

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

**BIOCHEMICAL ENGINEERING BSC PROGRAM**

**2024**

## TABLE OF CONTENTS

<b>Dean`s Welcome.....</b>	<b>1</b>
<b>University of Debrecen.....</b>	<b>2</b>
<b>Faculty of Science and Technology .....</b>	<b>3</b>
<b>Department of Biochemical Engineering .....</b>	<b>4</b>
<b>Academic Calendar .....</b>	<b>6</b>
<b>The Biochemical Engineering Bachelor program .....</b>	<b>7</b>
Information about the Program .....	7
Objectives of the BSc program.....	7
Professional competences to be acquired .....	7
<b>Completion of the BSc Program .....</b>	<b>10</b>
The Credit System .....	10
<b>Model Curriculum of Biochemical Engineering BSc Program.....</b>	<b>11</b>
Work and Fire Safety Course .....	15
Internship.....	15
Physical Education .....	15
Pre-degree Certification.....	15
Thesis.....	16
Final Exam .....	16
<b>Diploma .....</b>	<b>18</b>
<b>Course Descriptions of Biochemical Engineering BSc Program .....</b>	<b>19</b>

## **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:** 29954

**Full time teachers of the University of Debrecen:** 1557

197 full university professors and 1224 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 (11 Bachelor programs and 13 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 770 students). The attractiveness of our education is indicated by the popularity of the Faculty in terms of incoming Erasmus students, as well.

### **THE ORGANIZATIONAL STRUCTURE OF THE FACULTY**

Dean: Prof. Dr. Ferenc Kun, Full Professor  
E-mail: [ttkdekan@science.unideb.hu](mailto:ttkdekan@science.unideb.hu)

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

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

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

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

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

English Program Officer: Mr. Imre Varga – Applied Mathematics (MSc), Chemical Engineering (BSc/MSc), Chemistry (BSc/MSc), Earth Sciences (BSc), Electrical Engineering (BSc), Geography (BSc/MSc), Mathematics (BSc), Physics (BSc), Physicist (MSc), International Foundation Year, Intensive Foundation Semester  
Address: 4032 Egyetem tér 1., Chemistry Building, A/101, E-mail: [vargaimre@unideb.hu](mailto:vargaimre@unideb.hu)

English Program Officer: Mrs. Szilvia Gyulainé Szemerédi – Biochemical Engineering (BSc), Biology (BSc/MSc), Environmental Science (MSc), Hidrobiological Water Quality Management (MSc)  
Address: 4032 Egyetem tér 1., Chemistry Building, A/104,  
E-mail: [szemeredi.szilvia@science.unideb.hu](mailto:szemeredi.szilvia@science.unideb.hu)

# DEPARTMENT OF BIOCHEMICAL ENGINEERING

## Dear Biochemical Engineering Students!

Welcome to the Faculty of Sciences and Technology of University of Debrecen, in the Biochemical Engineering community! The Department of Biochemical Engineering intends to make the time you spend here in Debrecen rewarding and enjoyable while imparting useful professional knowledge to you.

There is no specialisation within the Biochemical Engineering BSc course, thus you should all accomplish the same requirements (210 credits, diploma work, external practice) to acquire your degree. In this bulletin, you can find general information, requirement and the outline of the study programme.

We hope that you will enjoy the three and a half years that you will be spending here in the default setting. The Biochemical Engineering programme helps you to establish a successful future in the various fields of biotechnology and biology.

The founder of the biochemical engineering/biotechnology school in Debrecen is

**Prof. ATTILA SZENTIRMAI (1930 – 2019)**

The head of the Department of Biochemical Engineering and programme coordinator of the Biochemical Engineering course is

**Prof. LEVENTE KARAFFA, Full Professor**

Chemistry Building Room D-8, Tel.: +36 52 512 900 ext. 62488

[levente.karaffa@science.unideb.hu](mailto:levente.karaffa@science.unideb.hu)

The advisor of the Biochemical Engineering students (BSc) is

**Assistant Professor NORBERT ÁG, PhD**

Chemistry Building Room D-210, .: +36 52 512 900 ext.22730

[ag.norbert@science.unideb.hu](mailto:ag.norbert@science.unideb.hu)

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

After graduation, BSc 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 knowledge on using computing systems, databases
- be able to learn and understand previously unknown systems, products, processes- understand technical documents in foreign language.

The curriculum includes 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).

**Department website:** <https://biotechnologia.unideb.hu/bemutakozas-biomernoki-tanszek>

**Department postal address:** 4032 Debrecen, Egyetem tér 1, Chemistry Building (wing “D”)

**Department staff:**

<b>Name</b>	<b>Position</b>	<b>E-mail</b>	<b>room</b>
(Mr.) <b>Dr. Levente Karaffa</b> , PhD, habil., DSc	Full Professor, Head of Department	levente.karaffa@science.unideb.hu	D8
(Ms.) <b>Dr. Erzsébet Fekete</b> , PhD, habil.	Full Professor, Deputy Head of Department	kicszsoka@unideb.hu	D8
(Mr.) <b>Dr. Ákos Péter Molnár</b> , PhD	Assistant Professor	molnar.akos@science.unideb.hu	D110
(Mr.) <b>Dr. Norbert Ág</b> , PhD	Assistant Professor	ag.norbert@science.unideb.hu	D210
(Mr.) <b>Dr. Michel Flipphi</b> , PhD	Assistant Lecturer	michel.flipphi@science.unideb.hu	D7
(Ms.) <b>Vivien Bíró</b>	Assistant Lecturer	biro.vivien@science.unideb.hu	D7
(Ms.) <b>Dr. Alexandra Márton</b> , PhD	Researcher	martonszandi7@gmail.com	D7
(Mr.) <b>Zoltán Fekete</b> , BSc	Department Engineer	fekete.zoltan@science.unideb.hu	D7

## ACADEMIC CALENDAR

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

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

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

For further information, please check the following link:

<https://www.edu.unideb.hu/p/university-calendars>



# THE BIOCHEMICAL ENGINEERING BACHELOR PROGRAM

## Basic informations:

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:	Prof. Dr. Levente Karaffa
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 apparatus 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 of 210 credits, which is approximately 30 credits per semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing the subjects, which takes into account the prerequisite(s) of each subject. Please 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)											
<b>Economic and Human Sciences</b>											
<b>Micro- and Macro-Economic module</b>											
<b>6</b>											
<b>Introduction to Economics</b> Dr. Kapás Judit	TTBEBVVM-KT1_EN	-	200							E	3
<b>Macroeconomics</b> Dr. Czeglédi Pál	TTBEBVVM-KT3_EN	Introduction to Economics (TTBEBVVM-KT1_EN)			200					E	3
<b>Management and Business module</b>											
<b>11</b>											
<b>Introduction to Business</b> Dr. Nábrádi András	TTBEBVVM-KT2_EN	-							200	E	3
<b>Quality Management</b> Dr. Kotsis Ágnes	TTBEBVVM-KT6_EN	(Management of Value Creating Processes) TTBEBVVM-KT4_EN							200	E	3
<b>Management of Value Creating Processes</b> Dr. Pakurár Miklós	TTBEBVVM-KT4_EN	-		200						E	2
<b>Marketing</b> Dr. Kiss Marietta	TTBEBVVM-KT5	-						200		E	3
<b>Business Law module</b>											
<b>5</b>											
<b>Basics of Civil Law I.</b> Dr. Fézer Tamás	TTBEBVVM-JA1_EN	-		200						E	2
<b>History and Structure of European Union</b> Dr. Teperics Károly	TTTBE0030_EN	-	100							E	1
<b>Basics of Civil Law II.</b> Dr. Fézer Tamás	TTBEBVVM-JA2_EN	Basics of Civil Law I. (TTBEBVVM-JA1_EN)						200		E	2
<b>Mathematical and Scientific Foundations</b>											
<b>46</b>											
<b>Mathematics module</b>											
<b>12</b>											
<b>Mathematics I.</b> Dr. Muzsnay Zoltán	TTMBE0802_EN	-	400							E	5
<b>Mathematics I.</b> Dr. Muzsnay Zoltán	TTMBG0802_EN	-	030							P	2
<b>Mathematics II.</b> Dr. Muzsnay Zoltán	TTMBE0803_EN	Mathematics I. (TTMBE0802_EN)		200						E	3
<b>Mathematics II.</b> Dr. Muzsnay Zoltán	TTMBG0803_EN	Mathematics I. (TTMBE0802_EN)		030						P	2
<b>Physics module</b>											
<b>17</b>											
<b>Introduction to Physics lecture</b> Dr. Szabó István	TTFB3101	-	200							E	2
<b>Introduction to physics problems class</b> Dr. Szabó István	TTFBG3101	-	010							P	2
<b>General Chemistry I. (lecture)</b> Dr. Kalmár József	TTKBE0101_EN	-	300							E	3
<b>General Chemistry I. (seminar)</b> Dr. Herman Petra	TTKBG0101_EN	-	030							P	3
<b>General Chemistry II. (lab)</b> Dr. Herman Petra	TTKBL0101_EN	General Chemistry I. (lecture) (TTKBE0101_EN) General Chemistry I. (seminar) (TTKBG0101_EN)		003						P	3
<b>Organic Chemistry I.</b> Dr. Kurtán Tibor	TTKBE0301_EN	General Chemistry I. (TTKBE0101_EN)		210						E	4
<b>BioChemistry module</b>											
<b>5</b>											
<b>Biochemistry I.</b> Dr. Kerégyártó János	TTBBE2035_EN	General Chemistry I. (TTKBE0101_EN)		200						E	2
<b>Biochemistry I. lab.</b> Dr. Kerégyártó János	TTBBL2035_EN	General Chemistry I. (TTKBE0101_EN)		002						P	1
<b>Biochemistry II.</b> Dr. Barna Teréz	TTBBE2040_EN	Biochemistry I. (TTBBE2035_EN)			100					E	2
<b>Biology module</b>											
<b>12</b>											
<b>Introduction to Cell Biology</b> Revák Gyuláné	TTBBE3032_EN	-	200							E	3
<b>General Microbiology and Mycology</b> Dr. Pfliegler Valter Péter	TTBBE3030_EN	-		300						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)											
<b>General Microbiology and Mycology (seminar)</b> Dr. Pfliegler Valter Péter	TTBBG3031_EN	-			020					P	1
<b>Bioinformatics</b> Dr. Sipiczki Mátyás	TTBBE2060_EN	Genetics (TTBBE3020_EN)					100			E	3
<b>Bioinformatics</b> Dr. Sipiczki Mátyás Dr. Csoma Hajnalka	TTBBG2060_EN	Genetics (TTBBE3020_EN)					020			P	2
<b>Basics of Professional knowledge</b>											
<i>Organic Chemistry and Biology module</i>											
<b>Organic Chemistry II.</b> Dr. Kurtán Tibor	TTKBE0302_EN	Organic Chemistry I. (TTKBE0301_EN)			210					E	4
<b>Organic Chemistry III.</b> Dr. Juhász Dr. Tóth Éva	TTKBE0303_EN	Organic Chemistry II. (TTKBE0302_EN)				200				E	3
<b>Organic Chemistry IV.</b> Dr. Juhász Dr. Tóth Éva	TTKBL0301-L_EN	General Chemistry II. (TTKBL0101_EN) Organic Chemistry II. (TTKBE0302_EN)				013				P	3
<b>Microbiology</b> Dr. Pfliegler Valter Péter	TTBBE0506_EN	-			100					E	1
<b>Microbiology practice</b> Dr. Pfliegler Valter Péter	TTBBG0506_EN	General Microbiology and Mycology (TTBBE3030_EN)				002				P	1
<b>Microbial Physiology</b> Dr. Fekete Erzsébet	TTBBE0525_EN	Microbiology (TTBBE0506_EN)		200						E	3
<b>Microbial Physiology practice</b> Dr. Fekete Erzsébet Dr. Michel Flippi	TTBBL0525_EN	Microbiology (TTBBE0506_EN)			020					P	1
<b>Genetics</b> Dr. Batta Gyula	TTBBE3020_EN	-				300				E	3
<b>Genetics practice</b> Dr. Batta Gyula Dr. Papp László Attila	TTBBG3020_EN	-				020				P	2
<b>Methods in Molecular Biology</b> Gálné Dr. Miklós Ida	TTBBE2042_EN	-			200					E	3
<b>Methods in Molecular Biology</b> Dr. Batta Gyula	TTBBG2042_EN	-			020					P	2
<i>Physical-Chemistry and Materials Science module</i>											
<b>Physical Chemistry (lecture)</b> Dr. Horváth Henrietta	TTKBE0431_EN	General Chemistry I. (lecture) (TTKBE0101_EN) Mathematics I. (TTMBE0802) Mathematics I. (TTMBG0802)				200				E	3
<b>Physical Chemistry (seminar)</b> Dr. Horváth Henrietta	TTKBG0431_EN	General Chemistry I. (lecture) (TTKBE0101_EN) Mathematics I. (TTMBE0802) Mathematics I. (TTMBG0802)				020				P	1
<b>Bio-Physical Chemistry</b> Dr. Horváth Henrietta	TTKBE0419_EN	Physical Chemistry (lec.) (TTKBE0431_EN) Physical Chemistry (sem.) (TTKBG0431_EN)					200			E	3
<b>Colloid and Surface Chemistry</b> Dr. Novák Levente	TTKBE0406_EN	Physical Chemistry (lec.) (TTKBE0431_EN) Physical Chemistry (sem.) (TTKBG0431_EN)					200			E	3
<i>Measurement and Control module</i>											
<b>Informatics for Engineers</b> Dr. Kuki Ákos	TTKBG0911_EN	-	020							P	2
<b>Computer Modeling of Chemical Technology Systems I.</b> Dr. Kuki Ákos	TTKBG0912_EN	Unit Operation I. (TTKBG0614_EN)					020			P	2
<b>Analytical Chemistry I.</b> Dr. Buglyó Péter	TTKBE0501_EN	General Chemistry I. (TTKBE0101_EN) Organic Chemistry I. (TTKBE0301_EN)			200					E	3
<b>Process control I.</b> Dr. Nagy Lajos	TTKBG0612_EN	Informatics for Engineers (TTKBG0911_EN)			210					T	4
<b>Process control II.</b> Dr. Nagy Lajos	TTKBG0613_EN	Process control I. (TTKBG0612_EN)					030			T	3
<b>Mathematics III.</b> Dr. Bérczes Attila	TTMBG0804_EN	Mathematics II. (TTMBE0803_EN)			020					P	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)											
<b>Analytical Chemistry II.</b> Dr. Kállay Csilla	TTKBL0513_EN	General Chemistry I. (TTKBE0101_EN) General Chemistry II. (TTKBL0101_EN)			003					P	3
<b>Application of Instrumental Analysis (lecture)</b> Dr. Lázár István	TTKBE0512_EN	Analytical Chemistry I. (TTKBE0501_EN)					100			E	1
<b>Application of Instrumental Analysis (practice)</b> Dr. Gáspár Attila	TTKBL0512_EN	Application of Instrumental Analysis, lecture, (TTKBE0512_EN) Analytical Chemistry II., practice, (TTKBL0513_EN)						003		P	3
<b>Process Engineering module</b>											
<b>27</b>											
<b>Bioprocess Engineering I.</b> Dr. Karaffa Levente	TTBBE0571_EN	-				200				E	3
<b>Bioprocess Engineering II.</b> Dr. Karaffa Levente	TTBBE0572_EN	Bioprocess Engineering I. (TTBBE0571_EN)					200			E	3
<b>Bioprocess Engineering II. practice</b> Dr. Karaffa Levente Dr. Michel Flippi	TTBBL0572_EN	Bioprocess Engineering I. (TTBBE0571_EN)					003			P	3
<b>Basic Engineering</b> Dr. Tiba Zsolt	MFMS31K03-EN	-	210							E	3
<b>Unit operations I.</b> Dr. Kéki Sándor	TTKBG0614_EN	Basic Engineering (MFMS31K03-EN) Organic Chemistry I. (TTKBE0301_EN)			230					T	5
<b>Unit operations II.</b> Illyésné Dr. Czifrák Katalin	TTKBG0615_EN	Unit operations I. (TTKBG0614_EN)				230				T	5
<b>Unit operations III.</b> Illyésné Dr. Czifrák Katalin	TTKBG0616_EN	Unit operations II. (TTKBG0615_EN)					230			T	5
<b>Technology module</b>											
<b>12</b>											
<b>Mechanical engineering</b> Dr. Michel Flippi (Zsigmond Endre, Jakó Anikó - external)	TTBBG0575_EN	-		120						P	3
<b>Safety</b> Dr. Nagy Tibor	TTKBE0711_EN	Basic Engineering (MFMS31K03-EN)						200		E	3
<b>Environmental Technology</b> Illyésné Dr. Czifrák Katalin	TTKBE1114_EN	General Chemistry II. (lab) (TTKBL0101_EN)						200		E	3
<b>Environmental Technology lab.</b> Illyésné Dr. Czifrák Katalin	TTKBL1114_EN	General Chemistry II. (lab) (TTKBL0101_EN)						002		P	2
<b>Visits to Biotech Companies</b> Dr. Michel Flippi	TTBBG0550_EN	-			020					P	1
<b>Specialized courses in Biology</b>											
<b>16</b>											
<b>Plant Physiology I.</b> Dr. Máthé Csaba	TTBBE3010_EN	-				200				E	5
<b>Plant Physiology II. (seminar)</b> Dr. Surányi Gyula	TTBBE2106_EN	-						020		P	2
<b>Research Techniques in Plant Biology</b> Dr. Mikóné Dr. Hamvas Márta	TTBBE0120_EN	-							110	E	3
<b>Mathematical modelling of biological systems</b> Dr. Pintér Ákos	TTMBE0805_EN	Mathematics III. (TTMBG0804_EN)					220			E	3
<b>Numerical mathematics</b> Dr. Mészáros Fruzsina	TTMBG0806_EN	Mathematics III. (TTMBG0804_EN)						120		P	3
<b>Diploma work</b>	TTBBG1002_EN								P	P	15
<b>Facultative module*</b>											
<b>12</b>											
<b>Genetics II.</b> Dr. Csoma Hajnalka	TTBBE2043_EN	Genetics (TTBBE3020_EN)					100			E	2
<b>Organic Chemistry Seminar I.</b> Dr. Juhász László	TTKBG0311_EN	General Chemistry I. (TTKBE0101_EN)		010						P	1
<b>Organic Chemistry Seminar II.</b> Dr. Juhász László	TTKBG0312_EN	Organic Chemistry I. (TTKBE0301_EN)			010					P	1
<b>Advanced Organic Chemistry Seminar</b> Dr. Juhász László	TTKBG0313_EN	Organic Chemistry II. (TTKBE0302_EN)				020				P	2
<b>Plant Physiology I. lab.</b> Dr. Máthé Csaba	TTBBL3010_EN	-					020			P	2
<b>Plant Biochemistry and Molecular Biology</b> Dr. Mészáros Ilona	TTBBE5050_EN	-					300			E	3
<b>Sustainability and current environmental issues</b> Dr. Oláh Viktor	TTBBE4045_EN		110 (spring semester)							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)											
<b>Additional requirements</b>											
<b>External practise (industry)</b> Dr. Michel Flipphi	TTBBG0560_EN	-							6 wee ks	S	
<b>Introduction course</b> Dr. Michel Flipphi	TTBBG0561_EN	-	010							S	
<b>Physical Education</b>			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 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.

