University of Debrecen
Faculty of Science and Technology
Department of Biochemical Engineering

BIOCHEMICAL ENGINEERING BSC PROGRAM

2019

TABLE OF CONTENTS

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 included 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: state university

Founder of the University of Debrecen: Hungarian State Parliament

Supervisory body of the University of Debrecen: Ministry of Education

Number of Faculties at the University of Debrecen: 14

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

Faculty of Humanities

Faculty of Informatics

Faculty of Law

Faculty of Medicine

Faculty of Music

Faculty of Pharmacy

Faculty of Public Health

Faculty of Science and Technology

Number of students at the University of Debrecen: 26938

Full time teachers of the University of Debrecen: 1542

207 full university professors and 1159 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 3000 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 (10 Bachelor programs and 12 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 student 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 570 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, University Professor
E-mail: ttkdekan@science.unideb.hu

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

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

Consultant on Economic Affairs: Dr. Sándor Alex Nagy, Associate Professor
E-mail: nagy.sandor.alex@science.unideb.hu

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

Quality Assurance Coordinator: Dr. Zsolt Radics, Assistant Professor
E-mail: radics.zsolt@science.unideb.hu

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

Registrar's Office
Registrar: Ms. Ildikó Kerekes
E-mail: kerekes.ildiko@science.unideb.hu

English Program Officer: Mr. Imre Varga
Address: 4032 Egyetem tér 1., Chemistry Building, A/101
E-mail: vargaimre@unideb.hu

DEPARTMENT OF BIOCHEMICAL ENGINEERING

Dear Biochemical Engineer Student!

Welcome in the University of Debrecen, Faculty of Sciences and Technology, in the Biochemical Engineer community. The University of Debrecen, Faculty of Sciences has three technical engineer training including biochemical engineering, which is one of the most popular year by year. The Department of Biochemical Engineering intends to make your years substantial and impart useful scientific knowledge to you during 7 semesters.

There is no specialisation within Biochemical Engineering, you should perform the requirements (210 credits, one intermediate level state language certificate “type C” or an equivalent language certificate, diploma work, external practice) to acquire your degree. In this bulletin, you can find the general information, requirement and the outline of the study programme.

Our Department hopes, you will enjoy this three and a half year. Biochemical Engineering training helps to establish your successful future in the different fields of biotechnology and biology.

The founder and honorary leader of the biochemical engineering/biotechnology school is

Attila Szentirmai, PhD

Emeritus professor

The head of the Department of Biochemical Engineering and leader of the biochemical engineering school is

Levente Karaffa, PhD, habil., DSc

Associate professor

Chemistry Building Room D-8, Tel.: +36 52 512 900 ext. 62488
BioChemEng@science.unideb.hu

The advisor of the biochemical engineering students (BSc) is

Norbert Ág, PhD

Senior lecturer

Chemistry Building Room D-210, .: +36 52 512 900 ext.22730
ag.norbert@science.unideb.hu

Biochemical engineers have wide profession horizons on the field of Biotechnology and Biology, Chemistry, Physics and Mechanical engineering. The objectives of the program: to train Biochemical engineers who are able to apply the advanced technology of process and control engineering, molecular biology, biochemistry, microbiology, mycology and are able to control biotechnological processes in biotechnological industry or pharmaceutical industry as well as in agriculture and environs.

After graduation, first level degree biochemical engineers should:

- be able to operate biological/biotechnological systems safely and environmentally friendly,
- be able to solve the problems on scientific field and commercial tasks, perform projects in the laboratory or semi pilot plant or plant
- be able to learn new methods, perform complex tasks, apply their knowledge

- be able to develop new products or new methods, perform subtasks in the development or planning of a technological system.
- have a knowledge of using computering systems, databases-be able to learn and understand previously unknownsystems, products, processes-understand technical documents in foreign language.

The educations include modules such as Economic and Human Sciences (e.g. Civil law, Macroeconomics); Mathematical and Scientific Foundations (e.g. Mathematics, Biochemistry, General Microbiology and Mycology); Basics of Professional knowledge (e.g. Bioprocess engineering, Molecular biology, Organic chemistry, Process control); Specialized courses in Biology (e.g. Plant biochemistry and molecular biology).

http://biochemeng.unideb.hu/

4032 Debrecen, Egyetem tér 1, Chemistry Building

Name	**Position**	**E-mail**	**room**
Mr. Dr. Levente Karaffa, PhD, habil., DSc	Associate Professor, Head of Department	karaffa.levente@science.unideb.hu	D8
Ms. Dr. Erzsébet Fekete, PhD, habil.	Associate Professor, Deputy Head of Department	kicsizsoka@yahoo.com	D8
Mr. Dr. Zoltán Németh, PhD	Assistant Professor	nemeth.zoltan@science.unideb.hu	D210
Mr. Dr. Ákos Péter Molnár, PhD	Assistant Professor	molnar.akos@science.unideb.hu	D7
Mr. Dr. Norbert Ág, PhD	Assistant Professor	ag.norbert@science.unideb.hu	D210
Zoltán Fekete, BSc	Department Engineer	fekete.zoltan@science.unideb.hu	D207

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:
http://www.edu.unideb.hu/tartalom/downloads/University_Calendars_2019_20/1920_Science.pdf

THE BIOCHEMICAL ENGINEERING BACHELOR PROGRAM

Information about the Program

Name of BSc Program:	Biochemical Engineering BSc Program
Specialization available:	
Field, branch:	technical, engineer
Qualification:	Biochemical Engineer
Mode of attendance:	Full-time
Faculty, Institute, Department:	Faculty of Science and Technology Biotechnology Institute Department of Biochemical Engineering
Program coordinator:	Dr. Levente Karaffa, Associate Professor
Duration:	7 semesters
ECTS Credits:	210

Objectives of the BSc program:

The Biochemical Engineer Bachelor of Sciences program offers a unique combination in a variety of studies which together provide a thorough background in the field of biotechnology. Our aim is to enable students to be competent in all fields of biotechnology by obtaining a deep theoretical knowledge and practical skills (engineering and technological). Students will have their own experience in laboratory and manufacturing practices that a biochemical engineer may encounter in everyday work. Students will get acquainted with the equipment and apparati used in the biotechnological industry and understand their optimal operation. Therefore, graduates can choose from a wide range of carrier opportunities in different areas in biotechnology according to their field of interest and to work either in theoretical or practical areas. They will also have opportunity to work in the field of research and development.

Professional competences to be acquired

A Biochemical Engineer:

a) Knowledge:

- He/she is familiar with the structure, operation and control possibilities of biological systems.
- He/she knows the basic rules of chemical, biochemical and microbiological processes and the methods of testing that are based on them.

- He/she knows modern molecular biological principles, techniques and their interrelations.
- He/she knows the principles, relationships and procedures of general and bio-industrial operations.
- He/she is familiar with the widely understood biotechnology operations, equipment, and their management.
- He/She knows the main products of the biological, biotechnological industry, manufacturing technologies and design principles.
- He/she is familiar with the basic requirements of environmental protection and biological safety requirements of fire and safety related areas of his field.
- He/she knows the basics, boundaries and requirements of quality assurance, information technology, legal, economics and management disciplines that are closely related to the field.
- He/she knows the methods of learning, acquiring and collecting data in the field of biomedical engineering, their ethical limits and problem-solving techniques.
- He/she is familiar with the principles, contexts and environmental principles of environmental protection and environmental technologies.

b) Abilities:

- He/she is capable of safe, environmentally conscious operation of biological, biotechnological and microbiological systems, professional services and commercial tasks.
- He/she is able to carry out biotechnological laboratory, semi-industrial and industrial tasks, to acquire new methods of testing, methods and work safety.
- He/she has the appropriate manual for laboratory practice.
- He/she can apply computational, biometric and modeling methods related to the field, and is able to apply computer skills and databases.
- He/she is able to use and process professional databases and literature.
- He/she is able to perform laboratory or technological sub-processes independently, and is able to identify emerging problems and make decisions for their solution.
- He/she is able to control and monitor broadly interpreted biotechnology production processes with quality assurance and quality control elements in mind.
- He/she is able to perform sub-tasks in the development, design, development of new processes, and products in biological and related sciences.
- He/she is able to carry out complex tasks, to apply knowledge in practice in the chosen field of specialization.
- He/she is capable of solving biotechnology and bio-industrial safety tasks.
- He/she is able to understand technical documentation in at least one foreign language.
- He/she can collaborate and communicate properly with other professionals (engineer, lawyer, IT, manager, etc.).
- He/she is able to get to know and understand new processes, products and systems.

c) Attitude:

- He/she is open to getting to know, accepting and authenticating the professional, technological development and innovation in biotechnology, bio-industry.
- He/she is interested in new knowledge, methods and tools related to the field of biotechnology, biotechnology.
- He/she adheres to the bio-safety rules and labor law rules of work that is particularly important for the biotechnology area.
- He/she will endeavor to solve his/her tasks and to make decisions about the management by understanding the opinions of the supervised employees, preferably in cooperation.

- He/she has the necessary endurance and monotony tolerance to perform practical activities.
- He/she demands and expects quality work from his colleagues.
- He/she is sensitive to the micro and macro environment.

d) Autonomy and responsibility:

- He/she takes responsibility for his decisions and subordinates, manages responsibility and self-direction.
- He/she is characterized by initiative, personal responsibility and decision-making.
- He/she is capable of reconciling personal motivation and teamwork.
- He/she is autonomous in interpreting comprehensive professional issues in the field of biotechnology.
- He/she strives to comply with law-abiding behavior and ethical and bioethical rules.
- He/she demands and supports continuous monitoring of effectiveness and safety.

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 210 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 “Model Curriculum of Biochemical Engineering BSc Program”.

Model Curriculum of Biochemical Engineering BSc Program

COURSE Lecturer	**CODE**	**PREREQUISITE**	**SEMESTER (Lec./Sem.-Prac./Lab.)**							**Evaluation**	**ECTS** **credit points**
			1	2	3	4	5	6	7		
(type of evaluation: **e**: exam, **p**: practice, **t**: term grade, **s**: signature)											
Economic and Human Sciences											**22**
Micro- and Macro-Economic module											**6**
Introduction to Economics Dr. Kapás Judit	TTBEBVVM-KT1_EN	-	200							E	3
Macroeconomics Dr. Czeglédi Pál	TTBEBVM-KT3_EN	Introduction to Economics (TTBEBVVM-KT1_EN)			200					E	3
Management and Business module											**11**
Introduction to Business Dr. Nábrádi András	TTBEBVVM-KT2_EN	-							200	E	3
Quality Management Dr. Kotsis Ágnes	TTBEBVM-KT6_EN	(Management of Value Creating Processes) TTBEBVM-KT4_EN							200	E	3
Management of Value Creating Processes Dr. Pakurár Miklós	TTBEBVM-KT4_EN	-		200						E	2
Marketing Dr. Kiss Marietta	TTBEBVVM-KT5	-					200			E	3
Business Law module											**5**
Basics of Civil Law I. Dr. Fézer Tamás	TTBEBVVM-JA1_EN	-		200						E	2
History and Structure of Europan Union Dr. Teperics Károly	TTTBE0030_EN	-	100							E	1
Basics of Civil Law II. Dr. Fézer Tamás	TTBEBVVM-JA2_EN	Basics of Civil Law I. (TTBEBVVM-JA1_EN)					200			E	2
Mathematical and Scientific Foundations											**46**
Mathematics module											**12**
Mathematics I. Dr. Muzsnay Zoltán	TTMBE0802_EN	-	400							E	5
Mathematics I. Dr. Muzsnay Zoltán	TTMBG0802_EN	-	030							P	2
Mathematics II. Dr. Muzsnay Zoltán	TTMBE0803_EN	Mathematics I. (TTMBE0802_EN)		200						E	3
Mathematics II. Dr. Muzsnay Zoltán	TTMBG0803_EN	Mathematics I. (TTMBE0802_EN)		030						P	2
Physics module											**17**
Introduction to Physics lecture Dr. Szabó István	TTFBE3101	-	200							E	2
Introduction to physics problems class Dr. Szabó István	TTFBG3101	-	010							P	2
General Chemistry I. (lecture) Dr. Kalmár József	TTKBE0101_EN	-	300							E	3
General Chemistry I. (seminar) Dr. Lihi Norbert	TTKBG0101_EN	-	030							P	3
General Chemistry II. (lab) Dr. Lihi Norbert	TTKBL0101_EN	General Chemistry I. (lecture) (TTKBE0101_EN) General Chemistry I. (seminar) (TTKBG0101_EN)		003						P	3
Organic Chemistry I. Dr. Kurtán Tibor	TTKBE0301_EN	General Chemistry I. (TTKBE0101_EN)		210						E	4
BioChemistry module											**5**
Biochemistry I. Dr. Kerékgyártó János	TTBBE2035_EN	General Chemistry I. (TTKBE0101_EN)		200						E	2
Biochemistry I. lab. Dr. Kerékgyártó János	TTBBL2035_EN	General Chemistry I. (TTKBE0101_EN)		002						P	1
Biochemistry II. Dr. Barna Teréz	TTBBE2040_EN	Biochemistry I. (TTBBE2035_EN)			100					E	2
Biology module											**12**
Introduction to Cell Biology Revák Gyuláné	TTBBE3032_EN	-	200							E	3
General Microbiology and Mycology Dr. Pfliegler Valter Péter	TTBBE3030_EN	-		300						E	3
General Microbiology and Mycology (seminar) Dr. Pfliegler Valter Péter	TTBBG3031_EN	-			020					P	1
Bioinformatics Dr. Sipiczki Mátyás	TTBBE2060_EN	Genetics (TTBBE3020_EN)					100			E	3

COURSE Lecturer	**CODE**	**PREREQUISITE**	**SEMESTER (Lec./Sem.-Prac./Lab.)**							**Evaluation**	**ECTS** **credit points**
			1	2	3	4	5	6	7		
(type of evaluation: **e**: exam, **p**: practice, **t**: term grade, **s**: signature)											
Bioinformatics Dr. Sipiczki Mátyás Dr. Csoma Hajnalka	TTBBG2060_EN	Genetics (TTBBE3020_EN)					020			P	2
Basics of Professional knowledge											**99**
Organic Chemistry and Biology module											**26**
Organic Chemistry II. Dr. Kurtán Tibor	TTKBE0302_EN	Organic chemistry I. (TTKBE0301_EN)			210					E	4
Organic Chemistry III. Dr. Juhász László	TTKBE0303_EN	Organic Chemistry II. (TTKBE0302_EN)				200				E	3
Organic Chemistry IV. Dr. Juhászné Dr. Tóth Éva	TTKBL0301-L_EN	General chemistry II. (TTKBL0101_EN) Organic chemistry II. (TTKBE0302_EN)				013				P	3
Microbiology Dr. Pfliegler Valter Péter	TTBBE0506_EN	-			100					E	1
Microbiology practice Dr. Pfliegler Valter Péter	TTBBG0506_EN	General Microbiology and Mycology (TTBBE3030_EN)				002				P	1
Microbial Physiology Dr. Fekete Erzsébet	TTBBE0525_EN	Microbiology (TTBBE0506_EN)		200						E	3
Microbial Physiology practice Dr. Fekete Erzsébet	TTBBL0525_EN	Microbiology (TTBBE0506_EN)			020					P	1
Genetics Dr. Batta Gyula	TTBBE3020_EN	-				300				E	3
Genetics practice Dr. Batta Gyula Dr. Papp László Attila	TTBBG3020_EN	-				020				P	2
Methods in Molecular Biology Gálné Dr. Miklós Ida	TTBBE2042_EN	-			200					E	3
Methods in Molecular Biology Dr. Batta Gyula	TTBBG2042_EN	-			020					P	2
Physical-Chemistry and Materials Science module											**10**
Physical Chemistry (lecture) Győrváriné Dr. Horváth Henrietta	TTKBE0431_EN	General Chemistry I. (lecture) (TTKBE0101_EN) Mathematics I. (TTMBE0802) Mathematics I. (TTMBG0802)				200				E	3
Physical Chemistry (seminar) Győrváriné Dr. Horváth Henrietta	TTKBG0431_EN	General Chemistry I. (lecture) (TTKBE0101_EN) Mathematics I. (TTMBE0802) Mathematics I. (TTMBG0802)				020				P	1
Bio-Physical Chemistry Győrváriné Dr. Horváth Henrietta	TTKBE0419_EN	Physical Chemistry (lec.) (TTKBE0431_EN) Physical Chemistry (sem.) (TTKBG0431_EN)						200		E	3
Colloid and Surface Chemistry Dr. Novák Levente	TTKBE0406_EN	Physical Chemistry (TTKBE0431_EN) Physical Chemistry (TTKBG0431_EN)						200		E	3
Measurement and Control module											**24**
Informatics for Engineers Dr. Kuki Ákos	TTKBG0911_EN	-	020							P	2
Computer Modeling of Chemical Technology Systems I. Dr. Kuki Ákos	TTKBG0912_EN	Informatics for Engineers (TTKBG0911_EN)						020		P	2
Analytical Chemistry I. Dr. Buglyó Péter	TTKBE0501_EN	General Chemistry I. (TTKBE0101_EN) Organic Chemistry I. (TTKBE0301_EN)			200					E	3
Process control I. Dr. Árpád István	TTKBG0612_EN	Informatics for Engineers (TTKBG0911_EN)				210				T	4
Process control II. Dr. Árpád István	TTKBG0613_EN	Process control I. (TTKBG0612_EN)					030			T	3
Mathematics III. Dr. Bérczes Attila	TTMBG0804_EN	Mathematics II. (TTMBE0803_EN)				020				P	3
Analytical Chemistry II. Dr. Kállay Csilla	TTKBL0513_EN	Analytical Chemistry I. (TTKBE0501_EN) General Chemistry II. (TTKBL0101_EN)				003				P	3
Application of Instrumental Analysis (lecture) Dr. Lázár István	TTKBE0512_EN	Analytical Chemistry I. (TTKBE0501_EN)					100			E	1

COURSE Lecturer	CODE	PREREQUISITE	SEMESTER (Lec./Sem.-Prac./Lab.)							Evaluation	ECTS credit points
			1	2	3	4	5	6	7		
(type of evaluation: **e**: exam, **p**: practice, **t**: term grade, **s**: signature)											
Application of Instrumental Analysis (practice) Dr. Kecskeméti Ádám	TTKBL0512_EN	Application of Instrumental Analysis, lecture, (TTKBE0512_EN) Analytical Chemistry II., practice, (TTKBL0513_EN)						003		P	3
Process Engineering module											**27**
Bioprocess Engineering I. Dr. Karaffa Levente	TTBBE0571_EN	-				200				E	3
Bioprocess Engineering II. Dr. Karaffa Levente	TTBBE0572_EN	Bioprocess Engineering I. (TTBBE0571_EN)					200			E	3
Bioprocess Engineering II. practice Dr. Karaffa Levente	TTBBL0572_EN	Bioprocess Engineering I. (TTBBE0571_EN)					003			P	3
Basic Engineering Dr. Tiba Zsolt	MFMIS31K03-EN	-	210							E	3
Unit operations I. Dr. Nagy Miklós	TTKBG0614_EN	Basic Engineering (MFMIS31K03-EN) Organic Chemistry I. (TTKBE0301_EN)			230					E	5
Unit operations II. Dr. Nagy Miklós	TTKBG0615_EN	Unit operations I. (TTKBG0614_EN)						230		T	5
Unit operations III. Dr. Nagy Miklós	TTKBG0616_EN	Unit operations II. (TTKBG0615_EN)							230	E	5
Technology module											**12**
Mechanical engineering Zsigmond Endre, Jákó Anikó	TTBBG0575_EN	-		120						P	3
Safety Dr. Kéki Sándor	TTKBE0711_EN	Basic Engineering (MFMIS31K03-EN)					200			E	3
Environmental Technology Illyésné Dr. Czifrák Katalin	TTKBE1114_EN	General Chemistry II. (lab) (TTKBL0101_EN)						200		E	3
Environmental Technology lab. Illyésné Dr. Czifrák Katalin	TTKBL1114_EN	General Chemistry II. (lab) (TTKBL0101_EN)						002		P	2
Visits to Biotech Companies Dr. Németh Zoltán	TTBBG0550_EN	-			020					P	1
Specialized courses in Biology											**16**
Plant Physiology I. Dr. Máthé Csaba	TTBBE3010_EN	-					200			E	3
Plant Physiology I. lab. Dr. Máthé Csaba	TTBBL3010_EN	-					020			P	2
Plant Physiology II. (seminar) Dr. Surányi Gyula	TTBBE2106_EN	-						020		P	2
Research Techniques in Plant Biology Dr. Mikóné Dr. Hamvas Márta	TTBBE0120_EN	-							110	E	3
Mathematical modelling of biological systems Dr. Pintér Ákos	TTMBE0805_EN	Mathematics III. (TTMBG0804_EN)					220			E	3
Numerical mathematics Dr. Mészáros Fruzsina	TTMBG0806_EN	Mathematics III. (TTMBG0804_EN)						120		P	3
Diploma work	TTBBG1002_EN								P	P	15
Facultative module*											12
Additional requirements											
External practise (industry) Dr. Németh Zoltán	TTBBG0560_EN	-						6 weeks		S	
Introduction course Dr. Karaffa Levente	TTBBG0561_EN	-	010							S	
Physical Education			002	002						S	

*In the Facultative Module any English-speaking course can be chosen from the Faculty of Science and Technology, Faculty of Engineering, Faculty of General Medicine, Faculty of Informatics and Faculty of Agricultural and Food Sciences and Environmental Management.

Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen a student has to complete the online course for work and fire safety. Registration for the course and completion are necessary for graduation. For MSc students the course is only necessary only if 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

The students should spend 6 weeks off the university at a company or research institute related to engineering in the summer between the 6thand the 7thsemester, if they performed Bioprocess Engineering I-II., Organic Chemistry I-III, Physical Chemistry, Microbiology, Unit Operations I and Process Control I.

Physical Education

According to the Rules and Regulations of University of Debrecen a student has to complete Physical Education courses at least in two semesters during his/her Bachelor's training. Our University offers a wide range of facilities to complete them. Further information is available from the Sport Centre of the University, its website: 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 has successfully completed the study and exam requirements as set out in the curriculum, the requirements relating to Physical Education as set out in Section 10 in Rules and Regulations, external practice (mandatory) – with the exception of preparing thesis – and gained the necessary credit points (210). 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 obtained the pre-degree certificate can submit the thesis and take the final exam.

Thesis

Students have to write a diploma work in the 7th semester, if ***Mathematical and Scientific Foundations*** and ***Basics of Professional knowledge*** are fully, 10 credits in ***Specialized courses in Biology***, 5 credits in ***Facultative module*** are performed. The diploma work is the solution of a biochemical engineering task which the student should solve relying on previous studies and secondary literature under the guidance of a tutor in one semester. The student can choose any topic for a diploma work suggested by the faculty or in occasional cases individual topics acknowledged by the head of the department. Only those tasks can be given as diploma work that can be accomplished within the allotted time limit relying on the skills acquired during the years of study. Students must be informed of the diploma topics in the first academic week of the semester the latest. The diploma works are written with the close collaboration of the candidate and the tutor. The students have to submit the diploma work to the department, 10 days before the final exam's first day. The thesis paper is evaluated by an external graduate professional or supervisor who gives a grade or/with a short written comment on it (not necessary). The diploma work receives a grade from the final exam committee.

Final Exam

The defense of diploma work will be graded by the final exam board. In case the diploma work is not accepted student cannot carry on the exam. The final exam is the essential for anyone who wants to get a biochemical engineer BSc diploma. The final exam must be taken in front of the final exam committee.
The requirements of the final exam:

1. absolutorium (performed every aspect of student's educational and examinational requirements)
2. submission of the diploma work
3. evaluated diploma work (at least grade satisfactory)

Subjects (topics) of the final exam:

1. Topics: General Microbiology and Mycology, Microbial Physiology, Genetics, Methods in Molecular Biology
2. Topics: Organic chemistry I-III., Biochemistry I-II.
3. Topics: Bioprocess Engineering I-II., Unit operations I, Process control I.

Parts of the final exam:

1. Oral exam (from topics1-3)
2. Defense of the diploma work (questions must be answered)

Final Exam Board
Board chair and its 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 Exam 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. If the Board qualified the Thesis unsatisfactory a student cannot take the final exam and he has to make a new thesis. A repeated final exam can be take twice on each subject.

Diploma

The diploma is an official document decorated with the coat of arms of Hungary which verifies the successful completion of studies in the Biochemical Engineering 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 Biochemical Engineering 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 State 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 Biochemical Engineering BSc Program

Title of course: Introduction to economics **Code**: TTBEBVVM-KT1_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
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 (or any later fall semester)	
Its prerequisite(s): -	
Further courses built on it: Macroeconomics (TTBEBVM-KT3_EN)	

Topics of course

10 principles of economics, how markets work: demand and supply analysis, the effects of governmental interventions, cost of production, profit-maximizing behaviour of firms, analysis of perfect competition and monopoly

Literature

Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009.
Heyne, Paul – Boettke, Peter – Prychitko, David: The Economic Way of Thinking. Twelfth Edition. Pearson Education International, New Jersey, 2010.

Schedule:

1st week
Introduction: Basic concepts and fundamental questions of economics
SR: Understanding the basic concepts and the economic way of thinking

2nd week
Human needs, scarcity, inputs, trade and its benefits
SR: Knowing the concept of scarcity and how free-will trade makes everyone better off

3rd week
Principles of economics
SR: Understanding the meaning of the 10 main principles

4th week

Production possibilities frontier, opportunity cost
SR: Knowing the role of opportunity cost in the model of PPF curve

5th week
Demand and Supply
SR: Understanding the model of market, able to derive the changes of variables

6th week
Market allocation
SR:Able to characterize the equilibrium and disequilibrium

7th week
Welfare economics
SR: Concept of consumer and producer surplus and Dead Weight Loss

8th week
Application: Governmental interventions
SR: Able to identify the effects of government's interventions on market and the welfare of the society

9th week
Cost of production
SR: The main types of cost and their relationship

10th week
Competitive industry I.
SR: Criteria of perfect competition, and profit-maximization

11th week
Competitive industry II.
SR: Welfare effects and industry in the long run

12th week
Monopoly I.
SR: Criteria of monopoly, and profit-maximization

13th week
Monopoly II.
SR: Understanding the welfare effects of monopoly

14th week
Summary, discussion of questions emerging during the semester.
SR: --

Requirements:
- *for a signature*
There is no requirement for a signature.
- *for a grade*

Assessment is based on a written exam which will be evaluated according to the following grading schedule: 0 -50% – fail (1) 50%+1 point -63% – pass (2) 64% -75% – satisfactory (3) 76% -86% – good (4) 87% -100% – excellent (5)
Person responsible for course: Prof. Dr. Judit Kapás, university professor, PhD
Lecturer: Dr. István Kovács, assistant professor, PhD

Title of course: Macroeconomics **Code**: TTBEBVM-KT3_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
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 (or any later fall semester)	
Its prerequisite(s): TTBEBVVM-KT1_EN	
Further courses built on it: -	

Topics of course

The course is aimed at making students familiar with the basic issues of macroeconomics, and make them able to use those fundamental analytical tools which are needed to think about macroeconomic questions. By the end of the course the students have to be able to use a model of a closed economy in analysing macroeconomic phenomena will have some basic insights about an open economy, too. The topics of the course cover the basic principles of macroeconomics, measuring GDP, inflation, and unemployment, the basics of the financial system, labour market processes, and economic policy.

