University of Debrecen
Faculty of Sciences and Technology
Department of Biochemical Engineering
H-4032, Egyetem tér 1.
Debrecen, Hungary

Dear Biochemical Engineer Student!

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

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

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

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

Attila Szentirmai, PhD

Emeritus professor

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

Levente Karaffa, PhD

Associate professor

Chemistry Building Room D-8, Tel.: +36 52 512 900 ext. 62488
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The advisor of the biocehmical engineering students (BA) is

P. Ákos Molnár

Assistant lecturer

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

After graduation, first level degree biochemical engineers should:

- be able to operate biological/biotechnological systems safely and environmentally friendly,
- be able to solve the problems on scientific field and commercial tasks, perform projects in the laboratory or semi pilot plant or plant
- be able to learn new methods, perform complex tasks, apply their knowledge
- be able to develop new products or new methods, perform subtasks in the development or planning of a technological systems
- have a knowledge of using computering systems, databases
- be able to learn and understand previously unknown systems, products, processes
- understand technical documents in foreign language.

The educations 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).

Course title *resposible teacher*	**semesters**								**Credits**	**accountability**
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**		
	teaching time (weekly, and semi anually **Course types (ea / sz / gy / konz)**									**(koll / gyj /egyéb**
Economic and Human Sciences										
Micro- and Macro-Economic module										
1.Introduction to Economics *Judit Kapás*	*2/30 ea*								*3*	*koll*
2.Macroeconomics *Pál Czeglédi*			*2/30 ea*						*3*	*koll*
Management and Business module										
3.Introduction to Business *Miklós Szanyi*							*2/30 ea*		*3*	*koll*
4.Quality Management *Ágnes Kotsis*							*2/30 ea*		*3*	*koll*

5.Management of Value Creating Processes *András István Kun*		*2/30 ea*							*2*	*koll*
6.Marketing *László Erdey*					*2/30 ea*				*3*	*koll*
Business Law module										
7.Civil Law I. *Tamás Fézer*		*2/30 ea*							*2*	*koll*
8.EU Studies *Klára Czimre*	*1/15 ea*								*1*	*koll*
9.Civil Law II. *Tamás Fézer*					*2/30 ea*				*2*	*koll*
total	***3/45 ea***	***4/60 ea***	***2/30 ea***		***4/60 ea***		***4/60 ea***		***22***	***9 koll***
Mathematical and Scientific Foundations										
Mathematics module										
10.Mathematics I. *Zoltán Muzsnay*	*4/60 ea 3/45 sz*								*7*	*koll./ gyj.*
11.Mathematics II. *Zoltán Muzsnay*		*2/30 ea 3/45 sz*							*5*	*koll./ gyj.*
Physics module										
12.Introduction to Physics *István Szabó*	*2/30 ea 1/15 gy*								*3*	*koll.*
Chemistry module										
13.General Chemistry *Gábor Lente*	*3/45 ea 2/30 sz 3/45 gy*								*7*	*koll/gyj*
14.Organic Chemistry I. *László Juhász*		*2/30 ea 1/15 sz*							*4*	*koll*
Biochemistry module										
15.Biochemistry I. *János Kerékgyártó*		*2/30 ea*							*3*	*koll/gyj*
16.Biochemistry II. *Terézia Barna*				*1/15 ea*					*2*	*koll*
Biology module										
17.Introduction to Cell Biology *Ibolya Markóczi*	*2/30 ea*								*3*	*koll*