## **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 7<sup>th</sup> semester, if *Mathematical and Scientific Foundations* and *Basics of Professional knowledge* are full, 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 defence 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 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 topics 1-3)
2. Defence 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 taken 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 defence 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 THE BIOCHEMICAL ENGINEERING BSC PROGRAM

<b>Title of course:</b> Introduction to economics <b>Code:</b> TTBEVVVM-KT1_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester (or any later fall semester)	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> Macroeconomics (TTBEVVVM-KT3_EN)	

<b>Topics of course</b>
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
<b>Literature</b>
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.

<b>Schedule:</b>
<i>1<sup>st</sup> week</i> Introduction: Basic concepts and fundamental questions of economics SR: Understanding the basic concepts and the economic way of thinking
<i>2<sup>nd</sup> week</i> Human needs, scarcity, inputs, trade and its benefits SR: Knowing the concept of scarcity and how free-will trade makes everyone better off
<i>3<sup>rd</sup> week</i> Principles of economics SR: Understanding the meaning of the 10 main principles

*4<sup>th</sup> week*

Production possibilities frontier, opportunity cost

SR: Knowing the role of opportunity cost in the model of PPF curve

*5<sup>th</sup> week*

Demand and Supply

SR: Understanding the model of market, able to derive the changes of variables

*6<sup>th</sup> week*

Market allocation

SR: Able to characterize the equilibrium and disequilibrium

*7<sup>th</sup> week*

Welfare economics

SR: Concept of consumer and producer surplus and Dead Weight Loss

*8<sup>th</sup> week*

Application: Governmental interventions

SR: Able to identify the effects of government's interventions on market and the welfare of the society

*9<sup>th</sup> week*

Cost of production

SR: The main types of cost and their relationship

*10<sup>th</sup> week*

Competitive industry I.

SR: Criteria of perfect competition, and profit-maximization

*11<sup>th</sup> week*

Competitive industry II.

SR: Welfare effects and industry in the long run

*12<sup>th</sup> week*

Monopoly I.

SR: Criteria of monopoly, and profit-maximization

*13<sup>th</sup> week*

Monopoly II.

SR: Understanding the welfare effects of monopoly

*14<sup>th</sup> 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

<b>Title of course:</b> Macroeconomics <b>Code:</b> TTBEVVM-KT3_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester (or any later fall semester)	
<b>Its prerequisite(s):</b> TTBEVVM-KT1_EN	
<b>Further courses built on it:</b> -	

<b>Topics of course</b>
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.
<b>Literature</b>
<i>Compulsory:</i> Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009. <i>Recommended:</i> 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.

<b>Schedule:</b>
<i>1<sup>st</sup> week</i> The fundamental questions of macroeconomics. LO: The students are aware of the main questions of macroeconomics and some of the connections between them.
<i>2<sup>nd</sup> week</i>



Aggregates in macroeconomics.

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

*3<sup>rd</sup> week*

Measuring income: nominal and real GDP.

LO: The students understand the different approaches to measuring GDP and the relationships between these approaches.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> week*

The time value of money

LO: The students are aware of the methods of comparing future income flows with different timing.

*8<sup>th</sup> 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.

*9<sup>th</sup> 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.

*10<sup>th</sup> week*

Short-run economic fluctuations I.

LO: The students re familiar with the notion of aggregate demand and supply.

*11<sup>th</sup> week*

Short-run aggregate fluctuations II.

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

*12<sup>th</sup> week*

The economy in the long run.

LO: Students are familiar with the factors that determine aggregate income in the long run.

*13<sup>th</sup> week*

International economic relations.

LO: Students are familiar with the basic welfare implications of international trade, and the effects of protectionism.

*14<sup>th</sup> 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

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

<b>Topics of course</b>
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.
<b>Literature</b>
<i>Compulsory:</i> - 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 <i>Recommended:</i> - 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 21 <sup>st</sup> Century. Irwin, Homewood, pp.1-121, 188-701, 736-771, ISBN 0-256-09222-2
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction. Managing within the Dynamic Business Environment <i>2<sup>nd</sup> week</i> How Economics Affects Business

3<sup>rd</sup> week

Competing in Global Markets

4<sup>th</sup> week

Choosing a Form of Business Ownership

5<sup>th</sup> week

Management, Leadership and Employee Empowerment

6<sup>th</sup> week

Adapting Organizations to Today's Markets

7<sup>th</sup> week

Producing World-Class Goods and Services

8<sup>th</sup> week

Motivating Employees and Building Self-Managed Teams

9<sup>th</sup> week

Human Resource Management: Finding and Keeping the Best Employees

10<sup>th</sup> week

Marketing: Building Customer Relationships; Developing and Pricing Product and Services

11<sup>th</sup> week

Distributing Products Quickly and Efficiently Using Effective Promotional Techniques

12<sup>th</sup> week

Understanding Financial Information and Accounting; Financial Management

13<sup>th</sup> week

Security Markets: Financing and Investing Opportunities

14<sup>th</sup> 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

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

<b>Topics of course</b>
The series of lectures are based on the topics of Quality Management. 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.
<b>Literature</b>
<i>Compulsory:</i> - Foster S. Thomas (2017): <i>Managing Quality: Integrating the Supply Chain</i> . 6th edition. Pearson Prentice-Hall, New-Jersey, ISBN-13: 978-0133798258
<i>Recommended:</i> -Joel E. Ross – Susan Perry (2004): <i>Total Quality Management, Text, Cases and Readings</i> . 3rd Edition, Vanity Books International. -David L. Goetsch - Stanley Davis (2015): <i>Quality Management for Organizational Excellence: Introduction to Total Quality</i> . 8th Edition. Pearson Prentice-Hall, New-Jersey, ISBN-13: 978-0133791853

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

4<sup>th</sup> week: Quality theories- Taguchi method (Design of Experiments)

5<sup>th</sup> week: Tools of quality - 7 basic tools of quality (Ishikawa)

6<sup>th</sup> week: Statistical Process Control I – Charts for Variables

7<sup>th</sup> week: Statistical Process Control II – Charts for Attributes

8<sup>th</sup> week: Process Capability

9<sup>th</sup> week: Quality management: International Quality standards (ISO, TQM, EFQM model)

10<sup>th</sup> week: LEAN Manufacturing and Quality

11<sup>th</sup> week: Six Sigma System

12<sup>th</sup> week: Product Design – Quality Function Deployment

13<sup>th</sup> week: Risk Evaluation: Failure Mode and Effects Analysis

14<sup>th</sup> 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

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

<b>Topics of course</b>
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.
<b>Literature</b>
<i>Compulsory:</i> – Russell, R. S. - Taylor, B. W. : Operations Management, 8th Edition, Wiley & Sons, 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 <i>Recommended:</i> – 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

<b>Schedule:</b> <i>1<sup>st</sup> week</i> 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. <hr/> <b>TE:</b> Should know the basic functions and features of the value creating processes. Should understand the process of the evolution of management.
---

*2<sup>nd</sup> 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.

*3<sup>rd</sup> 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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, queueing models.

---



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

*9<sup>th</sup> week*

Process design and technology. Outsourcing, process selection with 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.

*10<sup>th</sup> week*

Capacity and facilities planning. The basics of facility layouts. Basic layouts: process layouts, product layouts, and fixed 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> 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.

*14<sup>th</sup> 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 Gantt 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 (Gantt 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

<b>Title of course:</b> Marketing <b>Code:</b> TTBEVVVM-KT5	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 40 hours Total: 70 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> 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 <i>Recommended:</i> KOTLER, P.—KELLER, K. L. (2016): Marketing Management. Global edition, 15th edition, Pearson/Prentice Hall, Boston, ISBN-10: 1292092629, ISBN-13: 9781292092621	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> 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.  <i>2<sup>nd</sup> week:</i> 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.	

*3<sup>rd</sup> 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).

*4<sup>th</sup> 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.

*5<sup>th</sup> week:* Consumer markets and buyer behavior. Introduction to the Model of Consumer Behavior and the characteristics of its parts.

*6<sup>th</sup> 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.

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

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

*9<sup>th</sup> 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.

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

*11<sup>th</sup> 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> week:* Retailing and wholesaling. Distinguishing between wholesaling and retailing activities. Identifying and characterizing different types of wholesalers and retailers.

*14<sup>th</sup> 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

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

<b>Topics of course</b>
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.
<b>Literature</b>
<i>Compulsory:</i> - 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

<b>Schedule:</b> <i>1<sup>st</sup> week</i> Distinction between private and public laws. <i>2<sup>nd</sup> week</i>
--

General principles of civil law: good faith, fault-based liability

*3<sup>rd</sup> week*

Law of natural persons: legal capacity and capacity to act

*4<sup>th</sup> week*

Law of legal entities (company law) I.: Formation

*5<sup>th</sup> week*

Law of legal entities (company law) I.: Structure

*6<sup>th</sup> week*

Personality rights and privacy laws

*7<sup>th</sup> week*

Consumer rights in the EU

*8<sup>th</sup> week*

Distance selling, e-commerce laws

*9<sup>th</sup> week*

Contract formation

*10<sup>th</sup> week*

Breach of the contract

*11<sup>th</sup> week*

Remedies to a breach scenario

*12<sup>th</sup> week*

Calculation of damages

*13<sup>th</sup> week*

Rights to property

*14<sup>th</sup> 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

<b>Title of course:</b> History and Structure of the EU <b>Code:</b> TTTBE0030_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: 1 hour/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 54 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	

<b>Topics of course</b>
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.
<b>Literature</b>
Bergmann, Julian – Niemann, Arne (2013): Theories of European Integration and their Contribution to the Study of European Foreign Policy, <i>Paper prepared for the 8th Pan-European Conference on International Relations, Warsaw 2013</i> . 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: <a href="https://europa.eu/european-union/about-eu_en">https://europa.eu/european-union/about-eu_en</a>

<b>Schedule:</b>
<i>1<sup>st</sup> week</i>
<b>History of the Integration.</b> 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.
<i>2<sup>nd</sup> week</i>



**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.

*3<sup>rd</sup> 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

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

*10<sup>th</sup> 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

**Migration and the European Union.** Theoretical background to the migration crisis in 2015 and its practical consequences. History of the migration routes and movements. Natural and social (political) causes contributing to the crisis situation.

*14<sup>th</sup> 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

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

<b>Topics of course</b>
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..
<b>Literature</b>
<i>Compulsory:</i> - 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

<b>Schedule:</b> <i>1<sup>st</sup> week</i> The nature of IP laws in Europe. <i>2<sup>nd</sup> week</i> Copyright law in the EU I. <i>3<sup>rd</sup> week</i> Copyright law in the EU II. <i>4<sup>th</sup> week</i> Patent rights.
---

*5<sup>th</sup> week*

Patent restrictions and commercial chains.

*6<sup>th</sup> week*

Trademark protection.

*7<sup>th</sup> week*

Contractual relations to IP law.

*8<sup>th</sup> week*

Insurance Laws.

*9<sup>th</sup> week*

Dispute settlement mechanisms.

*10<sup>th</sup> week*

International commercial arbitration.

*11<sup>th</sup> week*

International Sales Law I.

*12<sup>th</sup> week*

International Sales Law II.

*13<sup>th</sup> week*

Transportation laws.

*14<sup>th</sup> 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

<b>Title of course:</b> Mathematics I. <b>Code:</b> TTMBE0802_EN	<b>ECTS Credit points: 5</b>
<b>Type of teaching, contact hours</b> - lecture: 4 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 56 hours - practice: - - laboratory: - - home assignment: 44 hours - preparation for the exam: 50 hours Total: 150 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Mathematics II. (TTMBE0803_EN)</li> <li>• Mathematics II. (TTMBG0803_EN)</li> </ul>	
<b>Topics of course</b> Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and improper integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.	
<b>Literature</b> <i>Compulsory:</i> - <i>Recommended:</i> 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,	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> 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. <i>2<sup>nd</sup> week</i> 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. <i>3<sup>rd</sup> week</i>	

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.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> week*

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

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

Improper integrals. Applications.

*10<sup>th</sup> week*

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

*11<sup>th</sup> 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.

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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)
<b>Person responsible for course:</b> Dr. Zoltán Muzsnay, associate professor, PhD	
<b>Lecturer:</b> Dr. Zoltán Muzsnay, associate professor, PhD	

<b>Title of course:</b> Mathematics I. <b>Code:</b> TTMBG0802_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 3 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 42 hours - laboratory: - - home assignment: 18 hours - preparation for the exam: Total: 60 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and improper integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.	
<b>Literature</b>	
<i>Compulsory:</i> - <i>Recommended:</i> 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,	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> 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. <i>2<sup>nd</sup> week</i> 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. <i>3<sup>rd</sup> week</i> 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. <i>4<sup>th</sup> week</i>	



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

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> week*

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

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

Improper integrals. Applications.

*10<sup>th</sup> week*

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

*11<sup>th</sup> 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.

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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

<b>Title of course:</b> Mathematics II. <b>Code:</b> TTMBE0803_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 22 hours - preparation for the exam: 40 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Mathematics I. (TTMBE0802_EN)	
<b>Further courses built on it:</b> Mathematics III. (TTMBG0804_EN)	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> - <i>Recommended:</i> Thomas, Weir & Hass: Thomas' Calculus, P. Sahoo: Probability and Mathematical Statistics E. Mendelson: Schaum's 3000 Solved Problems in Calculus,	
<b>Schedule:</b>	
<i>1<sup>st</sup> week</i> R <sup>n</sup> : the n-dimensional Euclidean space. Sequences in R <sup>n</sup> . Function of several variables with real and vector values.	
<i>2<sup>nd</sup> week</i> Limit and continuity of multivariable functions.	
<i>3<sup>rd</sup> week</i> Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse function theorem. The implicit function theorem.	
<i>4<sup>th</sup> week</i> Directional derivative. Gradient and its application. Extreme values of real functions of several variables.	

*5<sup>th</sup> week*

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

*6<sup>th</sup> week*

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

*7<sup>th</sup> week*

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

*8<sup>th</sup> week*

Line integral. Basic properties. Applications.

*9<sup>th</sup> week*

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

*10<sup>th</sup> week*

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

*11<sup>th</sup> 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.

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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

<b>Title of course:</b> Mathematics II. <b>Code:</b> TTMBG0803_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 3 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 42 hours - laboratory: - - home assignment: 18 hours - preparation for the exam: Total: 60 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Mathematics I. (TTMBE0802_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> - <i>Recommended:</i> Thomas, Weir & Hass: Thomas' Calculus, P. Sahoo: Probability and Mathematical Statistics E. Mendelson: Schaum's 3000 Solved Problems in Calculus,	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values. <i>2<sup>nd</sup> week</i> Limit and continuity of multivariable functions. <i>3<sup>rd</sup> week</i> Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse function theorem. The implicit function theorem. <i>4<sup>th</sup> week</i> Directional derivative. Gradient and its application. Extreme values of real functions of several variables. <i>5<sup>th</sup> week</i>	

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

*6<sup>th</sup> week*

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

*7<sup>th</sup> week*

Test.

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

*8<sup>th</sup> week*

Line integral. Basic properties. Applications.

*9<sup>th</sup> week*

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

*10<sup>th</sup> week*

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

*11<sup>th</sup> 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.

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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

<b>Title of course:</b> General Chemistry I. (lecture) <b>Code:</b> TTKBE0101_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 3 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 42 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 48 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• General Chemistry II. (lab) (TTKBL0101_EN)</li> <li>• Organic Chemistry I. (TTKBE0301_EN)</li> <li>• Biochemistry I. (TTBBE2035_EN)</li> <li>• Biochemistry I. lab. (TTBBL2035_EN)</li> <li>• Physical Chemistry (lecture) (TTKBE0431_EN)</li> <li>• Physical Chemistry (seminar) (TTKBG0431_EN)</li> <li>• Analytical Chemistry I. (TTKBE0501_EN)</li> </ul>	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> <ul style="list-style-type: none"> <li>- John McMurry, Robert C. Fay: Chemistry, 7th ed., Prentice Hall ISBN: 0321943171.</li> <li>- Darrell D. Ebbing: General Chemistry, 9th ed. Belmont, CA, ISBN: 1439049829</li> <li>- James E. Brady, Gerard E. Humiston: General chemistry: principles and structure, 3rd ed., New York, Wiley, ISBN: 0471808164</li> </ul>	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> 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.	

*2<sup>nd</sup> 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.

*3<sup>rd</sup> 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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.

*9<sup>th</sup> 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.

*10<sup>th</sup> 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> week*

Solubility equilibria, solubility product. Temperature dependence of solubility. Gas-liquid and liquid-liquid equilibria. Extraction. Different theories of acid-base reactions (Arrhenius, Brønsted,



Lewis). Characterization of aqueous solutions, electrolytic dissociation. Strength of acids and bases. Super acids. Dissociation constant and degree of dissociation.

*13<sup>th</sup> 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.

*14<sup>th</sup> 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, associate professor, PhD

**Lecturer:** Dr. József Kalmár, associate professor, PhD

<b>Title of course:</b> General Chemistry I. (seminar) <b>Code:</b> TTKBG0101_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: - - practice: 3 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 42 hours - laboratory: - - home assignment: 28 hours - preparation for the exam: 20 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> General Chemistry II. (lab) (TTKBL0101_EN)	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> - The collection of calculation problems will be available at the Department's home page (inorg.unideb.hu) <i>Recommended:</i> - Darrell Ebbing, Steven D. Gammon: General Chemistry 10 <sup>th</sup> edition - Darrell Ebbing, Steven D. Gammon: General Chemistry – Standalone book	
<b>Schedule:</b> The seminar will be held in 11 weeks. <i>1<sup>st</sup> week</i> 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. <i>2<sup>nd</sup> week</i> 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. <i>3<sup>rd</sup> week</i> 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. <i>4<sup>th</sup> week</i>	

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.