Literature

Compulsory:
Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009.
Recommended:
Heyne, Paul – Boettke, Peter – Prychitko, David: The Economic Way of Thinking. Twelfth Edition. Pearson Education International, New Jersey, 2010.
Mankiw, Gregory: Macroeconomics. Sixth Edition. Worth Publisher, New York, 2007.

Schedule:

1st week
The fundamental questions of macroeconomics.
LO: The students are aware of the main questions of macroeconomics and some of the connections between them.

2nd week

Aggregates in macroeconomics.
LO: The students understand the meaning of aggregation and the aggregates that are used most often.

3rd week
Measuring income: nominal and real GDP.
LO: The students understand the different approaches to measuring GDP and the relationships between these approaches.

4th week
Measuring the costs of living.
LO: The students understand the steps through which the consumer price index is calculated, and the meaning of that index.

5th week
Money, monetary system, money supply, demand for money, and inflation I
LO: The students know the functions of money and have a birds-eye view of the money creation process.

6th week
Money, monetary system, money supply, demand for money, and inflation II
LO: The students understand the role and structure of the banking sector in the economy, are aware of the basic roles of the central bank, are able to explain some of the social costs, and cause, of inflation.

7th week
The time value of money
LO: The students are aware of the methods of comparing future income flows with different timing.

8th week
Saving, investment, and the financial system.
LO: The students understand the function of savings, and that of the market for loanable funds in the economy. They know the basic types of financial assets such as stocks and bonds.

9th week
Labour market and unemployment.
LO: The students know the main measures to describe the labour market with, the main reasons, and the types of, unemployment.

10th week
Short-run economic fluctuations I.
LO: The students re familiar with the notion of aggregate demand and supply.

11th week
Short-run aggregate fluctuations II.

LO: The students are familiar with the possibilities and limitations of fiscal and monetary policy in countervailing recessions.

12th week
The economy in the long run.
LO: Students are familiar with the factors that determine aggregate income in the long run.

13th week
International economic relations.
LO: Students are familiar with the basic welfare implications of international trade, and the effects of protectionism.

14th week
Summary.
LO: Students have a birds-eye view of the relationships of the topics that will have been discussed.

Requirements:
- for a signature
There is no requirement for a signature.
- for a grade
Assessment is based on a written exam which will be evaluated according to the following grading schedule:
0 -50% – fail (1)
50%+1 point -63% – pass (2)
64% -75% – satisfactory (3)
76% -86% – good (4)
87% -100% – excellent (5)

Person responsible for course: Dr. Pál Czeglédi, associate professor, PhD

Lecturer: Dr. István Kovács, assistant professor, PhD

Title of course: Introduction to Business **Code**: TTBEBVVM-KT2_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 12 hours - preparation for the exam: 50 hours Total: 90 hours	
Year, semester: 4th year, 1st semester	
Its prerequisite(s): -	
Further courses built on it:-	

Topics of course

The course explores the question 'what is a business'; and investigates the business functions of human resource management, marketing, operations management, accounting and finance. Different internal and external elements of a business are introduced, and the context in which a business operates explained. Students will explore the common aims and characteristics of business – investigating what makes them different. Business structures, cultures and functions are identified and the political, social, economic, and technological considerations affecting business are introduced. Students get an insight into the international competition, too.

Literature

Compulsory:
- Nickels, William G. – McHugh, James M. – McHugh, Susan M. (2008): Understanding Business. Eighth edition, McGraw-Hill/Irwin, New York, pp.1-87, 116-147, 180-319, 348-543, ISBN 978-0-07-310597-0

Recommended:
- Ferrell, O. C. – Hirt, Geoffrey (1993): Business – A Changing World. Irwin, Homewood, pp.1-29, 80-471, 502-633, ISBN 0-256-11683-0
- Skinner, Steven J. – Ivancevich, John M. (1992): Business for the 21st Century. Irwin, Homewood, pp.1-121, 188-701, 736-771, ISBN 0-256-09222-2

Schedule:

1st week
Introduction. Managing within the Dynamic Business Environment

2nd week
How Economics Affects Business

3rd week

Competing in Global Markets
4th week
Choosing a Form of Business Ownership
5th week
Management, Leadership and Employee Empowerment
6th week
Adapting Organizations to Today's Markets
7th week
Producing Word-Class Goods and Services
8th week
Motivating Employees and Building Self-Managed Teams
9th week
Human Resource Management: Finding and Keeping the Best Employees
10th week
Marketing: Building Customer Relationships; Developing and Pricing Product and Services
11th week
Distributing Products Quickly and Efficiently Using Effective Propotional Techniques
12th week
Understanding Financial Information and Accounting; Financial Management
13th week
Security Markets: Financing and Investing Opportunities
14th week
Summary

Requirements:

- for a signature

Attendance at **lectures** is compulsory.

Students have to **submit their solutions to two hypotheticals as home work assignments during the semester**.

- for a grade

The course ends in a written **examination**.

The minimum requirement for the written exam is 60%. Based on the score of the exam, 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)

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

Person responsible for course: Prof. Dr. András Nábrádi, university professor, PhD

Lecturer: Prof. Dr. András Nábrádi, university professor, PhD

Title of course: Quality Management **Code**: TTBEBVM-KT6_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 4th year, 1st semester	
Its prerequisite(s): Management of Value Creating Processes (TTBEBVM-KT4_EN)	
Further courses built on it: -	

Topics of course
The series of lectures are based on the topics of Quality Managment. This course introduces the participants into the philosophy, the theories and the basic calculations of quality management. Lectures give opportunity to discuss the topics and to get practice in basics techniques of measuring quality, quality improvement, statistical process control, quality management, international standards of quality.
Literature
Compulsory: - Foster S. Thomas (2017): *Managing Quality: Integrating the Supply Chain.* 6th edition. Pearson Prentice-Hall, New-Jersey, ISBN-13: 978-0133798258 *Recommended:* -Joel E. Ross – Susan Perry (2004): Total Quality Management, Text, Cases and Readings. 3rd Edition, Vanity Books International. -David L. Goetsch - Stanley Davis (2015): Quality Management for Organizational Excellence: Introduction to Total Quality. 8th Edition. Pearson Prentice-Hall, New-Jersey,ISBN-13: 978-0133791853

Schedule:
1st week: Basic issues of quality: quality of products, KANO-model 2nd week: Basic issues of quality: quality of services, SERVQUAL model 3rd week: Product Design – Paired comparison

4th week: Quality theories- Taguchi method (Design of Experiments)

5th week: Tools of quality - 7 basic tools of quality (Ishikawa)

6th week: Statistical Process Control I – Charts for Variables

7th week: Statistical Process Control II – Charts for Attributes

8th week: Process Capability

9th week: Quality management: International Quality standards (ISO, TQM, EFQM model)

10th week: LEAN Manufacturing and Quality

11th week: Six Sigma System

12th week: Product Design – Quality Function Deployment

13th week: Risk Evalutaion: Failure Mode and Effects Analysis

14th week: Practicing Case Studies

Requirements:

- *for a signature*

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

- *for a grade*

The course ends in an **examination**. The grade for 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.

Person responsible for course: Dr. Ágnes Kotsis, assistant professor, PhD

Lecturer: Dr. Ágnes Kotsis, assistant professor, PhD

Title of course: Management of Value Creating Processes **Code**: TTBEBVM-KT4_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 12 - preparation for the exam: 20 hours Total: 90 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): -	
Further courses built on it: Quality Management (TTBEBVM-KT6_EN)	

Topics of course

Introduction to operations management. Strategy. Decision analysis support tools. Quality management. Process capability and statistical process control. Acceptance sampling. Designing products. Designing services. Process design. Capacity and facility planning. Facility location. HR management, Work measurement. Project management.

Literature

Compulsory:

- Russell, R. S. - Taylor, B. W. : Operations Management, 8th Edition, Wiley & Suns, INC., ISBN10 1118808908 ISBN13 9781118808900, 2014
- Heizer, J. - Barry R. - Chuck M.: Operations Management: Sustainability and Supply Chain Management (12th Edition), Pearson, ISBN-13: 978-0134130422, ISBN-10: 0134130421, 2016

Recommended:

- Lee J. Krajewski, L. J. - Malhotra, M. K. - Larry P. Ritzman, L. P.: Operations Management: Processes and Supply Chains, 11th Edition, ISBN-13: 9780133872132, Pearson, 2016

Schedule:

1st week

Introduction. The structure of value creating processes. Production processes. Service processes. The role of the operations manager. The evolution of operations management. Supply chain management. Globalisation. Productivity and competitiveness.

TE: Should know the basic functions and features of the value creating processes. Should understand the process of the evolution of management.

2nd week
Strategy. The steps of strategy formulation: primary task, core competencies, order winners and order qualifiers, positioning the firm, and strategy deployment. Hoshin kanri and balance scorecard as methods of strategy deployment. Operations strategy.

TE: Should know the steps of strategy formulation. Should understand the relationships between strategy deployment and business development.

3rd week
Decision analysis support tools and processes. Optimist and pessimist decision maker. The meaning and usage of coefficient of optimism. Decision making criteria: maximax, maximin, equal likelihood, and Hurwitz.

TE: Should use the decision criteria to mitigate the risk. Should know the difference between pessimistic and optimistic decisions.

4th week
Quality and quality management. The TQM and quality management systems. Quality tools. The focus of quality management: the customer. Quality improvement. Lean six sigma. ISO 9000.

TE: Should know the methods of quality measurement and the techniques of quality improvements. Should be able to conform to the changing demand of the customer.

5th week
Process capability and statistical process control. The role of process control in the quality management. Attribute data and variable data. Construction and usage of process control charts: p, c, x mean and R diagrams. Tolerances and process capability.

TE: Should know how to control production and service processes using process control charts. Should understand the importance of preventing production and service processes from defects.

6th week
Acceptance sampling as decision support analysis. Single-sample attribute plan. The risk of producer and consumer. The operating characteristic curve. Average outgoing quality. Double- and multiple-sampling plans.

TE: Should know the risk of product acceptance and the techniques of sample taking as well as should be able to deduce the features of the base population from the analysis of the samples.

7th week
Product design. The product design process, idea generation, feasibility study, form design, functional design, reliability, maintainability, usability, and production design. Design for environment, and design for robustness.

TE: Should know the steps and interrelations of the product design. Should understand the importance of product development to adapt to the continuously changing demand of customers.

8th week
Service design. The service economy. The service design process. Tools for service design. Waiting line analysis for service improvement. Operating characteristics of the queueing system, traditional cost relationships in waiting line analysis. Psychology of waiting, queuing models.

TE: Should know the characteristics of services and the tools for service design. Should able to understand the effect of waiting lines on the service provider and can improve the queueing system.

9th week

Process design and technology. Outsourcing, process selection wit break even analysis. Process analysis, using process flowcharts, process development. Technology decisions: financial justification and technology primer.

TE: Should know the steps of process design. Should know how to select the best production or service process using adequate methods. Should understand the interrelations between the importance of process plan, process selection and business competitiveness.

10th week

Capacity and facilities planning. The basics of facility layouts. Basic layouts: process layouts, product layouts, and fix position layouts. Planning of process layouts, service layouts, product layouts, and hybrid layouts.

TE: Should know the main types of facility layouts and the means of their designs. Should understand the relationship between the facility layout and the capacity utilization.

11th week

Facility location decision support tools. The types of facilities. Site selection. The factors of the global supply chain. Location analysis techniques: location factor rating, center-of-gravity technique, and load-distance technique.

TE: Should know the types of facilities, the factors that influence facility locations and the techniques of facility locations. Should understand the relationship between geographic location of facilities and efficient operation of facilities.

12th week

Human resources in the operations management. HR and quality management. The changing nature of HR management. Contemporary trends in HR management. Management of diversities in HR. Job design, job analysis and the learning curve.

TE: Should know the characteristics of modern HR management and the methods of work design and work analysis. Should understand the role of human resources as the primary resource in business operations.

13th week

Work measurement decision analysis support Tools. Time studies: stopwatch study, normal time, number of cycles, elemental time files, and predetermined motion times. Work sampling.

TE: Should know the traditional work measurement methods, stopwatch study and work sampling. Should understand that the traditional methods are needed presently mainly in services.

14th week

Project management. The elements of a project plan. Global differences in project management. The control of projects: time, cost, performance, and communication. Project planning with Gannt chart and CPM/PERT. Microsoft Project. Project crashing, time-cost analysis.

TE: Should know the characteristics of projects, the procedure of project planning and the methods (Gannt diagram, CPM/PERT, Microsoft Project). Can control the project implementation. Should understand the importance of project management in the areas of production, services and researches.
Requirements: - *For a signature* Attendance at lectures is recommended, but not compulsory. -*For a grade* The course ends in an examination in the exam period. The minimum requirement for the examination is 60%. The grade for 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) -*An offered grade:* It may be offered to students if they solves problems at lectures and attend lectures on a regular basis (do not miss more than 1/3 of the lectures). The grade is the average of the papers filed in the semester, the grade is in accordance with the table above.
Person responsible for course: Dr. Miklós Pakurár, associate professor, PhD
Lecturer: Dr. Miklós Pakurár, associate professor, PhD

Title of course: Marketing **Code**: TTBEBVVM-KT5	**ECTS Credit points:** 3

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 40 hours

Total: 70 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Marketing: creating customer value and engagement. Company and marketing strategy: partnering to build customer engagement, values, and relationships. Analyzing the marketing environment. Managing marketing information to gain customer insights. Consumer markets and buyer behavior. Business markets and business buyer behavior. Customer-driven marketing strategy: creating value for target customers. Products, services, and brands: building customer value. New-product development and product life-cycle strategies. Pricing: understanding and capturing customer value. Pricing strategies: additional considerations. Marketing channels: delivering customer value. Retailing and wholesaling. Communicating customer value: integrated marketing communications strategy.

Literature

Compulsory:
KOTLER, P.—ARMSTRONG, G. (2018): Principles of Marketing plus Pearson MyLab Marketing with Pearson eText: Global Edition, 17/E, Pearson, ISBN-10: 1292220287, ISBN-13: 9781292220284
Recommended:
KOTLER, P.—KELLER, K. L. (2016): Marketing Management. Global edition, 15th edition, Pearson/Prentice Hall, Boston, ISBN-10: 1292092629, ISBN-13: 9781292092621

Schedule:

1st week: Marketing: creating customer value and engagement. Definition marketing, marketing process, and basic concepts of marketing (needs, wants, demand, market, exchange, and customer value). Introduction to the marketing management orientations.

2nd week: Company and marketing strategy: partnering to build customer engagement, values, and relationships. Introduction to the marketing planning process, including basic concepts such as segmentation, targeting, positioning, and integrated marketing mix, based on the companywide strategic planning process.

3rd week: Analyzing the marketing environment. Two levels of the marketing environment: microenvironment (the company, suppliers, marketing intermediaries, competitors, publics, customers) and macroenvironment (demographic, economic, natural, technological, political and social, cultural environments).

4th week: Managing marketing information to gain customer insights. Introduction to the marketing information system and its parts (internal databases, marketing intelligence, and marketing research). Steps of the marketing research process.

5th week: Consumer markets and buyer behavior. Introduction to the Model of Consumer Behavior and the characteristics of its parts.

6th week: Business markets and business buyer behavior. Distinguishing between business markets and consumer markets. Introduction to the Model of Business Buyer Behavior and its parts.

7th week: Customer-driven marketing strategy: creating value for target customers. The three parts of the value creating marketing strategy (segmentation, targeting and positioning).

8th week: Products, services, and brands: building customer value. Definition and classification of products. Basic product decisions (attributes, branding, packaging, labeling, and support services).

9th week: New-product development and product life-cycle strategies. Steps and characteristics of the new product development process. Phases of the product life cycle and strategies in each phase.

10th week: Pricing: understanding and capturing customer value. Definition of pricing. Basic pricing strategies: value-base, cost-based, and competition-based pricing.

11th week: Pricing strategies: additional considerations. Introduction to additional considerations affecting pricing decisions. Special pricing strategies: new-product pricing, product mix pricing, price adjustments, and price changes.

12th week: Marketing channels: delivering customer value. Definition of the supply chain and the marketing intermediaries. Distinguishing among types of distribution systems. Channel design decisions and marketing logistics.

13th week: Retailing and wholesaling. Distinguishing between wholesaling and retailing activities. Identifying and characterizing different types of wholesalers and retailers.

14th week: Communicating customer value: integrated marketing communications strategy. Elements of the promotion mix: advertising, sales promotions, personal selling, public relations, direct marketing. The communication process. Steps in developing effective marketing communication.

Requirements:

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

- for a grade

The students have to complete a written exam.
Person responsible for course: Dr. Marietta Kiss, assistant professor, PhD
Lecturer: Dr. Marietta Kiss, assistant professor, PhD

Title of course: Basics of Civil Law I **Code**: TTBEBVVM-JA1_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 12 hours - preparation for the exam: 20 hours Total: 60 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): -	
Further courses built on it: Basics of Civil Law II. (TTBEBVVM-JA2_EN)	

Topics of course
The course introduces students to the basic principles of civil law in order to provide up to date knowledge on the most important institutions of private law to engineers. During the course, the following topics of civil law are discussed: - law of natural persons (legal capacity, capacity to act); - personality rights and their protection; - company laws in the EU (formation, structure); - consumer protection laws in the EU; - general rules on contracts and obligations; - proprietary rights.
Literature
Compulsory: - Trstenjak, V. – Weingeri, P. (2016): The Influence of Human Rights and Basic Rights in Private Law, Springer, ISBN 978-3319253350 - Twigg-Flesner, C. (2010): The Cambridge Companion to European Union Private Law, Cambridge University Press, ISBN 978-0521736152 - Sauter, W. – Schepel, H. (2009): State and Market in European Union Law: The Public and Private Spheres of the Internal Market Before the EU Courts, Cambridge University Press, ISBN 978-0521674478

Schedule:

1st week

Distinction between private and public laws.

2nd week

General principles of civil law: good faith, fault-based liability
3rd week
Law of natural persons: legal capacity and capacity to act
4th week
Law of legal entities (company law) I.: Formation
5th week
Law of legal entities (company law) I.: Structure
6th week
Personality rights and privacy laws
7th week
Consumer rights in the EU
8th week
Distance selling, e-commerce laws
9th week
Contract formation
10th week
Breach of the contract
11th week
Remedies to a breach scenario
12th week
Calculation of damages
13th week
Rights to property
14th week
Summary

Requirements:
- for a signature
Attendance at **lectures** is compulsory.
Students have to **submit their solutions to two hypotheticals as home work assignments during the semester**.

- for a grade
The course ends in a written **examination**.
The minimum requirement for the written exam is 60%. Based on the score of the exam, 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)

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

Person responsible for course: Dr. Tamás Fézer, associate professor, PhD

Lecturer: Dr. Tamás Fézer, associate professor, PhD

Title of course: History and Structure of the EU **Code**: TTTBE0030_EN	**ECTS Credit points: 1**
Type of teaching, contact hours - lecture: 1 hour/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 54 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 give an overall picture for the students of the history of the development of the Community and the operation of its institutional system. It also aims at introducing the students to the enlargement process and the most important cooperation areas. On the level of EU policies, the issues of agriculture, regional policy, Economic and Monetary Union and the Schengen Area are discussed. The primary goal is that the future diploma holders have realistic knowledge about the functioning of the European Union, and of the international background of the Hungarian EU membership.
Literature
Bergmann, Julian – Niemann, Arne (2013): Theories of European Integration and their Contribution to the Study of European Foreign Policy, *Paper prepared for the 8th Pan-European Conference on International Relations, Warsaw 2013. p22.* Ott, Andrea – Vos, Ellen (eds.) (2009): Fifty Years of European Integration: Foundations and Perspectives. T.M.C. Asser Press, Springer. 480pp. ISBN: 978-90-6704-254-3 Official website: https://europa.eu/european-union/about-eu_en

Schedule:

1st week

History of the Integration. Integration theories, stages of integration around the world. Specific features of the European integration process before the Second World War. Impacts of the Second World War on the history of the cooperation. Predecessors, impacts of the European Coal and Steel Community (ECSC) on the foundation of the European Economic Community. Steps towards the European Union.

2nd week

Process of the enlargement of the organisation. Preconditions of the enrolment 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.

3rd 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. Brexit.

4th 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.

5th 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.

6th 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 regional policy.

7th 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.

8th week

Judicial co-operation in the Community. Legal order in the European Union. Role of the primary EU legislation in the European Community. European Community justice. Institutions serving the needs of judicial co-operation.

9th week

History of co-operations in home affairs. Schengen Convention. Regulations related to crossing state borders. Border checks. Checks between state borders, migration policy.

10th 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.

11th week

EU Budget: revenue side. Components of the EU budget and recent changes in the proportions. History of the EU budget. Budget revenues: duties, value-added tax (VAT), gross national product (GNP) sources.

12th week

Expenditures: agricultural policy, structural funds, external aid, research and development, pre-accession assistances, administrative expenditures. Economic characteristics. Budget procedure.

13th week **Migration and the European Union.** Theoretical background to the migration crisis in 2015and its practical consequences. History of the migration routes and movements. Natural and social (political) causes contributing to the crisis situation. *14th week* **Common vision for the European co-operation.** Possible development paths in the future of the European Union. Federal Europe or Europe of Nations? Reform options. Problem-solving attempts. Brexit.
Requirements: - *for a signature* Attendance at **lectures** is recommended, but not compulsory. - *for a grade* The course ends in a **written examination**.
Person responsible for course: Dr. Károly Teperics, associate professor, PhD
Lecturer: Dr. Klára Czimre, assistant professor, PhD

Title of course: Basics of Civil Law II **Code**: TTBEBVVM-JA2_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 12 hours - preparation for the exam: 20 hours Total: 60 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): Basics of Civil Law I. (TTBEBVVM-JA1_EN)	
Further courses built on it: -	

Topics of course

The course introduces students to intellectual property laws and their protection in a European and international level. The rules of international sales law, dispute settlement mechanisms and transportation are also discussed in order to grant better understanding on the legal background of technological inventions and commercial activities related to them..

Literature

Compulsory:

- Pila, J. – Wadlow, C. (2015): The Unitary EU Patent System, Hart Publishing, ISBN 978-1849466196
- Stamatoudi, I. – Torremans, P. (2014): EU Copyright Law, Edard Elgar, ISBN 978-1781952429
- Sauter, W. – Schepel, H. (2009): State and Market in European Union Law: The Public and Private Spheres of the Internal Market Before the EU Courts, Cambridge University Press, ISBN 978-0521674478

Schedule:

1st week

The nature of IP laws in Europe.

2nd week

Copyright law in the EU I.

3rd week

Copyright law in the EU II.

4th week

Patent rights.

5th week
Patent restrictions and commercial chains.
6th week
Trademark protection.
7th week
Contractual relations to IP law.
8th week
Insurance Laws.
9th week
Dispute settlement mechanisms.
10th week
International commercial arbitration.
11th week
International Sales Law I.
12th week
International Sales Law II.
13th week
Transportation laws.
14th week
Summary

Requirements:
- for a signature
Attendance at **lectures** is compulsory.
Students have to **submit their solutions to two hypotheticals as home work assignments during the semester**.

- for a grade
The course ends in a written **examination**.
The minimum requirement for the written exam is 60%. Based on the score of the exam, 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)

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

Person responsible for course: Dr. Tamás Fézer, associate professor, PhD

Lecturer: Dr. Tamás Fézer, associate professor, PhD

Title of course: Mathematics I. **Code**: TTMBE0802_EN	**ECTS Credit points: 5**

Type of teaching, contact hours

- lecture: 4 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 56 hours
- practice: -
- laboratory: -
- home assignment: 44 hours
- preparation for the exam: 50 hours

Total: 150 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:

- Mathematics II. (TTMBE0803_EN)
- Mathematics II. (TTMBG0803_EN)

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 improprius 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

Compulsory: -
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 rule. Applications.

14th week

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

Requirements:

Only students who have the grade from the practical part can take part of the exam. The exam is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)

87-100	excellent (5)
Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD	
Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD	

Title of course: Mathematics I. **Code**: TTMBG0802_EN	**ECTS Credit points: 2**

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 42 hours
- laboratory: -
- home assignment: 18 hours
- preparation for the exam:

Total: 60 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 improprius 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

Compulsory: -
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

Test.

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 rule. Applications.

14th week

Test.

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. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence.

- for a grade

During the semester one test is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)

85-100 excellent (5)
Students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD
Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics II. **Code**: TTMBE0803_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

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

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 22 hours
- preparation for the exam: 40 hours

Total: 90 hours

Year, semester: 1st year, 2st semester

Its prerequisite(s): Mathematics I. (TTMBE0802_EN)

Further courses built on it: Mathematics III. (TTMBG0804_EN)

Topics of course

Functions of several variables. Limit value, continuity, differentiation. Total derivative, partial derivatives, directional derivative. Partial Differential Equations. Multiple Integral. Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence. Line, surface and volume integrals. Stokes', Green's and Gauss' theorems. Probability. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events. Random variables. Discrete and continuous random variables. Probability distribution, density function. Expected value, standard deviation. Elements of statistics.

Literature

Compulsory: -
Recommended:
Thomas, Weir & Hass: Thomas' Calculus,
P. Sahoo: Probability and Mathematical Statistics
E. Mendelson: Schaum's 3000 Solved Problems in Calculus,

Schedule:

1st week

Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values.

2nd week

Limit and continuity of multivariable functions.

3rd week

Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse funciton theorem. The implicit function theorem.

4th week

Directional derivative. Gradient and its application. Extreme values of real functions of several variables.

5th week

Multiple integral. Calculation of multiple integral, successive integration. Integration in normal domains.

6th week

Partial differential equations and systems of differential equations. Basic definitions and examples. Some elementary examples and problems.

7th week

Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence.

8th week

Line integral. Basic properties. Applications.

9th week

Surface integral. Volume integrial. Basic properties. Stokes', Green's and Gauss' theorems.

10th week

Element of the probability theory. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events.

11th week

Concept of random variables. Probability distribution. Discrete probability variables. Some special discrete probability distributions: Bernoulli distribution, Binomial distribution, Geometric distribution, Binomial, Hypergeometric, and Poisson distribution. Continuous probability distributions, density function. Some special continuous distribution: uniform, normal, and exponential distributions.

12th week

Expected value of random variables, Variance of random variables. Examples. Markov and Chebychev inequality, the law of large numbers.