18.General Microbiology and Mycology *István Pócsi*		*3/45 ea*	*2/15gy*						*4*	*koll/gyj*
19.Bioinformatics *Mátyás Sipiczki*					*1/15 ea 2/30 sz*				*3*	*koll/gyj*
total	***11/165 ea 5/75 sz 4/60 gy***	***9/135 ea 4/60 sz 1/15 gy***	***2/15 gy***	***1/15 ea***	***1/15 ea 2/30 sz***				***41***	***11 koll, 6 gyj.***
Basics of Professional knowledge										
Organic Chemistry and Biology module										
20.Organic Chemistry II. *László Juhász*			*2/30ea 1/15sz*						*4*	*koll*
21.Organic Chemistry III. *László Somsák*				*2/30 ea*					*3*	*koll*
22.Organic Chemistry IV. *László Somsák*				*3/45 gy*					*3*	*gyj*
23.Microbiology *István Pócsi*			*2/30 gy*						*2*	*gyj*
24.Microbial Physiology *Erzsébet Fekete*				*2/30 ea*	*2/30 gy*				*4*	*koll/gyj*
25.Genetics I. *Mátyás Sipiczki*				*3/45 ea 2/30 gy*					*7*	*koll/gyj*
26.Methods in Molecular Biology *Ida Miklós*			*2/30 ea 2/30 gy*						*5*	*koll/gyj*
Physical-Chemistry and Materials Science module										
27.Physical Chemistry *György Póta*				*2/30 ea 2/30 sz*					*4*	*koll/gyj*
28.Bio-Physical Chemistry *Ferenc Joó*						*2/30 ea*			*3*	*koll*
29.Colloid and Surface Chemistry *István Bányai*						*2/30 ea*			*3*	*koll*

Measurement and Control module										
30.Informatics for Engineers *Ákos Kuki*			*2/30 gy*						*2*	*gyj*
31.Methods in Spectroscopy *Katalin Kövér*						*2/30 ea*			*3*	*koll*
32.Computer Modeling of Chemical Technology Systems I. *Ákos Kuki*						*2/30 gy*			*2*	*gyj*
33.Computer Modeling of Chemical Technology Systems II. *Ákos Kuki*							*2/30 gy*		*2*	*gyj*
34.Analytical Chemistry I. *Katalin Kövér*					*3/45 ea 1/15 sz*	*3/45 gy*			*6*	*koll/gyj*
35.Process control I. *Lajos Gulyás*				*2/30 ea 2/30 gy*					*4*	*koll/gyj*
36.Process control II. *LajosGulyás*						*2/30 gy*			*2*	*gyj*
37.Mathematics III. *Attila Bérczes*				*2/30 sz*					*3*	*gyj*
38.Analytical chemistry II. *Katalin Kövér*						*3/45 gy*			*2*	*gyj*
Process Engineering module										
39.Bioprocess Engineering I. *Levente Karaffa*				*2/30 ea*					*3*	*koll*
40.Bioprocess Engineering II. *Levente Karaffa*					*2/30 ea 3/15 gy*				*6*	*koll/gyj*
41.Basic Engineering *Zsolt Tiba*	*2/30 ea 1/15 sz*								*3*	*koll*
42.Unit operations I. *Lajos Gulyás*			*2/30 ea 3/45 gy*						*5*	*koll/gyj*

43.Unit operations II. *Lajos Gulyás*						*2/30 ea 3/45 gy*			*5*	*koll/gyj*
44.Unit operations III. *Lajos Gulyás*							*2/30 ea 3/45 gy*		*5*	*koll/gyj*
Technology module										
45.Mechanical engineering *Endre Zsigmond Anikó Jákó*		*1/15 ea 2/30sz*							*3*	*gy*
46.Safety *György Deák*							*2/30 ea*		*3*	*koll*
47.Environmental Technology *György Deák*			*2/30 ea 2/30 sz*						*4*	*koll/ évközi beszámoló*
48.Visits to Biotech Companies *Levente Karaffa*			*2/30 gy*						*1*	*aláírás*
total	***2/30 ea 1/15 sz***	***1/15 ea 2/30sz***	***8/135 ea 3/45 sz 11/165 gy***	***13/195 ea 4/60 sz 7/105 gy***	***5/75 ea 1/15 sz 5/75 gy***	***9/135 ea 13/195 gy***	***4/60 ea 5/75 gy***		***102***	***20 koll 19 gyj 1 évközi beszámoló 1 aláírás***
Specialized courses in Biology										
49.Plant Biochemistry and Molecular Biology *Ilona Mészáros*					*3/45 ea 2/30 gy*				*5*	*koll/gyj*
50.Plant Physiology I. *Ilona Mészáros*					*2/30 ea 2/30 gy*				*3*	*koll/gyj*
51.Plant Physiology II. *Ilona Mészáros*						*2/30 ea 2/30 gy*			*3*	*koll/gyj*
52.Research Techniques in Plant Biology *Márta Hamvas*							*1/15 ea 2/30 sz*		*3*	*koll*