*5<sup>th</sup> 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.

*6<sup>th</sup> week*

Review exercises in stoichiometry and concentration calculations.

*7<sup>th</sup> week*

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

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

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

*10<sup>th</sup> 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.

*11<sup>th</sup> 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. Herman Petra, assistant professor, PhD

**Lecturer:** Dr. Herman Petra, assistant professor, PhD

<b>Title of course:</b> General Chemistry II. (laboratory practice) <b>Code:</b> TTKBL0101_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 3 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 42 hours - home assignment: 32 hours - preparation for the exam: 16 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• General Chemistry I. (lecture) (TTKBE0101_EN)</li> <li>• General Chemistry I. (seminar) (TTKBG0101_EN)</li> </ul>	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Organic Chemistry IV. (TTKBL0301-L_EN)</li> <li>• Analytical Chemistry II. (TTKBL0513_EN)</li> <li>• Environmental Technology (TTKBE1114_EN)</li> <li>• Environmental Technology lab. (TTKBL1114_EN)</li> </ul>	
<b>Topics of course</b>	
<p>The objective of the laboratory practice is to introduce first-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.</p>	
<b>Literature</b>	
<p><i>Compulsory:</i></p> <ul style="list-style-type: none"> <li>- General chemistry laboratory practice (laboratory manual)</li> </ul> <p><i>Recommended:</i></p> <ul style="list-style-type: none"> <li>- Darrell Ebbing, Steven D. Gammon: General Chemistry 10<sup>th</sup> edition</li> <li>- Darrell Ebbing, Steven D. Gammon: General Chemistry – Standalone book</li> </ul>	
<p><b>Schedule:</b> The laboratory practice will be held in 11 weeks.</p> <p><i>1<sup>st</sup> week</i></p> <p>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.</p> <p><i>2<sup>nd</sup> week</i></p> <p>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.</p>	

*3<sup>rd</sup> week*

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

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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.

*9<sup>th</sup> 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.

*10<sup>th</sup> 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.

*11<sup>th</sup> 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. Herman Petra, assistant professor, PhD

**Lecturer:** Dr. Herman Petra, assistant professor, PhD

<b>Title of course:</b> Organic Chemistry I. <b>Code:</b> TTKBE0301_EN	<b>ECTS Credit points:</b> 4
<b>Type of teaching</b> - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated)</b> - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 18 hours - preparation for the exam: 60 hours Total: 120 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> General Chemistry I. TTKBE0101_EN	
<b>Further courses built on it:</b> TTKBE0202_EN, TTKBL0201_EN, TTKBE0402_EN, TTKBG0402_EN, TTKBL0401_EN, TTKBE0302_EN, TTKBE0501_EN, TTKBE0502_EN, TTKBE0601_EN, TTKBG0601_EN, TTKBE0204_EN, TTKBE0417_EN, TTKBG0614_EN, TTKBG0312_EN, MFVGE31V03_EN, TTKBE1111_EN	
<b>Topics of course</b>	
<ul style="list-style-type: none"> <li>• Types and theories of chemical bonds</li> <li>• Acid-base theories</li> <li>• Basic concepts of isomerism and stereochemistry.</li> <li>• Classification of organic reactions.</li> <li>• Structure, nomenclature, preparation and reactivity of aliphatic compounds</li> <li>• Aromatic compounds, benzene and its derivatives, polycyclic aromatic compounds and heteroarenes.</li> </ul>	
<b>Literature</b>	
<b>Compulsory:</b> 1. Lecture material and seminars available in the e-learning system. <b>Recommended:</b> 2. T. W. Graham Solomons, <a href="#">Craig B. Fryhle</a> , <a href="#">Scott A. Snyder</a> ; Organic Chemistry, 12th edition, John Wiley & Sons, Inc., 2016. 3. John McMurry: Organic Chemistry (8th Edition), 2012, Brooks/Cole 4. Herbert Meislich, Estelle Meislich, Jacob Sharefkin - 3000 Solved Problem in Organic Chemistry (1994)	
<b>Schedule:</b> 1st week	

The definition and brief history of organic chemistry Theories of the chemical bond, Lewis-Kössel theory, covalent and ionic bonds, LCAO-MO theory, types of atomic and molecular orbitals. Resonance contributors.

2nd week

VB theory, Hybridization. Electron shift phenomena, inductive and mesomeric effects, conjugation and hyperconjugation. Intermolecular interactions, hydrogen bond, dipole-dipole, dipole-induced dipole interactions.

3rd week

Description of functional groups in organic compounds. Classification of organic reactions based on the reagent and type of the reaction.

4th week

The basic nomenclature systems in organic chemistry: common or trivial names and systematic nomenclature. 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, kinetic and thermodynamic parameters of chemical reactions.

5th week

Multi-step reactions (consecutive reactions), intermediates. Parallel (competitive) reactions. Thermodynamic and kinetic control. Reactivity and selectivity. Reagents and reactive intermediates. Brønsted-Lowry, Lewis and Oláh acid-base theories, effects influencing acidity.

6th week

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. Preparation, conformation and physical properties. Reactions of alkanes, combustion, radical substitution with different halogens, chain reaction. Statistical and regioselective 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 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 of lectures is highly recommended and lecturer may make it compulsory for one-third of the lectures.

Attendance at seminars is compulsory. A student may not miss the seminar more than three times during the semester or the semester is not approved, and the student must repeat the course.

- for a grade

The course ends in an examination.

The exam grade is the result of a written exam.

The minimum requirement for achieving the course is 50%. The grade for the written exam 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)

If the score of any test is below 50%, the student may repeat the exam in accordance with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Tibor Kurtán, university professor, DSc

**Lecturer:** Dr. Tibor Kurtán, university professor, DSc

<b>Title of course:</b> Biochemistry I. <b>Code:</b> TTBBE2035_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - seminar: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 10 hours - preparation for the exam: 22 hours Total: 60 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> General Chemistry I. (TTKBE0101_EN)	
<b>Further courses built on it:</b> Biochemistry II. (TTBBE2040_EN)	
<b>Topics of course</b>	
Molecular design of life. Protein structure and function. Oxygen-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.	
<b>Literature</b>	
<i>Compulsory:</i> - Lubert Stryer, Biochemistry, W. H. Freeman and Company, New York, 2002, ISBN 1-7167-4684-0. <i>Recommended:</i> - 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)	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> Introduction to Biochemistry. Molecular design of life. Amino acids. Peptides. Primary, secondary, tertiary, quaternary structures.  <i>2<sup>nd</sup> week:</i> Determination of peptide structures. Protein structure and function. Oxygen-transporting proteins: Myoglobin and Hemoglobin.	

*3<sup>rd</sup> week:* Carbohydrates. Biological role of carbohydrates. Monosaccharides, disaccharides, polysaccharides. Glycoconjugates. Glycobiology.

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

*5<sup>th</sup> week:* Enzymes. Classification. Coenzymes. Mechanism of enzyme action. Control of enzyme activity.

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

*7<sup>th</sup> 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.

*8<sup>th</sup> week:* Gluconeogenesis. Cori cycle. The pentose phosphate pathway.

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

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

*11<sup>th</sup> week:* Glycogen metabolism. Glycogen degradation and synthesis. The coordinated control of synthesis and breakdown.

*12<sup>th</sup> week:* Fatty acid metabolism. Oxidation of fatty acids and unsaturated fatty acids. Energetics of fatty acid oxidation. Synthesis of ketone bodies.

*13<sup>th</sup> week:* Biosynthesis of fatty acids. The elongation cycle. Biosynthesis of cholesterol.

*14<sup>th</sup> 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 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> 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

<b>Title of course:</b> Biochemistry I. lab. <b>Code:</b> TTBBL2035_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture:- - practice:- - laboratory: 2 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 28 hours - home assignment: - preparation for the exam: 2 hours Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> General Chemistry I. (TTKBE0101_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> - 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) <i>Recommended:</i> - 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	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> <i>Laboratory techniques and safety instructions.</i> <i>2<sup>nd</sup> week</i> <i>Amino acids, peptides, proteins seminar.</i> 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. <i>3<sup>rd</sup> week</i> <i>Amino acids, peptides, proteins practice.</i> Chemical tests of proteins and amino acids: Biuret test, Xanthoproteic test, Millon's test. Thin-layer chromatography of amino acids. <i>4<sup>th</sup> week</i> <i>Amino acids, peptides, proteins practice.</i> Chemical tests of proteins and amino acids: ninhydrin test, sulfur test, heavy-metal ions test. Protein coagulation tests: effect of heat, alcohol, nitric acid. <i>5<sup>th</sup> week</i> <i>Purification of proteins practice.</i> Dialysis, gel-filtration chromatography. Quantitative determination of proteins by means of photometry. <i>6<sup>th</sup> week</i>	

*Carbohydrates seminar.* Carbohydrates. Monosaccharides, aldoses, ketoses, pentoses, hexoses. Stereochemistry of carbohydrates. Ring structure of monosaccharides. Conformation of pyranose and furanose rings.

*7<sup>th</sup> week*

*Carbohydrates practice.* Characterization reactions of carbohydrates: Molisch test, Bial's test, Seliwanoff's test. Thin-layer chromatography of carbohydrates.

*8<sup>th</sup> week*

*Carbohydrates seminar.* Disaccharides, reducing and nonreducing disaccharides. Polysaccharides.

*9<sup>th</sup> week*

*Carbohydrates practice.* Investigation of reducing and nonreducing disaccharides and starch. Fehling's test, hydrolysis test.

*10<sup>th</sup> week*

*Vitamines seminar.* Biological and chemical properties of water and fat soluble vitamins. The structure and reducing properties of vitamin C.

*11<sup>th</sup> week*

*Vitamines practice.* Quantitative determination of vitamin C content of juices and plant samples.

*12<sup>th</sup> week*

*Nucleotides, Nucleic acids seminar.* Structures of nucleotides, nucleic acids.

*13<sup>th</sup> 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.

*14<sup>th</sup> 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

<b>Title of course:</b> Biochemistry II. <b>Code:</b> TTBBE2040_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: - preparation for the exam: 16 hours Total: 30 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Biochemistry I (TTBBE2035_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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: <i>de novo</i> biosynthetic and salvage pathways, the formation of deoxyribonucleotides as well as the routes of the nucleotide degradation.	
<b>Literature</b>	
<i>Compulsory:</i> The lecture notes <i>Recommended:</i> 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	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Structural feature of amino acids. Characteristics of peptide bonds, rotation angles of C( $\alpha$ ), Ramachandran plot; Protein secondary structures; Forces and interactions in polypeptide chains; Supersecondary structures and protein domains. <i>2<sup>nd</sup> week</i> Structural classification of proteins. Fibrous proteins: $\alpha$ -keratin, fibroin and the structure of collagen fibrils. Anfinsen's experiment and Levinthal's paradox. Protein folding and chaperons. Protein misfolding. <i>3<sup>rd</sup> week</i> Thermodynamics of enzyme catalyzed reactions. Models explaining substrate specificities. Characteristics of enzyme catalyzed reactions. Enzyme classifications. Factors influencing enzyme activity: temperature and pH.	

*4<sup>th</sup> 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.

*5<sup>th</sup> week*

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

*6<sup>th</sup> week*

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

*7<sup>th</sup> week*

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

*8<sup>th</sup> week*

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

*9<sup>th</sup> week*

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

*10<sup>th</sup> week*

Pyrimidin *de novo* biosynthesis

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

*11<sup>th</sup> week*

The function and localisation of CAD and UMP synthase, the multienzyme complex 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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

<b>Title of course:</b> Introduction to Cell Biology <b>Code:</b> TTBBE3032_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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. Carbohidrates 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.	
<b>Literature</b>	
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	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> 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.  <i>2<sup>nd</sup> week:</i> Osmosis and diffusion. Physical explanation of diffusion. Process , types and influential 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.  <i>3<sup>rd</sup> week:</i> 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 polysaccharides. Structural polysaccharides.	

*4<sup>th</sup> week:* Lipids. Groups of lipids. Triglycerids. Importance of triglycerids in organic systems. Phospholipids. Carotenoids. Steroid.

*5<sup>th</sup> week:* Proteines. Amino acids. Peptides creation from amino acids. Classification of proteins on base hydrolyzable. Structure of proteines. Simple proteines and complex proteids. Coagulation and denaturation of proteines. Biological functions of proteines.

*6<sup>th</sup> week:* Nucleotides. Energy store nucleotides. Electron and hydrogen carrier nucleotids. Carrier nucleotids. Nucleotids in nucleic acids.

*7<sup>th</sup> week:* Definition of the cell. Structure of the cell. Cytoplasm. Structure and types of biological membranes. Cell membrane. Nuclear membrane. Endoplasmic- and Golgi membranes, lysosomes, mitochondria and chloroplast. Membrane transports. Nucleus, centriole. Vacuole. Cell wall.

*8<sup>th</sup> week:* Metabolism in cell. Assimilation and dissimilation. Difference of pro- and eukaryotic cell metabolism. Enzymes and ribosome.

*9<sup>th</sup> week:* Assimilation. Photosynthesis in cell. Mitchell's chemiosmotic theory. Dissimilation. Aerobic and anaerobic dissimilation. Biological oxidation and fermentation.

*10<sup>th</sup> week:* Matter of inheritance. Theory of central dogma. Genotype, gene, allele, phenotype, genome. Gene operation and its regulation. Lactose-operon theory. Exons and introns. Protein syntheses. DNA syntheses. Transcription, translation. Transzáríció. Genetic code.

*11<sup>th</sup> week:* Mutation and its types. Mutagens. Mutation at level of genome. Mutation rate. Importance of mutation in living organism.

*12<sup>th</sup> week:* Nucleosome. Chromosomes. Cell cycle. Cell division. Mitosis and meiosis.

*13<sup>th</sup> week:* Prokaryotic cell. Structure and function of bacterial cell. Importance of bacteria for industry, agriculture and environment.

*14<sup>th</sup> week:* General structure, function and taxonomy of fungi. Importance of fungi for genetic research, industry, agriculture 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. Markóczy Ibolya, associate professor, PhD

**Lecturer:** Revakné Dr. Markóczy Ibolya, associate professor, PhD

<b>Title of course:</b> General Microbiology and Mycology <b>Code:</b> TTBBE3030_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 3 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 42 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 48 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> Microbiology practice (TTBBG0506_EN)	
<b>Topics of course</b>	
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, Chloroflexi, 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 symbiotic organisms. Sporulation and spore dispersion. Medical mycology.	
<b>Literature</b>	
<i>Compulsory:</i> Handout slides of the course. <i>Recommended:</i> 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	
<b>Schedule:</b> 1 <sup>st</sup> 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.	

*2<sup>nd</sup> 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.

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

*4<sup>th</sup> week* Microbial taxonomy. The evolution of the three domains. Bacterial tree of life. Archaeal phyla. Methanogenic archaea.

*5<sup>th</sup> 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 Chloroflexi, Chlorobi, Cyanobacteria, Chlamydiae, Spirochaetes and Bacteroidetes

*6<sup>th</sup> week* Proteobacteria. Alpha-, Beta-, Gamma-, Delta- and Epsilonproteobacteria and their most important species.

*7<sup>th</sup> 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.

*8<sup>th</sup> week* Viruses: their characteristic features, morphology. DNA and RNA virus taxonomic groups. Bacteriophages. Plant viruses, viroids. Animal and human viruses.

*9<sup>th</sup> week* Plasmids of bacteria and yeasts. Prions. The taxa of Eukaryota. Medically important "protozoa".

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

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

*12<sup>th</sup> 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. Ascomycota from industrial and medical perspectives. The most important species of the phylum.

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

*14<sup>th</sup> 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.

15<sup>th</sup> 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

<b>Title of course:</b> General Microbiology and Mycology practice <b>Code:</b> TTBBG3031_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 28 hours - laboratory: - - home assignment: - - preparation for the test: 2 hours Total: 30 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> Handout slides of the course.	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction. Main methods and termini of microbiology. Exoenzymes in Bacteria, Fungi.  <i>2<sup>nd</sup> week</i> The growth curve of microbes. Environmental conditions and their effects on microbes.  <i>3<sup>rd</sup> week</i> Catabolism and oxidation of organic compounds in microbes. Media in microbiological laboratory work. Calculating molarity, concentrations for media. Determining colony forming unit numbers.  <i>4<sup>th</sup> week</i> Cellular transport of molecules in microbes (cell wall, membrane and nuclear transport). Chemolithotrophic pathways in microbes, methanogenesis by microbes.  <i>5<sup>th</sup></i> Prokaryotic photosynthesis in different phyla.	

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

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

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

9<sup>th</sup> week Calculations on the example of ethanolic fermentation.

10<sup>th</sup> week Biomass yields, ethanol yields.

11<sup>th</sup> week Bacterial and fungal cell wall synthesis.

12<sup>th</sup> week Secondary metabolite production. Antibiotics: production and importance.

13<sup>th</sup> week Microbial genomics in basic and applied research.

14<sup>th</sup> week Test.

15<sup>th</sup> 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



<b>Title of course:</b> Bioinformatics <b>Code:</b> TTBBE2060_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 1 hour/week - seminar: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - seminar: - laboratory: - - home assignment: - - preparation for the exam: 76 hours Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Genetics (TTBBE3020_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
Introduction to bioinformatics. Scopus, Web of Science, Pubmed, Agricola. Introduction to sequence search. Sequence databases. Pairwise and multiple sequence alignments. Computational phylogenetics.	
<b>Literature</b>	
<i>Recommended:</i> Choudhuri, S.: Bioinformatics for beginners. Academic Press, San Diego, 2014	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction to bioinformatics <i>2<sup>nd</sup> week</i> Introduction to mining literature <i>3<sup>rd</sup> week</i> Scopus, Web of Science <i>4<sup>th</sup> week</i> Pubmed, Agricola <i>5<sup>th</sup> week</i> Introduction to sequence search. Sequence databases <i>6<sup>th</sup> week</i> Pairwise sequence alignment I. Dynamic programmes <i>7<sup>th</sup> week</i> Pairwise sequence alignment II. Word programming, FASTA <i>8<sup>th</sup> week</i> Pairwise sequence alignment III. Word programming, BLAST	

*9<sup>th</sup> week*

Pairwise sequence alignment IV. Dot plots

*10<sup>th</sup> week*

Substitution matrices

*11<sup>th</sup> week*

Multiple sequence alignment. CLUSTAL

*12<sup>th</sup> week*

Computational phylogenetics I. Distance-based methods. UPGMA

*13<sup>th</sup> week*

Computational phylogenetics II Character-based methods. Maximum parsimony

*14<sup>th</sup> week*

End-of-semester consultation

**Requirements:**

Attendance at lectures is recommended, but not compulsory.

