theory and practice
12th week: Instrumental liquid chromatographies, theory and practice, HPLC, UHPLC
13th week: Gel chromatography, Gel electrophoresis
14th week: Other chromatography techniques., Data analysis, Chromatography networks and softwares

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
- for a grade
The course ends in an **examination**. The result of the examination determines the final grade.
The minimum requirement for the examination is 50%. Based on the score of the exam, the grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-87	good (4)
88-100	excellent (5)

In case of failure, students can take retake exam(s) in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Dr. István Lázár, associate professor of Chemistry, candidate of chemical sciences,

Lecturer: -

Title of course: **Separation Techniques Practical** Code: TTBBL3002_BT_EN	**ECTS Credit points**: 3
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 3 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 42 hours -home assignment: 48 hours -preparation for the exam: - Total: 90 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): Analitycal Chemistry Lecture and Practical	
Further courses built on it:	
Topics of course:	
Students acquire basic knowledge of separation analytical methods, which are connected to the Separation methods lecture. The course focuses at the separation methods, which are widely used in biotechnologic monitoring laboratories, food and environment analyses. The implementation techniques of the different methods and the evaluation of the obtained experimental results will be included. The students perform the laboratory practice of a given method (instrument) in a group of 1-4 person. The main Topicss of the course: Evaluation of chromatograms, Size exclusion chromatography (SEC), Puridication and separation of proteins, Thin layer chromatography (TLC), UV-Vis spectrometry, High performance liquid chromatography (HPLC)	
Literature:	
Mandatory literature: Departmental teaching aid, syllabuses. Recommended literature: Daniel C. Harris: Quantitative Chemical Analysis, 7th Ed., 2007, Freeman and CoH.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle: Instrumental methods of Analysis, Wadsworth Publ. Co., Belmont, 1988. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch: Fundamentals of Analytical Chemistry, 8th. ed., 2004, Brooks/Cole	
Schedule: *1st week*: Introductory guidance, accident protection (2h)	

2nd week: Evaluation of chromatograms (8h)
3rd week: Size exclusion chromatography (SEC) (6h)
4th week: High Performance Liquid Chromatography (6h)
5th week: Puridication and separation of proteins (6h)
6th week: Gel electrophoresis (6h)
7th week: Thin layer chromatography (6h)
8th week: Final test (2h)

Requirements:

- *for a signature*

Participation at practices is compulsory. A student must attend every practices during the semester. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- *for a grade*

Grading is given by the average of 3 separate grades:

- the average grade of the short tests written at the beginning of the instrumental analysis lab practices (an average of at least 2.0 is necessary to avoid a 'fail' final grade)

- the average grade of evaluation of the analytical data measured by the instrument, the laboratory notebook prepared by the student and final discussion/conclusion made between the student and the supervisor at the end of the lab practice (an average of at least 2.0 is necessary to avoid a 'fail' final grade)

- the grade of the final test

The grade of the final test is calculated according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course*:* Prof. Dr. Attila Gáspár, full professor, doctor of the Hungarian Academy of Sciences

Lecturer: Dr. Melinda Andrási, PhD, senior lecturer; Prof. Dr. Gyöngyi Gyémánt, PhD, full professor, Dr. Mária Szabó, PhD, senior lecturer

Title of course: **Methods in Molecular Biology and Gene Technology I. Lecture** Code: TTBBE3003_BT_EN	**ECTS Credit points**: 3
Evaluation: written exam	
Type of teaching, contact hours: -lecture: 2 hours/week -practice: - -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 28 hours -practice: - -laboratory -: -home assignment: - -preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Biochemistry I. Lecture and Seminar, Genetics I. Lecture and Seminar, Genetics II. Lecture	
Further courses built on it:	
Topics of course:	
Students will learn about the genetic, cellular, and molecular biological basis of life and understand the links between genome, environment, and health. Students will be introduced to the basic concepts of molecular biology and will build on these concepts to learn about the molecular biological mechanisms within the cell, such as the regulation of DNA replication, transcription, gene expression, etc. The student will learn about the theoretical background of the most common methods of molecular biology, their practical application, and their use in e.g. medical diagnostics. The student will acquire knowledge of the theoretical background of genomics, proteomics, and bioinformatics and their applications in treatments and discovery research in specific diseases.	
Literature:	
Mandatory literature: Lecture slides Methods in Molecular Biology (edited by. Dombrádi Viktor, DEOEC, 2007.) Molecular Cloning: A Laboratory Manual by Sambrook Molecular Biology of the Cell (6th ed.; Alberts; Garland), Essential Cell Biology (2nd ed., Alberts; Garland), Biochemistry with clinical correlations (6th ed., Devlin;Wiley -Liss), Molecular Cell Biology (6th ed., H .F. Lodish ; Freeman), Genoms (3rd ed.; T.A. Brown; Garland)	
Schedule: *1st week*: DNA structure, DNA replication, repair. *2nd week*: Transcription: RNA synthesis, mRNA maturation. *3rd week*: Translation, post-translational modifications.	

4th week: Regulation of gene expression.
5th week: Introduction to Genomics. Introduction to Proteomics.
6th week: Recombinant DNA cloning, DNA modifying enzymes.
7th week: Methods of nucleic acid hybridization. Oligonucleotide synthesis.
8th week: Polymerase chain reaction (PCR) and DNA sequencing.
9th week: Recombinant protein expression. Introduction to Bioinformatics.

Requirements:
Attendance at lectures is not compulsory but essential for the successful completion of the course.
Successfully completing the Methods in Molecular Biology and Gene Technology I. Practical subject (with a passing grade or better) is a prerequisite for the Methods in Molecular Biology and Gene Technology I. exam registration:
There are two self-control tests during the semester scheduled for week 6 and week 13. Self-control tests are optional, and there is no possibility to rewrite them.
Control tests and final exams will be assessed as follows:

Percentage (%)	Grade
0-49	fail (1)
50-64	pass (2)
65-74	satisfactory (3)
75-85	good (4)
86-100	excellent (5)

Students who pass both control tests get an offered grade. Offered grades are registered in Neptun and accepted as the final exam grade unless the student does not accept it by the end (Sunday midnight) of week 14.
The end-of-semester exam is a written exam covering the full semester material (lecture and practical). There are 3 exam chances in a semester (A, B, and C chance exams).
Successfully passed exams (grades 2, 3, or 4) can be improved once by retaking the exam in the given exam session.
Students who fail the C-chance exam will have the opportunity to take an oral exam in front of an examination committee (immediately after the written exam).

Person responsible for course*:* Dr. Krisztina Tar, PhD associate professor

Lecturer: Prof. Dr. Péter Bay, full professor, DSc, PhD, Dr. Kókai Endre, assistant professor, PhD, Révészné Dr. Réka Tóth, college associate professor, PhD, Dr. Csaba Hegedűs, assistant professor, PhD, Dr. Gergő Kalló, lecturer, PhD, Dr. Anita Boratkó, assistant professor PhD

Title of course: **Methods in Molecular Biology and Gene Technology I. Practical** Code: TTBBL3003_BT	**ECTS Credit points**: 1
Evaluation: grading of practices, practical exam	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 1 hour/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 14 hours -home assignment: 76 hours -preparation for the exam: Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Biocemistry I. Lecture and Seminar, Genetics I. Lecture and Seminar, Genetics II. Lecture	
Further courses built on it:	
Topics of course:	
Course program: Isolation and analysis of genomic DNA by gel electrophoresis. Restriction analysis. Use of the gel documentation system. Application of PCR reactions in medical diagnostics. Protein detection methods, SDS-PAGE and Western blot, and dot blot techniques. The knowledge acquired will be assessed by evaluation of the practical protocols, answers to questions from the required material, the quality of the completion of the laboratory labbook, and active participation during the practical.	
Literature:	
Mandatory literature: Lecture slides Methods in Molecular Biology (edited by. Dombrádi Viktor, DEOEC, 2007.) Molecular Cloning: A Laborytory Manual by Sambrook Molecular Biology of the Cell (6th ed.; Alberts; Garland), Essential Cell Biology (2nd ed., Alberts; Garland), Biochemistry with clinical correlations (6th ed., Devlin;Wiley -Liss), Molecular Cell Biology (6th ed., H .F. Lodish ; Freeman), Genoms (3rd ed.; T.A. Brown; Garland)	
Schedule: *3rd week*: Nucleic acid isolation *4th week*: Restriction analysis *5th week*: Immuntechniques *10th week*: Polymerase chain reaction (PCR)	

Requirements:
Attendance at laboratory practices is compulsory and recorded. Students should attend 100% of laboratory practices. Practical absences must be made up after consultation with the laboratory supervisor.
Each practical is graded by the laboratory teacher. Evaluation is based on the following:
- laboratory records kept during the practical training
- the completion of the laboratory practice
- answers to the questions of the laboratory practice

The laboratory material is handed out by the laboratory supervisor before the beginning of the practical.