13th week

Two Random Variables. Bivariate discrete and continuous random variables. Covariance of bivariate random variables. Correlation and independence.

14th week

Element of statistics.

Requirements:

Only students who have the grade from the practical part can take part of the exam. The exam is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD

Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics II. **Code**: TTMBG0803_EN	**ECTS Credit points: 2**
Type of teaching, contact hours - lecture: - - practice: 3 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 42 hours - laboratory: - - home assignment: 18 hours - preparation for the exam: Total: 60 hours	
Year, semester: 1st year, 2st semester	
Its prerequisite(s): Mathematics I. (TTMBE0802_EN)	
Further courses built on it: -	

Topics of course

Functions of several variables. Limit value, continuity, differentiation. Total derivative, partial derivatives, directional derivative. Partial Differential Equations. Multiple Integral. Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence. Line, surface and volume integrals. Stokes', Green's and Gauss' theorems. Probability. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events. Random variables. Discrete and continuous random variables. Probability distribution, density function. Expected value, standard deviation. Elements of statistics.

Literature

Compulsory: -
Recommended:
Thomas, Weir & Hass: Thomas' Calculus,
P. Sahoo: Probability and Mathematical Statistics
E. Mendelson: Schaum's 3000 Solved Problems in Calculus,

Schedule:
1st week
Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values.
2nd week
Limit and continuity of multivariable functions.
3rd week
Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse funciton theorem. The implicit function theorem.
4th week
Directional derivative. Gradient and its application. Extreme values of real functions of several variables.
5th week

Multiple integral. Calculation of multiple integral, successive integration. Integration in normal domains.
6th week
Partial differential equations and systems of differential equations. Basic definitions and examples. Some elementary examples and problems.
7th week
Test.
Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence.
8th week
Line integral. Basic properties. Applications.
9th week
Surface integral. Volume integrial. Basic properties. Stokes', Green's and Gauss' theorems.
10th week
Element of the probability theory. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events.
11th week
Concept of random variables. Probability distribution. Discrete probability variables. Some special discrete probability distributions: Bernoulli distribution, Binomial distribution, Geometric distribution, Binomial, Hyper-geometric, and Poisson distribution. Continuous probability distributions, density function. Some special continuous distribution: uniform, normal, and exponential distributions.
12th week
Expected value of random variables, Variance of random variables. Examples. Markov and Chebychev inequality, the law of large numbers.
13th week
Two Random Variables. Bivariate discrete and continuous random variables. Covariance of bivariate random variables. Correlation and independence.
14th week
Test. Element of statistics.

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. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence.

- for a grade

During the semester one test is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

Students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD

Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: General Chemistry I. (lecture) **Code**: TTKBE0101_EN	**ECTS Credit points:** 3

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 42 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 48 hours

Total: 90 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it:
- General Chemistry II. (lab) (TTKBL0101_EN)
- Organic Chemistry I. (TTKBE0301_EN)
- Biochemistry I. (TTBBE2035_EN)
- Biochemistry I. lab. (TTBBL2035_EN)
- Physical Chemistry (lecture) (TTKBE0431_EN)
- Physical Chemistry (seminar) (TTKBG0431_EN)
- Analytical Chemistry I. (TTKBE0501_EN)

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

Compulsory:
- 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

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 dissocation.

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.

- 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)

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

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

Lecturer: Dr. József Kalmár, assistant professor, PhD

Title of course: General Chemistry I. (seminar) **Code**: TTKBG0101_EN	**ECTS Credit points:** 3

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 42 hours
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 20 hours

Total: 90 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: General Chemistry II. (lab) (TTKBL0101_EN)

Topics of course

The main objective of the seminar is to give the basic knowledge and background for students to solve general calculation problems strictly connected to the general chemistry laboratory practice: calculations connected to mass and volume measurements, concentration and its units, crystallization, acid-base and redox equilibria, balancing chemical equations.

Literature

Compulsory:
- The collection of calculation problems will be available at the Department's home page (inorg.unideb.hu)

Recommended:
- Darrell Ebbing, Steven D. Gammon: General Chemistry 10th edition
- Darrell Ebbing, Steven D. Gammon: General Chemistry – Standalone book

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

4th 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.

5th 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.

6th week

Review exercises in stoichiometry and concentration calculations.

7th week

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

8th week

Theory of redox reactions. Balancing of redox reactions. Calculations based on redox reactions. Preparation of salts from its metal. Review exercises in balancing of redox and acid-base reactions.

9th week

Definition of pH. Theoretical background of pH calculation. Introduction to water ionisation constants. Relationship between the Kw and H+. Calculation of pH of strong acids and strong bases.

10th 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.

11th 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 1-5 and 7-11, 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 score from the general tests must be above 50 % to avoid a 'fail' final course grade. In order to pass the seminar, a student should collect minimum 50 points from the general tests. Students with 'fail' final course grade due to low test results can re-take once a comprehensive test exam in the examination period.

It is not allowed to miss any seminars. If a student misses two 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.

Person responsible for course: Dr. Norbert Lihi, assistant research fellow, PhD

Lecturer: Dr. Norbert Lihi, assistant research fellow, PhD

Title of course: General Chemistry II. (laboratory practice) **Code**: TTKBL0101_EN	**ECTS Credit points:** 3

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 42 hours
- home assignment: 32 hours
- preparation for the exam: 16 hours

Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s):
- General Chemistry I. (lecture) (TTKBE0101_EN)
- General Chemistry I. (seminar) (TTKBG0101_EN)

Further courses built on it:
- Organic Chemistry IV. (TTKBL0301-L_EN)
- Analytical Chemistry II. (TTKBL0513_EN)
- Environmental Technology (TTKBE1114_EN)
- Environmental Technology lab. (TTKBL1114_EN)

Topics of course

The objective of the laboratory practice is to introduce firs-year students of different background to laboratory work, 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 to familiarize themselves with chemical laboratory work.

Literature

Compulsory:
- General chemistry laboratory practice (laboratory manual)

Recommended:
- Darrell Ebbing, Steven D. Gammon: General Chemistry 10th edition
- Darrell Ebbing, Steven D. Gammon: General Chemistry – Standalone book

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: Dr. Norbert Lihi, assistant research fellow, PhD
Lecturer: Dr. Norbert Lihi, assistant research fellow, PhD

Title of course: Organic Chemistry I. **Code**: TTKBE0301_EN	**ECTS Credit points:** 4

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

Evaluation: exam

Workload (estimated)
- lecture: 28 hours
- practice: 14 hours
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 50 hours

Total: 120 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry I. (TTKBE0101_EN)

Further courses built on it:
- Organic Chemistry II. (TTKBE0302_EN)
- Analytical chemistry I. (TTKBE0501_EN)
- Unit Operations I. (TTKBG0614_EN)

Topics of course

- Review the basic of organic chemistry basics
- Types and theories of chemical bonds
- Review the acid-base theories
- Basic concepts of isomerism and stereochemistry.
- Classification of organic chemical reactions.
- Functional groups and the basics of organic nomenclature.
- The structure, nomenclature, synthesis and reactions of alkanes, alkenes, alkenes, alkynes, mono- and polycyclic, homo- and heteroaromatic hydrocarbons.

Literature

Compulsory:
1. Course material, concept and task collection for lectures, seminars in the e-learning system.

Recommended:
2. John McMurry: Organic Chemistry (8th Edition), ISBN-10: 0840054440 ISBN-13: 9780840054449, 2012, Brooks/Cole
3. Jonathan Clayden, Nick Greeves, and Stuart Warren: Organic Chemistry (Second Edition), ISBN: 978-0-19-927029-3; 2012, Oxford University Press
4. Francis A. Carey: Organic Chemistry (4th Edition), ISBN 0-07-290501-8; 2000, The McGraw-Hill Companies, Inc.
5. Leroy G. Wade: Organic Chemistry (8th Edition), ISBN-10: 0321768140; 2012, Pearson
6. T. W. Graham Solomons, Craig Fryhle, Organic Chemistry (10th Edition), ISBN-10: 0470556595; 2009, Wiley & Sons
7. Herbert Meislich, Estelle Meislich, Jacob Sharefkin - 3000 Solved Problem in Organic Chemistry (1994)

Schedule:

1st week
The definition and brief history of organic chemistry. Overview of the basic general chemical concepts needed for this subject. A brief summary of the theories of the chemical bond: the shared electron pair model, the valence bond model. Covalent and ionic bonds. The basics of LCAO-MO theories, types of atomic and molecular orbitals. Bi- and polycentric molecular orbitals, delocalization.

2nd week
VB theory, resonance structures and rules of their writing. Hybridization. Electron shift phenomena, inductive and mesomeric effects, conjugation and hyperconjugation. Secondary bonds, intermolecular interactions, hydrogen bond, dipole−dipole, dipole-induced dipole interactions.

3rd week
Description of functional groups in organic compounds. An overview of the most important organic compound groups based on their functional groups. The effect of functional groups on the electron structure of compounds.

4th week
The basic nomenclatutre systems in organic chemistry: common or trivial names and systematic nomenculture. Basic rules to generate systematic names of organic compounds; substitutive and functional class nomenclature. The rules to generate the names the groups derived from hydrocarbons. The rules to generate the name of unbranched and branched (saturated and unsaturated) hydrocarbons. Elemental reactions. Definitions of transition state, intermediates, Gibbs energy, kinetical and termodinamical parameters of chemical reactions.

5th week
Multi-step reactions (consecutive reactions), intermediates. Hammond postulate. Parallel (competitive) reactions. Thermodynamic and kinetic control. Reactivity and selectivity. Reagents and reactive intermediates. Classification of organic chemical reactions based on attack agent and type of the reaction. Brönsted and Lewis acid-base theory, "hard" and "soft" acids and bases.

6th week
Basics of stereochemistry: characterization of constitutional, conformational and configuration isomers. Chirality, types of chiral molecules. The concept of enantiomers and diastereomers, general comparison of their chemical and physical properties. Absolute and relative configuration. Optical activity. The representation of organic molecules. The absolute configuration of chiral compounds, Fischer and Cahn-Ingold-Prelog convention. The role of chirality in drug chemistry.

7th week
Characterization of the structures of alkanes and cycloalkanes. Review their conformational and physical properties. Chemical properties of alkanes, radical substitution, chain reaction. Statistical and regioselective halogenation and interpretation based on radical stability in alkane halogenation.

8th week
Sulphonation, sulphochlorination, nitration and oxidation of alkanes. The basic petrochemical processes (pyrolysis, cracking, isomerization) and their industrial significance. The most important natural sources and the synthetic methods of alkanes.

9th week
The characterization of the structure a of alkenes, cycloalkenes, di- and polyenes. The hindered rotation: characterization of E / Z isomers. Synthesis of alkenes, cycloalkenes. Physical and chemical properties of alkenes and cycloalkenes. Electrophilic and radical addition reactions and practical significance. Interpretation of the regioselectivity of the addition reactions; the Markovnikov rule.

10th week
Types of polymerization. Substitution in allylic position, interpretation of the stability of allylic intermediates. Oxidation of alkenes. Addition of conjugated dienes, partial and complete

addition. 1,2 and 1,4 addition and its interpretation based on kinetic and thermodynamic control. Diels-Alder cycloaddition.

11th week

Characterization of the structure of alkynes and their physical properties. The stability and synthesis of alkynes. Chemical transformations of alkynes: C-H acidity, addition reactions and their significance. The role of acetylene in the chemical industry, coal-based chemical industry.

12th week

The concept and the interpretation of aromaticity. Neutral and charged homo and heteroaromatic systems. The type and mechanism of the most important aromatic electrophilic substitution reactions (halogenation, nitration, sulphonation, Friedel-Crafts acylation and alkylation).

13th week

The S_{EAr} reactions of substituted benzene derivatives –the reactivity and regioselectivity. Classification of substituents and interpretation of their effect on reactivity and regioselectivity.

14th week

Electrophilic substitution reactions of five- and six-membered heteroaromatic base compounds. Addition reactions of monocyclic aromatic hydrocarbons. Reactions of aromatic hydrocarbons containing alkyl substituents, the stability of benzyl-type reactive intermediates. Most important representatives of polycyclic aromatic hydrocarbons.

Requirements:

- for a signature

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

Attendance at seminars is compulsory. A student may not miss the seminar more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed, and the student must repeat the course.

- for a grade

The course ends in an **examination**.

The exam grade is the result of the written exam.

The minimum requirement for the examination respectively is 50%. The grade for the written exam 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)

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

Person responsible for course:. Dr. László Juhász, associate professor, PhD

Lecturer: Éva Juhászné Dr. Tóth, assistant professor, PhD
Dr. Krisztina Kónya, assistant professor, PhD

Title of course: Biochemistry I. **Code**: TTBBE2035_EN	**ECTS Credit points:** 2

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

Evaluation: exam

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

Total: 60 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry I. (TTKBE0101_EN)

Further courses built on it: Biochemistry II. (TTBBE2040_EN)

Topics of course

Molecular design of life. Protein structure and function. Oxigen-transporting proteins: Myoglobin and Hemoglobin. Carbohydrates. Glycoconjugates. Glycobiology. Introduction to biological membranes. Enzymes. Metabolism: basic concepts and design. Glycolysis. Gluconeogenesis. Cori cycle. Citric acid cycle. Oxidative phosphorylation. The pentose phosphate pathway. Glycogen metabolism. The coordinated control of synthesis and breakdown. Fatty acid metabolism. Oxidation of fatty acids and unsaturated fatty acids. Synthesis of ketone bodies. Biosynthesis of fatty acids. Digestion of proteins. Amino acid degradation. The urea cycle. The link between the urea and the citric acid cycle. The fates of the carbon skeletons of amino acids.

Literature

Compulsory:
- Lubert Stryer, Biochemistry, W. H. Freeman and Company, New York, 2002, ISBN 1-7167-4684-0.

Recommended:
- Glycoscience-Chemistry and Chemical Biology, (Eds: B. Fraser-Reid, K. Tatsua, J. Thiem) 2001, Springer-Verlag, Berlin
- Essentials of glycobiology (Eds: A.Varki, R. Cummings, J. Esko, H. Freeze, G. Hart, J. Marth, 1999, Cold Spring Harbor, New York, ISBN 0-87969-559-5)

Schedule:

1st week: Introduction to Biochemistry. Molecular design of life. Amino acids. Peptides. Primary, secondary, tertiary, quaternary structures.

2nd week: Determination of peptide structures. Protein structure and function. Oxigen-transporting proteins: Myoglobin and Hemoglobin.

3rd week: Carbohydrates. Biological role of carbohydrates. Monosaccharides, disaccharides. polysaccharides. Glycoconjugates. Glycobiology.

4th week: Introduction to biological membranes. Lipids. Classification and functions of lipids. Neutral fats, oils and waxes. The major classes of membrane lipids. Membrane models.

5th week: Enzymes. Classification. Coenzymes. Mechanism of enzyme action. Control of enzyme activity.

6th week: The kinetic properties of enzymes. The Michaelis-Menten model. Graphic evaluation of the kinetic parameters. Inhibition of enzyme activity. Diagnostic importance of enzymes.

7th week: Metabolism: basic concepts and design. Purine and pyrimidine bases, nucleosides and nucleotides. cAMP, ATP. Nucleotide coenzymes. Metabolism of carbohydrates. Glycolysis. The fate of pyruvate. Entry of fructose and galactose into glycolysis.

8th week: Gluconeogenesis. Cori cycle. The pentose phosphate pathway.

9th week: Citric acid cycle. Pyruvate dehydrogenase complex. The citric acid cycle is a source of biosynthetic precursors. Control of the citric acid cycle.

10th week: Oxidative phosphorylation. The four enzyme complexes of the respiratory chain. Synthesis of ATP. The ATP yield of the complete oxidation of glucose.

11th week: Glycogen metabolism. Glycogen degradation and synthesis. The coordinated control of synthesis and breakdown.

12th week: Fatty acid metabolism. Oxidation of fatty acids and unsaturated fatty acids. Energetics of fatty acid oxidation. Synthesis of ketone bodies.

13th week: Biosynthesis of fatty acids. The elongation cycle. Biosynthesis of cholesterol.

14th week: Digestion of proteins. Amino acid degradation. Transamination and oxidative deamination. The urea cycle. The link between the urea and the citric acid cycle. The fates of the carbon skeletons of amino acids.

Requirements:

- for a signature

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

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

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

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 designing tasks 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 them.

Person responsible for course: Dr. János Kerékgyártó, senior research fellow, PhD

Lecturer: Dr. János Kerékgyártó, senior research fellow, PhD

Title of course: Biochemistry I. lab. **Code**: TTBBL2035_EN	**ECTS Credit points:** 1

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

Evaluation: mid-semester grade

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

Total: 30 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): General Chemistry I. (TTKBE0101_EN)

Further courses built on it: -

Topics of course

The students will acquire the basics of organic chemistry and will get acquainted with the structure and properties of biological macromolecules and their building blocks.

Literature

Compulsory:
- Switzer, R. and Garrity L.: Experimental biochemistry. Theory and exercises in fundamental methods, Third edition **;** W.H. Freeman and Company New park; (1999**)** ISBN: 0-7167-3300-5 (EAN: 9780716733003)

Recommended:
- F. A. Carey (2000): Organic Chemistry, McGraw-Hill (2000), 2016. ISBN 0-07-290501-8
- P. Gergely (2014): Organic and bioorganic chemistry for medical students, Debrecen University Press, ISBN 9789633181478

Schedule:

1st week

Laboratory techniques and safety instructions.

2nd week

Amino acids, peptides, proteins seminar. Amino acids. The structure and the classification of amino acids. Stereochemistry. Chemical reactions of amino acids. Peptides and proteins. Primary, secondary, tertiary, quaternary structures. Test reactions.

3rd week

Amino acids, peptides, proteins practice. Chemical tests of proteins and amino acids: Biuret test, Xanthoproteic test, Millon’s test. Thin-layer chromatography of amino acids.

4th week

Amino acids, peptides, proteins practice. Chemical tests of proteins and amino acids: ninhydrin test, sulfur test, heavy-metal ions test. Protein coagulation tests: effect of heat, alcohol, nitric acid.

5th week

Purification of proteins practice. Dialysis, gel-filtration chromatography. Quantitative determination of proteins by means of photometry.

6th week

Carbohydrates seminar. Carbohydrates. Monosaccharides, aldoses, ketoses, pentoses, hexoses. Stereochemistry of carbohydrates. Ring structure of monosaccharides. Conformation of pyranose and furanose rings.
7th week
Carbohydrates practice. Characterization reactions of carbohydrates: Molisch test, Bial's test, Seliwanoff's test. Thin-layer chromatography of carbohydrates.
8th week
Carbohydrates seminar. Disaccharides, reducing and nonreducing disaccharides. Polysaccharides.
9th week
Carbohydrates practice. Investigation of reducing and nonreducing disaccharides and starch. Fehling's test, hydrolysis test.
10th week
Vitamines seminar. Biological and chemical properties of water and fat soluble vitamines. The structure and reducing properties of vitamine C.
11th week
Vitamines practice. Quantitative determination of vitamin C content of juices and plant samples.
12th week
Nucleotides, Nucleic acids seminar. Structures of nucleotides, nucleic acids.
13th week
Nucleotides, Nucleic acids practice. Experiments with RNA. Hydrolysis of yeast RNA. Test reactions for building units of RNA. Quantitative determination of phosphorus content by means of photometry.
14th week
Semester closing papers

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
0-49	fail (1)
50-60	pass (2)
61-74	satisfactory (3)
75-87	good (4)
88-100	excellent (5)

Person responsible for the course: Dr. János Kerékgyártó, senior research fellow, PhD

Lecturer: Dr. János Kerékgyártó, senior research fellow, PhD

Title of course: Biochemistry II. **Code**: TTBBE2040_EN	**ECTS Credit points:** 2

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 14 hours
- practice: -
- laboratory: -
- home assignment:
- preparation for the exam: 16 hours

Total: 30 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Biochemistry I (TTBBE2035_EN)

Further courses built on it: -

Topics of course

The lectures describe the main features of protein structure, deal with the thermodynamic and kinetic background of enzyme catalyzed reactions, give an insight into the different strategies of controlling the enzyme activities. Nucleotide metabolism is also covered in details: *de novo* biosynthetic and salvage pathways, the formation of deoxyribonucleotides as well as the routes of the nucleotide degradation.

Literature

Compulsory: The lecture notes
Recommended:
Berg J.M., Tymoczky J.L., Gatto G.J. and Styer L.: Biochemistry (W. H. Freeman; Eighth edition, 2015), ISBN-13: 978-1464126109
Nelson D.L., Cox M.M.: Lehninger Principles of Biochemistry (W. H. Freeman Sixth edition, 2012) ISBN-13: 978-14234146
Voet D. and Voet J.: Biochemistry (Wiley, Fourth edition, 2010) ISBN-13: 978-0470570951

Schedule:

1st week

Structural feature of amino acids. Characteristics of peptide bonds, rotation angles of C(α), Ramachandran plot; Protein secondary structures; Forces and interactions in polypeptide chains; Supersecondary structures and protein domains.

2nd week

Structural classification of proteins. Fibrous proteins: α-keratin, fibroin and the structure of collagen fibrils. Anfinsen's experiment and Levinthal's paradox. Protein folding and chaperons. Protein misfolding.

3rd week

Thermodynamics of enzyme catalyzed reactions. Models explaining substrate specificities. Characteristics of enzyme catalyzed reactions. Enzyme classifications. Factors influencing enzyme activity: temperature and pH.

4th week

Kinetic model of enzyme catalyzed reaction by Michaelis and Menten. The rate equation and the interpretation of the kinetic parameters. The efficiency of the enzymatic catalyses. Linearization of the Michaelis–Menten equation.

5th week

Reversible inhibition of enzyme activity in a competitive, uncompetitive and noncompetitive manner. Inactivation of enzyme activity - mechanism of penicillin action.

6th week

The Modifying protein function. Allosteric regulation. The models of cooperativity, characteristics of allosteric regulation.

7th week

Reversible covalent modification. The phosphorylation. The regulation of muscle and liver glycogen phosphorylases. Modifying protein function by small regulatory protein (calmodulin).

8th week

Limited proteolysis - zymogen activation. Pancreatic zymogens, the proteolytic cascade. The structural features of chymotripsin active site and the catalytic steps of serine proteases. Protein protease inhibitors.

9th week

Nucleotide Metabolism. The building blocks, the structures and the nomenclature of nucleotides. The biological function of nucleotides. The source of the nucleotide pool.

10th week

Pyrimidin *de novo* biosynthesis

The origin of the atoms of the pyrimidine rings. The formation of carbamoyl phosphate, the features of carbamoyl phosphate synthethase II (domain function and metabolic channel) and its regulation in eukaryotes.

11th week

The function and localisation of CAD and UMP synthase, the multienzyme comlex in mammals. The regulatory points of prokaryotic and eukaryotic pyrimidin *de novo* biosynthesis. The interconversion of nucleoside mono- di- and triphosphates. The synthesis of CTP.

12th week

Purin *de novo* biosynthesis. Origin of the ring atoms in purin. The regulation of the committed step of purin *de novo* biosynthesis. The features and the role of tetrahydrofolate in nucleotide biosynthesis. The branch point of purin *de novo* synthesis and the allosteric control to balance of AMP and GMP synthesis.

13th week

Salvage pathway of purin and pyrimidine biosynthesis. Deoxyribonucleotides biosynthesis: the structure, the mechanism and the regulation of ribonucleotide reductase.

14th week

Biosynthesis of thymidylate, the role of dihydrofolate reductase. Degradation of purin nucleotides, urate and gout. Degradation of pyrimidine nucleotides.

Requirements:

- for a signature

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

- for a grade

The course ends in an **examination**.

The grade for 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 examination is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

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

Lecturer: Dr. Terez Barna, assistant professor, PhD

Title of course: Introduction to Cell Biology **Code**: TTBBE3032_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

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

Evaluation: exam

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

Concept of the cell. Comparison of procaryote and eucaryote cell. The endosymbiosis theory. Comparison animal and plant cell. Biogenic elements. Biogenic and abiogenic component in living organism. Water and its biological importance. Osmosis and diffusion. Colloid systems. Biological importance of lipids. Carbohídrates and its biological importance. Amino acids. Structure and function of proteins. Nucleotides. DNA and RNA. Mutaion. Metabolism in cell. Enzymes. Basical concepts of molecular genetics.
Structures and functions of the cellorganells. Cell cycle and cell division. Bacterias and fungies.

Literature

Sedava, D., Hillis, D. M., Heller, H. C., Berenbaum, M. R. (2012): Life. The Science of Biology. Sinauer Associates, Sunderland, USA
Ville, C. A., Martin, C. E., Berg, L, R., Davis P. W. (2008): Biology. Saunders College Publishing, Philadelphia

Schedule:

1st week:. Concept of cell. Concept and comparison of pro- and eucariotic cells. Endosymbiosis theory. Comparison of animal and plant cells. Biogenic elements. Inorganic compounds in cell. Importance of water in living organism. Properties of water.

2nd week: Osmosis and diffusion. Physical explanation of diffusion. Process , types and influental factors of diffusion. Diffusion in organism. The semi-permeable membrane. Osmosis. Concept of dinamic equilibrium in osmosis. Proportionality between osmotic concentration and osmotic pressure. Osmosis in organism. Hemolysis, plasmolysis. Dispers systems. Colloid systems.

3rd week: Carbohydrates. Classification on base chemical property. Chemical detection on base reducing capacity. Classification on base hydrolysable**.** Monosaccharides. Monosaccharides on base number of C atoms. Pentoses. Hexoses. Glucose. Other hexoses. Carbohydrate derivatives. Disaccharides. Oligosaccharides. Polysaccharides. Storage polysaccaharides. Structural polysaccaharides.

4th week: Lipids. Groups of lipids.Triglicerids. Importance of triglicerids in organic systems. Phospholipids. Carotenoids. Steroid.

5th week: Proteines. Amino acids. Peptides creation from amino acids. Classifycation of proteins on base hydrolisable. Structure of proteines. Simple proteines and complex proteids. Coagulation and denaturation of proteines. Biological functions of proteines.

6th week: Nucleotides. Energy store nucleotides. Electron and hydrogen carrier nucleotids. Carrier nucleotids. Nucleotids in nucleic acids.

7th week: Definition of the cell. Structure of the cell. Cytoplasm. Structure and types of biological membranes. Cell membrane. Nuclear mambrane. Endoplasmic- and Golgi mambranes, lysosomes, mitocondria and chloroplast. Membrane transports. Nucleus, centriole. Vacuole. Cell wall.

8th week: Metabolism in cell. Assimilation and dissimalitation. Difference of pro- and eukaryotic cell metabolism. Enzymes and rybosime.

9th week: Assimilation. Photosyntese in cell. Mitchell'chemiosmotic theory. Dissimilation. Aerob and anaerob dissimilation. Biological oxidation and fermentation.