During the semester, there are two tests: in the 6<sup>th</sup> week and in the 10<sup>th</sup> 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 in the standard essay 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 Sipiczki, professor emeritus, DSc

**Lecturer:** Prof. Dr. Matyas Sipiczki, professor emeritus, DSc

<b>Title of course:</b> Bioinformatics <b>Code:</b> TTBBG2060_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 28 hours in blocks - laboratory: - - home assignment: - - preparation for the exam: 32 Total: 60 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Genetics (TTBBE3020_EN)	
<b>Further courses built on it:-</b>	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:-</i> <i>Recommended:-</i>	
<b>Schedule:</b>	
<b>Requirements:</b> - <i>for a signature</i> Participation at practice classes is <b>compulsory</b> . 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. - <i>for a grade</i> 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

<b>Title of course:</b> Organic chemistry II. <b>Code:</b> TTKBE0302_EN	<b>ECTS Credit points:</b> 4
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> term mark	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 18 hours - preparation for the exam: 60 hours Total: 120 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
<b>Further courses built on it:</b> TTKBE0303_EN, TTKBE0611_EN, TTKBE1212_EN, TTKBL1212_EN, TTKBE0503_EN, TTKGB0313_EN	
<b>Topics of course</b>	
Structure, physical and chemical properties of organic derivative containing heteroatoms such as halogenated hydrocarbons, organometallic derivatives, alcohols, phenols, ethers, sulfur analogues; amines, nitro derivatives, diazonium salts, aldehydes, ketones, carboxylic acids and their derivatives, derivatives of carbonic acid.	
<b>Literature</b>	
<b>Compulsory:</b> 1. Lecture material and seminars are available in the e-learning system.	
<b>Recommended:</b> 2. T. W. Graham Solomons, <a href="#">Craig B. Fryhle</a> , <a href="#">Scott A. Snyder</a> ; Organic Chemistry, 12th edition, John Wiley & Sons, Inc., 2016. 3. John McMurry: Organic Chemistry (8th Edition), 2012, Brooks/Cole 4. Herbert Meislich, Estelle Meislich, Jacob Sharefkin - 3000 Solved Problem in Organic Chemistry (1994)	

**Schedule:***1<sup>st</sup> 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.

*2<sup>nd</sup> 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 ( $S_N1$ ,  $S_N2$ ;  $\alpha$ - and  $\beta$ -elimination; E1, E2). Reaction of halogenated compounds with metals.

*3<sup>rd</sup> week*

The basics of chemistry of organometallic compounds. Their bonding system, the term "umpolung". Synthesis and reactivity of organometallic compounds. Organometallic 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> week*

Alcohols and phenols 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 enolethers. Cumene-based phenol synthesis.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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.

*9<sup>th</sup> 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  $\alpha$ -hydrogen, keto-enol tautomerism. Synthesis of aldehydes and ketones.

*10<sup>th</sup> 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

$\alpha$ -carbon; aldol dimerization,  $\alpha$ -halogenation. Nucleophilic addition reactions of  $\alpha,\beta$ -unsaturated oxo compounds.

*11<sup>th</sup> 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> week*

$\beta$ -Dicarbonyl and  $\beta$ -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.

*14<sup>th</sup> 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 of **lectures** is highly recommended and the lecturer may make it compulsory for one-third of the lectures.

Attendance at seminars is compulsory. A student may not miss the seminar more than three times during the semester or the semester is not approved, and the student must repeat the course.

- *for a grade*

The course ends in an **examination**.

The exam grade is the result of a written exam.

The minimum requirement for achieving the course is 50%. The grade for the written exam 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)

If the score of any test is below 50%, the student may repeat the exam in accordance with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Tibor Kurtán, university professor, DSc

**Lecturer:** Tibor Kurtán, university professor, DSc

<b>Title of course:</b> Organic chemistry III. <b>Code:</b> TTKBE0303_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> term mark	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 14 hours - preparation for the exam: 48 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Organic Chemistry II. (TTKBE0302_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
<p>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, porphyrin compounds).</p>	
<b>Literature</b>	
<p><i>Compulsory:</i></p> <ol style="list-style-type: none"> <li>1. Course material, concept and task collection for lectures, seminars in the e-learning system.</li> </ol> <p><i>Recommended:</i></p> <ol style="list-style-type: none"> <li>2. J. G. Smith: Organic Chemistry, 5<sup>th</sup> Edition, 2016, McGraw Hill; ISBN-13: 9780077354725</li> <li>3. C. Stan Tsai: Biomacromolecules, John Wiley &amp; Sons, New Jersey (2007)</li> <li>4. A. Miller-J. Tanner: Essentials of Chemical Biology, John Wiley &amp; Sons, Chichester (2008)</li> <li>5. P. M. Dewick: Medicinal Natural Products: A Biosynthetic Approach, 3<sup>rd</sup> Edition. John Wiley &amp; Sons, Chichester (2009)</li> </ol>	



**Schedule:***1<sup>st</sup> 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

*2<sup>nd</sup> week*

Structure, synthesis and chemical properties of amino acids. Characterization of  $\alpha$ -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.

*3<sup>rd</sup> 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> week*

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

*7<sup>th</sup> 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.

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

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

*10<sup>th</sup> 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.

*11<sup>th</sup> week*

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

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

Definition of symbiosis, antibiosis. Definition and classification of antibiotics:  $\beta$ -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.

*14<sup>th</sup> 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:** László Dr. Juhász, associate professor, PhD, Habil

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

<b>Title of course:</b> Organic Chemistry IV. <b>Code:</b> TTKBL0301-L_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hour/week - laboratory: 3 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: 42 hours - home assignment: 34 hours - preparation for the exam: - Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• General chemistry II. (TTKBL0101_EN)</li> <li>• Organic Chemistry II. (TTKBE0302_EN)</li> </ul>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>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.</p> <p>Laboratory practice is also linked to a one-hour seminar per week and its goal is to review the theoretical background of practical tasks.</p>	
<b>Literature</b> <i>Compulsory:</i> <ol style="list-style-type: none"> <li>1. L. Juhász: Organic Laboratory Techniques and Manuals for Pharmacist Students, Debrecen, 2009</li> <li>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), 4<sup>th</sup> edition, W. H. Freeman and Company. ISBN-13: 978-1-4641-3422-7.</li> </ol> <i>Recommended:</i> <ol style="list-style-type: none"> <li>3. H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1<sup>st</sup> Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244</li> <li>4. R. O. C. Norman, J. M. Coxon: Principles of Organic Synthesis, 3<sup>rd</sup> Edition, 1993, Blackie Academic &amp; Professional, Glasgow, U K; ISBN-13: 9780751401264</li> <li>5. J. McMurry: Organic Chemistry, 8<sup>th</sup> Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449</li> <li>6. J. Clayden, N. Greeves, S. Warren: Organic Chemistry, 2<sup>nd</sup> Edition, 2012, Oxford University Press; ISBN-13: 9780199270293</li> <li>7. F. A. Carey: Organic Chemistry, 4<sup>th</sup> Edition, 2000, The McGraw-Hill Companies; ISBN-10: 0072905018</li> </ol>	

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

**Schedule:**

*1<sup>st</sup> 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.

*2<sup>nd</sup> 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.

*3<sup>rd</sup> 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> week*

Short written test.

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

Distillation of acetone from KMnO<sub>4</sub> at atmospheric pressure.

Distillation of water in vacuum.

*6<sup>th</sup> 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 polyols with copper(II) ions.

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

Iodoform test of 2-alkanols.

Identification of unknown compounds.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

Short written test.

Presentation of steam distillation.

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

*10<sup>th</sup> 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> 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  $\alpha$ -amino acids (Ninhydrin test).

Detection of  $\alpha$ -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).

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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

<b>Title of course:</b> Microbiology <b>Code:</b> TTBBE0506_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: 1 hour/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> Handout slides of the course. <i>Recommended:</i> Willey, J., Sherwood, L., Woolverton, C. J.: Prescott's Microbiology, 9th Edition, McGraw-Hill Education, 2014	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction. Primary nutritional groups in microbes. Exoenzymes in Bacteria, biotechnological application of microbial enzymes.  <i>2<sup>nd</sup> week</i> Exoenzymes in Fungi, biotechnological application of microbial enzymes.  <i>3<sup>rd</sup> week</i> Cellular transport of molecules in microbes (cell wall, membrane and nuclear transport).  <i>4<sup>th</sup> week</i> Catabolism and oxidation of organic compounds in microbes, methyltrophic fungi and their importance.  <i>5<sup>th</sup> week</i> Fermentation types and pathways, the importance of fermentations, example species.	

6<sup>th</sup> week Microbial respiration, alternative oxidases, alternative respirations.

7<sup>th</sup> week Chemolithotrophic pathways in microbes, methanogenesis by microbes.

8<sup>th</sup> week Prokaryotic photosynthesis in different phyla, evolution of chloroplasts, radiotrophic fungi.

9<sup>th</sup> week Carbon fixation pathways, and anabolic processes in microbes.

10<sup>th</sup> week Nitrogen fixation, assimilative sulfate reduction by bacteria.

11<sup>th</sup> week Bacterial and fungal cell wall synthesis.

12<sup>th</sup> week Secondary metabolite production.

13<sup>th</sup> week Antibiotics: production and importance.

14<sup>th</sup> week Microbial Genomics in basic and applied research.

15<sup>th</sup> 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



<b>Title of course:</b> Microbiology Practice <b>Code:</b> TTBBG0506_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 2 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 28 hours - home assignment: 2 hours - preparation for the test: - Total: 30 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> General Microbiology and Mycology (TTBBE3030_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> Handout slides of the course.	
<b>Schedule:</b> 1 <sup>st</sup> week Introduction. Safety measures, fire safety during work.  2 <sup>nd</sup> week Growth media, agar plates, sterilization.  3 <sup>rd</sup> week Inoculating microbial cultures. Colony morphology of yeasts, molds and bacteria.  4 <sup>th</sup> week Preparing slides from cultures, microscopy: the use of the microscope, examining cells and cultures, direct cell counting.  5 <sup>th</sup> week Producing isolated colonies from mixed source.  6 <sup>th</sup> week Evaluating single-cell culture growth, carbon source utilization/fermentation tests.  7 <sup>th</sup> week Conservation of microbial cultures, evaluating fermentation and carbon utilization tests.	

*8<sup>th</sup> week* Reviving cultures from stock. Cell counting and plating for determining CFU.

*9<sup>th</sup> week* Evaluating CFU determination experiment, calculating survival after freezing in the stock culture.

*10<sup>th</sup> week* Evaluating previous result. Medium preparation for extracellular enzyme activity.

*11<sup>th</sup> week* Start of amylase production test.

*12<sup>th</sup> week* Evaluating amylase production test.

*13<sup>th</sup> week* Consultation about lab notes and calculations.

*14<sup>th</sup> week* Test.

*15<sup>th</sup> 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

<b>Title of course:</b> Microbial Physiology <b>Code:</b> TTBBE0525_EN & TTBBL0525_EN	<b>ECTS Credit points:</b> 3+1
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> exam, mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 28 hours - laboratory: - - home assignment: 30 hours - preparation for the exam: 34 hours Total: 120 hours	
<b>Year, semester:</b> lecture: 1 <sup>st</sup> year, 2 <sup>nd</sup> semester; practice: 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Microbiology (TTBBE0506_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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 phosphorylation. Oxidation/Reduction reactions. Photosynthesis.	
<b>Literature</b>	
<ul style="list-style-type: none"> <li>- Bernhard Atkinson and Ferda Mavituna: Biochemical Engineering and Biotechnology Handbook, The Nature Press, ISBN 0 333 33274 1</li> <li>- James Darnell, Harvey Lodish, David Baltimore: Molecular Cell Biology, Scientific American Books, ISBN 0-7167-1448-5</li> <li>- Wang DIC, Cooney CL, Demain AL, Dunnill P, Humphrey AE, Lilly MD: Fermentation and Enzyme Technology. John Wiley &amp; Sons, New York, U.S.A</li> </ul>	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> Introduction to the world of microorganisms.  <i>2<sup>nd</sup> week:</i> Bioenergetics (free energy, free enthalpy, redox reactions, redox pairs, electron carriers, energy-rich molecules, energy storage).  <i>3<sup>rd</sup> week:</i> Anabolism (amino acids; proteins; nucleotides; nucleotide acids; fatty acids; carbohydrates)	

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

*5<sup>th</sup> week:* Metabolic diversity I. (phototrophy, photosynthesis, CO<sub>2</sub> fixation, fixation of N<sub>2</sub>)

*6<sup>th</sup> week:* Metabolic diversity II. (Chemoorganotrophic metabolism: aerobic respiration, anaerobic respiration, fermentation, methylotrophs. Chemolithotrophic metabolism.)

*7<sup>th</sup> week:* Structure and characterization of prokaryotic cells.

*8<sup>th</sup> week:* Structure and characterization of eukaryotic cells.

*9<sup>th</sup> week:* Archeabacteria I.

*10<sup>th</sup> week:* Archeabacteria II.

*11<sup>th</sup> week:* Virology

*12<sup>th</sup> week:* Nutrition cycles

*13<sup>th</sup> week:* Biodegradation and bioremediation

*14<sup>th</sup> 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, university professor, PhD

**Lecturer:** Dr. Ákos Péter Molnár, assistant professor, PhD

<b>Title of course:</b> Genetics <b>Code:</b> TTBBE3020_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 3 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 42 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 48 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Bioinformatics (TTBBE2060_EN)</li> <li>• Bioinformatics (TTBBG2060_EN)</li> </ul>	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> - List of keywords sent out. Lecture materials sent out. Lecture notes taken during classes. <i>Recommended:</i> - Daniel L. Hartl: Essential Genetics, 6 <sup>th</sup> edition; ISBN-13: 978-1449686888 - Jocelyn E Crebs et. al.: Lewin's Genes XII; ISBN-1: 978-1284104493	
<b>Schedule:</b> <i>1<sup>st</sup> week: Introduction: genetics as a science field; historical overview. The nature of genetic material. DNA and RNA as genetic material. Prions.</i>  <i>2<sup>nd</sup> week: Structure of DNA. Superhelicity of DNA. The organization of prokaryotic genome.</i>  <i>3<sup>rd</sup> week: DNA organisation of eukaryotes: chromatin structures – euchromatin and heterochromatin. Basics of epigenetics.</i>	

*4<sup>th</sup> week: Structure of chromosomes. Telomere and telomerase. Chromosome sets – euploidy and aneuploidy. Human chromosomal aberrations. Prenatal diagnostics.*

*5<sup>th</sup> week: DNA replication mechanisms. Polymerase chain reaction (PCR). DNA repair mechanisms.*

*6<sup>th</sup> week: The mitotic cell division and its significance. Nondisjunction and its significance.*

*7<sup>th</sup> week: The first step of gene expression: transcription in prokaryotes and eukaryotes.*

*8<sup>th</sup> week: Regulation of transcription. Posttranscriptional modifications.*

*9<sup>th</sup> week: The second step of gene expression: translation and the genetic code. The change of genetic code – mutations.*

*10<sup>th</sup> week: Meiotic cell division, neocombination. Life cycles. The generation of human gametes.*

*11<sup>th</sup> week: Laws of Mendel. Mendelian inheritance – dominant and recessive autosomal inheritances.*

*12<sup>th</sup> week: Nonmendelian inheritances. Multifactorial inheritance.*

*13<sup>th</sup> week: Sex determination and sex linked inheritances.*

*14<sup>th</sup> 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

<b>Title of course:</b> Genetics practice <b>Code:</b> TTBBG3020_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - seminar: 2 hour/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - seminar: 28 hours - laboratory: - - home assignment: 32 hours - preparation for the exam: - Total: 60 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
-	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction to classical genetics and basic definitions. <i>2<sup>nd</sup> week</i> Introduction to 1 gene inheritance. (1 <sup>st</sup> topic) <i>3<sup>rd</sup> week</i> 1 gene inheritance and pedigrees. <i>4<sup>th</sup> week</i> Introduction to two- or more genes inheritance. (2 <sup>nd</sup> topic) <i>5<sup>th</sup> - 6<sup>th</sup> week</i> Two – or more genes inheritance complex examples. <i>7<sup>th</sup> week</i> First test from the 1 <sup>st</sup> and 2 <sup>nd</sup> topics. <i>8<sup>th</sup> week</i> Introduction to X-linked inheritance. (3 <sup>rd</sup> topic) <i>9<sup>th</sup> week</i> Introduction to “lethal genes” inheritance. (4 <sup>th</sup> topic) <i>10<sup>th</sup> week</i>	

Introduction to recombination calculations. (5<sup>th</sup> topic)

*11<sup>th</sup> week*

Test from the 3<sup>rd</sup> and 4<sup>th</sup> and 5<sup>th</sup> topics.

*12<sup>th</sup> 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 7<sup>th</sup> week and in the 11<sup>th</sup> 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



<b>Title of course:</b> Methods in Molecular Biology <b>Code:</b> TTBBE2042_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> 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.	
<b>Literature</b> RJ Reece: Analysis of Genes and Genomes , Wiley and Sons Ltd ISBN:0-470-84379-9	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction. Review of basic concepts, such as genome, gene, chromosome, DNA, RNA etc.  <i>2<sup>nd</sup> week</i> Structure of DNA, DNA extraction and purification methods.  <i>3<sup>rd</sup> week</i> Gel electrophoresis. Pulsed field gel electrophoresis.  <i>4<sup>th</sup> week</i> Restriction enzymes in molecular biology and their application.  <i>5<sup>th</sup> week</i>	

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

*6<sup>th</sup> week*

PCR methods.

*7<sup>th</sup> week*

Gene expression, central dogma, cDNA synthesis.

*8<sup>th</sup> week*

Cloning of genes. Ligation. Transformation.

*9<sup>th</sup> week*

DNA sequencing methods.

*10<sup>th</sup> week*

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

*11<sup>th</sup> week*

DNA libraries. Southern hybridisation.

*12<sup>th</sup> week*

Studying of gene expression: quantitative PCR, microarray methods.