Person responsible for course*:* Dr. Krisztina Tar, associate professor, PhD

Lecturer: Dr. Kókai Endre, PhD, assistant professor, Dr. Magdolna Szántó, lecturer, PhD, Dr. Katalin Kovács, assistant professor, PhD, Dr. Zsuzsanna Polgár, lecturer, PhD, Dr. Zoltán Kónya, junior lecturer, PhD

Title of course: **Methods in Molecular Biology and Gene Technology II. Lecture and Seminar** Code: TTBBE3004_BT_EN	**ECTS Credit points**: 3
Evaluation: oral exam	
Type of teaching, contact hours: -lecture: 2 hours/week -practice: 1 hour/week -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 28 hours -practice: 14 hours -laboratory -: -home assignment: - -preparation for the exam: 28 hours Total: 70 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): Methods in Molecular Biology and Gene Technology I. Lecture and Practical	
Further courses built on it:	
Topics of course:	
Students will acquire the general and applied knowledge necessary to develop a molecular approach, carry out subsequent work in molecular biology, and understand the subject of synthetic biology and the molecular subjects of the Master's degree courses (MSc in Biotechnology, MSc in Molecular Biology, MSc in Biology). Our aim is to provide an understanding of the basic concepts of molecular biology and the application of genetic engineering methods. In the course, the students will learn the basic steps and methods of DNA isolation and purification, the determination of DNA purity and concentration, the principles and applications of gel electrophoresis, and the factors that influence the running. There will be presentations about pulsed-field gel electrophoresis, restriction enzymes, their characteristics, and practical applications. The students learn the main benefits, characteristics, and application of the plasmid and phage vectors, cosmids, and eukaryotic vectors. They learn about cloning- and expression vectors. They study the steps of gene cloning, the concept of recombinant DNA, ligation steps, blunt and sticky end joining, and the benefits of phosphatase treatment. After a brief overview of DNA replication, they learn about the steps of PCR reaction, primers, and practical applications of PCR, real-time PCR, and multiplex PCR. After reviewing the central dogma, they learn about reverse transcriptase and cDNA synthesis. The presentation shows briefly the DNA sequencing methods, results of genome sequencing projects of certain research model organisms, and the sequencing of the human genome. The presentation shows the applications of sequencing results in research and medicine. They learn about the concept and types of DNA libraries, DNA hybridization, transformation methods, and transgenic animals. The presentations concern also Topicss of gene expression, and the possibilities of studying gene function, such as transcriptomic studies. In the seminar, the students will practice transcription of DNA to mRNA and protein sequences, they can use the code dictionary to better understand the steps of gene expression. They design mutant alleles and perform virtual gene cloning. They will practice the determination of DNA size, and virtual restriction digestion, and learn to check and correct sequencing data. They can design PCR	

primers, practice how to buy tools and enzymes for genetic engineering work and collect information from databases.

Literature:

Mandatory literature:
The departmental teaching aid.

Recommended literature: Dale J: From genes to genomes: concepts and applications of DNA technology.

Schedule:
1st week: Introduction, requirements. DNA structure, DNA isolation and purification from cells, and determination of DNA purity and concentration.
2nd week: The principles and applications of agarose gel electrophoresis, the factors that influence the running.
3rd week: Pulsed-field gel electrophoresis and its application.
4th week: Restriction enzymes, their characteristics, and applications.
5th week: The plasmid and phage vectors, cosmids, and eukaryotic vectors. Cloning- and expression vectors.
6th week: Steps of gene cloning, the concept of recombinant DNA, ligation steps, blunt and sticky end joining, and the benefits of phosphatase treatment.
7th week: Overview of DNA replication. Steps of PCR reaction, primers, real-time PCR, and multiplex PCR.
8th week: Central dogma, reverse transcriptases, and cDNA synthesis.
9th week: DNA sequencing, and genome sequencing projects. Modell organisms.
10th week: The human genome. Applications of sequencing results in research and medicine.
11th week: DNA libraries, DNA hybridization.
12th week: Transformation methods, selection.
13th week: Study of gene expression. Genomic studies.
14th week: Consultation

Requirements:
<50 % - fail (1)
50-62 % - pass (2)
63-75 % - satisfactory (3)
76-88 % - good (4)
≥89 % - very good/excellent (5)

Person responsible for course*:* Dr. Ida Miklós, head of the Department of Genetics and Molecular Biology, PhD

Lecturer: Dr. László Attila Papp, and Dr. Zsuzsa Antunovics, assistant professors, PhD

Title of course: **Methods in Molecular Biology and Gene Technology II. Practical** Code: TTBBL3004_BT_EN	**ECTS Credit points**: 4

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 3 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 42 hours
-home assignment: 48 hours
-preparation for the exam:
Total: 90 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Methods in Molecular Biology and Gene Technology I. Lecture and Practical

Further courses built on it:

Topics of course:

Students will acquire the general and applied knowledge necessary to develop a molecular approach, carry out subsequent work in molecular biology, and understand the subject of synthetic biology and the molecular subjects of the Master's degree courses (MSc in Biotechnology, MSc in Molecular Biology, MSc in Biology). Our aim is to provide an understanding of the basic concepts of molecular biology and the application of genetic engineering methods.

In the practical course, the students will do experiments concerning the basic steps of gene cloning. Planning of gene cloning steps. Preparation of bacterial medium and sterilization. Preparation of bacterial culture. DNA isolation, determination of DNA concentration, and purity. PCR amplification of genes and agarose gel electrophoresis, determination of size. Restriction digestion and ligation of DNA. Plasmid isolation from *E. coli.* Transformation of bacterial and yeast cells. RNA isolation, cDNA synthesis, Colony PCR, and replica plating technique for checking the transformants.

Literature:

Mandatory literature:
The departmental teaching aid.

Recommended literature: Dale J: From genes to genomes: concepts and applications of DNA technology.

Schedule:
1st week: Gene cloning design.
2nd week: Gene cloning design.
3rd week: Preparation of bacterial and yeast media. Sterilization.
4th week: Preparation of bacterial and yeast cultures. gDNA isolation, determination of DNA concentration, and purity.

5th week: PCR amplification of genes and agarose gel electrophoresis, determination of size. *6th week*: Restriction digestion and ligation of DNA into a cloning vector. *7th week*: Joint PCR. *8th week*: Transformation of bacterial cells. *9th week*: Plasmid isolation from *E. coli.* *10th week*: Transformation of yeast cells. *11th week*: Colony PCR, and replica plating technique for checking the transformants. *12th week*: cDNA synthesis, gel electrophoresis. *13th week*: Discussion. *14th week*: Consultation
Requirements: <50 % - fail (1) 50-62 % - pass (2) 63-75 % - satisfactory (3) 76-88 % - good (4) ≥89 % - very good/excellent (5)
Person responsible for course*:* Dr. László Attila Papp, assistant professor, PhD
Lecturer:

Title of course: **Synthetic Biology Lecture** Code: TTBBE3005_BT_EN	**ECTS Credit points**: 2

Evaluation: written exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 62
Total: 90 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): Molecular Biology and Gene Technology II. Lecture and Seminar

Further courses built on it:

Topics of course:

Synthetic biology is the design and creation of biological systems (genes, modules, genetic networks, even whole cells, organisms) that do not exist in their given form in nature.
There is a large-scale, explosive development in the number of known genomes and gene networks, as well as in molecular technologies. This makes it possible and necessary for the hitherto largely analyzing and understanding biology to turn towards "assembly", construction using engineering methods. The students get to know these methods, which can also be used in modern industrial microbiology.
Living systems have been continuously transformed ever since we have been studying the processes taking place in living things with molecular biological methods in order to understand them. In terms of applications, we have already reached from simple mutants to genetically manipulated higher ones. In the framework of the course, students learn about the possibilities and methods of planning systems, as well as the most modern technical possibilities for the transformation of living organisms.
Synthetic biology can be approached from the side of computer technology and engineering sciences, emphasizing standardization, the application of engineering methods, and conscious planning. The other option represents the field of "metabolic engineering", i.e. it carries out targeted modifications of metabolic networks for biotechnological use. In the framework of this course, we will primarily focus on the latter area.
Students will learn about the branches of molecular biology techniques that have undergone tremendous development in recent years (DNA cleavage, splicing, introduction into cells, DNA synthesis) and their applications. They will learn about the methods of preparing DNA segments assembled with complicated cloning steps, and the products of specialized DNA synthesizing companies. They will receive useful knowledge about the use of robotic workstations that replace individual experiments involving a lot of manual work, the possibilities of automation, and the ways of performing fast and large-scale experiments.
Students learn about the usefulness of synthetic biology, the methods of creating modified living cells that perform useful tasks for humans, so that they can perform extremely complicated chemical steps with microorganisms in a cheap, environmentally friendly way. They will learn how to make these organizations even more effective through conscious planning.
The students also learn about the potential dangers of synthetic biology and the questions that also

concern lay people: isn't it dangerous to create organisms that have never existed before? Can't these get released, causing damage?
We aim to impart the following basic knowledge: DNA synthesis, genome editing: DNA writing, reading, Genome design techniques, Gene expression modification using synthetic DNA cassettes, site-specific genome modification.
Controlled protein production and protein activities: planning the use of constitutive and regulatable promoters, RNA splicing, effect of alternative RNA splicing on gene design, the role of small regulatory molecules, the design and creation of synthetic organelles, the use of DNA binding to increase metabolite production, the use of synthetic RNA fragments as bioengineering tools.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:

Mario Andrea Marchisio (2018) Introduction to Synthetic Biology,Springer Verlag, Singapore, ISBN 9811087512

Robert A. Meyers (2015) Synthetic Biology, Wiley-VCH Verlag GmbH, ISBN 3527334823

Paul S Freemont, Richard I Kitney (2015) Synthetic Biology — A Primer, Imperial College Press, Revised Edition, , ISBN 9781783268818

Schedule:

1st week:

Introduction, The Role of Genetic Engineering Technology in the Manipulation of Genetics of Organisms and Synthetic Biology, Artificial Intelligence, and Quantum Computing, Construction and Analysis of Metagenome Library from Bacterial Community Associated with Toxic Dinoflagellate Alexandrium tamiyavanichii

2nd week:

Applied Molecular Cloning: Present and Future for Aquaculture, Molecular Cloning of Genic Male-Sterility Genes and Their Applications for Plant Heterosis via Biotechnology-based Male-sterility Systems

3rd week:

PCR and Infectious Diseases, Polymerase Chain Reaction (PCR): Principle and Applications, Annealing Temperature of 55°C and Specificity of Primer Binding in PCR Reactions, Real-Time Quantitative PCR as a Tool for Monitoring Microbiological Quality of Food

4th week:

BIOLOGICAL BASIS, The Emergence of the First Cells, Regulation of Gene Expression, Microbiomes, Dynamics of Biomolecular Networks,

5th week:

E-Cell: Computer Simulation of the Cell, SynBioSS Designer Modeling Suite

6th week:

MODULAR PARTS AND CIRCUITS, Synthetic Gene Circuits, DNA Origami Nanorobots, RNAi Synthetic Logic Circuits for Sensing,

7th week:

Information Processing, and Actuation, Synthetic Hybrid Biosensors, Synthetic Biology in Metabolic

8th week:

Engineering: From Complex Biochemical Pathways to Compartmentalized Metabolic Processes Vitamin Connection

9th week:

SYNTHETIC GENOMES, The Minimal Gene-Set Machinery, Production of Mitochondrial Genome and Chromosomal DNA Segments Highly Engineered for Use in Mouse Genetics by a Bacillus subtilis-Based BGM Vector System,

10th week:

Synthetic Genetic Polymers Functioning to Store and Propagate Information by Genetic Alphabet Expansion,

11th week:

DISEASES AND THERAPEUTICS, Synthetic Biology Approaches for Regenerative Medicine, The Synthetic Biology Approach to Stem Cells and Regenerative Medicine,

12th week:

Synthetic Biology Approaches to Cell, Synthetic Biology Approaches for Vaccine Development

13th week:

CHEMICALS PRODUCTION, Metabolic Engineering for the Production of Diols, Synthetic Biology in Biofuels Production,

14th week:

Synthetic Biology of Antibiotic Production

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

- for a grade

The course ends in an **examination**. Exam is taken in exam period. It is primarily in written form, composed of A and B part. A part is a "short answer" test and 90 % must be reached. B part is composed of figures, fill in tests, long and short essays. Grade will be given based on the B part, but A part must be passed.

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If required oral exams can be taken.

Person responsible for course*:* Dr. Zsigmond Benkő, assistant professor, PhD

Lecturer:

Title of course: **Synthetic Biology Practical** Code: TTBBL3005_BT	**ECTS Credit points**: 2
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 2 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 28 hours -home assignment: 62 -preparation for the exam: Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): Molecular Biology and Gene Technology II. Lecture and Seminar	
Further courses built on it:	
Topics of course:	
Synthetic biology is the science of a pre-engineered genome modification with engineering precision. Introducing the basic steps of this planning process will be indispensable when starting independent work. To this end, the lab practice is designed to give students experience acquire basic design and experimental skills in synthetic biology in its elements. For this, gene modification must be planned in a given species (gene knockout, gene exchange, gene modification ranging from one base to several bases, gene labeling, chromosome fluorescent labeling at a given location, enzyme input to the specific location of the chromosome, etc.). First of all, this requires to work on the strategy, you have to find the most suitable techniques, plan the instrument and chemical requirements, develop the experimental steps then order these. To complete the task, they need to know programs that meet these goals and students must be familiar with and learn how to use them during their design work. For the specific experiment the students need to design the appropriate oligoes for repair DNA fragments, and the species-specific codon optimization of genes must be done. With these the student must complete the given modification task, which is a multi-step experimental sequence. Meanwhile, they must use their previously getting hold of basic microbiology practice (preparation of culture medium, PCR technique, digestion, ligation, transformation, selection, etc.) that is acquired for the experiments. The goal is to create the tested construction in that species. The aim is to acquaint the students with the modern tools and techniques, which they may encounter during their laboratory work. They need to get to know the services that are essential for effective synthetic for biology works (can be ordered: oligo types, sequencings positions, codon optimizations, cloning, etc.) They must learn about the safe operation of synthetic biology labs rules for protecting the health and environment of workers in lobar for the sake of it. They must know the rules applicable there, the hazards of the experiments the equipment and the chemicals, their storage, the effective principles of its use, as well as the storage and processing rules for your own safety and the safety of the environment.	
Literature:	

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Mario Andrea Marchisio (2018) Introduction to Synthetic Biology, Springer Verlag, Singapore, ISBN 9811087512

Josefine Liljeruhm, Erik Gullberg, Anthony C Forster (2014) Synthetic Biology: A Lab Manual, World Scientific Publishing Company, ISBN 9789814579568

Schedule:
1st block:
Safety is Priority #1: Fires, Chemicals, Biological Safety and Disposal, Dangerous Equipment
2nd block:
Introduction: The Physical Lab Spaces, Equipment, What is Synthetic Biology, Exactly? A Synthetic Biology Lab Manual
3rd block:
Genes, Chromoproteins and Antisense RNAs: E. coli DNA: Chromosomes, Plasmids and Copy Number, Coupling of Transcription and Translation in Bacteria, Promoter and Terminator for Transcription, Ribosome Binding Site (RBS), Codon Bias, Chromoproteins, Small Regulatory RNAs (sRNAs)
4th block:
Preparation of Chemical Solutions and Agar Plates
Coloring Bacteria by Adding a Promoter to a Chromoprotein Gene
Rational Engineering of Chromoprotein Expression Level
5th block:
Preparation of Solutions and Agar Plates
Overnight Cultures with Antibiotics, and Glycerol Stocks
BioBrick™ 3A Assembly and Gel Analysis
Agarose Gel Electrophoresis
Preparation of Competent E. coli Cells Using CaCl 2
Transformation of CaCl 2 -Competent E. coli Cells
Bacterial Re-Streaking Techniques
Lysis of *E. coli* Cells with Lysozyme
Polymerase Chain Reaction (PCR)
Inverse PCR Mutagenesis
Colony PCR
Golden gate Assembly
6th block:
Recombination in Plasmids and the Chromosome
Electrocompetent Cells

Requirements:

- for a signature
Participation at practice classes is compulsory. A student must attend the practice classes and may not miss during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at practice classes will be recorded by the practice leader. In case of further absences, a medical certificate needs to be presented.