10th week: Matter of inheritance. Theory of central dogme. Genotype, gene, allel, phenotype, genom. Gene operation and its regulation. Lactose-operon theory. Exons and introns. Protein syntheses. DNA syntheses. Transcription, translation.. Transzláció. Genetic code.

11th week: Mutation and its types. Mutagenes. Mutation at level of genom. Mutation rate. Importance of mutation in living organism.

12th week: Nucleosome. Chromosomes. Cell cycle. Cell division. Mitosys and meiosys.

13th week: Procaryotic cell. Structure and function of bacteria cell. Importance of bacterias for industry, agricultur and environment.

14th week: General structure, function and taxonomy of fungies. Importance of fungies for genetical research, industry, agricultur and environment.

Requirements:

- for a signature

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

- for a grade

The students have to complete an oral exam.

Person responsible for course: Revakné Dr. Markóczi Ibolya, associate professor, PhD

Lecturer: Revakné Dr. Markóczi Ibolya, associate professor, PhD

Title of course: General Microbiology and Mycology **Code**: TTBBE3030_EN	**ECTS Credit points:** 3

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 42 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 48 hours

Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it: Microbiology practice (TTBBG0506_EN)

Topics of course

The history of microbiology. The domain of Bacteria. The domains Archaea and Eukarya. Microbial taxonomy. The phyla of Archaea. The phyla of Bacteria: Deinococcus-Thermus, Chroroflexi, Chlorobi, Cyanobacteria, Chlamydiae, Spirochetes, Bacteroidetes, Proteobacteria, Firmicutes and Actinobacteria. Basics of virology, virus types. Plant, animal viruses and bacteriophages. Prions and plasmids. Eukaryote diversity. Taxonomy of true fungi and fungal-like organisms. Phyla of true fungi. Symbiosis: microbes as symbionts. Pathogenic microbes. Virulence factors. Antibacterial drugs. Medical protozoology. Basics of mycology. Fungal life cycles. The most important species of biotechnologically or medically important fungal species. Secondary metabolites of fungi. Plant parasitic fungi. Fungi as symbiontic organisms. Sporulation and spore dispersion. Medical mycology.

Literature

Compulsory:
Handout slides of the course.
Recommended:
Willey, J., Sherwood, L., Woolverton, C. J.: Prescott's Microbiology, 9th Edition, McGraw-Hill Education, 2014
Cavalier-Smith, T.: Megaphylogeny, cell body plans, adaptive zones: causes and timing of eukaryote basal radiations. J. Eukaryot. Microbiol. 56, 26-33, 2009
Adl, S.M. et al.: The revised classification of eukaryotes. J. Eukaryot. Microbiol. 59, 429-514, 2012

Schedule:
1st week Introduction. The history of microbiology. Main methods and termini of microbiology. The microbiome of the planet Earth and its roles in the history of life. General features of microbes.

2nd week The growth curve of microbes. Environmental conditions and their effects on microbes. The characteristic features of Bacteria. The size, morphology and subcellular anatomy of prokaryotes. The bacterial cell wall. Antibiotics.

3rd week Primary nutritional groups of organisms. Bacterial locomotion. Endospores. The charcteristic features of Archaea. Archaeal cell walls and membranes. Eukaryotic cell organelles. Eukaryotic locomotion. Mitosis and meiosis, eukaryotic life cycles and spores.

4th week Microbial taxonomy. The evolution of the three domains. Bacterial tree of life. Archaeal phyla. Methanogenic archaea.

5th week Symbiosis and parasitism in the domain Bacteria. Virulence of bacteria and immune activity against pathogens. Microbiome. Deinococci and Gram-negative prokaryotes. Introduction for the phyla Cloroflexi, Chlorobi, Cyanobacteria, Chlamydiae, Spirochaetes and Bacteroidetes

6th week Proteobacteria. Alpha-, Beta-, Gamma-, Delta- and Epsilonproteobacteria and their most important species.

7th week Gram-positive bacteria with low G+C content. The phylum Firmicutes. Tenericutes. Mollicutes, Clostridia, Bacilli. The importance of biofilms. The human microbiome. High G+C Gram-positive bacteria. Phylum Actinobacteria, Actinomycetales, Actinomycineae, Micrococcineae, Corynebacterineae, Micromonosporineae, Propionibacterineae, Streptomycineae, Streptosporangineae, Frankineae. Bifidobacteriales. Immunisation against microbes.

8th week Viruses: thier characteristic features, morphology. DNA and RNA virus taxonomic groups. Bacteriophages. Plant viruses, viroids. Animal and human viruses.

9th week Plasmids of bacteria and yeasts. Prions. The taxa of Eukaryota. Medically important "protozoa".

10th week General mycology. The subject of mycology, the life cycles and anatomy of fungi. Taxonomy of fungi. The hypha and the fungal organelles.

11th week Fungal like organisms, slime moulds, Chytrids, Cryptomycota, Blastocladiomycota and "Zygomycota". Glomerulomycota and endomycorrhizae. Important species and genera.

12th week The sac fungi. The Ascomycota classes. Ascus and ascoma types. Conidia and conidiomas, conidiogenesis. Taphrinomycotina, Saccharomycotina, Pezizomycotina (Pezizomycetes, Sordariomycetes, Leotiomycetes, Eurotiomycetes, Dothideomycetes and Orbiliomycetes classes). Yeast as a polyphyletic group. Dimorphic growth. Ascomyota from industrial and medical perspectives. The most important species of the phylum.

13th week The Basidiomycota. Basidiospore formation, basidiocarps. Pucciniomycotina, Ustilaginomycotina and Agaricomycotina (Tremellomycetes and Agaricomycetes). Human mycoses and their treatments.

14th week Fungi in ecosystems. The fungal spores and their dispersion. Symbiosis between bacteria/fungi and plants and animals. Lichens. Plant pathogenic microbes. Nutrition of fungi. Mycoparasitism.

15th week Consultation

Requirements:

- *for a signature*

Attendance of the **9 of 15 lectures (60%)** is compulsory.

- *for a grade*

The course ends in a **written examination**.

The minimum requirement for examination is 60%. The grade for 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)

-an offered grade:

it may be offered for students if they take an optional written exam before the first week of the exam period.

Person responsible for course: Dr. Valter Péter Pfliegler, assistant professor, PhD

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

Title of course: General Microbiology and Mycology practice **Code**: TTBBG3031_EN	**ECTS Credit points:** 1

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

Evaluation: mid-semester grade

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

Total: 30 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Standard laboratory work with microbes: determining colony forming unit numbers, composition of growth media, preparation of media, molarity, concentrations. Fermentation types and pathways, microbial respiration, microbial metabolism during fermentation, carbon and nitrogen source. Biomass, biomass composition, growth of microbial cultures. Calculation on the example of ethanolic fermentation. Biomass yields, ethanol yields. Growth rates. Exoenzymes in Bacteria and Fungi, biotechnological application of microbial enzymes, cellular transport of molecules, catabolism and oxidation of organic compounds in microbes, chemolithotrophic pathways, methanogenesis, prokaryotic photosynthesis, carbon fixation and anabolic processes in microbes, nitrogen fixation, bacterial and fungal cell wall synthesis, secondary metabolites and antibiotics.

Literature

Compulsory:
Handout slides of the course.

Schedule:

1st week Introduction. Main methods and termini of microbiology. Exoenzymes in Bacteria, Fungi.

2nd week The growth curve of microbes. Environmental conditions and their effects on microbes.

3rd week Catabolism and oxidation of organic compounds in microbes. Media in microbiological laboratory work. Calculating molarity, concentrations for media. Determining colony forming unit numbers.

4th week Cellular transport of molecules in microbes (cell wall, membrane and nuclear transport). Chemolithotrophic pathways in microbes, methanogenesis by microbes.

5th Prokaryotic photosynthesis in different phyla.

6th Carbon fixation pathways, and anabolic processes in microbes. Nitrogen fixation, assimilative sulfate reduction by bacteria.

7th week Fermentation types and pathways, the importance of fermentations, example species. Microbial metabolism during fermentation. Carbon and nitrogen source.

8th week Catabolism and oxidation of organic compounds in microbes, methyltrophic fungi and their importance. Biomass, biomass composition calculations.

9th week Calculations on the example of ethanolic fermentation.

10th week Biomass yields, ethanol yields.

11th week Bacterial and fungal cell wall synthesis.

12th week Secondary metabolite production. Antibiotics: production and importance.

13th week Microbial genomics in basic and applied research.

14th week Test.

15th week Retake tests.

Requirements:

- for a signature

Attendance of the 80% of **lectures (12 practices)** is compulsory.

- for a grade

The course has an end-term test.

The minimum requirement for the score of the test is 60%. The grade for the test 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.

Person responsible for course: Dr. Valter Péter Pfliegler, assistant professor, PhD

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

Title of course: Bioinformatics **Code**: TTBBE2060_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

- lecture: 1 hour/week
- seminar: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 14 hours
- seminar:
- laboratory: -
- home assignment: -
- preparation for the exam: 76 hours

Total: 90 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Genetics (TTBBE3020_EN)

Further courses built on it: -

Topics of course

Introduction to bioinformatics. Scopus, Web of Science, Pubmed, Agricola. Introduction to sequence search. Sequence databases. Pairwise and multiple sequence alignments. Computational phylogenetics.

Literature

Recommended:
Choudhuri, S.: Bioinformatics for beginners. Academic Press, San Diego, 2014

Schedule:

1st week
Introduction to bioinformatics

2nd week
Introduction to mining literature

3rd week
Scopus, Web of Science

4th week
Pubmed, Agricola

5th week
Introduction to sequence search. Sequence databases

6th week
Pairwise sequence alignment I. Dynamic programmes

7th week
Pairwise sequence alignment II. Word programming, FASTA

8th week
Pairwise sequence alignment III. Word programming, BLAST

9th week

Pairwise sequence alignment IV. Dot plots

10th week

Substitution matrices

11th week

Multiple sequence alignment. CLUSTAL

12th week

Computational phylogenetics I. Distance-based methods. UPGMA

13th week

Computational phylogenetics II Character-based methods. Maximum parsimony

14th week

End-of-semester consultation

Requirements:
Attendance at lectures is recommended, but not compulsory.

During the semester, there are two tests: in the 6th week and in the 10th week. Students have to sit for the tests but the results of the tests are not taken into consideration at the end-of-semester examination.

Examination (lectures):

The end-of-semester examination is based on the lectures, no additional reading is required. The students answer questions is the standard assay form. No time limit is set for writing the answers. Each answer is evaluated individually using the standard five-grade system. The final examination grade is the average of the individual grades. If necessary, students can also be examined orally.

Person responsible for course: Prof. Dr. Matyas Sipiczi, professor emeritus, DSc

Lecturer: Prof. Dr. Matyas Sipiczi, professor emeritus, DSc

Title of course: Bioinformatics **Code**: TTBBG2060_EN	**ECTS Credit points:** 2

Type of teaching, contact hours

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 28 hours in blocks
- laboratory: -
- home assignment: -
- preparation for the exam: 32

Total: 60 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Genetics (TTBBE3020_EN)

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

Compulsory:-
Recommended:-

Schedule:

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
0-9	fail (1)
10-11	pass (2)
12-13	satisfactory (3)
14-15	good (4)
16-17	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: Dr. Hajnalka Csoma, assistant professor, PhD

Title of course: Organic chemistry II. **Code**: TTKBE0302_EN	**ECTS Credit points:** 4

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 14 hours
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 50 hours

Total: 120 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Organic chemistry I. (TTKBE0301_EN)

Further courses built on it: Organic Chemistry III. (TTKBE0303_EN), Organic Chemistry IV. (TTKBL0301-L_EN)

Topics of course

Systematical overview the structure, physical, chemical properties of hydrocarbons possessing heteroatoms as halogenated hydrocarbons, organometallic derivatives, alcohols, phenols, ethers and their thio analogues; amines, nitro derivatives, diazonium salts, aldehyde, ketones, carboxylic acids and their derivatives, derivatives of carbonic acid

Literature

Compulsory:
1. Course material, concept and task collection for lectures, seminars in the e-learning system.

Recommended:
2. J. G. Smith: Organic Chemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725
3. J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449
4. J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293
5. F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014
6. L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-13: 9780321768148
7. T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons; ISBN-10: 0470556595
8. H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1st Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244

Schedule:

1st week

Classification of halogenated hydrocarbons, characterization of their structure and physical properties. The effect of the structure of the hydrocarbon skeleton, and the quality of the halogen on the strength of the C-Hlg bond and reactivity. Synthesis of halogenated hydrocarbons.

2nd week

Reactions of halogenated hydrocarbons. Interpretation of decreased, normal and high reactivity of halogenated hydrocarbons. Nucleophilic substitution and elimination of halogenated hydrocarbons. Interpretation of the mechanism of these reaction (S_N1, S_N2; α- and β-elimination; E1, E2 and E1cB). Reaction of halogenated compounds with metals.

3rd week

The basics of chemistry of organometallic compounds. Their bonding system, the term "umpolung". Synthesis and reactivity of organometallic compounds. Organimetallic compounds as nucleophiles and carbanion equivalents. C-C bond formation with organometallic reagents: Grignard compounds and their application. Synthesis and interconversion of organometallic compounds, transmetallation.

4th week

Classification and characterization of hydroxyl derivatives of hydrocarbons (alcohols, phenols) and their thio analogues. Interpretation of their physical properties derived from their bonding system. The acid-base properties of alcohols, phenols and thio analogues. Preparation of alcohols, ethers, phenols and thio analogues.

5th week

Alcohols and phenol es nucleophiles: alkylation, acylation, formation of sulphonate and inorganic esters; acid catalyzed transformations of alcohols (conversion of alcohols to halogenated derivatives, elimination reactions). Oxidation of alcohols and phenols. The characterization of ethers; synthesis and cleavage of ethers. Characterization of the special ether derivatives: epoxides, semi-acetals, acetals and enoleters. Cumene-based phenol synthesis.

6th week

Overview of the organic compounds possessing C-N single bond. Classification of amines and characterization of their bonding systems. Interpretation of their physical derived from their bonding system. Synthesis of aliphatic and aromatic amines; industrial methods.

7th week

Review and interpretation of basicity of amines. Chemical transformation of amines: alkylation, acylation of amino group. Synthesis of sulfonamide and reaction with nitric acid. Oxidation of the amines. S_EAr reactions of anilines.

8th week

Characterization of nitro compounds: the bonding system, interpretation of electron-withdrawing effect and C-H acidity. Synthesis of nitro compounds. Preparation of diazonium salts, reactions of diazonium salts and their practical significance. Azo compounds and their industrial significance.

9th week

Classification and characterization of oxo compounds: the bonding system and stability of carbonyl group. Physical properties of oxo compounds. Acid-base properties of aldehydes and ketones: acidity of the α-hydrogen, keto-enol tautomerism. Synthesis of aldehydes and ketones.

10th week

Reactions of aldehydes and ketones. Nucleophilic addition with O-, S-, N- and C-nucleophiles, the reversibility of the additions. Condensation reactions. Oxidation and reduction. Reactions on α-carbon; aldol dimerization, α-halogenation. Nucleophilic addition reactions of α,β-unsaturated oxo compounds.

11th week
Classification of carboxylic acids and their derivatives, description and comparison of their bonding systems. Stability and reactivity of the carboxylic acid derivatives. Physical properties and synthesis of carboxylic acids.

12th week
Review and interpretation of the acid-base properties of carboxylic acids and their derivatives (O-H, N-H and C-H acidity). Interconversion of the carboxylic acid derivatives, acyl nucleophilic substitution. Reductive transformations of carboxylic acid derivatives, transformation of their carbon skeleton.

13th week
β-Dicarbonyl and β-oxo-carboxylic acid derivatives, C-H acidity and basic of enolate chemistry: formation of carbon-carbon bond, malonic ester, acetoacetic ester and cyanoacetic ester syntheses.

14th week
Substituted (halogenated, hydroxy and oxo) carboxylic acid derivatives and their interconversion. Synthesis and interconversion of carbonic acid derivatives and their major representatives. Practical significance of carbonic acid derivatives.

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

Attendance at seminars is compulsory. A student may not miss the seminar more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed, and the student must repeat the course.

- for a grade
The course ends in an **examination**.

The exam grade is the result of the written exam.

The minimum requirement for the examination respectively is 50%. The grade for the written exam 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)

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

Person responsible for course: Dr. László Juhász, associate professor, PhD

Lecturer: Éva Juhászné Dr. Tóth, assistant professor, PhD;
Dr. Krisztina Kónya, assistant professor, PhD

Title of course: Organic chemistry III. **Code**: TTKBE0303_EN	**ECTS Credit points:** 3

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

Evaluation: term mark

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

Total: 90 hours

Year, semester: 2^{nd} year, 2^{st} semester

Its prerequisite(s): Organic Chemistry II. (TTKBE0302_EN)

Further courses built on it: -

Topics of course

Characterization of the building blocks of biomacromolecules (peptides and proteins, carbohydrates, nucleic acids, lipids) that form biological structures. Description and characterization of the most important biochemical reactions. Characterization of the structure of the biomacromolecules. Overview of the chemical and instrumental methods which can be used for the structure elucidation of these type of compounds. Review the basic of their information storage and storage capacity, the relationship between structure and function. Chemical properties of their monomers and synthesis of biopolymers. The structure and biological effect/function of some other significant natural compounds (isoprenoids, flavonoids, alkaloids, antibiotics, vitamins, porphinase compounds).

Literature

Compulsory:
1. Course material, concept and task collection for lectures, seminars in the e-learning system.

Recommended:
2. J. G. Smith: Organic Chemistry, 5^{th} Edition, 2016, McGrow Hill; ISBN-13: 9780077354725
3. C. Stan Tsai: Biomacromolecules, John Wiley & Sons, New Jersey (2007)
4. A. Miller-J. Tanner: Essentials of Chemical Biology, John Wiley & Sons, Chichester (2008)
5. P. M. Dewick: Medicinal Natural Products: A Biosynthetic Approach, 3^{rd} Edition. John Wiley & Sons, Chichester (2009)

Schedule:

1st week

Primary and secondary metabolism. Classification of natural compounds. Types of biological structural materials, general characterization. Common features of the synthesis of biopolymers: group protection, activation, coupling reactions, requirements for protective groups, orthogonality

2nd week

Structure, synthesis and chemical properties of amino acids. Characterization of α-amino acids which are forming protein/peptides. Structure and determinations of peptides. Determination of amino acid sequence by chemical and enzymatic methods, possibility of automation.

3rd week

Synthesis of peptides. The basic protecting groups and activation methods for peptide synthesis. Solid phase synthesis, automation. The occurrence, classification and functions of proteins. Levels of protein structure: primary, secondary, tertiary and quaternary structures, structure formation. Structure and function relationship.

4th week

Classification, structure and nomenclature of carbohydrates. Basic configuration and conformational conditions of monosaccharides. Most important chemical properties of monosaccharides: mutarotation, transformation of oxo group and hydroxyl groups, synthesis of glycosides.

5th week

Most important representatives of di- and oligosaccharides (sucrose, maltose, cellobiose, lactose, cyclodextrins), factors determining their structure. Synthesis of di- and oligosaccharides, basic protecting groups and activation methods.

6th week

Derivatives of Peptides / proteins and low molecular weight carbohydrates: peptidoglycans, glycoproteins, their biological significance. The carbohydrate code.

7th week

Polysaccharides (cellulose, chitin, starch, glycogen, pectin, mucopolysaccharides). Polysaccharides as structural materials and reserve nutrients. Derivatives of polysaccharides and proteins (proteoglycans). The industrial significance of polysaccharides.

8th week

Classification and characterization of nucleic acids, their building blocks. Synthesis of nucleosides and nucleotides. Primary, secondary and tertiary structure and biological function of DNA and RNA. The genetic code. Information content of the nucleotide, amino acid and carbohydrate code and their correlation. Nucleotide coenzymes.

9th week

Classification and characterization of lipids, their structure, their biological role. Basics of the biosynthesis of fats, phospho- and glycolipids ..

10th week

Isoprenes, terpenoids and carotenoids. The basics of their biosynthesis, and most important representatives of terpenoids. The chemical background of vision. Structure, classification of steroids, basics of their biosynthesis, their major representatives and their biological function.

11th week

Classification and structure of phenylpropanoids. The chemical synthesis of their basic skeletones. Structure and biological significance of flavonoids.

12th week

Classification of alkaloids and structure and function of their most important representatives. Alkaloids as drugs and medicines.

13th week

Definition of symbiosis, antibiosis. Definition and classification of antibiotics: β-lactam, amino acid or peptide, glycoside type antibiotics, polycyclic antibiotics. Preparation of antibiotics: fermentation, semi-synthetic and synthetic derivatives. The most important mode of action of antibiotics.

14th week

The structure, biosynthesis and biological role of porphyrins. Structure, biological role and metabolism of chlorophyll and hemoglobin. Classification of vitamins, their structure, their natural sources and their biological functions.
Requirements: - *for a signature* Attendance at **lectures** is recommended, but not compulsory. A student may not miss the lecture more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed and the student must repeat the course. - *for a grade* The course ends in an oral exam in the exam period.
Person responsible for course: Dr. László Juhász, associate professor, PhD
Lecturer: Dr. László Juhász, associate professor, PhD

Title of course: Organic Chemistry IV. **Code**: TTKBL0301-L_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

- lecture: -
- practice: 1 hour/week
- laboratory: 3 hours/week

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: 42 hours
- home assignment: 34 hours
- preparation for the exam: -

Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s):

- General chemistry II. (TTKBL0101_EN)
- Organic Chemistry II. (TTKBE0302_EN)

Further courses built on it: -

Topics of course

The aim of the course is to enable students to become familiar with the theoretical background of basic organic chemistry laboratory techniques and to learn how to apply them in practice; and to understand the reactivity of functional groups by synthesizing simple preparations on a semi-micro scale and by test tube reactions. The other goal is to provide students with the right material knowledge and to understand and apply cleaning and identification techniques as typical organic chemistry activities.
Laboratory practice is also linked to a one-hour seminar per week and its goal is to review the theoretical background of practical tasks.

Literature

Compulsory:

1. L. Juhász: Organic Laboratory Techniques and Manuals for Pharmacist Students, Debrecen, 2009
2. J. R. Mohrig, D. G. Alberg, G. E. Hofmeister, P. F. Schatz, C. Noring Hammond: Laboratory Techniques in Organic Chemistry **(**Supporting Inquiry-Driven Experiments)**,** 4th edition, W. H. Freeman and Company. ISBN-13: 978-1-4641-3422-7.

Recommended:

3. H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1st Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244
4. R. O. C. Norman, J. M. Coxon: Principles of Organic Synthesis, 3rd Edition, 1993, Blackie Academic & Professional, Glasgow, U K; ISBN-13: 9780751401264
5. J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449
6. J. Clayden, N. Greeves, S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293
7. F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-10: 0072905018

8. L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-10: 0321768140
9. T. W. Graham Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons, ISBN-10: 0470556595

Schedule:

1st week

Introduction: Timetable and requirements. Receiving of laboratory equipment and list of tasks. Safety education.

Presentation of the device for recrystallization.

Presentation of gravity and vacuum filtration equipment.

Description of the operation of the rotary vacuum evaporator.

Recrystallization of acetanilide from water.

2nd week

Short written test.

Presentation of thin layer chromatography (TLC).

Presentation of determination of melting point.

Check of the purity of the compound recrystallized in previous practice by melting point and TLC. Calculation of the yield of recrystallization.

Recrystallization of benzanilide from methanol.

Check of the purity of the recrystallized benzanilide by TLC.

3rd week

Short written test.

Description of liquid-liquid extraction.

Control the purity of the compound recrystallized in previous practice by melting point. Calculation of the yield of recrystallization.

Use of liquid-liquid extraction to separate m-dinitrobenzene and m-nitroaniline. Checking the success of the separation using TLC.

4th week

Short written test.

Identification of hydrocarbons and organic halides using test tube reactions.

Reaction of hydrocarbons with bromine.

Reaction of hydrocarbons with bromine in the presence of UV light.

Friedel-Crafts test of aromatic hydrocarbons.

Baeyer test of unsaturated hydrocarbons.

Beilstein and alcoholic silver nitrate test of organic halides.

Identification of unknown compounds.

5th week

Short written test.

Presentation of equipment used for distillation at atmospheric and reduced pressure.

Distillation of acetone from $KMnO_4$ at atmospheric pressure.

Distillation of water in vacuum.

6th week

Short written test.

Identification of hydroxyl derivatives of hydrocarbons using test tube reactions.

Solubility of alcohols and phenols.

Determination of order of substitution of the carbon carrying the OH group by Lucas probe.

Oxidation of alcohols with Jones reagent.

Reaction of diols or poliols with copper(II) ions.

Reaction of phenols and enols with iron(III) ions.

Iodoform test of 2-alkanols.

Identification of unknown compounds.

7th week

Short written test.

Preparation of 4-chlorobenzoic acid and 4-chlorobenzyl alcohol. Check the purity of the product using TLC and melting point measurement.

8th week

Short written test.

Identification of amino derivatives of hydrocarbons using test tube reactions.

The Hinsberg test.
Reactions of amines with nitrous acid.
The Rimini reaction of aliphatic primary amines
Complex formation of amine with Cu(II) ions.

Identification of unknown compounds.

9th week

Short written test.

Presentation of steam distillation.

Isolation of S-(+)-Carvone from caraway and preparation of its 2,4-dinitrophenylhydrazone derivative.

10th week

Short written test.

Identification of oxo compounds using test tube reactions.

Detection of aldehydes with 2,4-dinitrophenylhydrazine test.

Oxidation of aldehydes by neutral potassium permanganate solution.

Oxidation of oxo compounds by Jones reagent.

Reaction of oxo compounds with Tollens reagent.

Iodoform test of oxo compounds.

Identification of unknown compounds.

11th week

Short written test.

Presentation of a device used in reaction with three-necked round bottom flasks.

Preparation of benzamide and recrystallization of the product from water.

12th week
Short written test.
Identification of carbohydrates, amino acids and proteins.
Reductive properties of carbohydrates – Fehling and Tollens test.
Complex formation reactions of amino acids and proteins (Biuret test).
Detection of α-amino acids (Ninhydrin test).
Detection of α-amino acids containing an aromatic ring (Xantoprotein reaction).
Check of the purity of benzamide by melting point and TLC.
Preparation of benzotriazole (test tube variant).

13th week
Description of column chromatography. Separation of the mixture of acetanilide and m-dinitrobenzene by column chromatography.

14th week
Performing missed identification tasks (melting point measurement, TLC), yield calculation.
Cleaning and handovering of equipments.
Present the synthesized products to the instructor.
Evaluation.

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 (15-20 minutes).

On the one hand, the term mark consists of the marks obtained for the identification of the unknowns and on the other hand the marks written before the practice, which are closely related to the laboratory exercises carried out the week before (15-20 minutes). Of course, 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%)

Final grade: excellent (5): 90%; good (4): 75%; satisfactory (3): 60%; pass (2): 50%; fail (1): below 50%.