*13<sup>th</sup> week*

Consultation.

*14<sup>th</sup> 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%.

<b>Score</b>	<b>Grade</b>
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

<b>Title of course:</b> Methods in Molecular Biology practice <b>Code:</b> TTBBG2042_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 28 hours - home assignment: - - preparation for the exam: 32 hours Total: 60 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Compulsory:</i> Laboratory practices notes – sent out in the beginning of semester  <i>Recommended:</i> Lecture notes and slides	
<b>Schedule:</b> 1 <sup>st</sup> week: <i>Introduction. Lab safety instructions.</i>  2 <sup>nd</sup> week: <i>Microscopy of fission yeast, bacteria and mammalian cells</i>  3 <sup>rd</sup> week: <i>Isolation of plasmid DNA</i>  4 <sup>th</sup> week: <i>Isolation of genomic DNA from yeast</i>  5 <sup>th</sup> week: <i>Isolation of RNA from yeast</i>  6 <sup>th</sup> week: <i>Gel electrophoresis</i>  7 <sup>th</sup> week: <i>PCR</i>  8 <sup>th</sup> week: <i>Restriction digestion</i>	

*9<sup>th</sup> week: Ligation*

*10<sup>th</sup> week: Transformation of bacteria*

*11<sup>th</sup> week: Transformation of yeast*

*12<sup>th</sup> week: cDNA synthesis*

*13<sup>th</sup> week: qRT-PCR*

*14<sup>th</sup> 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

<b>Title of course:</b> Physical chemistry (lecture) <b>Code:</b> TTKBE0431_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• General Chemistry I. (lecture) (TTKBE0101_EN)</li> <li>• Mathematics I. (lecture) (TTMBE0802)</li> <li>• Mathematics I. (seminar) (TTMBG0802)</li> </ul>	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Bio-physical chemistry (TTKBE0419_EN)</li> <li>• Colloid and surface chemistry (TTKBE0406_EN)</li> </ul>	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> - 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 <sup>th</sup> edition, Oxford University Press - P. W. Atkins, J. de Paula (2008 or any later edition): Physical Chemistry, 8 <sup>th</sup> edition, Oxford University Press  <i>Recommended:</i> - 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	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> Introduction and general information. Presentation of the objectives of the lecture series and their connection with other knowledge acquired during the course.	

*2<sup>nd</sup> 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<sup>rd</sup> 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<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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.

13<sup>th</sup> week: Interfacial phenomena

14<sup>th</sup> 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. Horváth Henrietta, associate professor, PhD

**Lecturer:** Dr. Horváth Henrietta, associate professor, PhD

<b>Title of course:</b> Physical chemistry (seminar) <b>Code:</b> TTKBG0431_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 2 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• General Chemistry I. (lecture) (TTKBE0101_EN)</li> <li>• Mathematics I. (TTMBE0802)</li> <li>• Mathematics I. (TTMBG0802)</li> </ul>	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Bio-physical chemistry (TTKBE0419_EN)</li> <li>• Colloid and surface chemistry (TTKBE0406_EN)</li> </ul>	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> - 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 <sup>th</sup> edition, Oxford University Press - P. W. Atkins, J. de Paula (2008 or any later edition): Physical Chemistry, 8 <sup>th</sup> edition, Oxford University Press  <i>Recommended:</i> - 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	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> Introduction and general information. Presentation of the objectives of the lecture series and their connection with other knowledge acquired during the course.	



*2<sup>nd</sup> 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<sup>rd</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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.

13<sup>th</sup> week: Interfacial phenomena

14<sup>th</sup> 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 registering 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. Horváth Henrietta, associate professor, PhD

**Lecturer:** Dr. Horváth Henrietta, associate professor, PhD

<b>Title of course:</b> Bio-physical chemistry <b>Code:</b> TTKBE0419_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• Physical Chemistry lecture (TTKBE0431_EN)</li> <li>• Physical Chemistry seminar (TTKBG0431_EN)</li> </ul>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> - 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	
<b>Literature</b> <i>Compulsory:</i> lecture material on the Department of Physical Chemistry website <i>Recommended:</i> - P. W. Atkins: Physical Chemistry (8 <sup>th</sup> ed.) Oxford University Press for, 2006. ISBN: 0-7167-8759-8 - P. W. Atkins. J. de Paula: Physical Chemistry for the Life Sciences (2 <sup>nd</sup> ed.) Oxford University Press, 2011, ISBN:978-0-19-956428-6	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> 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.

#### *2<sup>nd</sup> 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.

#### *3<sup>rd</sup> 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 equilibrium constant.

#### *4<sup>th</sup> 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.

#### *5<sup>th</sup> 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

#### *6<sup>th</sup> week*

Electron transition reaction. Electrochemical cell: Daniell 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.

#### *7<sup>th</sup> 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.

#### *8<sup>th</sup> 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.

#### *9<sup>th</sup> 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.

#### *10<sup>th</sup> 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> 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.

*14<sup>th</sup> 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, associate professor, PhD

**Lecturer:** Reka Gombos, assistant lecturer

<b>Title of course:</b> Colloid and Surface Chemistry <b>Code:</b> TTKBE0406_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• Physical Chemistry (TTKBE0431_EN)</li> <li>• Physical Chemistry (TTKBG0431_EN)</li> </ul>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> - Lecture slides downloadable from the e-Learning homepage ( <a href="http://elearning.unideb.hu">http://elearning.unideb.hu</a> ) - 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	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction. The notion of colloids and the classification of colloid systems. Synthesis of colloids. Relation between colloids and nanotechnology. Average and types of average.  <i>2<sup>nd</sup> week</i> 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.  <i>3<sup>rd</sup> week</i>	

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

*4<sup>th</sup> week*

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

*5<sup>th</sup> week*

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

*6<sup>th</sup> week*

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

*7<sup>th</sup> week*

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

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

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

*10<sup>th</sup> week*

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

*11<sup>th</sup> week*

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

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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)
50-62	pass (2)
63-75	satisfactory (3)
76-88	good (4)
89-100	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



<b>Title of course:</b> Informatics for Engineers <b>Code:</b> TTKBG0911_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 28 hours - laboratory: - - preparation for the tests: 32 hours Total: 60 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Computer Modeling of Chemical Technology Systems I. (TTKBG0912_EN)</li> <li>• Process control I. (TTKBG0612_EN)</li> </ul>	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Recommended:</i> 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	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Implementation of mathematical functions in the spreadsheet software. Plotting the result in xy scatter graphs. <i>2<sup>nd</sup> week</i> Solving calculation problems in chemical engineering by implemented mathematical functions. <i>3<sup>rd</sup> week</i> Numerical differentiation by spreadsheet software and its application for problem-solving in chemical engineering. <i>4<sup>th</sup> week</i> Numerical integration by spreadsheet software and its application for problem-solving in chemical engineering. <i>5<sup>th</sup> week</i>	

Regression, curve fitting

*6<sup>th</sup> week*

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

*7<sup>th</sup> week*

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

*8<sup>th</sup> week*

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

*9<sup>th</sup> week*

Matrix operations

*10<sup>th</sup> week*

Solving sets of linear equations by matrix operations.

*11<sup>th</sup> week*

Application of spreadsheets in combinatorics and probability.

*12<sup>th</sup> week*

Application of spreadsheets in statistics. Probability distributions.

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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 14<sup>th</sup> 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

<b>Title of course:</b> Computer Modelling of Chemical Technology Systems I. <b>Code:</b> TTKBG0912_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 28 hours - laboratory: - - preparation for the tests: 32 hours - home assignment: - Total: 60 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Unit Operation I. (TTKBG0614_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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.	
<b>Literature</b>	
<i>Recommended:</i> 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)	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> The main features of a process simulation software. The steps of the simulations. Drawing process flow diagrams. <i>2<sup>nd</sup> week</i> Simulation of simple reactions, evaluation of the results. <i>3<sup>rd</sup> week</i> Simulation of reactions with more feeds and unit operations, evaluation of the results. <i>4<sup>th</sup> week</i> Study of vapor-liquid equilibrium. <i>5<sup>th</sup> week</i>	

Modeling of flash distillation and three phase flash distillation.

6<sup>th</sup> week

Application of sensitivity study.

7<sup>th</sup> week

Introduction into the use of the *controller*.

8<sup>th</sup> week

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

9<sup>th</sup> week

Modeling of heat exchangers.

10<sup>th</sup> week

Various reactor models.

11<sup>th</sup> week

Simulation of chemical processes with reactors and separators

12<sup>th</sup> week

Simulation of chemical processes with recycling.

13<sup>th</sup> week

Simulation of more complex chemical processes.

14<sup>th</sup> 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 14<sup>th</sup> 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

<b>Title of course:</b> Analytical Chemistry I. <b>Code:</b> TTKBE0501_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• General Chemistry I. (TTKBE0101_EN)</li> <li>• Organic Chemistry I. (TTKBE0301_EN)</li> </ul>	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Analytical Chemistry II. (TTKBL0513_EN)</li> <li>• Application of Instrumental Analysis (lecture) (TTKBE0512_EN)</li> </ul>	
<b>Topics of course</b>	
<b>Literature</b> <i>Compulsory:</i> 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	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction to analytical chemistry. Measurements. Basic equations of equilibrium calculations. <i>2<sup>nd</sup> week</i> Acids and bases, acid-base theories. The Broensted equation. Buffers. <i>3<sup>rd</sup> week</i> Basic terms related to titrations. Practice of acid-base titrations. <i>4<sup>th</sup> week</i> Basics of complexometry. Complexometric titrations. <i>5<sup>th</sup> week</i> Solubility equilibria. Precipitation titrations, argentometry. <i>6<sup>th</sup> week</i> Redoxi equilibria. Permanganometry. <i>7<sup>th</sup> week</i> Chromatometry. Bromatometry. Iodometry.	

*8<sup>th</sup> week*

Simple separation techniques I. Gravimetry.

*9<sup>th</sup> week*

Simple separation techniques II. Extraction.

*10<sup>th</sup> week*

Chromatographic separations and techniques.

*11<sup>th</sup> week*

Classification of instrumental analytical methods. Evaluation of analytical chemical results.

*12<sup>th</sup> week*

Spectroscopy I. Atomic spectroscopy.

*13<sup>th</sup> week*

Spectroscopy II. UV-Vis spectroscopy.

*14<sup>th</sup> 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, University Professor, PhD, habil

**Lecturer:** Dr. Péter Buglyó, University Professor, PhD, habil

<b>Title of course:</b> Process Control I. <b>Code:</b> TTKBG0612_EN	<b>ECTS Credit points:</b> 4
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 56 hours - preparation for the exam: 22 hours Total: 120 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Informatics for Engineers (TTKBG0911_EN)	
<b>Further courses built on it:</b> Process control II. (TTKBG0613_EN)	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> 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 <i>Recommended:</i> 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	
<b>Schedule:</b> 1 <sup>st</sup> week Introduction. Determination of scope of Process Control. Classification of industrial automation. 2 <sup>nd</sup> 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.

*3<sup>rd</sup> week*

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

*4<sup>th</sup> week*

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

*5<sup>th</sup> week*

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

Selective control.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> week*

Solutions of different examples for CSTR.

*9<sup>th</sup> 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.

*10<sup>th</sup> 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 ( $PT_1...T_n$ ).

*11<sup>th</sup> week*

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

*12<sup>th</sup> 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.

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> 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. Lajos Nagy, associate professor, PhD

**Lecturer:** Dr. Lajos Nagy, associate professor, PhD

<b>Title of course:</b> Process Control II. <b>Code:</b> TTKBG0613_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: - - practice: 3 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 42 hours - laboratory: - - home assignment: 48 hours - preparation for the exam: - Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Process control I. (TTKBG0612_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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).	
<b>Literature</b>	
<i>Compulsory:</i> 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 <i>Recommended:</i> 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	
<b>Schedule:</b> 1 <sup>st</sup> week	

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

*2<sup>nd</sup> week*

Oscillating second order process (P $\zeta$ T). Examples for P $\zeta$ T.

*3<sup>rd</sup> week*

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

*4<sup>th</sup> week*

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

*5<sup>th</sup> week*

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

*6<sup>th</sup> 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.

*7<sup>th</sup> 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).

*8<sup>th</sup> week*

Routh-Hurwitz criterion.

*9<sup>th</sup> week*

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

*10<sup>th</sup> week*

Nyquist and Bode diagrams of different behaviour elements.

*11<sup>th</sup> week*

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

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

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

*14<sup>th</sup> 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 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> 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. Lajos Nagy, associate professor, PhD

**Lecturer:** Dr. Lajos Nagy, associate professor, PhD

<b>Title of course:</b> Mathematics III. <b>Code:</b> TTMBG0804_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 28 hours - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Mathematics II. (TTMBE0803_EN)	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Mathematical modelling of biological systems (TTMBE0805_EN)</li> <li>• Numerical mathematics (TTMBG0806_EN)</li> </ul>	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> - <i>Recommended:</i> Douglas C. Montgomery, George C. Runger. Applied Statistics and Probability for Engineers, 5th edition. John Wiley & Sons, 2010.	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Random experiments and event algebra. Axiomatic definition of probability through relative frequency. Classical model of probability and counting techniques. <i>2<sup>nd</sup> week</i> Independence of events. Conditional probability, law of total probability, Bayes's theorem. The Simpson's paradox. <i>3<sup>rd</sup> week</i> Discrete random variables, distribution, mean, variance and standard deviation. Important discrete distributions.	

*4<sup>th</sup> week*

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

*5<sup>th</sup> week*

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

*6<sup>th</sup> week*

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

*7<sup>th</sup> week*

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

*8<sup>th</sup> week*

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

*9<sup>th</sup> 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.

*10<sup>th</sup> 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.

*11<sup>th</sup> week*

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

*12<sup>th</sup> week*

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

*13<sup>th</sup> week*

Preparation for the final test, solution of the sample test.

*14<sup>th</sup> 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:

<b>Total Score (%)</b>	<b>Grade</b>
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

<b>Title of course:</b> Analytical chemistry II. (practice) <b>Code:</b> TTKBL0513_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: – - practice: – - laboratory: 3 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: – - practice: – - laboratory: 42 h - home assignment: 48 h - preparation for the exam: – Total: 90 h	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• General Chemistry I. (TTKBE0101_EN)</li> <li>• General Chemistry II. (TTKBL0101_EN)</li> </ul>	
<b>Further courses built on it:</b> Application of Instrumental Analysis (practice) (TTKBL0512_EN)	
<b>Topics of course</b> 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.	

<b>Topics of course</b> Acid-base, redox, argentometric and complexometric titrations
<b>Literature</b> <i>Recommended:</i> Daniel C. Harris: Quantitative Chemical Analysis R. Kellner, J.-M. Mermet, M. Otto, H. M. Widner: Analytical Chemistry, Wiley, 1997
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction to the Quantitative Analytical Chemistry Laboratory. Laboratory Safety Information. Review of lab equipment. <i>2<sup>nd</sup> week</i> 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 Sørensen (500 ml) and determination of its exact concentration. <i>3<sup>rd</sup> week</i>



Determination of borax content of a solid sample (unknown sample).

Simultaneous determination of sulfuric acid and boric acid in a mixture (unknown sample).

*4<sup>th</sup> week*

Determination of oxalic acid (unknown sample).

Determination of  $\text{Na}_2\text{S}_2\text{O}_3$  by measuring the acid formed in the oxidation reaction of  $\text{Na}_2\text{S}_2\text{O}_3$  with bromine.

*5<sup>th</sup> 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).

*6<sup>th</sup> 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).

*7<sup>th</sup> 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).

*8<sup>th</sup> week*

Redetermination of the exact concentration of the prepared 0.02 M sodium thiosulfate titrant

Determination of copper(II) (unknown sample).

*9<sup>th</sup> week*

Preparation of 0.01 M  $\text{Na}_2\text{EDTA}$  titrant solution (250.00 ml).

Simultaneous determination of calcium(II) and magnesium(II) ions (unknown sample).

Determination of Bi(III) (unknown sample).

*10<sup>th</sup> week*

Simultaneous determination of copper(II) and zinc(II) ions (unknown sample).

*11<sup>th</sup> week*

Quantitative description of precipitation equilibria. Solubility product and solubility.

*12<sup>th</sup> week*

Determination of Al(III) (unknown sample).

*13<sup>th</sup> week*

Lab equipment return.

*14<sup>th</sup> week*

Evaluation

**Requirements:**

*- for a signature*

Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than one during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Being late is equivalent with an absence. In case of absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.

Each week the laboratory session begins with a short test (not more than 15 minutes) based exclusively on the preparatory material and calculations of that week.

Students are required to determine “unknown samples”.

*- for a grade*

The grade is calculated from the results of the tests (50%) and the unknown samples (50%). Both averages have to be to be minimum 2.00 in order to successfully complete the course. Otherwise

the final grade will be fail (1). Students with fail (1) final course grades thanks to unacceptable test results can take once a comprehensive test exam during the examination period.

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

**Lecturer:** Dr. Csilla Kállay, associate professor, PhD

<b>Title of course:</b> Application of Instrumental Analysis I. <b>Code:</b> TTKBE0512_EN	<b>ECTS Credit points: 1</b>
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Analytical Chemistry I. (TTKBE0501_EN)	
<b>Further courses built on it:</b> Application of Instrumental Analysis (practice) (TTKBL0512_EN)	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> 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. <i>Recommended:</i> 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, 2 <sup>nd</sup> 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, 3 <sup>rd</sup> Edition, B. D. Hames, Oxford University Press, 1998, ISBN 0-19-963641-9	
<b>Schedule:</b> 1 <sup>st</sup> 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. 2 <sup>nd</sup> week	

Partial freezing, removal of frozen solvent crystals, increase of concentration. Spray drying, freeze drying. Instruments of spray drying, practical use of spray drying for the production of drugs, and foods. Instruments of freeze drying, laboratory scale to industrial production. Freeze-dried food production and use.

*3<sup>rd</sup> 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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).

*9<sup>th</sup> 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.

*10<sup>th</sup> 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> 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. Separation of smaller molecules in organic solvent gel system. Characterization of the gel chromatograms, calculation of the molar mass.