- for a grade
The course ends in practical test. The minimum requirement for the end-term tests respectively is 60%. The grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course*:* Dr. Zsigmond Benkő, assistant professor, PhD

Lecturer:

Title of course: **Industrial and Environmental Biotechnology Lecture** Code: TTBBE3006_BT_EN	**ECTS Credit points**: 2
Evaluation: oral exam	
Type of teaching, contact hours: -lecture: 2 hours/week -practice: - -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: 28 hours -practice: - -laboratory -: -home assignment: - -preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Biochemistry I. Lecture and Seminar, Biochemistry Practical, General and Applied Microbiology Lecture and Practical	
Further courses built on it:	
Topics of course:	
Growth media. Importance of water in the fermentation industry. Industrial carbon and nitrogen sources. Inorganic components. Trace elements, vitamins. Precursors, antifoam agents. Bioreactors. General design, body construction. Mechanically agitated and air-lift fermentors. Acetators, cavitators. Fluidized bed reactor, membrane reactors, photoreactors. Single-use bioreactors. Batch, fed-batch, continuous bioprocesses. Substrate-, product-, biomass profiling. Limiting and residual substrates. Yields. Specific growth rate. Generation time. Monod-equation, steady-state substrate concentration. Chemostat, turbidostat. Solid state fermentation. Inoculum preparation: Master Cell Bank, Working Cell Bank. Fermentation modelling. Sterilization. Specific death rate. Sterilization of the medium, the air and the bioreactor. Del-factor. Continuous and batch sterilization. Economics, costs and safety measures during sterilization. Aeration and agitation. The impeller and the baffles. Stirrer glands and bearings. Spargers. The oxygen requirements of industrial fermentations: thermodynamics and kinetics of solubility. Henry's law. The overall mass transfer coefficients (KLa) and its determination. Factors affecting KLa values in fermentation vessels. The Reynolds-number. Instrumentation: manual and automatic control. Methods of measurement for process variables: temperature, pH, agitation rate, dissolved oxygen, redox potential air flow rate, exit gas analysis, weight, internal pressure, foaming. Sampling. The recovery and purification of bioprocess products. Extracellular products. Filtration. Darcy-equation. The centrifuge. Foam separation. Precipitation. Intracellular products. Cell disruption. Secondary purification step: extraction, adsorption, ion exchange- és affinity chromatography. Gel filtration, ultra filtration, drying, crystallization. Whole broth processing. Introduction to bacterial fermentations through amino acid production. Introduction to fungal fermentations through organic acid production. Mammalian cell- and insect cell fermentations. High cell density cultivations. Similarities and differences to microbial fermentations.	

Biofuel production: ethanol, biodiesel, biogas. Effluent treatment. factory surveys. Disposal of inorganic compounds by microbial means. Removal of inorganic nitrogen: ammonification, nitrification, nitrate reduction, ammonia oxidation. Removal of inorganic sulphur: oxidation, assimilatory and dissimilatory sulphate reduction. Perchlorate removal. Removal of metalloids (arsenium, selenium), and metals. Removal of persistent organic pollutants (POP) by microbial means. Aerobic and anaerobic hydrocarbon degradation. Methene utilization. Aromatic hydrocarbon degradation. Degradation of xenobiotics.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Stanbury PF, Whitaker A: Principles of Fermentation technology (Pergamon Press).
Soetaert W, Vandamme EJ: Industrial Biotechnology (Wiley)

Schedule:
1st week: nutritional requirements of fermentations
2rd-3th weeks: bioreactor design
4th week: mass balance of fermentations
5th week: aeration & agitation
6th-7th weeks: fermentation-related unit operations
8th-9th weeks: fermentation analytics
10th-11th weeks: fermentation downstream
12th-13th weeks: industrial and environmental bioprocesses
14th week: consultation

Requirements:
Two written mid-term tests for an offered mark. Alternatively, students have to complete a written exam in the exam period.

Person responsible for course*:* Prof. Dr. Levente Karaffa, Department Chair, Full Professor, Doctor of the Hungarian Academy of Sciences (biology)

Lecturer:

Title of course: **Industrial and Environmental Biotechnology Practical** Code: TTBBL3006_BT_EN	**ECTS Credit points**: 3
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: - -laboratory: 3 hours/week	
Workload (estimated), divided into contact hours: -lecture: - -practice: - -laboratory: 42 hours -home assignment: - -preparation for the exam: Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Biochemistry I. Lecture and Seminar, Biochemistry Practical, General and Applied Microbiology Lecture and Practical	
Further courses built on it:	
Topics of course:	
Understanding and performing the major operation steps of a submerged, batch fungal fermentation at laboratory scale (10-L): media preparation, sensor (dissolved oxygen, pH) calibration, sterilization, inoculum preparation, inoculation. Samplings. Carbon uptake, oxygen consumption, biomass and product formation kinetics.	
Literature:	
Mandatory literature: Departmental teaching aid. Recommended literature: Levente Karaffa: Industrial microbiology practicals (e-book)	
Schedule: *1st week:* Media preparation (C and N sources, salts, macro- and trace elements, vitamins, etc., minimal- and complex media). *2nd week:* Media preparation (equipment, pH setting, sterilization). *3rd week:* Sterilization methods (physical and chemical sterilization: autoclave, filters, UV radiation, chemicals). *4th week:* Bioreactors (principles of the structure: agitation system, ports, pumps, etc.).	

5th week:

pH sensor (principles of structure and measurement, calibration, sterilization, maintenance).

6th week:

DO sensor (principles of structure and measurement, calibration, sterilization, maintenance).

7th week:

Temperature monitoring in bioreactor (sensor, principles of structure and measurement, calibration, sterilization, maintenance).

8th week:

Sterilization of bioreactor (ex-situ and in situ methods, preparation of bioreactor).

9th week:

Preparation of inoculum (requirements of quality and quantity, minimal- and complex media, shaken flask cultures, cell and spore count, inoculation methods of shaken flasks).

10th week:

Inoculation of bioreactor (equipment and methods).

11th week:

Control in the bioreactor (agitation and dissolved oxygen, „route of the oxygen")

12th week:

Control in the bioreactor (temperature and pH).

13th week:

Samplings and dosing (biomass determination, DCW, etc.).

14th week:

Carbon uptake, oxygen consumption, biomass and product formation kinetics.

Requirements:

- *for a signature:*

Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.

Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- *for a grade:*

Students have to complete an oral exam.

Person responsible for course*:* Dr. Ákos Péter Molnár, assistant professor, PhD

Lecturer:

Title of course: **Pharmaceutical Biotechnology Lecture** Code: TTBBE3007_BT_EN oral exam	**ECTS Credit points**: 1

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 1 hour/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 14 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 28 hours
Total: 42 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Cell Physiology II. Lecture, Immunology Lecture and Practical, Physiology of Experimental Animals Lecture and Practical

Further courses built on it:

Topics of course:

Students acquire basic knowledge of general and applied pharmaceutical biotechnology, which serves as the basis for the subsequent General and Applied Pharmaceutical Biotechnology and Bioanalytics Lectures and Practice. Furthermore, we want to provide a professional basis and solid foundation for the Pharmaceutical Biotechnology and also Biopharmacy courses of the MSc programs based on Biotechnology BSc training, especially the Biotechnology MSc and Molecular Biology MSc courses. Within the frame of the subject, the student learns about the history of the origin, development and scientific research of pharmaceutical biotechnology and bioanalytics, acquires the basic knowledge of these fields and subjects, especially focusing on their importance in new technologies, and acquires the basic concepts of industrial pharmaceutical biotechnology as well. We aim to cover the following basic knowledge: Biotechnology methods and biotechnology products in therapy, Production of biotechnological drugs I.: fermentation, Production of biotechnological drugs II..: recombinant technology, GMO, Gene technology I. : GH, insulin, enzymes, mABs, cytokines, Gene technology II. : vaccines, antibiotics, Gene technology III. : gene therapy, personalized medication, Gene technology IV. : stem cells, stem cells in therapy, cell banks, Gene technology V. : pharmaco genetics, pharmaco genomics, HGP, ENCODE project, Modern drug delivery systems, nano and biotechnology based therapies, Biotechnology based targeted (cancer) therapies, novel drug delivery systems, monoclonal antibodies in human therapies, Industrial production: documentation, QA, QC, validity, Regulation, biosimilar products, FDA/EMA regulation, Ethics of biotechnology, future directions

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Albert Sasson (2005) Medical Biotechnology, United Nations University Press, New York, USA