Person responsible for course: Éva Juhászné Dr. Tóth, assistant professor, PhD

Lecturer: Éva Juhászné Dr. Tóth, assistant professor, PhD

Title of course: Microbiology **Code**: TTBBE0506_EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: 1 hour/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: -	

Topics of course

Exoenzymes in Bacteria and Fungi, biotechnological application of microbial enzymes, cellular transport of molecules, catabolism and oxidation of organic compounds in microbes, methyltrophic fungi, fermentation types and pathways, microbial respiration, alternative oxidases, alternative respirations, chemolithotrophic pathways, methanogenesis, prokaryotic photosynthesis, radiotrophic fungi, carbon fixation and anabolic processes in microbes, nitrogen fixation, assimilative sulfate reduction, bacterial and fungal cell wall synthesis, secondary metabolites and antibiotics.

Literature

Compulsory:
Handout slides of the course.
Recommended:
Willey, J., Sherwood, L., Woolverton, C. J.: Prescott's Microbiology, 9th Edition, McGraw-Hill Eduation, 2014

Schedule:

1st week Introduction. Primary nutritional groups in microbes. Exoenzymes in Bacteria, biotechnological application of microbial enzymes.

2nd week Exoenzymes in Fungi, biotechnological application of microbial enzymes.

3rd week Cellular transport of molecules in microbes (cell wall, membrane and nuclear transport).

4th week Catabolism and oxidation of organic compounds in microbes, methyltrophic fungi and their importance.

5th week Fermentation types and pathways, the importance of fermentations, example species.

6th week Microbial respiration, alternative oxidases, alternative respirations.

7th week Chemolithotrophic pathways in microbes, methanogenesis by microbes.

8th week Prokaryotic photosynthesis in different phyla, evolution of chloroplasts, radiotrophic fungi.

9th week Carbon fixation pathways, and anabolic processes in microbes.

10th week Nitrogen fixation, assimilative sulfate reduction by bacteria.

11th week Bacterial and fungal cell wall synthesis.

12th week Secondary metabolite production.

13th week Antibiotics: production and importance.

14th week Microbial Genomics in basic and applied research.
15th week Consultation.

Requirements:

- for a signature
Attendance of the 60% of **lectures (9 lectures)** is compulsory.

- for a grade
The course ends in an **examination**.

The minimum requirement for examination is 60%. The grade for 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)

-an offered grade:
it may be offered for students if they take an optional written exam before the first week of the exam period.

Person responsible for course: Dr. Valter Péter Pfliegler, assistant professor, PhD

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

Title of course: Microbiology Practice **Code**: TTBBG0506_EN	**ECTS Credit points:** 1

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

Evaluation: mid-semester grade

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

Total: 30 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): General Microbiology and Mycology (TTBBE3030_EN)

Further courses built on it: -

Topics of course

Standard laboratory work with microbes: determining colony forming unit numbers, composition of growth media, preparation of media, molarity, concentrations. Microbial safety. Sterilization, sterile work. Determining extracellular enzyme production. Isolating single cell colonies, preservation of cultures. Morphology of microbial cells and colonies, differences among bacterial, yeast and mold cultures. Determining aerobic/anaerobic growth and fermentative carbon source utilization. Microscopy.

Literature

Compulsory:
Handout slides of the course.

Schedule:

1st week Introduction. Safety measures, fire safety during work.

2nd week Growth media, agar plates, sterilization.

3rd week Inoculating microbial cultures. Colony morphology of yeasts, molds and bacteria.

4th week Preparing slides from cultures, microscopy: the use of the microscope, examining cells and cultures, direct cell counting.

5th week Producing isolated colonies from mixed source.

6th week Evaluating single-cell culture growth, carbon source utilization/fermentation tests.

7th week Conservation of microbial cultures, evaluating fermentation and carbon utilization tests.

8th week Reviving cultures from stock. Cell counting and plating for determining CFU.

9th week Evaluating CFU determination experiment, calculating survival after freezing in the stock culture.

10th week Evaluating previous result. Medium preparation for extracellular enzyme activity.

11th week Start of amylase production test.

12th week Evaluating amylase production test.

13th week Consultation about lab notes and caclulations.

14th week Test.

15th week Retake tests.

Requirements:

- for a signature

Attendance of the 80% of **lab classes (12 classes)** is compulsory.

- for a grade

The course has an end-term test. Detailed lab notes with calculations done as home assignment have to be presented and will be scored. Students shall prepare about the topics before each lab class.

The minimum requirement for the scores of the test and of the lab notes is 60%. The grade for these 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 the test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Lab notes account for three quarters of the final grade, test accounts for one quarter.

Person responsible for course: Dr. Valter Péter Pfliegler, assistant professor, PhD

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

Title of course: Microbial Physiology **Code**: TTBBE0525_EN & TTBBL0525_EN	**ECTS Credit points:** 3+1

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

Evaluation: exam, mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 28 hours
- laboratory: -
- home assignment: 30 hours
- preparation for the exam: 34 hours

Total: 120 hours

Year, semester: lecture: 1st year, 2nd semester; practice: 2nd year, 1st semester

Its prerequisite(s): Microbiology (TTBBE0506_EN)

Further courses built on it: -

Topics of course

General classification of microorganisms. Morphology (Prokaryotes, Eukariotes and Viruses). Flow of energy in the biological world. Classification of microorganisms by their carbon and energy sources. Cycling of matter in the biological world (carbon and oxygen cycle, nitrogen cycle, sulphur cycle). Thermodynamic concepts in the analysis of biological systems (chemical work and energy, free energy of formation of some biochemical compounds, free energy change of some biochemical reactions). Chemical energy: production, conservation and utilization in the cell (energy coupling through ATP system, energy coupling through NADP system and other coenzyme system. ATP systems. Production of ATP. Utilization of ATP. Regulation of ATP production. Transport. Respiratory-chain phosporylation. Oxidation/Reduction reactions. Photosynthesis.

Literature

- Bernhard Atkinson and Ferda Mavituna: Biochemical Engineering and Biotechnology Handbook, The Nature Press, ISBN 0 333 33274 1
- James Darnell, Harvey Lodish, David Baltimore: Molecular Cell Biology, Scientific American Books, ISBN 0-7167-1448-5
- Wang DIC, Cooney CL, Demain AL, Dunnill P, Humphrey AE, Lilly MD: Fermentation and Enzyme Technology. John Wiley & Sons, New York, U.S.A

Schedule:

1st week: Introduction to the world of microorganisms.

2nd week: Bioenergetics (free energy, free enthalpy, redox reactions, redox pairs, electron carriers, energy-rich molecules, energy storage).

3rd week: Anabolism (amino acids; proteins; nucleotides; nucleotide acids; fatty acids; carboghydrates)

4th week: Catabolism (glycolysis and auxiliary reactions, citrate cycles, respiration, proton-motive force, ATP synthesis)

5th week: Metabolic diversity I. (phototrophy, photosynthesis, CO_2 fixation, fixation of N_2)

6th week: Metabolic diversity II. (Chemoorganotrophic metabolism: aerobic respiration, anaerobic respiration, fermentation, methylotrophs. Chemolitotrophic metabolism.*)*

7th week: Structure and characterization of prokaryotic cells.

8th week: Structure and characterization of eukaryotic cells.

9th week: Archeabacteria I.

10th week: Archeabacteria II.

11th week: Virology

12th week: Nutrition cycles

13th week: Biodegradation and bioremediation

14th week: Consultation, answering questions.

Requirements:

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

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. Erzsébet Fekete, associate professor, PhD

Lecturer: Dr. Zoltán Németh, assistant professor, PhD
Dr. Ákos Péter Molnár, assistant professor, PhD

Title of course: Genetics **Code**: TTBBE3020_EN	**ECTS Credit points:** 3

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 42 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 48 hours

Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): -

Further courses built on it:
- Bioinformatics (TTBBE2060_EN)
- Bioinformatics (TTBBG2060_EN)

Topics of course

The series of lectures are based on the topics of classical and molecular genetics. It reviews the discovery of DNA, RNA and protein as genetic material. We will discuss DNA replication and the repair mechanisms of DNA. Chromatin and chromosome structures will be reviewed during classes, but also chromosomal aberrations. We will discuss gene expression and its regulation on DNA and chromatin level. In regard of gene expression also genetic code and mutations will be discussed. Basics of mitotic and meiotic cell division will be reviewed. Mendelian genetics will follow after: principles of Mendel, different types of inheritances. We will then continue the course with sex determination and sex-linked inheritances of different organisms. We will end the lecture course with the basics of meiotic and non-meiotic recombination events.

Literature

Compulsory:
- List of keywords sent out. Lecture materials sent out. Lecture notes taken during classes.

Recommended:
- Daniel L. Hartl: Essential Genetics, 6th edition; ISBN-13: 978-1449686888
- Jocelyn E Crebs et. al.: Lewin’s Genes XII; ISBN-1: 978-1284104493

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 – 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.

12th week: Nonmendelian inheritances. Multifactorial inheritance.

13th week: Sex determination and sex linked inheritances.

14th week: Meiotic recombination and its use in genetic mapping. Somatic recombination.

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 composed of “true or false” questions and keywords, and 70 % must be reached. B part is composed of single choice, multiple choice tests, 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
0-49	fail (1)
50-69	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. Gyula Batta, assistant professor, PhD

Lecturer: Dr. Gyula Batta, assistant professor, PhD

Title of course: Genetics practice **Code**: TTBBG3020_EN	**ECTS Credit points: 2**

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

Evaluation: mid-semedster grade

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

Total: 60 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Introduction to Mendelian genetics (classical genetics). Understanding of one and multiple gene inheritance, genetic interactions. X – linked inheritance (sex linked) and lethal genes. Recombination – coincidence, interference, linkage calculations.

Literature

-

Schedule:

1st week

Introduction to classical genetics and basic definitions.

2nd week

Introduction to 1 gene inheritance. (1st topic)

3rd week

1 gene inheritance and pedigrees.

4th week

Introduction to two- or more genes inheritance. (2nd topic)

5th - 6th week

Two – or more genes inheritance complex examples.

7th week

First test from the 1st and 2nd topics.

8th week

Introduction to X-linked inheritance. (3rd topic)

9th week

Introduction to “lethal genes” inheritance. (4th topic)

10th week

Introduction to recombination calculations. (5th topic)

11th week

Test from the 3rd and 4th and 5th topics.

12th week

Consultation and re-take opportunity.

End-of-semester consultation

Requirements:
Attendance at lectures is obligatory, two absences are allowed.

Test(s):

During the semester, there are two tests: in the 7th week and in the 11th week.

Each results have to be better than mark 1.

Person responsible for course: Dr. Laszlo Attila Papp, research fellow, PhD

Lecturer: Dr. Laszlo Attila Papp, research fellow, PhD

Title of course: Methods in Molecular Biology **Code**: TTBBE2042_EN	**ECTS Credit points:** 3

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

Evaluation: exam

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): -

Further courses built on it: -

Topics of course

Review of basic concepts, such as genome, gene, chromosome, DNA, RNA etc. Structure of DNA, DNA extraction and purification methods. Gel electrophoresis. Pulsed field gel electrophoresis. Restriction enzymes in molecular biology and their application. Vectors for recombinant technology: plasmid and viral vectors, cosmids, artificial chromosomes, cloning and expression vectors. PCR methods. Gene expression, central dogma, cDNA synthesis. Cloning of genes. Ligation. Transformation. DNA sequencing methods. Genome sequencing of model organisms, human genome project and its results. DNA libraries. Southern-blot hybridisation. Studying of gene expression: quantitative PCR, microarray methods.

Literature

RJ Reece: Analysis of Genes and Genomes , Wiley and Sons LtdISBN:0-470-84379-9

Schedule:

1st week

Introduction. Review of basic concepts, such as genome, gene, chromosome, DNA, RNA etc.

2nd week

Structure of DNA, DNA extraction and purification methods.

3rd week

Gel electrophoresis. Pulsed field gel electrophoresis.

4th week

Restriction enzymes in molecular biology and their application.

5th week

Vectors for recombinant technology. Plasmid and viral vectors, cosmids, artificial chromosomes, cloning and expression vectors.

6th week
PCR methods.

7th week
Gene expression, central dogma, cDNA synthesis.

8th week
Cloning of genes. Ligation. Transformation.

9th week
DNA sequencing methods.

10th week
Genome sequencing of model organisms, human genome project and its results.

11th week
DNA libraries. Southern hybridisation.

12th week
Studying of gene expression: quantitative PCR, microarray methods.

13th week
Consultation.

14th week
Essay writing.

Requirements:
Attendance at **lectures** is recommended, but not compulsory. The course ends with **exam.**

The minimum requirement for the exam is 50%.

Score	**Grade**
under 50%	fail (1)
50-63%	pass (2)
64-76%	satisfactory (3)
77-89%	good (4)
90-100%	excellent (5)

If the score of the exam is below 50%, students can take further exams according to the EDUCATION AND EXAM RULES.

Person responsible for course: Dr. Ida Miklós, associate professor, PhD

Lecturer: Dr. Ida Miklós, associate professor, PhD

Title of course: Methods in Molecular Biology practice **Code**: TTBBG2042_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 28 hours - home assignment: - - preparation for the exam: 32 hours Total: 60 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: -	

Topics of course

The series of laboratory practices will be about basic molecular biology techniques that are commonly used. Basic microbiological and biology experiments will be also carried out. These include cell morphology analysis, staining of DNA and other components of the cell. Also DNA isolation, cloning procedures and different PCR techniques will be applied.

Literature

Compulsory:
Laboratory practices notes – sent out in the beginning of semester

Recommended:
Lecture notes and slides

Schedule:

1st week: Introduction. Lab safety instructions.

2nd week: Microscopy of fission yeast, bacteria and mammalian cells

3rd week: Isolation of plasmid DNA

4th week: Isolation of genomic DNA from yeast

5th week: Isolation of RNA from yeast

6th week: Gel electrophoresis

7th week: PCR

8th week: Restriction digestion

9th week: Ligation

10th week: Transformation of bacteria

11th week: Transformation of yeast

12th week: cDNA synthesis

13th week: qRT-PCR

14th week: Test

Requirements:

- for a signature
Attendance in the classes are compulsory.

- for a grade
The course ends with a written test.

Score (in percentage)	Grade
0-49	fail (1)
50-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

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

Lecturer: Dr. Gyula Batta, assistant professor, PhD

Title of course: Physical chemistry (lecture) **Code**: TTKBE0431_EN	**ECTS Credit points:** 3

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

Evaluation: exam

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

Total: 90 hours

Year, semester: 2^{nd} year, 2^{nd} semester

Its prerequisite(s):
- General Chemistry I. (lecture) (TTKBE0101_EN)
- Mathematics I. (lecture) (TTMBE0802)
- Mathematics I. (seminar) (TTMBG0802)

Further courses built on it:
- Bio-physical chemistry (TTKBE0419_EN)
- Colloid and surface chemistry (TTKBE0406_EN)

Topics of course

The series of lectures are based on the topics 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 well-established surrounding. Application of the approach of physical chemistry in engineering is discussed through examples.

Literature

Compulsory:
- 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, 8^{th} edition, Oxford University Press

Recommended:
- 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:

1^{st} week: Introduction and general information. Presentation of the objectives of the lecture series and their connection with other knowledge acquired during the course.

2nd week: Basic notions of thermodynamics. System, surroundings, state variables, state equation. Perfect and real gases. Open, closed and isolated systems. Homogeneous, inhomogeneous and heterogeneous systems.

3rd week: First law of thermodynamics. Work, heat, internal energy, enthalpy. Conservation of energy, the first law. Heat capacities, special processes. Standard reaction enthalpy, standard enthalpy of formation, Hess theorem.

4th week: The second and third laws of thermodynamics. Various formulations of the second law, the direction of natural processes, irreversibility. Entropy, potential functions, Gibbs and Helmholtz functions. Heat engines and refrigerators. The behavior of substances at low temperatures, the unattainability of the absolute zero. Statistical mechanics aspects of the second and third laws.

5th week: Phase transitions. Phase equilibria of pure substances. Vaporization, fusion, sublimation and allotropic (polymorphic) transformations. The Clapeyron and Clausius–Clapeyron equations. Phase diagrams, Gibbs phase rule. Saturated vapor pressure of curved surfaces.

6th week: Homogeneous mixtures. Ideal and real mixtures, partial molar quantities, chemical potential. The activity. Raoult's and Henry's laws. Pressure and boiling point vs. composition diagrams for liquid mixtures and distillation. The temperature and pressure dependence of the activity of saturated solutions. Colligative properties. Freezing point vs. composition diagrams, partition equilibrium.

7th week: Chemical equilibrium. The minimum of Gibbs energy in reactive systems at constant pressure and temperature, reaction Gibbs energy, equilibrium constant. Temperature and pressure dependence of equilibrium constant. Le Chatelier--Braun principle. Heterogeneous and solution equilibria.

8th week: Transport processes. Notion, temperature dependence and measurement of viscosity, Stokes formula. Notions of diffusion and convection, their fluxes and differential equations. Notion, flux and differential equation of heat conduction. Heat conduction in mixtures and solids.

9th week: Electrical conduction of electrolyte solutions. Conductivity and molar conductivity of electrolyte solutions, their concentration dependence. Kohlrausch law and law of independent migration of ions. Ionic movement in solutions, ionic mobility. Ostwald dilution law.

10th week: Galvanic cells and electrodes. Structure and diagram of galvanic cells, cell reaction, cell potential, electromotive force. Thermodynamics of galvanic cells. Concentration cells. Liquid-liquid junction potentials. Electrode potential, types of electrodes.

11th week: Reaction kinetics 1. Measurement of temporal concentration changes. Reaction rate, rate equation, order, kinetic differential equations. Determination of the rate equation, integral and differential methods, half-life.

12th week: Reaction kinetics 2. Elementary reactions, molecularity, mechanism. Bodenstein (steady state) principle. Chain reactions, homogeneous and heterogeneous catalysis, enzyme reactions, Michaelis-Menten kinetics. Autocatalysis, oscillation.

13th week: Interfacial phenomena

14th week: Basics of colloid chemistry

Requirements:

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

- for a grade
Lecture is not compulsory but presence of its 30 % is obligatory. Otherwise, passing the exam is not allowed.
The course ends in a **written or oral examination**. Based on the result of the examination questions scored according to pre-set maximum points for each sub-questions. The type of the examination (written or oral) is the choice of the student.

The minimum requirement for the examination is 60 %. Based on the score of the tests separately, the grade for the tests and/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 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 on the basis of the result of the end-term test if the grade is at least satisfactory (3).

Person responsible for course: Dr. Győrvári-Horváth Henrietta, senior research fellow, PhD

Lecturer: Dr. Győrvári-Horváth Henrietta, senior research fellow, PhD

Title of course: Physical chemistry (seminar) **Code**: TTKBG0431_EN	**ECTS Credit points:** 1

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

Evaluation: exam

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

Total: 30 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s):
- General Chemistry I. (lecture) (TTKBE0101_EN)
- Mathematics I. (TTMBE0802)
- Mathematics I. (TTMBG0802)

Further courses built on it:
- Bio-physical chemistry (TTKBE0419_EN)
- Colloid and surface chemistry (TTKBE0406_EN)

Topics of course

The series of lectures are based on the topics 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 well-established surrounding. Application of the approach of physical chemistry in engineering is discussed through examples.

Literature

Compulsory:
- 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, 4th edition, Oxford University Press
- P. W. Atkins, J. de Paula (2008 or any later edition): Physical Chemistry, 8th edition, Oxford University Press

Recommended:
- 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: Introduction and general information. Presentation of the objectives of the lecture series and their connection with other knowledge acquired during the course.

2^{nd} *week:* Basic notions of thermodynamics. System, surroundings, state variables, state equation. Perfect and real gases. Open, closed and isolated systems. Homogeneous, inhomogeneous and heterogeneous systems.

3^{rd} *week*: First law of thermodynamics. Work, heat, internal energy, enthalpy. Conservation of energy, the first law. Heat capacities, special processes. Standard reaction enthalpy, standard enthalpy of formation, Hess theorem.

4^{th} *week*: The second and third laws of thermodynamics. Various formulations of the second law, the direction of natural processes, irreversibility. Entropy, potential functions, Gibbs and Helmholtz functions. Heat engines and refrigerators. The behaviour of substances at low temperatures, the unattainability of the absolute zero. Statistical mechanics aspects of the second and third laws.

5^{th} *week*: Phase transitions. Phase equilibria of pure substances. Vaporization, fusion, sublimation and allotropic (polymorphic) transformations. The Clapeyron and Clausius–Clapeyron equations. Phase diagrams, Gibbs phase rule. Saturated vapour pressure of curved surfaces.

6^{th} *week*: Homogeneous mixtures. Ideal and real mixtures, partial molar quantities, chemical potential. The activity. Raoult's and Henry's laws. Pressure and boiling point vs. composition diagrams for liquid mixtures and distillation. The temperature and pressure dependence of the activity of saturated solutions. Colligative properties. Freezing point vs. composition diagrams, partition equilibrium.

7^{th} *week*: Chemical equilibrium. The minimum of Gibbs energy in reactive systems at constant pressure and temperature, reaction Gibbs energy, equilibrium constant. Temperature and pressure dependence of equilibrium constant. Le Chatelier--Braun principle. Heterogeneous and solution equilibria.

8^{th} *week*: Transport processes. Notion, temperature dependence and measurement of viscosity, Stokes formula. Notions of diffusion and convection, their fluxes and differential equations. Notion, flux and differential equation of heat conduction. Heat conduction in mixtures and solids.

9^{th} *week*: Electrical conduction of electrolyte solutions. Conductivity and molar conductivity of electrolyte solutions, their concentration dependence. Kohlrausch law and law of independent migration of ions. Ionic movement in solutions, ionic mobility. Ostwald dilution law.

10^{th} *week*: Galvanic cells and electrodes. Structure and diagram of galvanic cells, cell reaction, cell potential, electromotive force. Thermodynamics of galvanic cells. Concentration cells. Liquid-liquid junction potentials. Electrode potential, types of electrodes.

11^{th} *week*: Reaction kinetics 1. Measurement of temporal concentration changes. Reaction rate, rate equation, order, kinetic differential equations. Determination of the rate equation, integral and differential methods, half-life.

12^{th} *week*: Reaction kinetics 2. Elementary reactions, molecularity, mechanism. Bodenstein (steady state) principle. Chain reactions, homogeneous and heterogeneous catalysis, enzyme reactions, Michaelis--Menten kinetics. Autocatalysis, oscillation.

13th week: Interfacial phenomena

14th week: Basics of colloid chemistry

Requirements:

- for a signature

Attendance at **seminars** is compulsory.

The signature in Neptun (and possibly in your study book) that acknowledges the completed seminars also serves as a signature for the lectures. Those not registrating themselves in the program Neptun, „do not exist” from the viewpoint of this subject and exclude themselves from the physical chemistry studies. *Two missed seminars are allowed by the teacher. Be careful, however, you cannot exceed this even if you are ill. So keep this possibility for the really serious cases.*

- for a grade

During the semester we write *2 tests.* The seminar mark is derived from the average of these written thesis papers. Based on the result of the test questions scored according to pre-set maximum points for each sub-questions.

The minimum requirement for the examination is 60 %. Based on the score of the tests separately, the grade for the tests and/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 any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Győrvári-Horváth Henrietta, senior research fellow, PhD

Lecturer: Dr. Győrvári-Horváth Henrietta, senior research fellow, PhD

Title of course: Bio-physical chemistry **Code**: TTKBE0419_EN	**ECTS Credit points:** 3

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

Evaluation: exam

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):
- Physical Chemistry lecture (TTKBE0431_EN)
- Physical Chemistry seminar (TTKBG0431_EN)

Further courses built on it: -

Topics of course

- The subject of biophysics-chemistry, thermodynamic concepts
- Structure of macromolecules, interactions with small molecules
- The concept of chemical potential, its effect on thermodynamic parameters, the properties of solutions.
- Definition and interpretation of pH in biological systems
- The significance of electron transfer reactions in live systems
- Simple and complex reactions, kinetic description of enzymatic catalysed reactions
- Basic concepts related to biochemical pathways
- NMR spectroscopy in biological systems

Literature

Compulsory:
lecture material on the Department of Physical Chemistry website
Recommended:
- P. W. Atkins: Physical Chemistry (8th ed.) Oxford University Press for, 2006. ISBN: 0-7167-8759-8
- P. W. Atkins. J. de Paula: Physical Chemistry for the Life Sciences (2nd ed.) Oxford University Press, 2011, ISBN:978-0-19-956428-6

Schedule:

1st week
The subject of bio-physical chemistry. Environmental and environmentally-independent constraints of biological systems. The basics of thermodynamics. The system and the surroundings. Thermodynamic first and second law. Concept of internal energy, work, heat, enthalpy, entropy, Gibbs energy. Applications in biological systems: calculation of mechanical, electrical, extension

work. (Bio)chemistry reactions, energy, enthalpy, and Gibbs energy changes. Introduction of standard conditions. Hess law The thermodynamics of ATP.

2nd week

First, secondary, tertiary and quaternary structures of proteins. Secondary interactions that determine the tertiary structure of proteins. Interactions between hydrophobic side chains - the role of water. Elevation and repression of proteins change in entropy during conformational change. First and secondary structure of nucleic acid, interactions that determine the secondary structure. Changing of the Gibbs energy while the the double-single DNA threads (fibers) transform.

3rd week

The concept of chemical potential, used to calculate a change in the free-enthalpy accompanying a chemical reaction or a transport process. Concentration dependence of the free-enthalpy, reaction rate and equilibrium constant. Temperature dependence of equlibrium constant.

4th week

Measuring the thermodynamic quantities of the reactions. Binding of small molecules to macromolecules, independent binding, cooperation. Dissociation macro- and microconstants. Average ligand number, saturation degree, number of binding sites. Hughes-Klotz-representation. Scatchard-representation.

5th week

Autoprotolysis of water. Acid-base theory Arrhenius and Bronsted. The pH scale in chemical and biochemical systems. Conjugated acids and bases. Determination of the strength of acids and bases, the concept of pK. Dissociation degree. pK values of free amino acids, pH change its charge, isoelectric focusing. Change of pK with (bio) chemical environment. pH control in biochemical systems: buffer systems, ion transport

6th week

Electron transition reaction. Electrochemical cell: Danielle cell. Electrodes, halfcell-reaction, electromotive force. Standard electrode potential and their application: electrochemical line. Concentration dependence of electromotive force: Nernst equation, hydrogen electrode, glass electrode, combined glass electrode. Electrochemical discussion of terminal oxidation.

7th week

Specifications of solutions. Chemical potential of the solvent. Colligative properties: boiling-point elevation, freezing point depression, osmosis. Vegetable water transport and water potential. Determination of the molecular weight of protein according to their osmotic properties. Osmolarity and tonicity of the solution. Chemical potential of the solute. pH determination with weak acids and bases penetrating the membrane. Membrane potential. Electrochemical gradient as energy storage in the cell. Theory of chemio-osmosis. Stoichiometry of proton pump and ATP synthesis during oxidative phosphorylation.