*14<sup>th</sup> 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

<b>Title of course:</b> Application of Instrumental Analysis (practice) <b>Code:</b> TTKBL0512_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 3 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - laboratory: 42 hours - home assignment: 48 hours - preparation for the exam: - Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• Application of Instrumental Analysis, lecture, (TTKBE0512_EN)</li> <li>• Analytical Chemistry II., practice, (TTKBL0513_EN)</li> </ul>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The series of laboratory practices are based on the topics of different instrumental 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.	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Daniel C. Harris: Quantitative Chemical Analysis, 7th Ed., 2007, Freeman and Co.H.H.</li> <li>2. Willard, L.L. Merritt, J.A. Dean, F.A. Settle: Instrumental methods of Analysis, Wadsworth Publ. Co., Belmont, 1988.</li> <li>3. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch: Fundamentals of Analytical Chemistry, 8th. ed., 2004, Brooks/Cole</li> <li>4. Syllabuses provided by the tutor.</li> </ol>	
<b>Schedule:</b> 1 <sup>st</sup> week: Introductory guidance, accident protection (2h)  2 <sup>nd</sup> week: Evaluation of chromatograms (8h)  3 <sup>rd</sup> week: UV-vis spectroscopy (6h)  4 <sup>th</sup> week: High Performance Liquid Chromatography II (6h)  5 <sup>th</sup> week: Atomic spectroscopy (6h)  6 <sup>th</sup> week: pH-metry (6h)	

7<sup>th</sup> week: Thin layer chromatography (6h)

8<sup>th</sup> week: Final test (2h)

**Requirements:**

- *for a signature*

Participation at practices is compulsory. A student must attend every practices during the semester. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- *for a grade*

Grading is given by the average of 3 separate grades:

- the average grade of the short tests written at the beginning of the instrumental analysis lab practices (an average of at least 2.0 is necessary to avoid a 'fail' final grade)

- the average grade of evaluation of the analytical data measured by the instrument, the laboratory notebook prepared by the student and final discussion/conclusion made between the student and the supervisor at the end of the lab practice (an average of at least 2.0 is necessary to avoid a 'fail' final grade)

- the grade of the final test

The grade of the final test is calculated according to the following table:

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

**Person responsible for course:** Prof. Dr. Attila Gáspár, university professor, DSc

**Lecturer:** Prof. Dr. Attila Gáspár, university professor, DSc

<b>Title of course:</b> Bioprocess Engineering I. <b>Code:</b> TTBBE0571_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Bioprocess Engineering II. (TTBBE0572_EN)</li> <li>• Bioprocess Engineering II. Practice (TTBBL0572_EN)</li> </ul>	
<b>Topics of course</b> 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 stoichiometry. 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 continuous 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.	
<b>Literature</b> <i>Compulsory:</i> - Stanbury PF, Whitaker A: Principles of Fermentation Technology, Pergamon Press, Oxford, UK, 1984 <i>Recommended:</i> - 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.	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> 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.	



*2<sup>nd</sup> 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).

*3<sup>rd</sup> week:* The media of industrial fermentation. Repeating the concept of heterotrophy, autotrophy, phototropicality, photoorganotrophy, chemolithotrophy, chemoorganotrophy through examples. Comparison of media requirements of laboratory and production-scale fermentations.

*4<sup>th</sup> 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.

*5<sup>th</sup> 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.

*6<sup>th</sup> 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.

*7<sup>th</sup> 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.

*8<sup>th</sup> 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).

*9<sup>th</sup> 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.

*10<sup>th</sup> 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> 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.

*14<sup>th</sup> 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:** Prof. Dr. Levente Karaffa, university professor, DSc

**Lecturer:** Prof. Dr. Levente Karaffa, university professor, DSc

Dr. Erzsébet Fekete, university professor, PhD, habil.

<b>Title of course:</b> Bioprocess Engineering II. <b>Code:</b> TTBBE0572_EN & TTBBL0572_EN	<b>ECTS Credit points:</b> 3+3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 3 hours/week - laboratory: -	
<b>Evaluation:</b> exam, mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 42 hours - laboratory: - - home assignment: 50 hours - preparation for the exam: 60 hours Total: 180 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Bioprocess Engineering I. (TTBBE0571_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
<p>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.</p> <p><b>Description of the course:</b> 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.</p> <p><b>Description of the practical course:</b> 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 dioxide 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.</p>	
<b>Literature</b>	
<ul style="list-style-type: none"> <li>- Stanbury PF and Whitaker A: Principles of Fermentation Technology. Pergamon Press, Oxford, UK.</li> <li>- McNeil B, Harvey LM: Fermentation: a Practical Approach. IRL Press, Oxford, UK.</li> <li>- Pirt, SJ: Principles of Microbe and Cell Cultivation. Blackwell Scientific Publications, Oxford, UK.</li> <li>- Wang DIC, Cooney CL, Demain AL, Dunnill P, Humphrey AE, Lilly MD: Fermentation and Enzyme Technology. John Wiley &amp; Sons, New York, U.S.A.</li> </ul>	

**Schedule:**

*1<sup>st</sup> week:* Production of organic acids by bacteria and fungi.

*2<sup>nd</sup> week:* Technological parameters of citric acid production.

*3<sup>rd</sup> week:* Production of gluconic acid and acetic acid. Biochemistry of the formation of gluconic acid and acetic acid.

*4<sup>th</sup> week:* Overview of amino acids and their physical and chemical characteristics. The biochemical background of amino acid overproduction.

*5<sup>th</sup> week:* Biochemistry and technology of glutamic acid production. Preparation and application of poly- $\gamma$ -glutamic acid.

*6<sup>th</sup> week:* Biochemistry and technology of lysine production

*7<sup>th</sup> week:* Biochemistry and technology of threonine, phenylalanine and tryptophan production

*8<sup>th</sup> week:* Biofuels vs. fossil fuels. Energy recovery from biomass. The technology of bioalcohol production.

*9<sup>th</sup> week:* Options for using biodiesel. Production of biodiesel. The technology of biogas formation.

*10<sup>th</sup> week:* Overview and grouping of vitamins. Physiological role and production of vitamin C. Production methods of B12 vitamin.

*11<sup>th</sup> week:* Grouping of  $\beta$ -lactam antibiotics: penam, cephem, clavam, carbapenem, monolactam. Ampicillin, amoxicillin. *Penicillium chrysogenum* and *Acremonium chrysogenum*. Penicillin and cephalosporin biosynthesis.

*12<sup>th</sup> week:*  $\beta$ -lactam production: strain development (classical and molecular methods), technological developments. Recovery and purification of penicillin and cephalosporin C.

*13<sup>th</sup> week:* Aminoglycoside (streptomycin, gentamicin, kanamycin, neomycin, tobramycin) and tetracycline (oxy tetracycline, aureomycin) antibiotics. Structure, producing microorganisms, mechanism of action, biosynthesis. Production technology (fermentation, extraction).

*14<sup>th</sup> 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, university professor, DSc

**Lecturer:** Prof. Dr. Levente Karaffa, university professor, DSc

Dr. Erzsébet Fekete, university professor, PhD

Dr. Norbert Ág, assistant professor, PhD

Dr. Ákos Péter Molnár, assistant professor, PhD

<b>Title of course:</b> Basic Engineering <b>Code:</b> MFMIS31K03-EN	ECTS Credit points: 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hour/week - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 25 hours - preparation for the exam: 23 hours Total: 90 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> <ul style="list-style-type: none"> <li>• Unit operations I. (TTKBG0614_EN)</li> <li>• Safety (TTKBE0711_EN)</li> </ul>	
<b>Topics of course</b>	
<p>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.</p> <p>In seminar there are four tasks to elaborate: to elaborate the workshop drawing of different machine elements and components.</p>	
<b>Literature</b>	
<p><i>Compulsory:</i></p> <ul style="list-style-type: none"> <li>- TIBA.: Machine Drawing, ISBN 978-963-318-066-2, Debrecen University Press 2010.</li> <li>- J.-P. Mercier: Introduction to Materials Science, Elsevier, 2002.</li> <li>- M. F. Ashby: Materials Selection in Mechanical Design. 3.rd edition. Elsevier. London, 2005. ISBN 0-7506-6168-2.</li> <li>- 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</li> </ul>	
<b>Schedule:</b> 1 <sup>st</sup> 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

*2<sup>nd</sup> 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.

*3<sup>rd</sup> 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.

*4<sup>th</sup> week:*

**Lecture:** General prescriptions for dimensioning, choosing basis surfaces. Conventional dimensioning methods.

**Practice:** elaborating the task 2. Practicing the presentation methods.

*5<sup>th</sup> 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.

*6<sup>th</sup> week:*

**Lecture:** ISO Tolerance system. Defining fits: clearance, transition and interference fit.

**Practice:** elaborating the task 3.

*7<sup>th</sup> 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.

**Practice:** Submitting the task 3.

*8<sup>th</sup> week:*

**Mid-term test**

**Lecture:** Defining and calculating loads, and stresses.

**Practice:** Calculating and drawing load diagrams.

*9<sup>th</sup> 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.

*10<sup>th</sup> 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.

*11<sup>th</sup> 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.

*12<sup>th</sup> week:*

**Lecture:** Structural materials. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis.

**Practice:** Destructive test methods.

*13<sup>th</sup> 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.

*14<sup>th</sup> 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 may 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 8<sup>th</sup> week and the end-term test in the 14<sup>th</sup> 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)
<b>Person responsible for course:</b> Dr. Zsolt Tiba, college professor, PhD	
<b>Lecturer:</b> Dr. Zsolt Tiba, college professor, PhD Dr. Sándor Pálinkás, associate professor, PhD	

<b>Title of course:</b> Unit Operations I <b>Code:</b> TTKBG0614_EN	<b>ECTS Credit points:</b> 5
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 3 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 42 hours - laboratory: - - home assignment: 40 - preparation for the exam: 40 hours Total: 150 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> <ul style="list-style-type: none"> <li>• Basic Engineering (MFMIS31K03-EN)</li> <li>• Organic Chemistry I. (TTKBE0301_EN)</li> </ul>	
<b>Further courses built on it:</b> Unit operations II. (TTKBG0615_EN)	
<b>Topics of course</b> 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.	
<b>Literature</b> <i>Compulsory:</i> McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill <a href="#">Richard G. Griskey</a> : 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	
<b>Schedule:</b> 1 <sup>st</sup> week Definition and classification of unit operations. batch and continuous processes. Flowsheets.  2 <sup>nd</sup> week	

Physical quantities, units, dimensions. The SI system. Extensive and intensive quantities. Dimensional and tensorial homogeneity. Scalar-vector-tensor quantities.

*3<sup>rd</sup> week*

The fundamental equation of thermodynamics. Conditions of equilibrium, driving force, rate of processes. Degrees of freedom of a chemical system.

*4<sup>th</sup> week*

Flows and fluxes. Scalar and vector fields and their derivatives. The Nabla vector, gradient and divergence.

*5<sup>th</sup> 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.

*6<sup>th</sup> week*

The mathematical model. Initial and boundary conditions. Balance equations for simple systems: Fourier-I and Fick-I laws.

*7<sup>th</sup> week*

Similitude and modelling. Dimensional analysis, dimensionless numbers.

*8<sup>th</sup> week*

Mass and energy balances for simple and complex unit operations.

*9<sup>th</sup> 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.

*10<sup>th</sup> week*

Basic types of fluid flow. Reynolds' experiment. Hagen-Poiseuille equation. Modified Bernoulli equation. Fanning equation. Moody diagram. Energy requirement of fluid transport. Types of pumps.

*11<sup>th</sup> 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.

*12<sup>th</sup> 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.

*13<sup>th</sup> week*

Mixing of solids, apparatus. Mixing of fluids. Momentum balance for the agitator. Power requirement of agitation. Fluid mixers.

*14<sup>th</sup> week*

Terminal velocity of sedimentation. Stokes' law. Drag coefficient as a function of Reynolds number. Apparatus 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 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> 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:** Prof. Dr. Sandor Kéki, university professor, DSc

**Lecturer:** Prof. Dr. Sandor Kéki, university professor, DSc

<b>Title of course:</b> Unit Operations II. <b>Code:</b> TTKBG0615_EN	<b>ECTS Credit points:</b> 5
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 3 hours/week - laboratory: -	
<b>Evaluation: mid-semester grade</b>	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 42 hours - laboratory: - - home assignment: 40 hours - preparation for the exam: 40 hours Total: 150 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Unit operations I. (TTKBG0614_EN)	
<b>Further courses built on it:</b> Unit operations III. (TTKBG0616_EN)	
<b>Topics of course</b>	
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 evaporators. Cooling and coolers. 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.	
<b>Literature</b>	
<i>Compulsory:</i> McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill <a href="#">Richard G. Griskey</a> : 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	
<b>Schedule:</b> 1 <sup>st</sup> week Heat transfer. General characterization of heat transfer. 2 <sup>nd</sup> week	

Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat-transfer by convection. Analogies between momentum and heat transfer. Chilton-Colburn analogy.

*3<sup>rd</sup> week*

The heat equation. Types and calculation of heat transport. Steady state heat conduction in plane pipe walls. Fourier-I equation and thermal insulation.

*4<sup>th</sup> 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.

*5<sup>th</sup> week*

Boundary layer theory of heat transfer. The Nusselt and Prandtl number. Forced convection heat transfer. Natural convection heat transfer. Radiation heat transfer and solution of complex heat transfer problems

*6<sup>th</sup> week*

Heat exchangers. Stationary heat transmission with constant temperature difference through flat and cylindrical wall. Determination of heat flow and thermal resistances.

*7<sup>th</sup> 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.

*8<sup>th</sup> week*

Boiling of liquids. Boiling curves. Critical heat flux of boiling. Leidenfrost effect.

*9<sup>th</sup> week*

The aim of evaporation, Calandria, falling film and Robert-type evaporator. Multistage evaporators and their connections.

*10<sup>th</sup> week*

Cooling and coolers.

*11<sup>th</sup> week*

Introduction to chemical reactors. 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.

*12<sup>th</sup> week*

Heat balance of a reactor. Stability of reactors.

*13<sup>th</sup> 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.

*14<sup>th</sup> week*

Practice.

**Person responsible for course:** Dr. Katalin Margit Illyésné Czifrák, assistant professor, PhD

**Lecturer:**

<b>Title of course:</b> Unit Operations III. <b>Code:</b> TTKBG0616_EN	<b>ECTS Credit points:</b> 5
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 3 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 42 hours - laboratory: - - home assignment: 50 - preparation for the exam: 60 hours Total: 180 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> TTKBG0615_EN	
<b>Further courses built on it:</b> -	

<b>Topics of course</b>
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. Absorption, Adsorption. Evaporation. Distillation. Rectification. Extraction. Crystallization. Humidification. Drying.
<b>Literature</b>
<i>Compulsory:</i> McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill <u>Richard G. Griskey</u> : Transport phenomena and unit operations: a combined approach, (2002), Wiley, ISBN 0-47 1-43819-7 <u>Christie J Geankoplis</u> : 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
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Mass transfer theories. Two-film and boundary layer theory of component transfer. <i>2<sup>nd</sup> week</i> Absorption-desorption: Concentration-space diagram of a continuous counter current absorption unit operation. Equation of operating line. <i>3<sup>rd</sup> week</i>

Transfer unit and its graphical determination. Chemisorption. Types of absorption-desorption apparatus.

*4<sup>th</sup> week*

Adsorption-desorption. Physical and chemical adsorption. Isotherms.

*5<sup>th</sup> week*

Types of absorption-desorption apparatus. The PSA adsorption.

*6<sup>th</sup> week*

Thermal separation operations: distillation: Batch and continuous distillation.

*7<sup>th</sup> week*

Rectification. Operating point. Types and parts of a continuous rectification apparatus.

*8<sup>th</sup> week*

Operating lines of a rectifier. The q-line. Equilibrium stage, its determination using McCabe-Thiele diagram.

*9<sup>th</sup> week*

Liquid-liquid extraction. Ternary phase diagram. Distributional diagram of the key component. Batch and continuous extraction. Continuous one-stage mixer-settler extractor.

*10<sup>th</sup> week*

Liquid-solid extraction and its apparatus.

*11<sup>th</sup> week*

Crystallization and its phase diagram. Apparatus for crystallization.

*12<sup>th</sup> week*

Humidification.

*13<sup>th</sup> week*

Drying. Types of moisture binding. Rate of drying. Enthalpy of moist air. Types, material-and energy balance of drying apparatus

*14<sup>th</sup> 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<sup>th</sup> week and the end-term test in the 15<sup>th</sup> 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. Katalin Margit Illyésné Czifrák, associate professor, PhD

**Lecturer:**

<b>Title of course:</b> Safety <b>Code:</b> TTKBE0711_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - preparation for the tests: 62 hours Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> Basic Engineering (MFMIS31K03-EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> - 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.	
<b>Literature</b> <i>Recommended:</i> 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.: Sax's Dangerous properties of Industrial Materials, John Wiley (2005) 4. C. D. Classen, Caserett and Doull's Toxicology, McGraw-Hill, New York (2008)	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> General and basic security rules. Definition of accident, near-miss (quasi-accident) and first aid. Can we learn from accidents that have not happened? <i>2<sup>nd</sup> week</i> Accident statistics, industry comparison. Conclusions from the figures. <i>3<sup>rd</sup> week</i> 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. <i>4<sup>th</sup> week</i> 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. <i>5<sup>th</sup> week</i>	

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.

*6<sup>th</sup> week*

Purpose and implementation of inerting. Nitrogen-Purging, Vacuum, Pressure, Combination and Siphon Method. Advantages disadvantages. Simplification of a simple oxygen concentration calculation method..

*7<sup>th</sup> 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

*8<sup>th</sup> 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.

*9<sup>th</sup> week*

Types of safety valves and their operation. Multiple protection. Comparison of safety valves, advantages and disadvantages.

*10<sup>th</sup> week*

Removal of excess pressure in case of danger. Technical solutions. Protective devices and their use.

*11<sup>th</sup> week*

Identification of hazards (environmental and safety). Solution options. Explosion limits of gas mixtures. Options for security protection.

*12<sup>th</sup> week*

Watching educational videos on safety. Learn the GHS pictograms and safety signs.

*13<sup>th</sup> week*

Consultation.