Selected Scientific publications

G Halmos: Selected chapters in Pharmaceutical Biotechnology and Bioanalytics, e-learning study notes (Univ.of Debrecen Faculty of Pharmacy)

Schedule:
1st week*:*
Lecture: Modern biotechnology (history, basic concept)
2nd week*:*
Lecture: Biotechnology methods and biotechnology products in therapy
3rd *week:*
Lecture: Production of biotechnological drugs I.: fermentation
4th week:
Lecture: Production of biotechnological drugs II.: recombinant technology, GMO
5th week:
Lecture: Gene technology I.: GH, insulin, enzymes, mABs, cytokines
6th week:
Lecture: Gene technology II.: vaccines, antibiotics
7th week:
Lecture: Gene technology III.: gene therapy, personalized medication
1st self-control test
8th week:
Lecture: Gene technology IV.: stem cells, stem cells in therapy, cell banks
9th week:
Lecture: Gene technology V.: pharmacogenetics, pharmacogenomics, HGP, ENCODE project
10th week:
Lecture: Modern drug delivery systems, nano and biotechnology based therapies
11th week:
Lecture: Biotechnology based targeted (cancer) therapies
12th week:
Lecture: Industrial production: documentation, QA, QC, validity
13th week:
Lecture: Regulation, biosimilar products, FDA/EMA regulation. Ethics of biotechnology, future directions
14th week:
Lecture: 2nd self-control test

Requirements:

At least 30% of the lectures must be visited. Students have to write two self-control tests, in the middle of the semester and at the end of the semester.
Only students having adequately fulfilled the requirements are allowed to get the signature and take the final oral exam.
Without taking the oral exam, students are offered a grade calculated from the average of the two self-control tests passed during the semester (both tests must be above 60 %): 61-70% - pass (2), 71-80% – satisfactory (3), 81-90% – good (4), 91-100% – excellent (5).

Person responsible for course*:* Prof. Dr. Gábor Halmos, head of department, full professor, Vice Dean of the Faculty of Pharmacy, Pharm.D., Ph.D.

Lecturer: Dr. Nikoletta Dobos, assistant professor, PhD, Dr. Zsuzsanna Szabó, assistant professor, PhD, Dr.Barbara Zsebik, assistant professor, PhD, Dr. Eva Sipos, assistant professor, PhD.

Title of course: **Pharmaceutical Biotechnology Practical**
Code: TTBBL3007_BT_EN

ECTS Credit points: 2

Evaluation: practical grade with mid term test

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 28 hours
-home assignment: 28 hours
-preparation for the exam:
Total: 56 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Cell Physiology II. Lecture, Immunology Lecture and Practical, Physiology of Experimental Animals Lecture and Practical

Further courses built on it:

Topics of course:

Students acquire basic knowledge of general and applied pharmaceutical biotechnology and practice, which serves as the basis for the subsequent General and Applied Pharmaceutical Biotechnology and Bioanalytics Lectures and Practice. Furthermore, we want to provide a professional basis and solid foundation for the Pharmaceutical Biotechnology and also Biopharmacy courses of the MSc programs based on Biotechnology BSc training, especially the Biotechnology MSc and Molecular Biology MSc courses. Within the frame of the subject, the student learns about the history of the origin, development and scientific research of pharmaceutical biotechnology and bioanalytics, acquires the basic knowledge of these fields and subjects, especially focusing on their importance in new technologies, and acquires the basic concepts of industrial pharmaceutical biotechnology as well. We aim to cover the following basic practice knowledge: Immunoanalytical methods I.: Southern-blotting, Northern-blotting, Western-blotting, dot-blot, Introduction, laboratory safety instructions, Immunoanalitycal methods II.: RIA, ELISA, IHC, FISH, cell proliferation assay, MTT assay, Protein isolation, Isolation of nucleic acids, types of gel electrophoresis, SCG, DNS-chip, Comet assay, Microarray technics, PCR, RT-PCR: basic principles and practical applications, Western-blot, Synthesis of oligonucleotides and peptides. Sequencing of nucleic acids and proteins,
Basic principles of proteomics, applications in medical and pharmaceutical research, Isolation of nucleic acids, agarose gel electrophoresis, ELISA, Basics and application in the pharmaceutical research and clinical diagnosis, Analytical techniques in clinical diagnosis of selected diseases, laboratory tests, Immunohistochemistry, Therapeutic Drug Monitoring, Toxicology, Instrumental analysis of some selected drugs, RIA, Bioanalysis: the role and importance of bioanalytical experiments in drug research and drug development, Analytical aspects of quality insurance in the pharmaceutical industry,
Environmental rules, prescriptions and applied analytical methods and techniques in the pharmaceutical industry.

Literature:

Mandatory literature:

Departmental teaching aid.

Recommended literature:
Albert Sasson (2005) Medical Biotechnology, United Nations University Press, New York, USA

Selected Scientific publications

G Halmos: Selected chapters in Pharmaceutical Biotechnology and Bioanalytics, e-learning study notes (Univ.of Debrecen Faculty of Pharmacy)

Schedule:
1st week:
Practice: Introduction, laboratory safety instructions
2nd week:
Practice: Introduction to the basic instruments, equipments and workflows of mammalian cell culturing
3rd week:
Practice: Principles of DNA, RNA and protein isolation, RNA isolation using Trizol reagent
4th week:
Practice: Fundamentals of nucleic acid isolation, gel electrophoresis, polymerase chain reaction and their application in bioanalytics and laboratory diagnostics, PCR
5th week:
Practice: Basics of RT-PCR
6th week:
Practice: Western-blotting
7th week:
Practice: Western-blotting
8th week:
Practice: Immunohistochemistry.
1st self-control test
9th week:
Practice: Immunohistochemistry
10th week:
Practice: Basics of rapid tests, point of care assays
11th week:
Practice: Application of rapid tests
12th week:
Practice: FISH
13th week:
Practice: Microarray
14th week:
Practice: Principles and applications of molecular imaging techniques
2nd self-control test

Requirements:
Absence of more than one practice is not allowed during the semester. Students have to write two self-control tests, in the middle of the semester and at the end of the semester.
Only students having adequately fulfilled the requirements of practice are allowed to get the signature and take the oral exam covering the two semesters.

Person responsible for course*:* Prof. Dr. Gábor Halmos, head of department, full professor, Vice Dean of the Faculty of Pharmacy, Pharm.D., Ph.D.

Lecturer: Dr. Nikoletta Dobos, assistant professor, PhD, Dr. Zsuzsanna Szabó, assistant professor, PhD, Dr. Barbara Zsebik, assistant professor, PhD, Dr. Eva Sipos, assistant professor, PhD.

Title of course: **Medical Biotechnology and Cell Culture Lecture** Code: TTBBE3008_BT_EN	**ECTS Credit points**: 1

Evaluation: written exam

Type of teaching, contact hours:
-lecture: 1 hour/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 14 hours
-practice: -
-laboratory: -
-home assignment: -
-preparation for the exam: 28 hours
Total: 42 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Cell Physiology II. Lecture, Immunology Lecture and Practical, Physiology of Experimental Animals Lecture and Practical

Further courses built on it:

Topics of course:

Students acquire basic knowledge of histology and cell culture, as well as the basic measurement techniques of medical laboratories and some of the diagnostic methods. This knowledge lays the professional foundation for the subsequent master's courses, especially the medical biotechnology courses of the MSc Biotechnology and MSc Molecular Biology courses.
Students of the subject learn about basic tissues, the basic tools of cell laboratories, and ways to ensure sterility. They learn the main types of cell and tissue cultures. They learn about stem cells and their importance in medical biotechnology, the types of biomaterials, their areas of use, and 3D printing.
In addition to what has been described, we also pay attention to getting to know the measurement and diagnostic repertoire used in medical laboratories, for which, in addition to the methods of spectrophotometry, osmometry, and dialysis, we also discuss separation techniques. We consider it important to familiarize the students with the types of electrophoresis (immunoelectrophoresis, isoelectric focusing), centrifugation and chromatography. Emphasis is also placed on the possibilities of investigating the interaction of proteins, in the framework of which techniques such as enzyme-linked immunosorbent assay (ELISA), surface plasmon resonance (SPR) and nano differential scanning fluorimetry (nDSF) are presented. Within the basic molecular diagnostic methods, we focus on both traditional procedures and new types of tests. Classified as the former, we present PCR techniques, the importance of using restriction enzymes, FRET methods, Sanger DNA sequencing, and MLPA analysis. New generation DNA sequencing will be introduced among the newly used methods.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
John W Baynes, Marek H Dominiczak (2018): Medical Biochemistry, Saunders Elsevier, eBook
ISBN: 9780702073007

Schedule:
1st week:
Introduction. General cell biology overview. Animal cell, plant cell, fungal cell
2nd week:
Animal cell culture: historical overview. Primary cell cultures and cell lines
3rd week:
Plant cell culture
4th week:
Stem cell biology, stem cell culture
5th week:
Cell differentiation
6th week:
Tissue engineering: principles, applications
7th week:
Methods in a Biomedical Laboratory: work with nucleic acids I.
8th week:
Methods in a Biomedical Laboratory: work with nucleic acids II.
9th week:
Methods in a Biomedical Laboratory: work with proteins I.
10th week:
Methods in a Biomedical Laboratory: work with proteins II.
11th week:
State-of-the-art methods in molecular and cell biology: single-cell multi-omics
12th week:
Cell-based therapies for human disorders. Ethical and legal problems associated with cell therapy and tissue engineering
13th week:
Consultation
14th week:
Student feedback.