8th week

Ideal and real system. Properties of the perfect gas. Ideal solution features. Discussing a real, dilute solution. Activity coefficient and affecting its value in solution containing ions: Debye-Hückel's theory. The role of ion strength in practice.

9th week

Chemical reaction rates – kinetics. Thermodynamic and kinetic stability. Specify the velocity of a chemical reaction. The concentration dependence of the chemical reaction rate. Rate equation. Temperature dependence of chemical reaction rate. Ionic strength dependence of the reaction rate. Isotope substitution method for detecting the mechanism of the reaction. Effect of pH on reaction rate. Kinetics of sequential, parallel and reversible reactions.

10th week

Kinetics of enzymatic catalyzed reactions. Catalysis concept, catalysts. Classification of enzymes. Energy profile of enzyme catalysis. Use of steady-state approximation in enzyme-catalyzed reactions. The application and limitations of the Michaelis-Menten approach. Determination of K_M

and V_{max}. Expression of catalytic activity of enzymes. Temperature dependence of the rate of enzymatic catalysis. pH dependent on the rate of enzymatic catalysis reactions.

11th week

Kinetics of multi-substrate enzymes. Activation parameters of multi-substrated enzymatic catalyzed reactions. The role of antigen-specific antibodies in the formation of "artificial enzymes". Discussion of kinetics of dual substrate enzyme catalyzed reaction, three-molecule complex approach and ping-pong mechanism. Inhibition in the enzyme reactions. Interpretation of different inhibition types, changes in K_M and V_{max} for different types of inhibition. The Dixon representation and the information that can be gained from it.

12th week

Industrial utilization of enzymatic catalysis: applications. Myths and facts about the industrial enzyme application area. Basics of enzyme immobilization. Use of ionic liquids as a reaction medium. Enzyme catalysis in non-aqueous medium (ionic liquids): regioselectivity, enantioselectivity.

13th week

Associated chemical reactions and biochemical pathways. Consecutive (serial) coupling of chemical reactions. Parallel coupling of chemical reactions. Structure of biochemical pathways from coupled reactions. Kinetic and thermodynamic control of biochemical pathways. Systemic analysis of kinetic control of biochemical pathways. Metabolic control analysis: control coefficient, elasticity coefficient.

14th week

Briefly about quantum mechanics: particles, waves, quantization of energy. Limitations of classical mechanical description. Interaction of molecules by electromagnetic radiation. General characterization of spectroscopic methods. Electro-dissemination spectra and their biochemical applications. The basics of NMR spectroscopy and its biochemical, medical applications.

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 minimum requirement for the examination is 50%. The grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

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

- offered grade

It may be offered for students if the student gives a 10-15 minute presentation related to the topic of the subject. The possible topics are discussed with the lecturer. The offered grade can be satisfactory (3) or better, in case of lower evaluation exam should be taken.

Person responsible for course: Dr. Henrietta Horváth, senior research fellow, PhD

Lecturer: Reka Gombos, assistant lecturer

Title of course: Colloid and Surface Chemistry **Code**: TTKBE0406_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

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

Evaluation: exam

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):

- Physical Chemistry (TTKBE0431_EN)
- Physical Chemistry (TTKBG0431_EN)

Further courses built on it: -

Topics of course

The goal of this series of lectures is to give knowledge about the relation between size, shape, structure and physico-chemical properties. Students are expected to get acquainted with the behavior of nanosized particles, colloidal systems, and the role of interfaces as well as their possible applications.

Literature

Compulsory:

- Lecture slides downloadable from the e-Learning homepage (http://elearning.unideb.hu)
- Barnes, GT, Gentle, IR: Interfacial Science. Oxford UP. ISBN 0-a19-a927882-a2, 2005
- Pashley, R. M.: Applied Colloid & Surface Chemistry. Wiley&Sons, ISBN 0-a470-a86883-aX, 2004
- Cosgrove T.: Colloid science. Blackwell Publishing ISBN:978-a14051-a2673-a1, 2005

Schedule:

1st week

Introduction. The notion of colloids and the classification of colloid systems. Synthesis of colloids. Relation between colloids and nanotechnology. Average and types of average.

2nd week

Molecular interactions. Quantitative description of electrostatic and van der Waals interactions, their role in the synthesis of colloids. Lennard-Jones potential. Hydrophilic and hydrophobic interactions.

3rd week

Notion and characterization of interfaces. Fluid interfaces. Interfacial phenomena, the concept of surface tension. The Eötvös rule. Laplace pressure, importance of curved surfaces.

4th week

Nonfluid interfaces. Contact angle, wetting and spreading. Adhesion and cohesion. Adsorption at fluid interfaces, the Gibbs isotherm. Langmuir and Langmuir-Blodgett layers.

5th week

Adsorption at solid-liquid interfaces. Adsorption isotherms. Formation of charged interfaces and their significance. Chromatographies.

6th week

Formation of the electrostatic double layer, its structure and description. Comparison of the Helmholtz, Gouy-Chapman and Stern models. Potentials. Zeta potential.

7th week

Electrokinetic phenomena. Electrophoretic mobility. The phenomenon of electroosmosis and its practical use in capillary electrophoresis.

8th week

Stabilization and destabilization of lyophobic colloids. The Hamaker model. The DLVO theory. Sterical stabilization. Salting out. Destabilization of lyophilic colloids. The technology of butter- and cheese-making.

9th week

Gas-liquid disperse systems. Stability, preparation and importance of aerosols. Stability, preparation and practical use of foams.

10th week

Liquid-liquid disperse systems. Preparation and breaking of emulsions. Emulsifiers, the HLB value.

11th week

Solid-liquid disperse systems. Their preparation, stabilization, kinetic description of their formation.

12th week

Association colloids. Surface activity. Amphiphilic molecules and micelles. Micelle formation, the critical micelle concentration. Surfactants, detergents.

13th week

Types of macromolecular colloids. Macromolecules and plastics. Drug transport and targeted delivery.

14th week

Basics of rheology. Viscosity and its measurement. Viscosity- and flow curves. Basic rheological types. Applications.

Requirements:

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

- for a grade
The course ends in an **examination**. The minimum requirement for the examination is 50%. The grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

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

Person responsible for course: Dr. Levente Novák, assistant professor, PhD

Lecturer: Dr. Levente Novák, assistant professor, PhD

Title of course: Informatics for Engineers **Code**: TTKBG0911_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - preparation for the tests: 32 hours Total: 60 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: • Computer Modeling of Chemical Technology Systems I. (TTKBG0912_EN) • Process control I. (TTKBG0612_EN)	

Topics of course

Application of spreadsheets: mathematical operations, equations, charts, curve fitting, least-squares fitting, numerical integration, numerical derivation, solving of nonlinear equations, solving of set of equations, linear regression, matrix operations, introductions to statistics.

Literature

Recommended:

1. Joan Preppernau, Joyce Cox and Curtis Frye. Microsoft® Office Home and Student 2007 Step by Step, Microsoft Press, 2007
2. Robert de Levi. Advanced Excel® for scientific data analysis, Oxford University Press, New York, 2004
3. Robert de Levi. How to Use Excel® in Analytical Chemistry: And in General Scientific Data Analysis, Cambridge University Press, Cambridge, 2004

Schedule:

1st week

Implementation of mathematical functions in the spreadsheet software. Plotting the result in *xy* scatter graphs.

2nd week

Solving calculation problems in chemical engineering by implemented mathematical functions.

3rd week

Numerical differentiation by spreadsheet software and its application for problem-solving in chemical engineering.

4th week

Numerical integration by spreadsheet software and its application for problem-solving in chemical engineering.

5th week

Regression, curve fitting

6th week

The application of interpolation for problem-solving in chemical engineering.

7th week

Solving nonlinear equations by spreadsheet software and its application for problem-solving in chemical engineering.

8th week

Solving nonlinear set of equations by spreadsheet software and its application for problem-solving in chemical engineering.

9th week

Matrix operations

10th week

Solving sets of linear equations by matrix operations.

11th week

Application of spreadsheets in combinatorics and probability.

12th week

Application of spreadsheets in statistics. Probability distributions.

13th week

Maxwell–Boltzmann molecular speed distribution for gases. Typical speeds.

14th week

Application of t-tests for problem-solving in chemical engineering.

Requirements:

- for a signature

Participation at the classes is compulsory. A student must attend the 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. Attendance at the 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 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 the practice grade

The course ends with a test in the 14th week. The minimum requirement for the test is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

The students are allowed to retake the test once to improve their scores. Further improvement is in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Ákos Kuki, associate professor, PhD

Lecturer: Dr. Ákos Kuki, associate professor, PhD

Title of course: Computer Modelling of Chemical Technology Systems I. **Code**: TTKBG0912_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - preparation for the tests: 32 hours - home assignment: - Total: 60 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): Informatics for Engineers (TTKBG0911_EN)	
Further courses built on it: -	

Topics of course

Application of a chemical process simulation software for the simulation of industrial processes. Drawing the flowcharts. Creating a simulation step by step. Simulation of simple reactions, evaluation of the results, creating reports, exporting data. Study of vapor-liquid equilibrium. Modeling of flash distillation and three phase flash distillation. Application of sensitivity study. Applications of the controller module. Modeling of heat exchangers.

Literature

Recommended:

1. J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt
2. ChemCAD tutorial file
3. J.H. Perry: Chemical Engineers Handbook, McGraw-Hill, New York (2007)
4. Warren L. McCabe, Julian Smith, Peter Harriott: Unit Operations of Chemical Engineering McGraw-Hill, New York (2007)

Schedule:

1st week

The main features of a process simulation software. The steps of the simulations. Drawing process flow diagrams.

2nd week

Simulation of simple reactions, evaluation of the results.

3rd week

Simulation of reactions with more feeds and unit operations, evaluation of the results.

4th week

Study of vapor-liquid equilibrium.

5th week

Modeling of flash distillation and three phase flash distillation.

6th week

Application of sensitivity study.

7th week

Introduction into the use of the *controller*.

8th week

Application of *controller* for problem-solving in chemical engineering.

9th week

Modeling of heat exchangers.

10th week

Various reactor models.

11th week

Simulation of chemical processes with reactors and separators

12th week

Simulation of chemical processes with recycling.

13th week

Simulation of more complex chemical processes.

14th week

Simulation of more complex chemical processes.

Requirements:

- for a signature

Participation at the classes is compulsory. A student must attend the 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. Attendance at the 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 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 the practice grade

The course ends with a test in the 14th week. The minimum requirement for the test is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

The students are allowed to retake the test once to improve their scores. Further improvement is in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Ákos Kuki, associate professor, PhD

Lecturer: Dr. Ákos Kuki, associate professor, PhD

Title of course: Analytical Chemistry I. **Code**: TTKBE0501_EN	**ECTS Credit points:** 3

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

Evaluation: exam

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 I. (TTKBE0101_EN)
- Organic Chemistry I. (TTKBE0301_EN)

Further courses built on it:
- Analytical Chemistry II. (TTKBL0513_EN)
- Application of Instrumental Analysis (lecture) (TTKBE0512_EN)

Topics of course

Literature

Compulsory:
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

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.

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: Dr. Péter Buglyó, associate professor, PhD

Lecturer: Dr. Péter Buglyó, associate professor, PhD

Title of course: Process Control I. **Code**: TTKBG0612_EN	**ECTS Credit points:** 4

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 14 hours
- laboratory: -
- home assignment: 56 hours
- preparation for the exam: 22 hours

Total: 120 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Informatics for Engineers (TTKBG0911_EN)

Further courses built on it: Process control II. (TTKBG0613_EN)

Topics of course

Simple process control systems. Steady state and dynamic behaviour of chemical equipment. Determination of signal transmission of chemical equipments and control systems. Writing the balance/conservation equations. Basics of mathematical modelling.

Literature

Compulsory:

1) Seborg D. E., Edgar T.F., Mellichamp D. A., Doyle III F. J.: Process Dynamics and Control., Third Edition, published by John Wiley & Sons, Inc., 2011

Recommended:

2) Ingham J., Dunn I.J., Heinzle E., Prenosil J.E., Snape J.B.: Chemical Engineering Dynamics. An Introduction to Modelling and Computer Simulation., Third completely revised ed., WILEY-VCH Verlag GmbH, Weinheim, 2007
3) Smith A.C, Corripio A.B.: Principles and Practice of Automatic Process Control. Second ed., 2007
4) Luyben W.L.: Process Modeling, Simulation, and Control for Chemical Engineers. McGraw-Hill, International Edition, 1996.
5) Stephanopoulos G.: Chemical Process Control. An Introduction to Theory and Practice., published by Prentice Hall PTR, Englewood Cliffs, New Jersey, 1984
6) Bequette B. W.: Process Dynamics. Modeling, Analysis, and Simulation., Prentice Hall International Series in the Physical and Chemical Engineering Sciences, Prentice Hall PTR, 1998
7) Elnashaie S. S. E. M., Garhyan P.: Conversation Equations and Modelling of Chemical and Biochemical Processes., published by Marcel Dekker, Inc., 2003

Schedule:

1st week

Introduction. Determination of scope of Process Control. Classification of industrial automation.

2nd week

Single input and single output systems (SISOs). Feed-back Control (FBC) system and Feed-forward Control system (FFC). Symbols of process control and P&I diagrams. Signals and hardware elements of process control systems. Operations of signals. Block diagram and schematic structure/diagram.

3rd week

Industrial examples for process control. Comparison of FBC and FFC.

4th week

Industrial examples for process control. Comparison of FBC and FFC.

5th week

Enhanced control strategies. Ratio control. Cascade control. Inferential control.
Selective control.

6th week

Proportional signal transmission. Block diagram algebra. Block diagram reduction rules. Determination of equivalent summation amplification factor of FBC systems. Regulatory and servo operational mode of FBC systems.

7th week

Signal transmission. Basics of mathematical modelling. Total mass, component, energy and momentum conservation equations of chemical equipments and describe these balance equations for CSTR with exothermic first order chemical reaction. Solutions of different examples.

8th week

Solutions of different examples for CSTR.

9th week

Signal transmission. The basics of dynamic behaviour. The basics of transient behaviour. The signal transmission of hardware elements of process control which can be describe with ordinary linear differential equations (ODEs). The general equation of signal transmission in the time domain. Forcing functions, typical test signals.

10th week

Standard dynamic behaviours of hardware elements and processes. Proportional (P), integrative (I), derivative (D), first order process (PT_1), second order process (PT_1T_2) and n-order process ($PT_1...T_n$).

11th week

Forcing functions' indicated respons functions of different behaviour of hardware elements and processes. Practical examples.

12th week

Difference between steady-state behaviour and dynamic behaviour of chemical equipments. Operational point and operational line. Characteristic curves and diagrams of time domain. Transient operational mode of chemical equipments.

13th week

Self regulating and unstable systems. Practical examples for self regulating systems and them operational point.

14th week

exam

Requirements:

- for a signature

Participation in lectures and seminars. *The total number of absences for the semester does not exceed three (3).*

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

- for a grade

At the end of the course based on the result of written exam (100%).

0 % - 40 % mark: 1 (fail), > 40 % - 60 % mark: 2 (pass, sufficient), > 60 % - 77 % mark: 3 (satisfactory or average), > 77 % - 90 % mark: 4 (good), > 90 % mark: 5 (excellent).

In the case of failure to perform of first exam, it is possible to write a second written exam.

Person responsible for course: Dr. István Árpád, assistant professor, PhD

Lecturer: Dr. István Árpád, assistant professor, PhD

Title of course: Process Control II. **Code**: TTKBG0613_EN	**ECTS Credit points:** 3

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 42 hours
- laboratory: -
- home assignment: 48 hours
- preparation for the exam: -

Total: 90 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Process control I. (TTKBG0612_EN)

Further courses built on it: -

Topics of course

Process control systems with hardware elements which are described with ODE. Determination of equivalent summation function in time domain of these FBC systems used Laplace transformation. Frequency response analysis and the Bose and Nyquist diagrams. Stability requirements for process control systems. Basics of selection, adjustment and tuning of different controller (P, PI, PID).

Literature

Compulsory:

1) Seborg D. E., Edgar T.F., Mellichamp D. A., Doyle III F. J.: Process Dynamics and Control., Third Edition, published by John Wiley & Sons, Inc., 2011

Recommended:

2) Ingham J., Dunn I.J., Heinzle E., Prenosil J.E., Snape J.B.: Chemical Engineering Dynamics. An Introduction to Modelling and Computer Simulation., Third completely revised ed., WILEY-VCH Verlag GmbH, Weinheim, 2007
3) Smith A.C, Corripio A.B.: Principles and Practice of Automatic Process Control. Second ed., 2007
4) Luyben W.L.: Process Modeling, Simulation, and Control for Chemical Engineers. McGraw-Hill, International Edition, 1996.
5) Stephanopoulos G.: Chemical Process Control. An Introduction to Theory and Practice., published by Prentice Hall PTR, Englewood Cliffs, New Jersey, 1984
6) Bequette B. W.: Process Dynamics. Modeling, Analysis, and Simulation., Prentice Hall International Series in the Physical and Chemical Engineering Sciences, Prentice Hall PTR, 1998
7) Elnashaie S. S. E. M., Garhyan P.: Conversation Equations and Modelling of Chemical and Biochemical Processes., published by Marcel Dekker, Inc., 2003

Schedule:

1st week

Introduction. Repeat of standard dynamic behaviours chemical equipments and process control systems. Dead time.

2nd week

Oscillating second order process (PξT). Examples for PξT.

3rd week

The Laplace Transform. Example for solution of ordinary linear differential equations.

4th week

Definition of transfer function. Transfer functions of different dynamic behaviour elements.

5th week

Examples for determination of response function in time domain used Laplace transformation.

6th week

Transfer function of FBC with proportional (P) controller. Comparison the behaviour of process with controller and without controller. Residual control discrepancy. Transfer function of FBC with integral (I) controller.

7th week

Stability of dynamical systems. Stability condition according to Lyapunov. Stability in the Laplace-domain. Determination of stability on the basis of the locations of roots of characteristic polynomial equation (root-locus analysis).

8th week

Routh-Hurwitz criterion.

9th week

Periodical (cosine) function as a typical test signal. Frequency response analysis. Nyquist and Bode diagrams.

10th week

Nyquist and Bode diagrams of different behaviour elements.

11th week

Geometrical conditions of stability, Nyquist and Bode criteria. Impact of dead time.

12th week

Basics of selection, adjustment and tuning of different controller (P, PI, PID). Ziegler-Nichols tuning technique.

13th week

Introduction to using of Matlab Control System Toolbox and Simulink software systems.

14th week

exam

Requirements:

- for a signature

Participation in lectures and seminars. *The total number of absences for the semester does not exceed three (3).*

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

- for a grade

At the end of the course based on the result of written exam (100%).

0 % - 40 % mark: 1 (fail), > 40 % - 60 % mark: 2 (pass, sufficient), > 60 % - 77 % mark: 3 (satisfactory or average), > 77 % - 90 % mark: 4 (good), > 90 % mark: 5 (excellent).

In the case of failure to perform of first exam, it is possible to write a second written exam.

Person responsible for course: Dr. István Árpád, assistant professor, PhD
Lecturer: Dr. István Árpád, assistant professor, PhD

Title of course: Mathematics III. **Code**: TTMBG0804_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

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

Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Mathematics II. (TTMBE0803_EN)

Further courses built on it:

- Mathematical modelling of biological systems (TTMBE0805_EN)
- Numerical mathematics (TTMBG0806_EN)

Topics of course

Random experiments and event algebra. Axiomatic definition of probability, classical model of probability. Independence, conditional probability, law of total probability, Bayes's theorem. Discrete and continuous random variables, mean, variance and standard deviation. Important distributions. Joint distribution of random variables, independence, covariance, and correlation. Normal distribution and related distributions. Numerical and graphical summaries of data. Point estimators, the method of moments and the maximum likelihood method. Interval estimates. Basics of hypothesis testing, testing the mean, the variance, and the population proportion in single and multiple populations.

Literature

Compulsory:

-

Recommended:

Douglas C. Montgomery, George C. Runger. Applied Statistics and Probability for Engineers, 5th edition. John Wiley & Sons, 2010.

Schedule:

1st week

Random experiments and event algebra. Axiomatic definition of probability through relative frequency. Classical model of probability and counting techniques.

2nd week

Independence of events. Conditional probability, law of total probability, Bayes's theorem. The Simpson's paradox.

3rd week

Discrete random variables, distribution, mean, variance and standard deviation. Important discrete distributions.

4th week

Continuous random variables, probability density function, mean, variance and standard deviation. Important continuous distributions.

5th week

Joint distributions of random variables, contingency tables, marginal distributions. Independence of random variables, covariance, correlation.

6th week

Normal distribution and related distributions, Student's t distribution, chi-squared distribution, F distribution. Statistical tables.

7th week

Statistical sample, numerical summaries of data, mean, standard deviation, quantiles. Graphical summaries of data, histogram, cumulative frequency plot, box plot.

8th week

Point estimators, method of moments, maximum likelihood method. Interval estimators, confidence intervals for mean, variance, and population proportion.

9th week

Basics of hypothesis testing, test statistic, distribution, critical values, acceptance and rejections, type I and type II errors. Testing the mean of a single population.

10th week

Testing the difference of the mean of two independent populations. Testing the variance of a single population and the difference of variance of two independent populations.

11th week

Testing the proportion of a single population and the difference of proportion of two independent populations. Normality testing and graphical methods.

12th week

Case studies for efficient and inefficient applications of statistics in real life situations.

13th week

Preparation for the final test, solution of the sample 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 a written test 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 – 70	satisfactory (3)
71 – 85	good (4)
86 – 100	excellent (5)

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

-an offered grade:

It is not possible to obtain an offered grade in this course.
Person responsible for course: Prof. Dr. Ákos Pintér, university professor, DSc
Lecturer: Prof. Dr. Ákos Pintér, university professor, DSc

Title of course: Analytical chemistry II. (practice) **Code**: TTKBL0513_EN	**ECTS Credit points:** 3

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: –
- practice: –
- laboratory: 42 h
- home assignment: 48 h
- preparation for the exam: –

Total: 90 h

Year, semester: 2nd year, 2st semester

Its prerequisite(s):
- Analytical Chemistry I. (TTKBE0501_EN)
- General Chemistry II. (TTKBL0101_EN)

Further courses built on it: Application of Instrumental Analysis (practice) (TTKBL0512_EN)

Topics of course

This practice trains the students in quantitative analytical chemistry laboratory operations. The students will perform quantitative analytical measurements using classical titration methods. Acid-base, redox, argentometric and complexometric titrations will be performed. In each practice the students have to analyse an unknown sample and hand in the results for evaluation.

Topics of course

Acid-base, redox, argentometric and complexometric titrations

Literature

Recommended:
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 $Na_2S_2O_3$ by measuring the acid formed in the oxidation reaction of $Na_2S_2O_3$ with bromine.

5th week
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).
Preparation of 0.02 M potassium bromate titrant (250.00 ml).

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 Na_2EDTA 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, senior research fellow, PhD
Lecturer: Dr. Csilla Kállay, senior research fellow, PhD

Title of course: Application of Instrumental Analysis I. **Code**: TTKBE0512_EN	**ECTS Credit points: 1**

Type of teaching, contact hours

- lecture: 1 hours/week
- practice:
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 14 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 16 hours

Total: 30 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Analytical Chemistry I. (TTKBE0501_EN)

Further courses built on it: Application of Instrumental Analysis (practice) (TTKBL0512_EN)

Topics of course

Basic concepts, theoretical and practical aspects, carry-out and use of fundamental laboratory and industrial scale separation processes related to the instrumental analytical chemistry. Set-up, major components and basic operation principles of modern analytical instruments using separation methods in their working methods.

Literature

Compulsory:

1) Separation process principles: chemical and biochemical operations / J. D. Seader, Ernest J. Henley, D. Keith Roper.—3rd ed. 2011, ISBN 978-0-470-48183-7, John Wiley & Sons, Inc.
2) Modern analytical chemistry / David Harvey. — 1st ed., 2000, ISBN 0–07–237547–7, The McGraw-Hill Companies, Inc.

Recommended:

3) Modern HPLC for practicing scientists / by Michael W. Dong., 2006, John Wiley & Sons, Inc., Hoboken, New Jersey, ISBN-13: 978-0-471-72789-7
4) Modern size-exclusion liquid chromatography / André M. Striegel et al., 2nd ed., 2009 by John Wiley & Sons, Inc., ISBN 978-0-471-20172-4
5) Modern practice of gas chromatography., 4th ed. / edited by Robert L. Grob, Eugene F. Barry. 2004 by John Wiley & Sons, Inc., ISBN 0-471-22983-0
6) Affinity Chromatography Methods and Protocols, 2nd Ed., Ed. by Michael Zachariou, 2008, Humana Press, a part of Springer Science+Business Media, LLC, ISBN: 978-1-58829-659-7
7) Gel Electrophoresis of Proteins A Practical Approach, 3rd Edition, B. D. Hames, Oxford University Press, 1998, ISBN 0-19-963641-9

Schedule:

1st week

Basic concepts of separation processes. Removal of solvents from a mixture by different techniques: partial evaporation, batch and continuous mode thin film evaporators and concentrators. Partial evaporation by a rotating and circulating gas flow. Centrifugal evaporators.

2nd week

Partial freezing, removal of frozen solvent crystals, increase of concentration. Spray drying, freeze drying. Instruments of spray drying, practical use of spray dryin for the production of drugs, and foods. Instruments of freeze drying, laboratory scale to industrial production. Freeze-dried food production and use.

3rd week

Separation of solid mixtures by physical methods: air flow sedimentation, selective dissolution, magnetic separation, flotation. Separation by solubilities, fractionated crystallization, crystallization. Stoke's law. Removal of solids from liquids and gases: sedimentation, centrifugation, cyclons, ultracentrifugation. Separation of emulsions by special centrifuges. Gas separation and isotopes enrichments with gas centrifuges.

4th week

Filtration: basic concepts, formation and role of filter cakes. The good laboratory practice of filtration. Removal of dust from gas streams, industrial sack-type filteres, filter candles, electrostatic dust collectors. Types of filter media, filter papers, filter membranes. Filtration apparatuses. Vacuum filtration, pressure filtration. Tangential filtration.

5th week

Extraction: liquid-liquid liquid-solid and liquid-gas processes. From laboratory scale to undustrial liquid-liquid extractors, the role of density, practical uses. Basic rules of extraction, disribution coefficients, selectivites, design of an extraction scheme. Soxhlet extractors, heated and non-heated types. Solid phase extraction (SPE) and solid phase microextraction (SPME), use of SPME in sample preparation. Osmosis, dialysis, reverse osmosis instruments and their use in drinking water production. Membrane dialysis, separation of molecules by size, medical application, hemodialysis.