*14<sup>th</sup> 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:** Dr Nagy Tibor, assistant professor, PhD

**Lecturer:** Dr Nagy Tibor, assistant professor, PhD

<b>Title of course:</b> Environmental Technology <b>Code:</b> TTKBE1114_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 6 hours - preparation for the exam: 56 hours Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> General Chemistry II. (lab) (TTKBL0101_EN)	
<b>Further courses built on it:</b> -	

<b>Topics of course</b>
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.
<b>Literature</b>
<i>Compulsory:</i> - D.A. Vallero: Fundamentals of Air Pollution (Academic Press, 2007) ISBN: 780123736154 - N.L. Nemerow: Industrial Waste Treatment (Butterworth-Heinemann, 2007) ISBN: 9780123724939 <i>Recommended:</i> - 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, 2 <sup>nd</sup> edition, 2004 by Blackwell Science Ltd, ISBN 0-632-05905-2

<b>Schedule:</b> <i>1<sup>st</sup> week</i> Overpopulation (problems, effects and solutions). Causes of Environmental Pollution. Effects of Environmental Pollution (Greenhouse Effect, Global Warming, Climate Change). <i>2<sup>nd</sup> week</i> The Areas of the Environmental Protection. The Theory of the Sustainable Development. <i>3<sup>rd</sup> week</i>
---

The Type and Composition of Waste. The Technology System of the Waste Management (Selective Collection, Transportation, Pre-Treatment, Utilization, Disposal and Landfilling).

4<sup>th</sup> week

The Principles of the Product and Production Integrated Environmental Protection.

5<sup>th</sup> week

Waste processing technologies. Description of Major Waste Treatment Equipments (Shredders, Mills, Comminutors...).

6<sup>th</sup> week

Description of the Waste Collection, Separation and Sorting Equipments and Technologies.

7<sup>th</sup> week

The Type of Air Pollutants. Description of Technologies to Remove Air Pollutants.

8<sup>th</sup> week

The Different Type of Water Pollutants (Oil, Detergents, Pesticides, Organic Substances).

Determining the Organic Pollution of Waters (BOD, COD, TOC)

9<sup>th</sup> week

Main Soil Components. Type of Soil Pollution. Treatments Technologies of Contaminated Soil.

10<sup>th</sup> week

Description of a Sewage Treatment Plant. Near-Natural Wastewater Treatment Technologies

11<sup>th</sup> week

Noise and Vibrations. Effects and Noise Abatement.

12<sup>th</sup> week

Effect of Radioactivity on the Human Body. Application of Radioactivity (Medicine, Energy Production).

13<sup>th</sup> week

Renewable Energy Sources (Solar Energy, Hydropower Wind Energy, Sea Energy, Geothermal Energy)

14<sup>th</sup> 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 14<sup>th</sup> 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:** Illyésné Dr. Czifrák, Katalin, assistant professor, PhD

**Lecturer:** Illyésné Dr. Czifrák, Katalin, assistant professor, PhD

<b>Title of course:</b> Environmental technology Lab <b>Code:</b> TTKBL1114_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 2 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 28 hours - preparation for the tests: 32 hours Total: 60 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> TTKBE1114_EN parallel recording	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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. Measurement of plasticizer content (qualitative and quantitative) from waste materials.	
<b>Literature</b>	
<i>Recommended:</i> 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	
<b>Schedule:</b> <i>8<sup>th</sup> week</i> Identification of plastic wastes using simple physical and chemical methods. <i>9<sup>th</sup> week</i> Desalination of waste water on ion exchange column. <i>10<sup>th</sup> week</i> Removal of floating particles from waste water by sedimentation. <i>11<sup>th</sup> week</i> Determination of the solvent content of waste water by GC method. <i>12<sup>th</sup> week</i>	

Measurement of extractable matter content (plasticizer content) from (qualitative and quantitative) waste plastics. Carry out the extraction, prepare the sample.

*13<sup>th</sup> week*

Measurement of plasticizer content (qualitative and quantitative) from waste materials.

*14<sup>th</sup> 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:** Katalin Illyésné Dr. Czifrák, assistant professor, PhD

**Lecturer:** Katalin Illyésné Dr. Czifrák, assistant professor, PhD



<b>Title of course:</b> Visits to Biotech Companies <b>Code:</b> TTBBG0550_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 28 hours - laboratory: - - home assignment: 2 - preparation for the exam: - Total:30 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
<p>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.</p> <p>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).</p>	
<b>Literature</b>	
<b>Schedule:</b> <i>1<sup>st</sup> week:</i> Visit to TEVA Pharmaceutical Company at Debrecen. (8 hours)  <i>2<sup>nd</sup> week:</i> Visit to Evonik-Agroferm Zrt at Kaba. (6 hours)  <i>3<sup>rd</sup> week:</i> Visit to Richter Gedeon Nyrt at Budapest. (10 hours)  <i>4<sup>th</sup> week:</i> Visit to Sanofi-Chinoin Zrt. at Miskolc. (6 hours)  <i>5<sup>th</sup> week:</i>	

6<sup>th</sup> week:

7<sup>th</sup> week:

8<sup>th</sup> week:

9<sup>th</sup> week:

10<sup>th</sup> week:

11<sup>th</sup> week:

12<sup>th</sup> week:

13<sup>th</sup> week:

14<sup>th</sup> 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. Michel Flippi, assistant professor, PhD

**Lecturer:** -

<b>Title of course:</b> Research techniques in Plant Biology <b>Code:</b> TTBBE0120_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 1 hour/week - practice: 1 hour/week - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: 14 hours - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
<b>Year, semester:</b> 4 <sup>th</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
<p>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 tertiary 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.</p> <p>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.</p> <p>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 biochemical adaptation of plants to dry environments.</p>	

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:

*1<sup>st</sup> 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.

*2<sup>nd</sup> week:* Interesting properties and possible applications of duckweeds as future crops. Duckweeds in toxicity-tests.

*3<sup>rd</sup> 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.

*4<sup>th</sup> 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.

*5<sup>th</sup> week:* Advance in methods of molecular taxonomy.

*6<sup>th</sup> week:* Significance and analysis of soil seed banks

*7<sup>th</sup> week:* Particularities of plant cells and related research methods. Plant tissue cultures and their importance.

*8<sup>th</sup> week:* Plant biotechnology I.: History of plant genomes modification, crop plant domestication.

*9<sup>th</sup> week:* Plant biotechnology II.: Modern molecular technologies in plant breeding.

*10<sup>th</sup> week:* Specialized metabolite production in *in vitro* plant tissue cultures.

*11<sup>th</sup> week:* Biology of Cyanobacteria and other oxygenic photosynthesizing microbes –algae.

*12<sup>th</sup> 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.

13<sup>th</sup> week: Specialized metabolite production in cyanobacteria and eucaryotic algae with economic, public health, therapeutical, diagnostical importances.

14<sup>th</sup> 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, university 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

<b>Title of course:</b> Mathematical modelling of biological systems <b>Code:</b> TTMBE0805_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: 28 hours - laboratory: - - home assignment: - - preparation for the exam: 34 hours Total: 900 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Mathematics III. (TTMBG0804_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
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 evolutionary 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.	
<b>Literature</b>	
<i>Compulsory:</i> - <i>Recommended:</i> 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)	
<b>Schedule:</b>	
<i>1<sup>st</sup> week</i> 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. <i>2<sup>nd</sup> week</i> Population growth models. Conversation equation, natural rate of birth and death, migration, harvest, carrying capacity. Continuous models, exponential growth, logistic equation.	

*3<sup>rd</sup> week*

Age-structured population. Analogues of continuous models in discrete setting.

*4<sup>th</sup> week*

Stochastic effects in smaller populations. The simplest models of stochastic population growth. Asymptotics of large initial population.

*5<sup>th</sup> week*

Interaction of multiple populations. Lotka-Volterra equations. Predatory-prey and competitive models.

*6<sup>th</sup> week*

Infectious disease spread models. The SI, SIS, SIR, and SIRS models. Vaccination and evolution of virulence.

*7<sup>th</sup> week*

Population genetics. Haploid and diploid genetics. Frequency dependent selection. Random genetic drift.

*8<sup>th</sup> week*

Biochemical reactions, the law of mass action. Differences in enzyme kinetics. Michaelis-Menten kinetics.

*9<sup>th</sup> week*

Reversible catalysis and non-Michaelis-Menten kinetics. Inhibition and cooperativity.

*10<sup>th</sup> week*

Evolutional game theory. Preliminaries from game theory: strategies, payoffs, pure and mixed strategies, Nash equilibrium.

*11<sup>th</sup> week*

Evolutional game theory. Evolutionarily stable strategies, relations to Nash equilibrium, replicator dynamics. The hawk-dove game.

*12<sup>th</sup> week*

Branching processes in biology. Fractals constructed by iteration: the Mandelbrot and the Julia set. The Koch curve. Fractal dimension.

*13<sup>th</sup> week*

Further types of fractals: non self-similar fractals, diffusion-limited aggregation. Biological examples.

*14<sup>th</sup> 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:

<b>Total Score (%)</b>	<b>Grade</b>
0 – 50	fail (1)
51 – 60	pass (2)

61 – 70	satisfactory (3)
71 – 85	good (4)
86 – 100	excellent (5)
<i>-an offered grade:</i>	
It is not possible to obtain an offered grade in this course.	
<b>Person responsible for course:</b> Prof. Dr. Ákos Pintér, university professor, DSc	
<b>Lecturer:</b> Prof. Dr. Ákos Pintér, university professor, DSc	



<b>Title of course:</b> Numerical mathematics <b>Code:</b> TTMBG0806_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: 28 hours- - laboratory: - - home assignment: - - preparation for the tests: 48 hours Total: 90 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Mathematics III. (TTMBG0804_EN)	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
Features of computations 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.	
<b>Literature</b>	
<i>Compulsory:</i> - <i>Recommended:</i> - 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.	
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Features of computations by computer, error propagation. Some important matrix transformations for solving linear systems and eigenvalue problems. <i>2<sup>nd</sup> week</i> Solution of system of linear equations: Gaussian elimination and its variants <i>3<sup>rd</sup> week</i> Algorithms of the Gauss elimination and its operational complexity. Pivoting. <i>4<sup>th</sup> week</i> Decompositions of matrices: Schur complement, LU decomposition, LDU decomposition, Cholesky factorisation, QR factorisation of matrices. <i>5<sup>th</sup> week</i> Iterative methods for solving linear systems: Gauss-Seidel iteration and its convergence <i>6<sup>th</sup> week</i> Preconditioning. The gradient method and the conjugate gradient method <i>7<sup>th</sup> week</i> Approximate solution of nonlinear equations: Newton method, local and global convergence, quasi-Newton method, Levenberg–Marquardt algorithm, Broyden-method	

8<sup>th</sup> week Numerical methods for solving eigenvalue problems: power method and inverse iteration  
 9<sup>th</sup> week Numerical methods for solving eigenvalue problems: shift method, the QR algorithm  
 10<sup>th</sup> week Interpolation and approximation problems: Lagrange-interpolation, Hermite-interpolation. Spline interpolation. Error of the approximation. Tschebisev-approximation  
 11<sup>th</sup> week Numerical integration: Newton-Cotes formulas. Composite quadrature formulas  
 12<sup>th</sup> week Gauss quadrature. Existence, convergence, error estimation  
 13<sup>th</sup> week Numerical methods for solving initial value problems of ordinary differential equations: Euler method, Runge-Kutta method  
 14<sup>th</sup> 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 7<sup>th</sup> week and the other test in the 14<sup>th</sup> 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

<b>Title of course:</b> Genetics II. <b>Code:</b> TTBBE2043_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice:- - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 14 Total: 28 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Genetics (TTBBE3020_EN)	
<b>Further courses built on it:-</b>	
<b>Topics of course</b>	
<p>The aim of the course is to introduce special genetic topics not discussed in the basic genetics course.</p> <p>Molecular mechanism of genetic recombination: detection of crossing over, gene conversion and postmeiotic segregation. Molecular models of genetic recombination. Mobile genetic elements: insertion sequences, transposons, inversion elements, retro sequences. The mechanisms of conservative, replicative and retro-transposition. Genetic transformation. Generalized transduction. Specialized transduction. Bacterial conjugation. R-factors and other plasmids. Extracromosomal inheritance: the construction of chondriome and plastome, mitochondrial inheritance.</p>	
<b>Literature</b>	
<p><i>Compulsory:</i></p> - <p><i>Recommended:</i></p> -	
<b>Course objective/intended learning outcomes</b>	
<p><b>a) Knowledge</b></p> - He/she fundamentally knows the important terms used in genetics. - He/she knows the molecular background of genetic events. - He/she knows examples of hereditary factors. <p><b>b) Abilities</b></p> - He/she is able to interpret molecular mechanisms. - He/she understands the relationship between the organization and inheritance of certain cellular organs. - He/she understands the genetic background of some genetic engineering methods. <p><b>c) Attitude</b></p> - He/she is striving to understand and uncover relationships. - He/she is interested and motivated.	

**d) Autonomy and responsibility**

- Even in unexpected decision-making situations he/she is capable of considering complex, fundamental questions from his/her professional field and elaborating them on the basis of the given sources.
- He/she is open to critical remarks which are professionally well-founded.

**Schedule:**

*1<sup>st</sup> week*

Description the course themes and requirements.

Review of the processes of mitosis and meiosis.

*2<sup>nd</sup> week*

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

*3<sup>rd</sup> week*

Molecular mechanism of genetic recombination II: molecular models.

*4<sup>th</sup> week*

Mobilis genetic elements I: insertion sequences, transposons.

*5<sup>th</sup> week*

Mobilis genetic elements II: retro sequences, retro elements, retrons, retroposones, retroviruses, pararviruses.

*6<sup>th</sup> week*

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

*7<sup>th</sup> week*

Genetic transformation.

*8<sup>th</sup> week*

Transduction in bacteria: generalized transduction.

*9<sup>th</sup> week*

Transduction in bacteria: specialized transduction.

*10<sup>th</sup> week*

Conjugation in bacteria. R-factors and other plasmids.

*11<sup>th</sup> week*

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

*12<sup>th</sup> week*

Extrachromosomal inheritance II: pollensterility and phylogenetic aspects.

*13<sup>th</sup> week*

Extrachromosomal inheritance III: the plastome and eukaryotic plasmids.

*14<sup>th</sup> week*

Consultation.

**Requirements:**

- *for a signature*

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

- *for a grade*

The course ends in an **examination**.

The minimum requirement for the examination respectively is 60%.

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. Csoma Hajnalka assistant professor, PhD

**Lecturer:** Dr. Csoma Hajnalka assistant professor, PhD

<b>Title of course:</b> Seminar in Organic Chemistry I. <b>Code:</b> TTKBG0311_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hour/week - laboratory: -	
<b>Evaluation:</b> term mark	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 14 hours - preparation for the exam: - Total: 28 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> General Chemistry I. (lecture) TTKBE0101_EN	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
<ul style="list-style-type: none"> <li>• Review the basic of organic chemistry basics</li> <li>• Types and theories of chemical bonds</li> <li>• Review the acid-base theories</li> <li>• Basic concepts of isomerism and stereochemistry.</li> <li>• Classification of organic chemical reactions.</li> <li>• Functional groups and the basics of organic nomenclature.</li> <li>• The structure, nomenclature, synthesis and reactions of alkanes, alkenes, alkynes, mono- and polycyclic, homo- and heteroaromatic hydrocarbons.</li> </ul>	
<b>Literature</b>	
<p><i>Compulsory:</i></p> <ol style="list-style-type: none"> <li>1. Course material, concept and task collection for lectures, seminars in the e-learning system.</li> </ol> <p><i>Recommended:</i></p> <ol style="list-style-type: none"> <li>2. J. G. Smith: Organic Chemistry, 5<sup>th</sup> Edition, 2016, McGraw Hill; ISBN-13: 9780077354725</li> <li>3. J. McMurry: Organic Chemistry, 8<sup>th</sup> Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449</li> <li>4. J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2<sup>nd</sup> Edition, 2012, Oxford University Press; ISBN-13: 9780199270293</li> <li>5. F. A. Carey: Organic Chemistry, 4<sup>th</sup> Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014</li> <li>6. L. G. Wade: Organic Chemistry, 8<sup>th</sup> Edition, 2012, Pearson; ISBN-13: 9780321768148</li> <li>7. T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10<sup>th</sup> Edition, 2009, Wiley &amp; Sons; ISBN-10: 0470556595</li> <li>8. H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1<sup>st</sup> Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244</li> </ol>	
<b>Course objective/intended learning outcomes</b>	

**a) Knowledge**

He/She knows the basic concepts and theories which are necessary to understand and interpret structure and reactivity of organic compounds (chemical bond, hybridization, resonance theory, isomerism) He/she knows the structure, physical and chemical properties and synthetic methods of saturated, unsaturated and aromatic hydrocarbons and He/She can apply these knowledges to solve chemical problems.

**b) Abilities**

- He/she knows and is able to apply his/her knowledge to solve simple tasks on the field of hydrocarbons.
- He/she is able to participate in professional communication on the field of structure, and chemical transformation of hydrocarbons.
- He/she is able to expand and/or develop his/her knowledge from the natural products.

**c) Attitude**

- He/she is open to getting new, scientifically proven knowledge on the subject, but to reject unsubstantiated or possibly misleading claims

**d) Autonomy and responsibility**

- He/she is able to independently perform the tasks of the course with professional guidance, and he/she can interpret and evaluate of the results obtained.

**Schedule:***1<sup>st</sup> week*

Comparison and exercise of representation of organic compounds. Determination of the order (primary, secondary, tertiary, quaternary) of carbon atoms in compounds.

*2<sup>nd</sup> week*

The use of resonance structures and hybridization in the interpretation of the structure of organic compounds. Interpretation of electron shift or delocalization phenomena (inductive and mesomeric effect, conjugation and hyperconjugation).

*3<sup>rd</sup> week*

Exercise the recognition of organic compounds and functional groups.

*4<sup>th</sup> week*

Use of the substitutive and functional class nomenclature in naming hydrocarbons. Practice the names of alkyl groups.

*5<sup>th</sup> week*

Exercise of the most important types of organic chemical reactions, recognition of reactive particles (electrophile, nucleophile, radical).

*6<sup>th</sup> week*

Exercise the concept of constitution, conformation and configuration. Recognition and differentiation of enantiomers and diastereomers.

*7<sup>th</sup> week*

Practice the representation and projection of the organic molecules. The absolute configuration of chiral compounds, Fischer and Cahn-Ingold-Prelog convention.

*8<sup>th</sup> week*

Interpretation of radical transformations of alkanes. Statistical and regioselective halogenation of alkanes. Synthesis of alkanes.

*9<sup>th</sup> week*

Methods for the synthesis of alkenes, cycloalkenes. Addition reactions of alkenes, regioselectivity and its interpretation in addition reactions.

*10<sup>th</sup> week*

Addition reactions 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.

*11<sup>th</sup> week*

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.