Requirements:
Attending the lectures is strongly recommended as the content being delivered constitutes part of the examination. Examination: written exam, multiple choice questions (MCQ). Students who have not passed the regular examination are entitled to participate in two more examinations. If the student is not approved after three examinations, he/she is recommended to retake the course at the next regular course date. The number of times that the student has participated in one and the same examination is regarded as an examination session. Submission of a blank examination is regarded as an examination. An examination for which the student registered but not participated in, will not be regarded as an examination.

Person responsible for course*:* Dr. Csaba Matta, assistant professor, PhD

Lecturer: Dr. Roland Takács, departmental engineer, Dr. Róza Zákány, associate professor, PhD.

Title of course: **Medical Biotechnology and Cell Culture Practical** Code: TTBBL3008_BT_EN	**ECTS Credit points:** 2

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 24 hours
-home assignment: -
-preparation for the exam: –
Total: 24 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Cell Physiology II. Lecture, Immunology Lecture and Practical, Physiology of Experimental Animals Lecture and Practical

Further courses built on it:-

Topics of course:

Students acquire basic knowledge of histology and cell culture, as well as the basic measurement techniques of medical laboratories and some of the diagnostic methods. This knowledge lays the professional foundation for the subsequent master's courses, especially the medical biotechnology courses of the MSc Biotechnology and MSc Molecular Biology courses.
The students of the subject get to know the basic tissues in the framework of 3 x 2 hours of human microscopic histology practice. The cell culture exercises also take place in 3x2 hours, in a small group rotation, where the students learn the basic tools of the cell labs and the methods of ensuring sterility. They learn about stem cells and their importance in medical biotechnology, the types of biomaterials, their areas of use, and 3D printing. The Department of Orthopedics provides an opportunity in 2 hours for a visit to its Biomechanics Laboratory, where students get an insight into the application of medical 3D technologies.
In addition to what has been described, we also pay attention to getting to know the measurement and diagnostic repertoire used in medical laboratories, for which, in addition to the methods of spectrophotometry, osmometry, and dialysis, we also discuss separation techniques. We consider it important to familiarize the students with the types of electrophoresis (immunoelectrophoresis, isoelectric focusing), centrifugation and chromatography. During the exercises, various chromatograms will be analyzed. Emphasis is also placed on the possibilities of investigating the interaction of proteins, in the framework of which techniques such as enzyme-linked immunosorbent assay (ELISA), surface plasmon resonance (SPR) and nano differential scanning fluorimetry (nDSF) are presented.
Within the basic molecular diagnostic methods, we focus on both traditional procedures and new types of tests. Classified as the former, we present PCR techniques, the importance of using restriction enzymes, FRET methods, Sanger DNA sequencing, and MLPA analysis. New generation DNA sequencing will be introduced among the newly used methods.

Literature:

Mandatory literature:

Departmental teaching aid.

Recommended literature:
John W Baynes, Marek H Dominiczak (2018): Medical Biochemistry, Saunders Elsevier, eBook
ISBN: 9780702073007

Schedule:
1st week:

Introduction. General cell biology overview. Animal cell, plant cell, fungal cell. Introduction to cell culture
2nd week:

Cell culture laboratory. Safety, equipment. Aseptic technique. Contaminations
3rd week:

Cell culture basics. Cell lines. Cell culture environment. Maintaining cell cultures. Subculturing, freezing, thawing cells.
4th week:

An example of primary cell cultures: chicken limb bud-derived cultures
5th week:

Cell differentiation. An example of differentiating cultures: chondrifying cell cultures
6th week:

Methods in a Biomedical Laboratory: work with nucleic acids I.

7th week:

Methods in a Biomedical Laboratory: work with nucleic acids II.

8th week:

Methods in a Biomedical Laboratory: work with nucleic acids III.

9th week:

Methods in a Biomedical Laboratory: work with proteins I.

10th week:

Methods in a Biomedical Laboratory: work with proteins II.

11th week:

Methods in a Biomedical Laboratory: work with proteins III.

12th week:
In-class Exam
13th week:
Consultation, student feedback
14th week:
re-sit exam

Requirements:
Attendance in the lab and completion of all lab exercises is mandatory. If a student misses more than two labs, and therefore does not demonstrate sufficient mastery of those technical skills to progress and data collection for reports, they may not receive credit for the course or receive a grade of Incomplete (INC) with subsequent academic outcomes.
The lab participation will be evaluated based on following four grading criteria, each is worth of 5 points:
1. Lab Safety (lab coat, long pants, socks and close-toed shoes, confine long hairs, no food/drinks in the lab).
2. Punctuality and Readiness (late to class, no lab notebook, did not read lab notes).
3. Performance and Professionalism (extra time, not doing right, proper labelling on slides, fail to clean lab benches, accuracy of lab reports, teamwork, cell phones, inappropriate behaviour).

4. Engagement (knowledge of protocols and workflow, proactive contribution, offering ideas, enthusiasm, ask appropriate questions). In-class Examination: A test (20 multiple-choice questions format) will be given at the last (week 12) lab module. The length of the test is 40 min. Students who have not passed the regular examination are entitled to participate in two more examinations. If the student is not approved after three examinations, he/she is recommended to retake the course at the next regular course date. The number of times that the student has participated in one and the same examination is regarded as an examination session. Submission of a blank examination is regarded as an examination. An examination for which the student registered but not participated in, will not be regarded as an examination.
Person responsible for course*:* Dr. Csaba Matta, assistant professor, PhD
Lecturer: Dr. Roland Takács, departmental engineer, Dr. Róza Zákány, associate professor, PhD.

Title of course: **Microbial Pharmaceuticals Lecture** Code: TTBBE3009_BT_EN	**ECTS Credit points**: 2

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 72 hours
Total: 100 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): Microbial Metabolism Seminar and Practical

Further courses built on it:-

Topics of course:

Students will acquire professional basis for the microbiology and microbial biotechnology courses of the subsequent Master's degree programs, especially the MSc in Biotechnology and the MSc in Molecular Biology. The course covers the following Topics: General characterisation of secondary metabolism and microbial secondary metabolites. Activity of polyketide synthases and non-ribosomal peptide synthases. Basics and major problems of industrial production of microbial secondary metabolites: The importance of classical and molecular strain improvement, metabolic engineering, protein engineering, metagenomics, heterologues expression in industrial microbiology. Production of semi-synthetic products by bioconversion. Using molecular breeding techniques to develop new products. Antifungal agents of microbial origin and their production; possibilities for strain improvement. Major groups of antibacterial agents of microbial origin and their production; options for strain improvement. Options for production of fungal alkaloids; production of non-microbial alkaloids by microbes. Production of cholesterol synthesis inhibitors, immunosuppressants, chemotherapeutics using microorganisms.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Alexander N. Glazer and Hiroshi Nikaido (2007) Microbial Biotechnology (Fundamentals of Applied Microbiology) ISBN 978-0-521-84210-5

Schedule:
1st week:
General characterization of secondary metabolism and microbial secondary metabolites. Ecological, and practical significance of secondary metabolites. Secondary metabolite gene clusters. Using molecular breeding techniques to develop new products.
2nd week:
Characterization of polyketide synthases and non-ribosomal peptide synthases. Using protein

engineering to develop new products.
3rd week:
Written test.
4th week:
Basics and major problems of industrial production of microbial secondary metabolites I. Upstream and downstream processes during industrial production of microbial secondary metabolites.
5th week:
Basics and major problems of industrial production of microbial secondary metabolites II. The importance of classical and molecular strain improvement, metabolic engineering, protein engineering, metagenomics, heterologues expression in industrial microbiology.
6th week:
Principals of bioconversion. Production of semi-synthetic products by bioconversion. Bioconversion by living cells and immobilized enzymes. Bioconversion of steroids.
7th week:
Written test.
8th week:
Antifungal agents. Antifungal agents of microbial origin and their production; possibilities for strain improvement.
9th week:
Production of cholesterol synthesis inhibitors, immunosuppressants, chemotherapeutics using microorganisms.
10th week:
Written test.
11th week:
Antibacterial agents. Major groups of antibacterial agents of microbial origin. Production of β-lactams.
12th week:
Non-β-lactam antibiotics, their production and options for strain improvement.
13th week:
Options for production of fungal alkaloids; production of non-microbial alkaloids by microbes.
14th week:
Written test.