6th week

General aspects and types of different chromatographic techniques. Grouping of techniques by the dimension of the separating medium. Layer chromatographies: paper chromatography (PC), thin layer chromatography (TLC). Basics of TLC: tools, chambers, separation modes, geometry, types of layers, calculations, visualization and evaluation methods. Computer aided analysis of TLC and HPTLC plates. Two-dimensional TLC.

7th week

Gas chromatography 1: Definition, basics of intruments. Sample preparation for chromatographic analysis: concentration, dissolution, filtration, extraction, head-space sampling, SPME, derivatization, adsorption. General setup, gas supply system , rotating and robot arm sample holders, injectors. The inlet: the key role of rapid sample evaporation.

8th week

Gas chromatography 2: Types of inlets, oven, temperature control, gas chromatography detectors (FID, ECD, MS). Types of analytes that can be measured by the given detectors. Working principles of FID? ECD and MS detectors. Preparative gas chromatography. Web communication within and outside of laboratories. 2D-gas chromatography (2D-GCxGC).

9th week

High pressure liquid chromatography (HPLC) 1. Basic principles, structure, potential fields of applications. Separation mechanisms and separation modes. Most important structural units and components of the HPLC instrument. Solvent supply system, degass station. Role of degassing, different degassing modes. Graadient formation unit. HPLC pumps, workin g principles, types, role of depulser. Major types of HPLC columns. Stationary phases, normal phase and reversed phase.

10th week

HPLC detectors, their working principles, structure, mode of use. (UV-Vis, scanning UV-Vis, dioade array, refractive index, fluorescence, evaporative light scattering, and mass spectrometry detectors). Isocratic and gradient elutions. Characterization of the chromatograms. Preparative HPLC.

11th week

Low pressure chromatography. Traditional, classic column chromatography, dry column chromatography, flash chromatography. Basic operating techniques, limits of separations, hardware requirements, manual mode and instrumentation.

12th week

Affinity chromatography. General principles, hardware requirements, special interaction between the stationary phase and the analytes. Elution of the analytes. Operation in column mode and in the batch mode.

13th week

Gel chromatography. Basic principles, working concepts. Dead volume, gel volume, exclusion limit, penetration. Measurement of the bed volume, separation of large molecules. Bed making, conditioning. Separtion of smaller molecules in organic solvent gel system. Characterization of the gel chromatograms, calculation of the molar mass.

14th week

Gel electrophoresis. Basic principles, translation of ions within a gel by the external electric potential. Types of gel materials, their use in the separation of proteins and nucleic acids. Vertical and horizontal electrophoresis chamber, gel casting, use of the comb. Loading of samples. Development of the gel. Visualization of the gel electroferograms, blotting. Computer aided evaluation and documentation.

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 50 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-88	good (4)
89-100	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.

Person responsible for course: Dr. István Lázár, associate professor, PhD

Lecturer: Dr. István Lázár, associate professor, PhD

Title of course: Application of Instrumental Analysis (practice) **Code**: TTKBL0512_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

- lecture: -
- practice: -
- laboratory: 3 hours/week

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice:
- laboratory: 42 hours
- home assignment: 48 hours
- preparation for the exam: -

Total: 90 hours

Year, semester: 3nd year, 2st semester

Its prerequisite(s):

- Application of Instrumental Analysis, lecture, (TTKBE0512_EN)
- Analytical Chemistry II., practice, (TTKBL0513_EN)

Further courses built on it: -

Topics of course

The series of laboratory practices are based on the topics of different intsrumental analysis like electrophoresis, atomic spectrometry, electroanalysis, validation, spectroscopic methods (atomic spectrometry, UV/vis, HPLC). The instrumental laboratories are connected to the topics of the Instrumental Analysis lecture.

Literature

1. Daniel C. Harris: Quantitative Chemical Analysis, 7th Ed., 2007, Freeman and CoH.H.
2. Willard, L.L. Merritt, J.A. Dean, F.A. Settle: Instrumental methods of Analysis, Wadsworth Publ. Co., Belmont, 1988.
3. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch: Fundamentals of Analytical Chemistry, 8th. ed., 2004, Brooks/Cole
4. Syllabuses provided by the tutor.

Schedule:

1st week: Introductory guidance, accident protection (2h)

2nd week: Evaluation of chromatograms (8h)

3rd week: UV-vis spectroscopy (6h)

4th week: High Performance Liquid Chromatography II (6h)

5th week: Atomic spectroscopy (6h)

6th week: pH-metry (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: Dr. Ádám Kecskeméti, assistant research fellow, PhD

Lecturer: Dr. Ádám Kecskeméti, assistant research fellow, PhD

Title of course: Bioprocess Engineering I. **Code**: TTBBE0571_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

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

Evaluation: exam

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): -

Further courses built on it:

- Bioprocess Engineering II. (TTBBE0572_EN)
- Bioprocess Engineering II. Practice (TTBBL0572_EN)

Topics of course

Economic significance of biotechnology, major products, production statistics and trends. Microbial (viral, procaryotic, yeast and fungal) growth kinetics – parameters of growth and analysis of growth data. The isolation, preservation and improvement of industrial microorganisms. Microbial stochiometry. Media for industrial fermentations. The development of inocula for industrial fermentations. Batch, fed-batch and continuous flow cultures. Multistage systems, feedback systems. The application of continuos culture in industrial processes, strain isolation and improvement. Application of fed-batch culture. Design of a fermenter. Agitation and aeration. Fluid rheology. Foaming and its control. The packed tower, the Waldhof-type, the cyclone column, the air-lift, deep-jet and rotating disc fermenter. Acetators and cavitators. Sterilization of fermenters and vessels, liquid media and gases. Aseptic operation and containment.

Literature

Compulsory:
- Stanbury PF, Whitaker A: Principles of Fermentation Technology, Pergamon Press, Oxford, UK, 1984

Recommended:
- McNeil B, Harvey LM: Fermentation: a Practical Approach. IRL Press, Oxford, UK.
- Pirt, SJ: Principles of Microbe and Cell Cultivation. Blackwell Scientific Publications, Oxford, UK.
- Wang DIC, Cooney CL, Demain AL, Dunnill P, Humphrey AE, Lilly MD: Fermentation and Enzyme Technology. John Wiley & Sons, New York, U.S.A.

Schedule:

1st week: Introduction. Presentation of the objectives of the lecture series and their connection with other knowledge acquired during the course. The meaning and interpretation of fermentation, fermenter, bioreactor, fermentation technology.

2nd week: The chronological development of the fermentation-biotechnology industry: the biotechnology of antiquity and the Middle Ages (beer, wine, vinegar, bread, curd, cheese, cottage cheese, use of filtered broth for wound treatment). Spreading the scientific results of the 18-19th centuries to the fermentation industry (heat exchanger, thermometer, metal containers, breweries).

3rd week: The media of industrial fermentation. Repeating the concept of heterotrophy, autotrophy, phototropicality, photoorganotrophy, chemolitotrophy, chemoorganotrophy through examples. Comparison of media requirements of laboratory and production-scale fermentations.

4th week: The kinetics of cell growth. Properties of the ideal culture. Interpretation of cell count and biomass. Temporal changes in substrate, biomass and product concentrations during batch fermentation. Concept and calculation of generation time.

5th week: The estimation of growth. The importance of biomass measurement. The basic principles of the measurement: indirect and direct methods. The methods of practical measurement: weighing, volume or length determination, weight measurement of a component of biomass, quantitative determination of the consumed substrate, quantitative determination of the product, light scattering, cell counting, staining methods.

6th week: Continuous cultures. Principles of the chemostat theory. The definition and derivation of dilution rate. The degree of cell growth in the chemostat, the ratio of the dilution rate and the specific growth rate, the formation of steady-state status.

7th week: Isolation of microorganisms of industrial importance. The microbiological meaning of the term 'isolation' and the significance of the process. Criteria for selecting microorganisms used in biochemical engineering. Theoretical possibilities of obtaining the required strain.

8th week: Strain improvement of microorganisms of industrial importance. The significance and aims of strain improvement. Definition of prototrophy and auxotrophy. A brief description of the genetic material of microorganisms (prokaryotes and eukaryotes).

9th week: Sterilization. The microbiological meaning of the term, its importance in the work of biochemical engineer. Sterility criteria. Kinetics of the process of sterilization. Inoculation production. Interpretation of the concept. Criteria for optimum inoculum. Qualitative and quantitative comparison of inoculum culture and producer culture.

10th week: Design of bioreactors. Basic functions of a bioreactor and the most important requirements. The material, structure, dimensions and proportions of the fermenter, depending on the size and function of the fermenter. Structure of mechanically stirred tank reactor. Types of air-lift reactors, their construction, operation and application.

11th week: Quantitative issues of oxygen demand and oxygen supply. Oxidation of glucose and oxygen demand for aerobic respiration. The total oxygen demand of the fermentation. The carbon source dependence of oxygen demand. The relationship between biomass concentration and oxygen demand.

12th week: Significance of controlled environment in the success of the fermentation process. Basic elements of the control system (control circuit): the variable, the sensor, the transducer and the regulator. Control options: manual control, automated control.

13th week: The cost of product recovery within the fermentation process. The product's localization, product concentration, chemical and physical properties of the product, intended use of the product, product purity criteria, contaminants in fermentation, the price of the product, and their effects on the recovery process.

14th week: Recovery of Intracellular Products: cell disruption. Physical-mechanical possibilities of cell disruption: high-pressure liquid homogenizers (Manton-Gaulin homogenizer), solid state homogenizers (X-press, French-press), rotary disk homogenizers.

Requirements:

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

- for a grade
The students have to complete an oral exam.

Person responsible for course: Dr. Levente Karaffa, associate professor, DSc

Lecturer: Dr. Levente Karaffa, associate professor, DSc
Dr. Erzsébet Fekete, associate professor, PhD

Title of course: Bioprocess Engineering II. **Code**: TTBBE0572_EN & TTBBL0572_EN	**ECTS Credit points:** 3+3

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: 3 hours/week
- laboratory: -

Evaluation: exam, mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: 42 hours
- laboratory: -
- home assignment: 50 hours
- preparation for the exam: 60 hours

Total: 180 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Bioprocess Engineering I. (TTBBE0571_EN)

Further courses built on it: -

Topics of course

To provide additional basic knowledge in bioengineering science not discussed in Part I. In addition, via a compact lab course attached to this lecture set, we want to ensure that our student understand the most crucial and widespread techniques of bioengineering in practical terms, too.

Description of the course: Fermenter instrumentation and control. Sensors. Control systems – manual and automatic control. On-line analysis. Cell morphology and its impact on product formation. The recovery and purification of fermentation products. Filtration, centrifugation, cell disruption, liquid-liquid extraction, solvent recovery, chromatography, crystallization, whole-broth processing. Effluent treatment – physical, chemical and biological treatment. Aerobic and anaerobic treatment. Fermentation economics: producing costs, market potential. Processes and operations using enzymes. Enzyme isolation. Classification of enzymes of industrial importance. Kinetics of enzymes. Enzyme reactions in homogenous and heterogenous phase. Principles of enzyme and whole-cell based bioconversions. Enzyme immobilization.

Description of the practical course: Laboratory-scale (10 L), submerged, batch fermentation of a filamentous fungus will be monitored and analysed. Time-profiles of carbon source consumption, oxygen uptake rate, biomass, carbon dioxid and product formation rate are determined by standard bioanalytical equipments (HPLC, GC, ion-exchange chromatography). Demonstration of certain downstream processing techniques such as adsorption evaporation, filtration and dialysis. Qualitative and quantitative analysis of alcohol production by yeast.

Literature

- Stanbury PF and Whitaker A: Principles of Fermentation Technology. Pergamon Press, Oxford, UK.
- McNeil B, Harvey LM: Fermentation: a Practical Approach. IRL Press, Oxford, UK.
- Pirt, SJ: Principles of Microbe and Cell Cultivation. Blackwell Scientific Publications, Oxford, UK.
- Wang DIC, Cooney CL, Demain AL, Dunnill P, Humphrey AE, Lilly MD: Fermentation and Enzyme Technology. John Wiley & Sons, New York, U.S.A.

Schedule:

1st week: Production of organic acids by bacteria and fungi.

2nd week: Technological parameters of citric acid production.

3rd week: Production of gluconic acid and acetic acid. Biochemistry of the formation of gluconic acid and acetic acid.

4th week: Overview of amino acids and their physical and chemical characteristics. The biochemical background of amino acid overproduction.

5th week: Biochemistry and technology of glutamic acid production. Preparation and application of poly-γ-glutaimc acid.

6th week: Biochemistry and technology of lysin acid production

7th week: Biochemistry and technology of threonine, phenylalanine and tryptophan production

8th week: Biofuels vs. fossil fuels. Ebergy recovery from biomass. The technology of bioalcohol production.

9th week: Options for using biodiesel. Production of biodiesel. The technology of biogas formation.

10th week: Overview and grouping of vitamins. Physiological role and production of vitamin C. Production methods of B12 vitamin.

11th week: Grouping of β-lactam antibiotics: penam, cephem, clavam, carbapenem, monolactam. Ampicillin, amoxicillin. *Penicillium chrysogenum* and *Acremonium chrysogenum*. Penicillin and cephalosporin biosynthesis.

12th week: ß-lactam production: strain development (classical and molecular methods), technological developments. Recovery and purification of penicillin and cephalosporin C.

13th week: Aminoglycoside (streptomycin, gentamicin, kanamycin, neomcin, tobramycin) and tetracycline (oxy tetracycline, aureomycin) antibiotics. Structure, producing microorganisms, mechanism of action, biosynthesis. Production technology (fermentation, extraction*)*.

14th week: Mechanism of antifungal agents. Biochemistry, microbiology and production technology of polypeptide type antibiotics.

Requirements:

- for a signature

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

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. Levente Karaffa, associate professor, DSc
Lecturer: Dr. Levente Karaffa, associate professor, DSc Dr. Erzsébet Fekete, associate professor, PhD Dr. Norbert Ág, assistant professor, PhD Dr. Ákos Péter Molnár, assistant professor, PhD

Title of course: Basic Engineering **Code**: MFMIS31K03-EN	ECTS Credit points: 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hour/week - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 25 hours - preparation for the exam: 23 hours Total: 90 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: • Unit operations I. (TTKBG0614_EN) • Safety (TTKBE0711_EN)	

Topics of course

It reviews the fundamental rules of the formal requirements of the technical drawing, the drawing of the projections, profile and sectional drawing of the components. After that it deals with the drawing of standardized machine elements and the concept of manufacturing tolerance and fitting, dimensional specification, geometrical and positioning tolerance, surface irregularity. Contact among machine elements. Elements for energy process in machine systems. Elements for material flow in machine systems: pipes, pipe fittings, tanks etc. Structural materials. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis. Alloy steel and non-ferrous metals. Modification of material properties by heat treatment. Non-destruction tests. Notation of steel. Formation of welded bound by smelting processes. Destruction tests and non-destruction tests of welded bounds. Works of chemical machines: determination of machine, grouping. Types of energy, energy sources. Efficiency.

In seminar there are four tasks to elaborate: to elaborate the workshop drawing of different machine elements and components.

Literature

Compulsory:

- TIBA.: Machine Drawing, ISBN 978-963-318-066-2, Debrecen University Press 2010.
- J.-P. Mercier: Introduction to Materials Science, Elsevier, 2002.
- M. F. Ashby: Materials Selection in Mechanical Design. 3.rd edition. Elsevier. London, 2005. ISBN 0-7506-6168-2.
- William D. Callister, David G. Rethwisch: Fundamentals of materials science and engineering : SI version, John Wiley and Sons, 2013., ISBN 978 1 118 32269 7

Schedule:

1st week:

Lecture: Drawing standards, formal requirements of machine drawings. Drawing sheet dimensions, title block, defining the line types and thickness groups. Standardized letter and figure shape and sizes, scales, full size, reduction scales, enlarged scales.

Practice: issuing the task 1: Lettering

2nd week:
Lecture: Defining the surfaces of a part. Presentation method in machine drawing, views, auxiliary view, local view, breaking, sectional views and sections.
Practice: issuing the task 2: Drawing Machine Parts. Practicing the presentation methods.

3rd week:
Lecture: Complex sectional views, removed element, removed sections, specific sectional views and sections, conventional practice in machine drawing.

Practice: submitting the task 1: Lettering, elaborating the task 2. Practicing the presentation methods.

4th week:
Lecture: General prescriptions for dimensioning, choosing basis surfaces. Conventional dimensioning methods.
Practice: elaborating the task 2. Practicing the presentation methods.

5th week:
Lecture: ISO Tolerance system. Basic size, actual size, limits, deviations, fundamental deviation

Practice: Applying the dimensioning methods to dimensioning parts. Submitting the task 2. Issuing the task 3.

6th week:
Lecture: ISO Tolerance system. Defining fits: clearance, transition and interference fit.

Practice: elaborating the task 3.

7th week:
Lecture: Threaded joints. Spring, Keyed joints, splined shaft joint. Gears and toothed parts. Rolling bearings. Welded joints: butt joint, lap joint, tee joint, corner joint.

P**ractice:** Submitting the task 3.

8th week:
Mid-term test
Lecture: Defining and calculating loads, and stresses.

Practice: Calculating and drawing load diagrams.

9th week:
Lecture: Contact among machine elements. Elements for energy process in machine systems. Elements for material flow in machine systems: pipes, pipe fittings, tanks etc.

Practice: study drive train components in the lab.

10th week:
Lecture: Mechanical properties of metals. Concepts of stress and strain. Elastic, plastic deformation. The difference between the theoretical and practical strength of the materials.

Practice: Tensile test. Charpy impact test.

11th week:
Lecture: equation of energy equilibrium. Defining and calculating stresses in different load situations. Works of chemical machines: determination of machine, grouping. Types of energy, energy sources. Efficiency.

12th week:
Lecture: Structural materials. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis.

Practice: Destructive test methods.

13th week:
Lecture: Alloy steel and non-ferrous metals. Modification of material properties by heat treatment. Non-destructive tests. Notation of steel.

Practice: Non-destructive test methods.

14th week:
Mid-term test
Lecture: Formation of welded bound by smelting processes. Destruction tests and non-destruction tests of welded bounds.

Practice: Conducting destructive and non-destructive tests.

Requirements:

Attendance on the **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Student must attend the practices and my not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices 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 for the course with them to each practice. Active participation is evaluated by the teacher in every class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.

Students have to **submit all the drawing tasks** as scheduled minimum on a sufficient level and take part in the lab tests.

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

B, for grade:

The course ends with **exam grade**.

The grade of 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: Dr. Zsolt Tiba, college professor, PhD

Lecturer: Dr. Zsolt Tiba, college professor, PhD
Dr. Sándor Pálinkás, associate professor, PhD

Title of course: Unit Operations I **Code**: TTKBG0614_EN	**ECTS Credit points:** 5

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: 3 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: 42 hours
- laboratory: -
- home assignment: 40
- preparation for the exam: 40 hours

Total: 150 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s):

- Basic Engineering (MFMIS31K03-EN)
- Organic Chemistry I. (TTKBE0301_EN)

Further courses built on it: Unit operations II. (TTKBG0615_EN)

Topics of course

The essence of chemical engineering science. Unit Operations of Chemical Engineering. Basis of chemical engineering thermodynamics of unit operations. Quantities describing the operational unit. Measurement, units and dimensions in chemical engineering. Conversion of units. Conditions of thermal, mechanical and component equilibriums. Transport processes, component, heat and momentum streams. The extended- Damköhler's equation. The classification of operational units. The theory of similitude, dimensional analysis. Flow of fluids, energy and momentum relationships. Pumping of fluids. Pumps, compressors and vacuum pumps. Separation of heterogeneous systems: Sedimentation, filtration, centrifugation, mixing of liquid, gas cleaning.

Literature

Compulsory:

McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill

Richard G. Griskey:Transport phenomena and unit operations: a combined approach, (2002), Wiley, ISBN 0-47 1-43819-7

Christie J Geankoplis: Transport processes and unit operations (1993), 3rd edition, Prentice-Hall, ISBN 0-13-045253-X

J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Third Edition. Pergamon Press. Oxford

Schedule:

1st week

Definition and classification of unit operations. batch and continuous processes. Flowsheets.

2nd week

Physical quantities, units, dimensions. The SI system. Extensive and intensivequantities. Dimensional and tensorial homogenity. Scalar-vector-tensor quantities.

3rd week
The fundamental equation of thermodynamics. Conditions of equilibrium, driving force, rate of processes. Degrees of freedom of a chemical system.

4th week
Flows and fluxes. Scalar and vector fields and their derivatives. The Nabla vector, gardient and divergence.

5th week
The general transport equation. Differential and integral form of balance equations valid for one and two phase unit operations. The Damköhler equations. The Onsager theory.

6th week
The mathematical model. Initial and boundary conditions. Balance equations for simple systems: Fourier-I and Fick-I laws.

7th week
Similitude and modelling. Dimensional analysis, dimensionless numbers.

8th week
Mass and energy balances for simple and complex unit operations.

9th week
Flow in unpacked pipes and in pipelines: Fluids in rest, Pascal's law. Navier-Stokes equations. Bernoulli equation. Cavitation. Newtonian and non-Newtonian fluids. Newton's law of viscosity.

10th week
Basic types of fluid flow. Reynolds' experiment. Hagen-Poisseuille equation. Modified Bernoulli equation. Fanning equation. Moody diagram. Energy requirement of fluid transport. Types of pumps.

11th week
Flow near solids, in packed columns: Flow around immersed objects. Interpretation of Reynolds number. Types of flow around spherical particles. Stokes' law for the frictional force. Drag coefficient for laminar, transitional and turbulent regions. Ergun equation. Packed columns, characteristics and types of packings. Methods of flow measurement.

12th week
Basics of filtration. Darcy's law of filtration. Batch filtration using constant pressure, continuous filtration using constant flow rate. Filtration units. Filtration using centrifugal force. Types of centrifuges. Basics of membrane filtration. Concentration polarization.

13th week
Mixing of solids, apparatus. Mixing of fluids. Momentum balance for the agitator. Power requirement of agitation. Fluid mixers.

14th week

Terminal velocity of sedimentation. Stokes' law. Drag coefficient as a function of Reynolds number. Apparat us for settling, dust removers, cyclones.

Requirements:

- for a signature

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

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.

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

- for a grade

The course ends in an **examination**.

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 mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. Miklós Nagy, associate professor, PhD

Lecturer: Dr. Miklós Nagy, associate professor, PhD

Title of course: Unit Operations II **Code**: TTKBG0615_EN	**ECTS Credit points:** 5

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: 3 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 42 hours
- laboratory: -
- home assignment: 40 hours
- preparation for the exam: 40 hours

Total: 150 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): Unit operations I. (TTKBG0614_EN)

Further courses built on it: Unit operations III. (TTKBG0616_EN)

Topics of course

General characterization of transfer processes. Classification of transfer processes. Heat transfer. General characterization of heat transfer. Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat-transfer by convection. Heating and cooling. Heat transfer at standard- and changeable temperature difference. Unsteady- and steady state transfer of heat. The logarithmic mean temperature difference. Heat exchangers. Evaporation and crystallization. Evaporators and crystallizers. Cooling and coolers. Mass transfer processes. Mass transfer across a phase boundary, the two-film theory. Common interpretation of the operating line and the equilibrium curve. Mass transfer in the columns, the transfer units. Mass transfer in the cascades, the equilibrium units.

Literature

Compulsory:

McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill

Richard G. Griskey:Transport phenomena and unit operations: a combined approach, (2002), Wiley, ISBN 0-47 1-43819-7

Christie J Geankoplis: Transport processes and unit operations (1993), 3rd edition, Prentice-Hall, ISBN 0-13-045253-X

J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Third Edition. Pergamon Press. Oxford

Schedule:

1st week

Flow near solids, in packed columns: Flow around immersed objects. Interpretation of Reynolds number. Types of flow around spherical particles. Stokes' law for the frictional force. Drag coefficient for laminar, transitional and turbulent regions. Packed columns, characteristics and types of packings. Methods of flow measurement.

2nd week
Fluidization and pneumatic transport. Ergun equation. Geldart classification of powders.

3rd week
The heat equation. Types and calculation of heat transport. Steady state heat conduction in plane pipe walls. Fourier-I equation and thermal insulation.

4th week
Unsteady state heat conduction. Fourier-II equation. Dimensionless numbers for transient heat conduction: Fourier, Biot number and dimensionless temperature. Interpretation of the Heissler chart.

5th week
Boundary layer theory of heat transfer. The Nusselt and Prandtl number.

6th week
Forced convection heat transfer.

7th week
Natural convection heat transfer.

8th week
Radiation heat transfer and solution of complex heat transfer problems

9th week
Heat exchanngers. Stationary heat transmission with constant temperature difference through flat and cylindrical wall. Determination of heat flow and thermal resistances.

10th week
Direct and indirect heat exchange. Determination of the power requirement for a stationary recuperative heat exchanger. Temperature-space function of co-current and counter current heat exchangers. Logarithmic mean temperature difference. Types and apparatus of heat exchangers.

11th week
Boiling of liquids. Boiling curves. Critical heat flux of boiling. Leidenfrost effect.

12th week
The aim of evaporation, Calandria, falling film and Robert-type evaporator. Multistage evaporators and their connections.

13th week
Analogies between momentum and heat transfer. Chilton-Colburn analogy.

14th week
Practice.

Requirements:

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

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.

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

- for a grade

The course ends in an **examination**.

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 mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. Miklós Nagy, associate professor, PhD

Lecturer: Dr. Miklós Nagy, associate professor, PhD

Title of course: Unit Operations III **Code**: TTKBG0616_EN	**ECTS Credit points:** 5

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: 3 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: 42 hours
- laboratory: -
- home assignment: 40 hours
- preparation for the exam: 40 hours

Total: 150 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Unit operations II. (TTKBG0615_EN)

Further courses built on it: -

Topics of course

Mass transfer processes. Absorption. Evaporation. Distillation. Rectification. Extraction. Adsorption. Draying. Crystallization.Chemical reaction engineering. Chemical reactors. Classification of reactors and choice of reactor type in the industry. Chemical kinetics. Residence time and distribution of residence time. Batch reactors and continuous reactors. Influence of heat of reaction on reactor type. Isothermal, adiabatic polytrophic reactors. Mechanical operations. Size reduction of solids. Methods of operating crushers: coarse-, intermediate-, fine crushers and colloid mills. Classification of solid particles and settling. Blending of solid particles.

Literature

Compulsory:

McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill

Richard G. Griskey:Transport phenomena and unit operations: a combined approach, (2002), Wiley, ISBN 0-47 1-43819-7

Christie J Geankoplis: Transport processes and unit operations (1993), 3rd edition, Prentice-Hall, ISBN 0-13-045253-X

J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Third Edition. Pergamon Press. Oxford

Schedule:

1st week

Mass transfer theories. Two-film and boundary layer theory of component transfer.

2nd week

Absorption-desorption: Concentration-space diagram of a continuous counter current absorption unit operation. Equation of operating line.