*12<sup>th</sup> week*

Exercise the criteria of aromaticity. Interpretation of aromatic electrophilic substitution reactions.  
*13<sup>th</sup> week*

The S<sub>EAr</sub> reactions of substituted benzene derivatives –the reactivity and regioselectivity.  
Classification of substituents and interpretation of their effect on reactivity and regioselectivity.

*14<sup>th</sup> week*

Reactions of aromatic hydrocarbons containing alkyl residues, interpretation of the stability of benzyl-type reactive intermediates. Most important representatives of polycyclic aromatic hydrocarbons.

**Requirements:**

The course is recommended in parallel with the lecture Organic Chemistry I. (TTKBE0301\_EN).

**Evaluation:**

*- for a signature*

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.

The performance of the students in the seminar is verified 4 times in the form of written tests.

*- for a grade*

The term mark is based on the average of the grades of written tests.

The minimum requirement for the written tests respectively is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-49	fail (1)
50-65	pass (2)
66-80	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

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

**Lecturer:** László Dr. Juhász, associate professor, PhD, Habil.



<b>Title of course:</b> Seminar in Organic Chemistry II. <b>Code:</b> TTKBG0312_EN	<b>ECTS Credit points: 1</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hour/week - laboratory: -	
<b>Evaluation:</b> term mark	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 14 hours - preparation for the exam: - Total: 28 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> Inorganic Chemistry I. (lecture) TTKBE0201_EN, Organic Chemistry I. (lect .and sem.) TTKBE0301_EN, Physical Chemistry I. (lecture) TTKBE0401_EN	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
Overview and exercising of 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	
<b>Literature</b>	
<i>Compulsory:</i> 1. Course material, concept and task collection for lectures, seminars in the e-learning system. <i>Recommended:</i> 2. J. G. Smith: Organic Chemistry, 5 <sup>th</sup> Edition, 2016, McGraw Hill; ISBN-13: 9780077354725 3. J. McMurry: Organic Chemistry, 8 <sup>th</sup> Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449 4. J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2 <sup>nd</sup> Edition, 2012, Oxford University Press; ISBN-13: 9780199270293 5. F. A. Carey: Organic Chemistry, 4 <sup>th</sup> Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014 6. L. G. Wade: Organic Chemistry, 8 <sup>th</sup> Edition, 2012, Pearson; ISBN-13: 9780321768148 7. T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10 <sup>th</sup> Edition, 2009, Wiley & Sons; ISBN-10: 0470556595 8. H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1 <sup>st</sup> Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244	
<b>Course objective/intended learning outcomes</b>	
<b>a) Knowledge</b> - He/she knows the structure, physical and chemical properties and synthetic methods of the most important organic compounds possessing heteroatoms (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). He/she is able to apply his/her knowledge to solve simple tasks on the field of this compounds. He/she knows the application and practical significance of these derivatives., and their applicabilities

**b) Abilities**

- He/she knows and is able to apply his/her knowledge to solve simple tasks on the field of hydrocarbons.
- He/she is able to participate in professional communication on the field of structure, and chemical transformation of hydrocarbons.
- He/she is able to expand and/or develop his/her knowledge from the natural products.

**c) Attitude**

- He/she is open to getting new, scientifically proven knowledge on the subject, but to reject unsubstantiated or possibly misleading claims

**d) Autonomy and responsibility**

- He/she is able to independently perform the tasks of the course with professional guidance, and he/she can interpret and evaluate of the results obtained.

**Schedule:**

*1<sup>st</sup> week*

Practice the classification and synthesis of halogenated hydrocarbons.

*2<sup>nd</sup> week*

Practice the elimination and substitution reactions of halogenated hydrocarbons.

*3<sup>rd</sup> week*

Practice the preparation of Grignard compounds and their application.

*4<sup>th</sup> week*

Preparation of alcohols, ethers, phenols and their thioanalogues. The acid-base properties of alcohols, phenols and their thioanalogues

*5<sup>th</sup> week*

Practice the chemical properties of alcohols and phenols, ethers and their thioanalogues.

*6<sup>th</sup> week*

Practice the classification of amines and characterization of their bonding systems. Practice the synthetic methodologies of aliphatic and aromatic amines, industrial methods.

*7<sup>th</sup> week*

Practice the basicity and chemical transformations of the amines (alkylation, acylation, sulfonamide formation, reaction with nitric acid). Reactions of aromatic rings of anilines.

*8<sup>th</sup> week*

Practice the preparation of nitro compounds, diazonium salts. Reactions and practical significance of aromatic diazonium salts.

*9<sup>th</sup> week*

Practice the synthetic possibilities of aldehydes and ketones and an overview of their acid-base properties.

*10<sup>th</sup> week*

Practice the transformations of aldehydes and ketones. Reactions of the carbonyl group (nucleophilic addition reactions with O-, S-, N- and C-nucleophiles) and reactions on the  $\alpha$ -carbon atoms.

*11<sup>th</sup> week*

Practice the classification and preparation of carboxylic acids and their derivatives.

*12<sup>th</sup> week*

Practice the acid-base properties of carboxylic acids and its derivatives. The acyl nucleophilic substitution and the reductive transformations of carboxylic acid derivatives, transformation of their carbon skeleton.

*13<sup>th</sup> week*

Chemical properties of  $\beta$ -dicarboxylic acids, malonester synthesis.

*14<sup>th</sup> week*

Chemical properties of  $\beta$ -oxocarboxylic acid derivatives, acetoacetic ester and cyanoacetic ester syntheses.

**Requirements:**

The course is recommended in parallel with the lecture Organic Chemistry II. (TTKBE0302\_EN).

**Evaluation:**

*- for a signature*

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.

The performance of the students in the seminar is verified 4 times in the form of written tests.

*- for a grade*

The term mark is based on the average of the grades of written tests.

The minimum requirement for the written tests respectively is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-49	fail (1)
50-65	pass (2)
66-80	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

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

**Lecturer:** László Dr. Juhász, associate professor, PhD, dr. habil

<b>Title of course:</b> Advanced seminar in organic chemistry <b>Code:</b> TTKBG0313_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 2 hours/week - laboratory: -	
<b>Evaluation:</b> term mark	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 28 hours - laboratory: - - home assignment: 21 hours - preparation for the exam: - Total: 49 hours	
<b>Year, semester:</b> 2 <sup>nd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Organic Chemistry II. (lect .and sem.) TTKBE0302_EN	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
The aim of the course is to enable students to master the complex organic chemistry problem solving skills, and to be able to apply the knowledge acquired in basic courses in solving complex synthetic tasks and designing syntheses.	
<b>Literature</b>	
<p><i>Compulsory:</i></p> <ol style="list-style-type: none"> <li>1. Course material, concept and task collection for lectures, seminars in the e-learning system.</li> </ol> <p><i>Recommended:</i></p> <ol style="list-style-type: none"> <li>2. J. G. Smith: Organic Chemistry, 5<sup>th</sup> Edition, 2016, McGraw Hill; ISBN-13: 9780077354725</li> <li>3. J. McMurry: Organic Chemistry, 8<sup>th</sup> Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449</li> <li>4. J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2<sup>nd</sup> Edition, 2012, Oxford University Press; ISBN-13: 9780199270293</li> <li>5. F. A. Carey: Organic Chemistry, 4<sup>th</sup> Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014</li> <li>6. L. G. Wade: Organic Chemistry, 8<sup>th</sup> Edition, 2012, Pearson; ISBN-13: 9780321768148</li> <li>7. T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10<sup>th</sup> Edition, 2009, Wiley &amp; Sons; ISBN-10: 0470556595</li> <li>8. H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1<sup>st</sup> Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244</li> </ol>	
<b>Course objective/intended learning outcomes</b>	

**a) Knowledge**

- He/she knows the structure, physical and chemical properties organic compounds and he/she is able to apply his/her knowledge to solve complex tasks on the field of this compounds. He/she knows the application and practical significance of these derivatives., and their applicabilities

**b) Abilities**

- He/she is able to participate in professional communication on the field of structure, and chemical transformation of this field.

- He/she is able to expand and/or develop his/her knowledge from the natural products.

**c) Attitude**

- He/she is open to getting new, scientifically proven knowledge on the subject, but to reject unsubstantiated or possibly misleading claims

**d) Autonomy and responsibility**

- He/she is able to independently perform the tasks of the course with professional guidance, and he/she can interpret and evaluate of the results obtained.

**Schedule:**

*1<sup>st</sup> week*

The basics of retrosynthetic analysis, the concept of synthones and retrones. Types of disconnections. Interconversion of functional groups. The use of the method in the exploration of simple synthetic possibilities for compounds.

*2<sup>nd</sup> week*

Retrosynthetic analysis of aromatic compounds. Use of the directing and activating/deactivating effects to form the appropriate substituent pattern.

*3<sup>rd</sup> week*

Methods for forming C-C bond I. Base catalyzed conversions I. (aldol condensation and its variants).

*4<sup>th</sup> week*

Methods for forming C-C bond II. Base catalyzed conversions II. (malonic ester and acetoacetic ester syntheses).

*5<sup>th</sup> week*

Methods for forming C-C bond III. Acid catalyzed transformations.

*6<sup>th</sup> week*

Methods for forming C-C bond IV. Possibilities for the formation and use of Grignard compounds.

*7<sup>th</sup> week*

Methods for forming C-C bond V. Transition metal (Pd, Pt, Ru, Cu, etc.) catalyzed conversions.

*8<sup>th</sup> week*

Methods for forming carbon-oxygen and carbon-sulfur bonds.

*9<sup>th</sup> week*

Possibilities for forming carbon-nitrogen bonds.

*10<sup>th</sup> week*

Reactions suitable for the synthesis of oxo compounds.

*11<sup>th</sup> week*

Reactions for the preparation of carboxylic acids and their derivatives.

*12<sup>th</sup> week*

Preparation and reactions of amino acids. Peptide synthesis.

*13<sup>th</sup> week*

The basic chemical properties of monosaccharides. Protecting Groups. Essential questions of synthesis of di- and oligosaccharides.

*14<sup>th</sup> week*

The synthesis of basic heterocycles and their chemical properties.

**Requirements:**

The course is recommended in parallel with the lecture Organic Chemistry III. (TTKBE0303\_EN).

- 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:** László Dr. Juhász, associate professor, PhD, dr. habil.

**Lecturer:** László Dr. Juhász, associate professor, PhD, dr. habil.

<b>Title of course: Sustainability and current environmental issues</b> <b>Code: TTBBE4045_EN</b>	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> exam + seminar work	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: 14 hours - laboratory: - - home assignment: 10 hours - preparation for the exam: 30 hours Total: 68 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester (suggested)	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
<p>The course gives an overview of the background, rise and interactions of the current global environmental, demographic and social problems, and possible ways of their alleviation. The students learn the evolution of mankind's attitude towards its surroundings, the current issues of the globalized society and economy, and the components of the worldwide escalating humanitarian and ecological crisis. The students learn the concept of sustainable development and the pitfalls and constraints of transforming the current societal and economic paradigm. The course also reviews the currently applied indices of the social and economic progress, the alternative proxies to measure environmental sustainability and human welfare, and the recently elaborated environmental economics approaches to meet sustainability.</p> <p>During the seminars the students present and discuss a selected topic of their choice, concerning their home regions'/countries' relevant environmental issues or good practices/projects in the field of sustainability.</p>	
<b>Literature</b>	
<i>Compulsory:</i> -  <i>Recommended:</i> -	
<b>Course objective/intended learning outcomes</b>	
<b>a) Knowledge</b> - He/she knows the background, development and interactions of the current issues of the globalized society and economy. - He/she knows the fundamental social, economic and environmental principles and concepts to understand the current environmental and social problems and to interpret the basic concept of sustainability. <b>b) Abilities</b> - He/she is able to apply the most important terminology and theories of environmental and social sciences in connection with completing relevant tasks.	

- He/she is able to interpret, put into context and apply new information pertaining the environment, economy and society when completing relevant tasks.

**c) Attitude**

- He/she is eager to learn about the processes of the natural environment and the effects of anthropogenic activities.

- He/she is open to gather new and environmentally relevant information and to use it in his/her profession.

- He/she performs environmentally conscious attitude both in his/her professional and private actions.

**d) Autonomy and responsibility**

- He/she makes decisions in complex and unexpected cases based on his/her professional knowledge.

- He/she is capable of considering complex, fundamental questions from his/her professional field and elaborating them on the basis of the given sources.

- He/she is able to cooperate with professionals from the fields of biology, agriculture, environmental science and social sciences.

**Schedule:**

*1<sup>st</sup> week*

The history and development of mankind's attitude towards the natural environment and its resources. The globalized economy and society and the rise of the global social and ecological crisis.

*2<sup>nd</sup> week*

Major components of the worldwide social and ecological crisis 1: Limited natural resources (natural ecosystems and genetic diversity, arable lands, freshwater, food production, non-renewable resources, e.g. fossil fuels and minerals)

*3<sup>rd</sup> week*

Major components of the worldwide social and ecological crisis 2: Limited natural sinks (air pollution: ozone depleting chemicals, greenhouse gases and climate change, smog; water pollution: eutrophication, petrochemicals, detergents, heavy metals, forever chemicals, plastics and microplastics; soil pollution, electronic waste, noise and light pollution)

*4<sup>th</sup> week*

Major components of the worldwide social and ecological crisis 3: Social aspects (overpopulation, urbanization, demographic trends, poverty, inequality, malnourishment and obesity, sanitary, contagions and further health issues)

*5<sup>th</sup> week*

The history of environmentalism (the raising awareness, international conferences and agreements, the impact of civil movements and NGOs)

*6<sup>th</sup> week*

The limits of growth and the interpretation of critical transitions and alternative stable states. Technological, economic and social constraints of the paradigm shift and the tragedy of the commons. The concept of sustainable development.

*7<sup>th</sup> week*

Demographic and economic indices. How to measure sustainability and human welfare? Social and economic proxies and indices to assess the environmental impact and sustainability.

*8<sup>th</sup> week*



Environmental economics: Society-level approaches, e.g. sharing economy, non-growth economy, circular economy. Policy-level approaches, e.g. command and control instruments, pollution quotas and tradeable emission, ecosystem services. Company-level approaches, e.g. PESTEL-analysis, clean production strategies, product life cycle assessment, green marketing

*9<sup>th</sup> week*

consultation

*10<sup>th</sup> week*

Seminar: presentation and discussion of students' projects elaborated on a chosen topic.

*11<sup>th</sup> week*

Seminar: presentation and discussion of students' projects elaborated on a chosen topic.

*12<sup>th</sup> week*

Seminar: presentation and discussion of students' projects elaborated on a chosen topic.

*13<sup>th</sup> week*

Seminar: presentation and discussion of students' projects elaborated on a chosen topic.

*14<sup>th</sup> week*

Seminar: presentation and discussion of students' projects elaborated on a chosen topic.

### **Requirements:**

*- for a signature*

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

Participation at **seminars** is compulsory. A student may not miss more than two of the five seminars. In case a student does so, the subject will not be signed and the student must repeat the course. In case of more than two missed seminars an official certificate needs to be presented. Being late is equivalent with absence. Active participation is evaluated by the teacher in every seminar 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.

The students -alone or in small groups with up to 5 people- have to prepare a brief seminar project essay (~5 pages) on a selected topic concerning their home region's/country's relevant environmental issues or good practices/projects in the field of sustainability; and also to give a short presentation (~10 min) during the seminar classes based on their seminar projects. The chosen topics will be discussed at the seminars and the reviews will be evaluated by the lecturer. In order to get the signature the seminar projects must reach at least sufficient level.

*- for a grade*

The course ends with a **written exam**.

The minimum requirement due to pass the written exam is 50%. The grade for the exam is given according to the following table:

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

The final grade is calculated as an average of the seminar grade and the exam grade, respectively. If the score of the exam is below 50%, students can retake the test in line with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Viktor Oláh assistant professor, PhD

**Lecturer:** Viktor Oláh assistant professor, PhD

<b>Title of course:</b> External practise <b>Code:</b> TTBBG0560_EN	<b>ECTS Credit points:</b> 0
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: -	
<b>Evaluation:</b> signature	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: - - home assignment: - - preparation for the exam: - Total: -	
<b>Year, semester:</b> 3 <sup>rd</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> Bioprocess Engineering I-II., Organic Chemistry I-III, Physical Chemistry, Microbiology, Unit Operations I and Process Control I.	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The students should spend 6 weeks off the university at a company or research institute related to engineering in the summer between the 6 <sup>th</sup> and the 7 <sup>th</sup> semester, if they performed Bioprocess Engineering I-II., Organic Chemistry I-III, Physical Chemistry, Microbiology, Unit Operations I and Process Control I.	
<b>Literature</b>	
<b>Schedule:</b>	
<b>Requirements:</b> - <i>for a signature</i> The students should spend 6 weeks at a company. The students have to write a report after the external practise.	
<b>Person responsible for course:</b> Dr. Michel Flipphi, assistant professor, PhD	
<b>Lecturer:</b> -	

<b>Title of course:</b> Introduction course <b>Code:</b> TTBBG0561_EN	<b>ECTS Credit points: 0</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> signature	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: - - preparation for the exam: - Total: 14 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:-</b>	

<b>Topics of course</b>
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.
<b>Literature</b>
<i>Compulsory:</i> - <i>Recommended:</i> -
<b>Schedule:</b> <i>1<sup>st</sup> week</i> Introduction in the Neptune system: Term-and subject registration. <i>2<sup>nd</sup> week</i> Useful information in the Biochemical engineering bulletin (subjects, credits, grades). <i>3<sup>rd</sup> week</i> Schedules, departments homepages, Head of Institute, Responsible for education. <i>4<sup>th</sup> week</i> Learn information through Neptune (Periods, Information). <i>5<sup>th</sup> week</i> Introduction the Chemistry Building. (Levels, laboratories, seminary rooms). <i>6<sup>th</sup> week</i> Education and Examination Rules and Regulations. <i>7<sup>th</sup> week</i> How to pay to Neptune account, student fees (invoices) and other payments. <i>8<sup>th</sup> week</i> Introduction in the "Administration" tab in Neptune. <i>9<sup>th</sup> week</i>

Registrars Department. <i>10<sup>th</sup> week</i> <i>11<sup>th</sup> week</i> External practice. <i>12<sup>th</sup> week</i> Thesis, final exam. <i>13<sup>th</sup> week</i> Type of exams, usage of the library. <i>14<sup>th</sup> week</i> Retake exams.
<b>Requirements:</b> -
<b>Person responsible for course:</b> Dr. Michel Flipphi, assistant lecturer, PhD
<b>Lecturer:</b> -