Requirements:
- for a signature
Attendance at lectures is recommended, but not compulsory.
- for a grade
The course is evaluated on the basis of four written tests during the end of the semester.

The grade is given according to the following table:

Total Score (%)	**Grade**
0 – 50	fail (1)
51 – 60	pass (2)
61 – 75	satisfactory (3)
76 – 85	good (4)
86 – 100	excellent (5)

The students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course*:* Prof. Dr. István Pócsi, head of department, full professor, candidate of chemical sciences, doctor of the Hungarian Academy of Sciences (biology)

Lecturer:

Title of course: **Microbial Pharmaceuticals Practical** Code: TTBBL3009_BT_EN	**ECTS Credit points**: 2

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 2 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 28 hours
-home assignment: 24 hours
-preparation for the exam:
Total: 52 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): Microbial Metabolism Seminar and Practical

Further courses built on it:-

Topics of course:

Students will acquire professional basis for the microbiology and microbial biotechnology courses of the subsequent Master's degree programs, especially the MSc in Biotechnology and the MSc in Molecular Biology. Students acquire knowledge of the definition, experimental determination and correlation of specific growth rate, specific substrate utilization rate, yield of product and biomass. Based on simple models students will learn how to estimate fermentation time, required amount and ratio of nutrients, amount of product, by-products and biomass formed.

Literature:

Mandatory literature:
Departmental teaching aid

Recommended literature:
Alexander N. Glazer and Hiroshi Nikaido (2007) Microbial Biotechnology
(Fundamentals of Applied Microbiology) ISBN 978-0-521-84210-5

Schedule:
1st-2nd weeks:

Detecting microbes; following microbial growth. Colony forming unit. Determining colony forming unit. Calculations with colony forming units. Solving basic exercises.

3rd-4th weeks:

Characterization of microbial growth. Specific growth rate, generation time and the length of lag phase. Determination of specific growth rate and the length of lag phase. Solving basic exercises.

5th-6th weeks:

Specific substrate utilization rate. Determining specific substrate utilization rates. Estimating the length of fermentation based on specific growth rate and specific substrate utilization rate. Solving basic exercises.

7th-10th weeks:

Biomass yield. Planning synthetic media based on biomass yield. Product yields. Estimation of product yield based on biomass yield, metabolic fluxes and stoichiometry of biochemical equations. Solving basic exercises.

11th-12th weeks:
Practicing for the test
13th week:
Consultation
14th week:
written test

Requirements:
- *for a signature:*
Attendance of classes is compulsory with the possibility of missing at most four classes during the semester. In case of further absences, a medical certificate needs to be presented, otherwise the signature is denied.
- *for a grade:*
The course is evaluated on the basis of a written test at the end of the semester. The grade is given according to the following table:

Total Score (%)	**Grade**
0 – 59	fail (1)
60 – 69	pass (2)
70 – 79	satisfactory (3)
80 – 89	good (4)
90 – 100	excellent (5)

If a student fails to pass at first attempt, then a retake of the test is possible.

Person responsible for course*:* Prof. Dr. István Pócsi, head of department, full professor, candidate of chemical sciences, doctor of the Hungarian Academy of Sciences (biology)

Lecturer:

Title of course: **Agricultural and Food Biotechnology Lecture** Code: TTBBE3010_BT_EN	**ECTS Credit points**: 2

Evaluation: oral exam

Type of teaching, contact hours:
-lecture: 2 hours/week
-practice: -
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: 28 hours
-practice: -
-laboratory -:
-home assignment: -
-preparation for the exam: 62 hours
Total: 90 hours

Year, semester: 3rd year,2nd semester

Its prerequisite(s): Physiology of Experimental Animals Lecture and Practical, Physiology of Model Plants Lecture and Practical

Further courses built on it:-

Topics of course:

Students acquire basic knowledge of general and applied biotechnology that serves as a basis for agricultural and food industry applications. In addition, we want to provide a professional basis for the agricultural and food biotechnology-related courses of the later master's courses, especially the Biotechnology MSc and Molecular Biology MSc courses. In the framework of the course, the student learns about the history of the emergence and development of agricultural and food biotechnology, the specialized areas of green biotechnology and their characteristics.
In the framework of the lectures, the students acquire professional knowledge with which they can apply the latest results and methods of plant molecular biology, plant biotechnology (cell and tissue culture, somatic cell genetics and gene technology) in the cultivation and breeding of plants, as well as the latest basic and applied research knowing and using the results. They will be able to use and change the genetic program of individual agricultural plants for human needs. In the field of animal biotechnology: familiarization with the basic genetic/genomic concepts used in animal breeding, the most frequently used genetic methods in the breeding of certain species of farm animals, introduction to biotechnical/biotechnological methods (artificial insemination and sperm cryopreservation, embryo transfer and cryopreservation, etc.); gamete sex test; molecular animal diagnostics and marker assisted selection (MAS).
During the lectures, they learn about the basic principles of the production of food industry raw materials made with biotechnological processes, the technological implementation and the possibilities of using the products, as well as the biotechnological aspects of food production. The students also get to know the nutritional genetic-genomic directions of innovative food developments, which form the basis of preventive and/or therapeutic nutrition based on the characteristics of individual-specific genomes.

Literature:

Mandatory literature:
George EF, Hall MA, De Klerk GJ. Plant propagation by tissue culture 3rd Edition. Volume 1. The Background. Springer, Dordrecht, The Netherlands. 2008. pp.501. ISBN: 978-1-4020-5004-6

Bidlack, WR, Rodrigez, RL. (2012). Nutritional Genomics. The impact of dietary regulation of gene function on human disease. CRC Press, Taylor & Francis Group, Boca Raton, London, New York, ISBN: 978-1-4398-4452-6.

Recommended literature:

Miyamoto, H. and Manabe, N. (2002): Reproductive Biotechnology, Hokuto Shobo, Kyoto, Japan

Schedule:
1st week: Introduction to the importance, novelty of the course
2nd week: Basics of the terms of animal breeding, mating-selection methods; molecular genetic-genomics
3rd week: Animal genome programs, basics/importance of different technics
4th week: Sampling, design of genetic-genomics studies on domestic animals
5th week: The importance and role of plant biotechnology in the plant breeding and agriculture
6th week: Basics of the cell and tissue culture methods, in vitro micropropagation 7th week
7th week Methods and importance of somatic cell genetics
8th week: Gene technology and genome editing: methods and practical use in plants
9th week: Food industry raw materials made with biotechnological processes
10th week:Food industry final products made with biotechnological processes
11th week: Nutritional genetic-genomic directions of innovative food developments
12th week: The relevance of genetically modified organisms for nutrition
13th week: Basis of preventive and/or therapeutic nutrition
14th week: Challenges of personalized nutrition

Requirements:

- for a signature
Attendance at **lectures** is highly recommended, but not compulsory.

- for a grade
The course ends with oral **examination (**colloquium).