3rd week
Transfer unit and its graphical determination. Chemisorption. Types of absorption-desorption apparatus.

4th week
Thermal separation operations: distillation: Batch and continuous distillation, rectification. The aim of evaporation.

5th week
Operating point. Types and parts of a continuous rectification apparatus. Operating lines of a rectifier. The q-line. Equilibrium stage, its determination using McCabe-Thiele diagram.

6th week
Liquid-liquid extraction. Ternary phase diagram. Distributional diagram of the key component. Batch and continuous extraction. Continuous one-stage mixer-settler extractor. Liquid-solid extraction and its apparatus.

7th week
Crystallization and its phase diagram. Apparatus for crystallization.

8th week
Drying. Types of moisture binding. Rate of drying. Enthalpy of moist air. Types, material-and energy balance of drying apparatus

9th week
Humidification.

10th week
Methods of feed preparation and surface increase: size reduction, sieving, vaporization, homogenization: Crushers and grinders. Energy requirement of size reduction. Screening and classification. Sieve analysis

11th week
Introduction to chemical reactors.

12th week
Classification of reactors based on flow, operation mode, component stream and heat. Operation time, residence time. Concentration-time and concentration-space functions of batch and continuous reactors.

13th week
Heat balance of a reactor. Stability of reactors.

14th week
Practice.

Requirements:

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

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.

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

- for a grade
The course ends in an **examination**.

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 mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. Miklós Nagy, associate professor, PhD

Lecturer: Dr. Miklós Nagy, associate professor, PhD

Title of course: Safety **Code**: TTKBE0711_EN	**ECTS Credit points:** 3

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

Evaluation: exam

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

Total: 90 hours

Year, semester: 3rd year, 1th semester

Its prerequisite(s): Basic Engineering (MFMIS31K03-EN)

Further courses built on it: -

Topics of course

-General safety rules.
- Describing major accidents and causes.
- Poisoning, noise.
- Inerting of chemical vessels.
- Hazards of electricity (Static electricity, Direct current and alternating current)
- Dangers of chemical reactions.
- Safety valves, regulation of pressure, solutions in case of emergency.

Literature

Recommended:

1. D. A. Crowl, J.F. Louvar: Chemical Process Safety, Pearson, Boston, USA (2011)
2. Roger L. Bauer: Safety and Health for Engineers, Wiley Interscience, New York (2005)
3. Richard J. Lewis ed.: Sax1s Dangerous properties of Industrial Materials, John Wiley (2005)
4. C. D. Classen, Caserett and Doull's Toxicology, McGraw-Hill, New York (2008)

Schedule:

1st week

General and basic security rules. Definition of accident, near-miss (quasi-accident) and first aid. Can we learn from accidents that have not happened?

2nd week

Accident statistics, industry comparison. Conclusions from the figures.

3rd week

Some major accidents are described, for example: in Bhopal, India (1984), Seveso, Italy (1976), Red Sludge (Red Mud) Disaster, Kolontar, Hungary (2010). Discussion of the possible causes of accidents.

4th week

Intoxications. Exposure and elimination of toxic substances to the body. Basic principles of toxicology. Definition of LD50. Cross effects of toxic substances, antidotes. Methanol poisoning.

5th week

Definition and classification of noise. Effect of the frequency and power of the noise. Dangers and diseases caused by noise. Work in a noisy workplace.

6th week

Purpose and implementation of inerting. Nitrogen-Purging, Vacuum, Pressure, Combination and Siphon Method. Advantages disadvantages. Simplification of a simple oxygen concentration calculation method..

7th week

Dangers of static electricity. Prevention of the formation of static electricity. The dust explosion. Electrical hazards. The role of insulation, earthing, residual current device (fi-relay) and fuse in the prevention of accidents

8th week

Dangers of chemical reaction. Run-away reaction and possible causes. Exothermic and/or gas producing reactions. Pyrophoric, peroxide-forming, reacting with water, highly oxidizing, self-reactive, impact-sensitive, heat-decomposing materials and their dangers.

9th week

Types of safety valves and their operation. Multiple protection. Comparison of safety valves, advantages and disadvantages.

10th week

Removal of excess pressure in case of danger. Technical solutions. Protective devices and their use.

11th week

Identification of hazards (environmental and safety). Solution options. Explosion limits of gas mixtures. Options for security protection.

12th week

Watching educational videos on safety. Learn the GHS pictograms and safety signs.

13th week

Consultation.

14th week

Test for a recommended grade.

Requirements:

Attendance at lectures is recommended, but not compulsory.

The course ends with test for a recommended grade. (This test is not compulsory!) The minimum requirement for the test is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-80	satisfactory (3)
81-90	good (4)
91-100	excellent (5)

The students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Prof. Dr. Sandor Kéki, university professor, DSc

Lecturer: Dr. György Deák, associate professor, PhD

Title of course: Environmental Technology **Code**: TTKBE1114_EN	**ECTS Credit points: 3**
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 6 hours - preparation for the exam: 56 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): General Chemistry II. (lab) (TTKBL0101_EN)	
Further courses built on it: -	

Topics of course

The Relationship Between Nature and Man (the Technosphere). Sustainable Development. Types of Industrial Waste, Possibilities to Prevent Their Formation. Additive, Environmentally Integrated Production and Product. Technological Methods for the Treatment of Different Types of Waste. Air and Water Pollutants, Wastewater Treatment. Soil Contamination and Management. Noise and Vibration Protection. Radioactivity. Renewable Energy Sources. Case Histories.

Literature

Compulsory:

- D.A. Vallero: Fundamentals of Air Pollution (Academic Press, 2007) ISBN: 780123736154
- N.L. Nemerow: Industrial Waste Treatment (Butterworth-Heinemann, 2007) ISBN: 9780123724939

Recommended:

- A. Malik, E. Grohmann: Environmental Protection Strategies for Sustainable Development (Springer, 2011), ISBN: 9789400715912
- J.E. Andrews, P. Brimblecombe,T.D. Jickells, P.S. Liss and B. Reid: An Introduction to Environmental Chemistry, 2nd edition, 2004 by Blackwell Science Ltd, ISBN 0-632-05905-2

Schedule:

1st week

Overpopulation (problems, effects and solutions). Causes of Environmental Pollution. Effects of Environmental Pollution (Greenhouse Effect, Global Warming, Climate Change).

2nd week

The Areas of the Environmental Protection. The Theory of the Sustainable Development.

3rd week

The Type and Composition of Waste.The Technology Sytem of the Waste Management (Selective Collection, Transportation, Pre-Treatment, Utilization, Disposal and Landfilling).
4th week
The Principles of the Product and Production Integrated Environmental Protection.
5th week
Waste processing technologies. Description of Major Waste Treatment Equipments (Shredders, Mills, Comminutors…).
6th week
Description of the Waste Collection, Separation and Sorting Equipments and Technologies.
7th week
The Type of Air Pollutants. Descripition of Technologies to Remove Air Pollutants.
8th week
The Different Type of Water Pollutants (Oil, Detergents, Pesticides, Organic Substances). Determining the Organic Pollution of Waters (BOD, COD, TOC)
9th week
Main Soil Components. Type of Soil Pollution. Treatments Technologies of Contaminated Soil.
10th week
Description of a Sewage Treatment Plant. Near-Natural Wastewater Treatment Technologies
11th week
Noise and Vibrations. Effects and Noise Abatement.
12th week
Effect of Radioactivity on the Human Body. Application of Radioactivity (Medicine, Energy Production).
13th week
Renewable Energy Sources (Solar Energy, Hydropower Wind Energy, Sea Energy, Geothermal Energy)
14th week
Case Histories About Great Environmental Pollutions and Their Effects.

Requirements: - *for a signature*
Attendance at **lectures** is recommended, but not compulsory.
During the semester there is a written end-term test in the 14th week. Students have to sit for the tests. The material of the test is the same as the exam. All questions cover several parts of the topics of the lectures and the sub-questions are scored according to the given points.
- for a grade
The course ends in a **written or oral examination**. Based on the result of the examination questions scored according to pre-set maximum points for each sub-questions. The type of the examination (written or oral) is the choice of the student.
The minimum requirement for the examination is 60%. Based on the score of the tests separately, the grade for the tests and/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 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 on the basis of the result of the end-term test if the grade is at least satisfactory (3).
Person responsible for course: Prof. Dr. Kéki Sándor, university professor, DSc
Lecturer: Illyésné Dr. Czifrák, Katalin, assistant professor, PhD

Title of course: Environmental technology **Code**: TTKBL1114_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 2 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 28 hours - preparation for the tests: 32 hours Total: 60 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): General Chemistry II. (lab) (TTKBL0101_EN)	
Further courses built on it: -	

Topics of course

Identification of plastic wastes using simple physical and chemical methods. Desalination of waste water on ion exchange column. Removal of floating particles from waste water by sedimentation. Determination of the solvent content of waste water by GC method. Adsorption of air pollutant organic solvent vapor on activated carbon. Measurement of plasticizer content (qualitative and quantitative) from waste materials.

Literature

Recommended:

1. Syllabus provided by the Department of Applied Chemistry
2. D.A. Vallero: Fundamentals of Air Pollution (Academic Press, 2007) ISBN: 9780123736154
3. N.L. Nemerow: Industrial Waste Treatment (Butterworth-Heinemann, 2007) ISBN: 978012372493912

4, A. Malik, E. Grohmann: Environmental Protection Strategies for Sustainable Development (Springer, 2011), ISBN: 978940071591

Schedule:

8th week

Identification of plastic wastes using simple physical and chemical methods.

9th week

Desalination of waste water on ion exchange column.

10th week

Removal of floating particles from waste water by sedimentation.

11th week

Determination of the solvent content of waste water by GC method.

12th week

Adsorption of air pollutant organic solvent vapor on activated carbon.

13th week

Measurement of plasticizer content (qualitative and quantitative) from waste materials.

14th week

Test writing.

Requirements:
The laboratory practices will be done in blocks (4 hours a week, 7 weeks).Attendance at laboratory practices are compulsory.

All measuring groups will prepare a laboratory notebook (laboratory record) after every practice.

The practice ends with a test for a partial grade. The test will cover the theoretical and the practical part of the laboratory practices. (The test is also compulsory!) The minimum requirement for the test is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

The practice grade will be calculated as a weighted average by the following way: 60% of the test result, 40% of the laboratory notebook.

Person responsible for course: Illyésné Dr. Czifák Katalin, assistant professor, PhD

Lecturer: Illyésné Dr. Czifák Katalin, assistant professor, PhD

Title of course: Visits to Biotech Companies **Code**: TTBBG0550_EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - home assignment: 2 - preparation for the exam: - Total:30 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: -	

Topics of course

Chemical, pharmaceutical and fermentation companies of regional or national importance will be visited upon to gain an insight into some of the production processes that occur there. In addition, the course wishes to facilitate communication between our senior students looking for a job and the companies seeking suitable applicants.
The course will be made available in each semester, thus our students should have the opportunity to visit and look around in some of the major regional and national plants of the chemical, pharmaceutical, fermentation, food-processing and dairy industry. The following companies host our students regularly: TEVA-Pharmaceutical Co. (Debrecen), Agroferm Co. (Kaba), Borsod Brewery Co. (Bőcs), Minna Dairy Co. (Miskolc), Tokaj Trading House Ltd. (Tokaj), Research Institute for Viticulture and Enology (Eger), Richter Gedeon Pharmaceutical Works Co. (Budapest-Kőbánya), Budafok Yeast Factory (Budapest-Budafok), Dréher Brewery (Budapest-Kőbánya), Nestlé Hungary Kft. (Miskolc-Diósgyőr).

Literature

Schedule:

1st week: Visit to TEVA Pharmaceutical Company at Debrecen. (8 hours)

2nd week: Visit to Evonik-Agroferm Zrt at Kaba. (6 hours)

3rd week: Visit to Richter Gedeon Nyrt at Budapest. (10 hours)

4th week: Visit to Sanofi-Chinoin Zrt. at Miskolc. (6 hours)

5th week:

6th week: *7th week:* *8th week:* *9th week:* *10th week:* *11th week:* *12th week:* *13th week:* *14th week:*
Requirements: *- for a signature* Attendance at **visits is** compulsory. *- for a grade* The students have to write a report after the visits and teacher classified the quality of the report.
Person responsible for course: Dr. Zoltán Németh, assistant professor, PhD
Lecturer: -

Title of course: Research techniques in Plant Biology **Code**: TTBBE0120_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 1 hour/week - practice: 1 hour/week - laboratory: -	
Evaluation: exam	
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: 4th year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: -	

Topics of course

Importance of the organisms having ability of photosynthesis in the ecosystems. Different levels of organization of primer producers. Oxygen evolving photoautotrophic organisms can be Cyanobacteria: Gram negative prokaryotic organisms with thylakoid systems, Algae: complex eukaryotic organisms with chloroplasts but without tissues (Protista), or Plants: morphologically complex embryophytes with real tissues. Origin of eukaryotic cell, the theory of primary, secondary and terciary endosymbiosis. Special metabolites produced by cyanobacteria and eukaryotic algae and their potential applications. Seed producing plants. The importance of seeds in evolution and ontogenesis of plants. The seed banks of soils, the methods of their investigation and the conclusions from the data of experiments and field studies.

Development of real plant tissues (evolution and ontogenesis). Particularities of plant cells. The main groups and types of tissues forming bodies of Ferns, Angio- and Gymnosperms. Location, function and main characteristic features of meristems and differentiated tissues. Storage tissues, organelles and stored substances. The importance of starch grains, protein- and oil-bodies produced by plants. Tissues of plant bodies suitable for tissue cultures, plant regeneration and genetic manipulation. Duckweeds, the smallest flowering plants of waters with high protein and starch contain -possible applications of duckweeds as future crops. Because of high productivity and cheap cultivation it has several fields of usability. It is an excellent test organ for toxicity tests as well.

Plants under changing environments. The effects of abiotic and biotic environmental parameters on the plants through phenotypic plasticity. Plant responses on stress (tolerance, avoidance, resistance). Global climate change, increase of temperature and frequency of extreme events and their effects on plants and vegetation. Common characteristics of abiotic and biotic stress factors, formation of reactive oxygen species (ROS) –the oxidative stress. Two mechanisms of oxygen molecule activation. Biological reactions of ROS. Enzymatic and non enzymatic defensive systems in plants –detoxification cascades to ROS. Plant responses to water deficit. Morphological and biochemichal adaptation of plants to dry environments.

Specialized metabolite production in *in vitro* plant tissue cultures. Advantages and disadvantages compared to *in vivo* plant metabolisms. Applied tissue culture types and produced special plant metabolisms with efficiency data. Optimization of media, elicitation, transformation, metabolite engineering for higher productivity. Plant metabolomics.

History of plant genomes modification; crop plant domestication, improvement of hybrid seeds, cross and selective breeding, features crops were selected for during domestication, the (First) Green Revolution, breeding technology developments, breeding for improved human health, for drought and disease tolerance of crops, agricultural innovation in Africa. Modern molecular technologies in plant breeding. Economic significance of plant biotechnology, major products, production statistics and trends. Advantages and disadvantages of the new genetic technologies.

On practices/seminars following lectures the instruments, methods and plant/tissue culture/alga collections in the laboratories of the Department of Botany are shown in connection with the topically presented subject.

Literature

Compulsory:
- uploaded ppt-s on the e-learning site

Recommended:
- topically presented articles with new scientific results

Schedule:

1st week: Introduction. Presentation of the objectives of the lecture series and their connection with other knowledge acquired during the course. Plant tissues, their evolution and ontogenesis, meristems and differentiated real tissues. Functions and characteristic features of tissues, special organelles. Stored and secreted substances investigated through bright-field microscope.

2nd week: Interesting properties and possible applications of duckweeds as future crops. Duckweeds in toxicity-tests.

3rd week: Stress physiology I. Plants under changing environments, the phenotypic plasticity of plants. Plant responses on stress. Drought caused diverse physiological and biochemical disorders in plants.

4th week: Stress physiology II.: Processes involved in formation of reactive oxygen species (ROS) in plant cells and the traits of ROS. Protection against the accumulation of ROS, enzymatic and non enzymatic ROS scavenging systems in plants for survival of stress.

5th week: Advance in methods of molecular taxonomy.

6th week: Significance and analysis of soil seed banks

7th week: Particularities of plant cells and related research methods. Plant tissue cultures and their importance.

8th week: Plant biotechnology I.: History of plant genomes modification, crop plant domestication.

9th week: Plant biotechnology II.: Modern molecular technologies in plant breeding.

10th week: Specialized metabolite production in *in vitro* plant tissue cultures.

11th week: Biology of Cyanobacteria and other oxygenic photosynthesizing microbes –algae.

12th week: The evolution of the first photosynthetic organism on the Earth. The origin of the organelles of eukaryotic cells – chloroplast and mitochondria. Evidences of the Endosymbiosis theory (SET). Evolutionary trees.

13th *week*: Specialized metabolite production in cyanobacteria and eucaryotic algae with economic, public health, therapeutical, diagnostical importances.

14th week: Test

Requirements:

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

- for a grade
The students have to complete a written exam.

Person responsible for course: Márta, Dr. Mikóné dr. Hamvas, associate professor, PhD

Lecturers:

- Dr. George Borbely, professor, PhD
- Dr. Sándor Gonda, senior lecturer, PhD
- Dr. Gábor Matus, associate professor, PhD,
- Dr. Csaba Máthé, associate professor, PhD
- Dr. Attila Molnár V., professor, PhD
- Dr. Ilona Mészáros, associate professor, PhD, CSc
- Márta, Dr. Mikóné dr. Hamvas -associate professor, PhD
- Dr. Viktor Oláh, senior lecturer, PhD
- Dr. Gyula Surányi, senior lecturer, PhD, CSc
- Dr. Gábor Vasas, professor, PhD

Title of course: Mathematical modelling of biological systems **Code**: TTMBE0805_EN	**ECTS Credit points:** 3

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 28 hours
- laboratory: -
- home assignment: -
- preparation for the exam: 34 hours

Total: 900 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Mathematics III. (TTMBG0804_EN)

Further courses built on it: -

Topics of course

Fundamental concepts in mathematical modelling of real-life phenomena. Continuous, discrete, and stochastic models of population growth with single species, interacting species, with and without migration and harvesting. Infectious disease spread modelling, the SI, SIS, SIR, SIRS models. Population genetics, haploid and diploid genetics. Enzyme kinetics, the Michaelis-Menten kinetics and non-Michaelis-Menten kinetics. Fundamentals of evolutional game theory, evolutionarily stable strategies, payoffs, mixed strategies, relation to Nash equilibrium, replicator dynamics. Branching processes in biology, fractals, fractal dimension, methods of measuring dimension, examples of self-similar and non self-similar fractals. An outlook on more complex mathematical models in biological systems.

Literature

Compulsory:

-

Recommended:

James D. Murray. Mathematical Biology, I. An Introduction. Springer 2004.
James D. Murray. Mathematical Biology, II. Spatial Models and Biomedical Applications. Springer, 2004.
John Maynard Smith. Evolution and the Theory of Games. Cambridge University Press, 1982.
Jeffrey R. Chasnov. Mathematical Biology, Lecture Notes for Math 4333. (online course notes)

Schedule:

1st week

Introduction to basic concepts in mathematical modelling. Simple examples of mathematical models. Some words on dynamical systems and their role in mathematical modelling of real-life phenomena.

2nd week

Population growth models. Conversation equation, natural rate of birth and death, migration, harvest, carrying capacity. Continuous models, exponential growth, logistic equation.

3rd week

Age-structured population. Analogues of continuous models in discrete setting.

4th week

Stochastic effects in smaller populations. The simplest models of stochastic population growth. Asymptotics of large initial population.

5th week

Interaction of multiple populations. Lotka-Volterra equations. Predatory-prey and competitive models.

6th week

Infectious disease spread models. The SI, SIS, SIR, and SIRS models. Vaccination and evolution of virulence.

7th week

Population genetics. Haploid and diploid genetics. Frequency dependent selection. Random genetic drift.

8th week

Biochemical reactions, the law of mass action. Differences in enzyme kinetics. Michaelis-Menten kinetics.

9th week

Reversible catalysis and non-Michaelis-Menten kinetics. Inhibition and cooperativity.

10th week

Evolutional game theory. Preliminaries from game theory: strategies, payoffs, pure and mixed strategies, Nash equilibrium.

11th week

Evolutional game theory. Evolutionarily stable strategies, relations to Nash equilibrium, replicator dynamics. The hawk-dove game.

12th week

Branching processes in biology. Fractals constructed by iteration: the Mandelbrot and the Julia set. The Koch curve. Fractal dimension.

13th week

Further types of fractals: non self-similar fractals, diffusion-limited aggregation. Biological examples.

14th week

An outlook on several more complex mathematical model in biology.

Requirements:

- for a signature

Attendance of practice 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.

The signature is evaluated on the basis of two written test during the semester. Students who obtain at least 51 percent of the total score obtain the signature. If a student fails to pass at first attempt, then a retake of the tests is possible.

- for a grade

The course ends in oral examination. The grade is given according to the following table:

Total Score (%)	**Grade**
0 – 50	fail (1)
51 – 60	pass (2)

61 – 70	satisfactory (3)
71 – 85	good (4)
86 – 100	excellent (5)

-*an offered grade:*
It is not possible to obtain an offered grade in this course.

Person responsible for course: Prof. Dr. Ákos Pintér, university professor, DSc

Lecturer: Prof. Dr. Ákos Pintér, university professor, DSc

Title of course: Numerical mathematics **Code**: TTMBG0806_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 1 hours/week - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: 28 hours- - laboratory: - - home assignment: - - preparation for the tests: 48 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): Mathematics III. (TTMBG0804_EN)	
Further courses built on it: -	

Topics of course

Features of computions by computer, error propagation. Some important matrix transformations for solving linear systems and eigenvalue problems. Gaussian elimination and its variants: its algorithms, operational complexity, pivoting. Decompositions of matrices: Schur complement, LU decomposition, LDU decomposition, Cholesky decomposition, QR decomposition. Iterative methods for solving linear and nonlinear systems: Gauss-Seidel iteration, gradient method, conjugate gradient method, Newton method, local and global convergence, quasi-Newton method, Levenberg–Marquardt algorithm, Broyden method. Solving eigenvalue problems: power method, inverse iteration, translation, QR method. Interpolation and approximation problems: Lagrange and Hermite interpolation, spline interpolation, Chebyshev-approximation. Quadrature rules: Newton-Cotes formulas, Gauss quadrature. Numerical methods for ordinary differential equations: Euler method, Runge-Kutta methods, finite-difference methods, finite element method.

Literature

Compulsory:

-

Recommended:

- Atkinson, K.E.: Elementary Numerical Analysis. John Wiley, New York, 1993.
- Lange, K.: Numerical analysis for statisticians. Springer, New York, 1999.
- Press, W.H. – Flannery, B.P. – Tenkolsky, S.A. – Vetterling, W.T.: Numerical recipes in C. Cambridge University Press, Cambridge, 1988.
- Engeln-Mullgens, G. – Uhling, F.: Numerical algorithms with C. Springer, Berlin, 1996.

Schedule:

1st week Features of computions by computer, error propagation. Some important matrix transformations for solving linear systems and eigenvalue problems.

2nd week Solution of system of linear equations: Gaussian elimination and its variants

3rd week Algorithms of the Gauss elimination and its operational comlexity. Pivoting.

4th week Decompositions of matrices: Schur complement, LU decomposition, LDU decomposition, Cholesky factorisation, QR factorisation of matrices.

5th week Iterative methods for solving linear systems: Gauss-Seidel iteration and its convergence

6th week Preconditioning. The gradient method and the conjugate gradient method

7th week Approximate solution of nonlinear equations: Newton method, local and global convergence, quasi-Newton method, Levenberg–Marquardt algorithm, Broyden-method

8th week Numerical methods for solving eigenvalue problems: power method and inverse iteration

9th week Numerical methods for solving eigenvalue problems: shift method, the QR algorithm

10th week Interpolation and approximation problems: Lagrange-interpolation, Hermite-interpolation. Spline interpolation. Error of the approximation. Tschebisev-approximation

11th week Numerical integration: Newton-Cotes formulas. Composite quadrature formulas

12th week Gauss quadrature. Existence, convergence, error estimation

13th week Numerical methods for solving initial value problems of ordinary differential equations: Euler method, Runge-Kutta method

14th week Numerical methods for solving boundary value problems of ordinary differential equations: finite difference methods, finite element method

Requirements:

- for a practical

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. 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.

During the semester there are two tests: one test in the 7th week and the other test in the 14th week. The minimum requirement for the tests respectively is 50%. Based on the score of the tests the practical grade is given according to the following table

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of any 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. Fruzsina Mészáros, assistant professor, PhD

Lecturer: Dr. Fruzsina Mészáros, assistant professor, PhD

Title of course: External practise **Code**: TTBBG0560_EN	**ECTS Credit points:** 0

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: -

Evaluation: signature

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

Total: -

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): Bioprocess Engineering I-II., Organic Chemistry I-III, Physical Chemistry, Microbiology, Unit Operations I and Process Control I.

Further courses built on it: -

Topics of course

The students should spend 6 weeks off the university at a company or research institute related to engineering in the summer between the 6th and the 7th semester, if they performed Bioprocess Engineering I-II., Organic Chemistry I-III, Physical Chemistry, Microbiology, Unit Operations I and Process Control I.

Literature

Schedule:

Requirements:

- for a signature

The students should spend 6 weeks at a company.
The students have to write a report after the external practise.

Person responsible for course: Dr. Zoltán Németh, senior lecturer, PhD

Lecturer: -

Title of course: Introduction course **Code**: TTBBG0561_EN	**ECTS Credit points: 0**
Type of teaching, contact hours - lecture: - - practice: 1 hours/week - laboratory: -	
Evaluation: signature	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: - - preparation for the exam: - Total: 14 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 introduce the students into the systems of University of Debrecen: NEPTUN (Finances, Periods, Administrations, Subject registrations) overview, Registrars Department, Department of Institute of Chemistry Credit system, Requests, Final Exam, Thesis.

Literature

Compulsory: **-**

Recommended: **-**

Schedule:

1st week
Introduction in the Neptune system: Term-and subject registration.
2nd week
Useful information in the Biochemical engineering bulletin (subjects, credits, grades).
3rd week
Schedules, departments homepages, Head of Institute, Responsible for education.
4th week
Learn information through Neptun (Periods, Information).
5th week
Introduction the Chemistry Building. (Levels, laboratories, seminary rooms).
6th week
Education and Examination Rules and Regulations.
7th week
How to pay to Neptun account, student fees (invoices) and other payments.
8th week
Introduction in the "Administration" tab in Neptun.

9th week Registrars Department. *10th week* *11th week* External practice. *12th week* Thesis, final exam. *13th week* Type of exams, usage of the library. *14th week* Retake exams.
Requirements: -
Person responsible for course: Dr. Levente Karaffa, associate professor, DSc
Lecturer: -