The minimum requirement for the examination respectively is 60%. Six questions are given from each part (animal, plant, food)

Person responsible for course*:* Prof. Dr. Judit Dobránszki, head of centre, scientific advisor, candidate of agricultural sciences, doctor of the Hungarian Academy of Sciences (agriculture)

Lecturer: Prof. Dr. Szilvia Kusza, PhD, full professor, doctor of the Hungarian Academy of Sciences (agriculture); Dr. Endre Máthé, associate professor, PhD

Title of course: **Agricultural and Food Biotechnology Practical** Code: TTBBL3010_BT_EN	**ECTS Credit points**: 3

Evaluation: practical grade

Type of teaching, contact hours:
-lecture: -
-practice: -
-laboratory: 3 hours/week

Workload (estimated), divided into contact hours:
-lecture: -
-practice: -
-laboratory: 42 hours
-home assignment: 28 hours
-preparation for the exam:
Total: 70 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): Physiology of Experimental Animals Lecture and Practical, Physiology of Model Plants Lecture and Practical

Further courses built on it:-

Topics of course:

Students gain practical knowledge and experience on the in vitro propagation and cultivation of plants, and the application of cell, tissue and organ culture techniques for herbaceous and woody plants. They become familiar with pathogen elimination methods and methods of diagnosing variety identity/genetic differences (immune reaction-based, nucleic acid-based diagnostic procedures). They gain knowledge about plant somatic cell genetics and gene technology methods. During the practical course, they learn the basic in vitro and molecular genetic methodologies, which are of great importance in animal breeding research and provide information for producers and breeders. They also acquire basic professional knowledge through which they get to know and master basic food biotechnology methods, and understand nutrition as one of the most significant environmental factors that has a significant impact on the general health of the consumer.

Literature:

Mandatory literature:
George EF, Hall MA, De Klerk GJ. Plant propagation by tissue culture 3rd Edition. Volume 1. The Background. Springer, Dordrecht, The Netherlands. 2008. pp.501. ISBN: 978-1-4020-5004-6

Bidlack, WR, Rodrigez, RL. (2012). Nutritional Genomics. The impact of dietary regulation of gene function on human disease. CRC Press, Taylor & Francis Group, Boca Raton, London, New York, ISBN: 978-1-4398-4452-6.

Recommended literature:

Miyamoto, H. and Manabe, N. (2002): Reproductive Biotechnology, Hokuto Shobo, Kyoto, Japan

Schedule:
1st week: Introduction to the genetics lab
2nd week: Introduction to the sampling procedures, storage conditions etc.
3rd week: DNA isolation methods

4th week: RNA isolation methods
5th week: Plant in vitro laboratory techniques and safety instructions. Presentation of a plant in vitro laboratory, acquaintance with the rules of sterile work. In vitro tissue culture: direct/indirect organogenesis
6th week: Somatic embryogenesis, production of artificial seeds by encapsulation. Automatization in plant tissue culture - plant cloning bioreactors. Elicitation.
7th week: Anther culture, in vitro androgenesis; ploidy determination by flow cytometry. Zygotic embryogeneis, embryo preparation.
8th week: DNA isolation. Genetic or DNA based marker techniques: Random Amplified Polymorphic DNA (RAPD), Simple Sequence Repeats (SSR).
9th week: Test on animal and plant parts
10th week:Nutritional genetic/genomic experimental models, the Drosophila based approach
11th week: Nutritional genetic/genomic experimental models, the Cyprinus larva based approach
12th week: Designing of transciptomic studies for nutritional interventions
13th week: Analysis of nutritional transcriptomic datasets
14th week: Validation of nutritional transcriptomic results

Requirements:
Animal parts of the course

- for a signature
Attendance at practise**s** is compulsory. Test on practical topics to obtain the signature

Plant parts of the course
- for a signature
Participation at practice classes is compulsory. Test on practical topics to obtain the signature

Food parts of the course
- for a signature
Participation at practice classes is compulsory. Test on practical topics to obtain the signature

Person responsible for course*:* Prof. Dr. Judit Dobránszki, head of centre, scientific advisor, candidate of agricultural sciences, doctor of the Hungarian Academy of Sciences (agriculture)

Lecturer: Prof. Dr. Szilvia Kusza, PhD, full professor, doctor of the Hungarian Academy of Sciences (agriculture); Dr. Endre Máthé, associate professor, PhD, Domokosné Dr. Éva Szabolcsy, senior lecturer, PhD, Dr. Zoltán Bagi, research fellow, PhD,

Title of course: **Quality Assurance, Risk Assessment and Safety in Biotechnology Seminar** Code: TTBBG3011_BT_EN	**ECTS Credit points**: 3
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: 3 hours/week -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: - -practice: 42 hours -laboratory: - -home assignment: - -preparation for the exam: Total: 90 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): -	
Further courses built on it:-	
Topics of course:	
Students acquire quality assurance (mainly GMP), risk assessment, risk management skills based on the basics of safety knowledge, which are relevant to the industry and later e.g. companies to be visited or to be identified as examples they help to understand its operation. The acquired knowledge will help to shed light on the industries related to the major trends, actors' behavior, goals, corporate and industry regulations systems operation. In addition, we want to provide a professional basis for the subsequent master's courses, especially the Biotechnology MSc and Molecular Biology MSc, Bioengineering MSc courses of a similar nature.	
Literature:	
Mandatory literature: Departmental teaching aid. Lecture slides.	
Schedule: *1st week*: introduction *2nd-5th week*: FMEA, Risk Assiment (RA) *6th-8 th week*: GMP details and accessories *9th-14th week*: safety detailes and accessories	
Requirements:written exam at the end of the semester and oral reports (3 pieces) at the end of the topics	
Person responsible for course*:* Dr. Dávid Domonkos, head of Biotechnology Institute, PhD	
Lecturer:	

Title of course: **Scientific Method and Analysis Seminar** Code: TTBBG3012_BT_EN written test	**ECTS Credit points**: 1

Evaluation: written test

Type of teaching, contact hours:
-lecture: -
-practice: 1 hour/week
-laboratory: -

Workload (estimated), divided into contact hours:
-lecture: -
-practice: 14 hours
-laboratory: -
-home assignment: 16 hours
-preparation for the exam: -
Total: 30 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:-

Topics of course:

Students acquire general and applied knowledge that helps them understand how science works, the goals of science, and science funding. Students gain insight into the world of scientific publishing, the methods of bibliography and reference management, the use of online databases and repositories, scientometric methods and databases. They get to know the concept of peer review, types of journals, and predatory journals. They learn to use and interpret researcher identifiers, databases (e.g. ORCiD, MTMT), data repositories (e.g. FigShare), modern tools of science communication and research organization.

Literature:

Mandatory literature:
Departmental teaching aid.

Recommended literature:
Jari Saramäki: How to Write a Scientific Paper: An Academic Self-Help Guide for PhD Students. 2018. Independent. ISBN 13: 9781730784163
Svetla Baykoucheva: Managing Scientific Information and Research Data. 2015. Chandos Publishing. ISBN: 978-00810001950

Schedule:
1st week:
The scientific method, history of science and scientific literature.
2nd week:
Scientific publishing, types of publications.
3rd week:
Scientific publishing, navigating the websites of journals.
4th week:
Peer review, preprints.
5th week:

Scientific publishers, types of publishers, problems of the publishing world. Retractions. PubPeer.
6th week:
Scientometrics, impact factors, Google Scholar, ResearchGate.
7th week:
Web of Science, searching the scientific literature. PubMed.
8th week:
Supplementary materials, Dryad, FigShare, GitHub.
9th week:
Predatory journals. Science communication.
10th week:
Scientific misconduct, image manipulations, data forging, paper mills, large language models in science.
11th week:
Open discussions.
12th week:
Presentations by students (home assignment).
13th week:
Presentations by students (home assignment).
14th week:
Presentations by students (home assignment).

Requirements:

- *for a signature*
Attendance of at least 75% of the lectures. Finishing the home assignment.

- *for a grade*
The course ends in a presentation of the home assignment which is graded. For passing the course, at least 60 points out of a maximum 100 is needed for the home assignment and its presentation.

Person responsible for course*:* Dr. Valter Péter Pfliegler, assistant professor, PhD

Lecturer:

Title of course: **Institutional Visit Practical** Code: TTBBG3014_BT_EN	**ECTS Credit points**: 1
Evaluation: practical grade	
Type of teaching, contact hours: -lecture: - -practice: 2 hours/week -laboratory: -	
Workload (estimated), divided into contact hours: -lecture: - -practice: 28 hours -laboratory: - -home assignment: - -preparation for the exam: Total: 28 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): -	
Further courses built on it:-	
Topics of course:	
Students visit the Institutes and Departments of the University of Debrecen participating in the education of the Biotechnology BSc programm, so the students will be informed about the current research activities, which help students' further orientation in the selection of Thesis Topics.	
Literature:	
Smith J.E. Biotechnology, Cambridge University Press, Cambridge, 2004 Renneberg R. Biotechnology for Beginners, Academic Press, Burlington, 2016	
Schedule: Students visit the Institutes, Departments participating in the education of the Biotechnology BSc programme.	
Requirements: *- for a practical grade:* Participation at institutional visits is compulsory.	
Person responsible for course: Dr. Éva Leiter, associate professor, PhD	
Lecturer:	