53. Mathematical modelling of biological systems					*2/30 ea 2/30 sz*				*3*	*koll*
54.Numerical mathematics						*1/15 ea 2/30 sz*			*3*	*gy*
összesen		***2/30 ea 2/30 sz***		***1/15 ea 2/30 sz***	***7/105ea 2/30 sz 4/60 gy***	***3/45 ea 2/20 sz 2/30 gy***	***1/15 ea 2/30 sz***		***20***	***5 koll 4 gyj***
55.Diploma work									***15***	*gyj*
Facultative module*										
*										
összesen									***10***	
Additional requirements										
External practise (industry)										
Physical Education	*2/30 a*	*2/30 a*	*2/30 a*	*2/30 a*						*aláírás*
Introduction course	*1/15 a*									*aláírás*

*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.

Symbols
ea-lecture, gy- practice, sz-seminar
a, aláírás – acceptance (no grade), gyj – practical grade, f – mid semester grades (practical)
koll – examination (written, or oral)

General information

Qualification: Biochemical Engineer
Education time: 7 semesters
Scientific field: technical, engineer
Scientific training branch: bio-, environmental-, chemical engineering
Credits: 210 credits are necessary to finish every aspect of student's educational and examinational requirements

External practise

The students should spend 6 weeks off the university at a company or research institute related to engineering in the summer between the 6^{th} and the 7^{th} semester, if they performed

Bioprocess Engineering I-II., Organic Chemistry I-III, Physical Chemistry, Microbiology, Unit Operations I and Process Control I.

Physical Education

Physical education is requirement to get absolutorium. Students have to perform P.E. in two semesters.

Language requirements

For acquiring a BSc diploma candidates must obtain at least one intermediate level state language certificate (type C) or an equivalent language certificate.

Thesis and Diploma work

Students have to write a diploma work in the 7th semester, if ***Mathematical and Scientific Foundations*** and ***Basics of Professional knowledge*** are fully, 20 credits in ***Specialized courses in Biology***, 5 credits in ***Facultative module*** are performed.

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

Final exam

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

The requirements of the final exam:
- absolutorium (performed every aspect of student's educational and examinational requirements)
- submition of the diploma work
- evaluated diploma work (at least grade satisfactory)

Subjects (topics) of the final exam:

1. Topics: General Microbiology and Mycology, Microbial Physiology, Genetics I-II., 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:
- Oral exam (from topics 1-3)
- Defense of the diploma work (questions must be answered)

Subject programs

Introduction to Economics
Credits: 3
Class/week: 2 hours of lecture
Prerequisites:-
Lecturer: Kapás, Judit

Topics: Basic concepts and fundamental questions of economics. Ten principles of economics and the economic way of thinking. Production possibilities and the gains from trade. How markets work I: demand and supply. How markets work II: applications of the theory of demand and supply. The economy as a whole: measurement. Measuring a country's income. Measuring the cost of living. Production and growth: why some countries are rich while others are poor. Savings and investment, and the role of the financial system. Unemployment. What is money and how is it "created"? Money and inflation.

Compulsory readings:
Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009 (ISBN10: 0-324-59132-2)
Recommended readings:
Heyne, Paul – Boettke, Peter – Prychitko, David: The Economic Way of Thinking. Twelfth Edition. Pearson Education International, New Jersey, 2010. (ISBN-10: 0136039855)

Macroeconomics
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Introduction to Economics
Lecturer: Kapás, Judit

Topics: Production and distribution of national income; functions of the money; the quantity theory of money; seigniorage; theories of money demand, money supply and the financial system; labour market and unemployment; macroeconomic consumption; investment; commodity market and the IS curve; the multiplier effect; aggregate demand; money market and the LM curve; inflation and the Phillips curve; fiscal and monetary policy in the IS-LM model; aggregate supply; business cycles; macroeconomic debate on economic policy; economic growth.

Compulsory readings:
Mankiw, Gregory: Macroeconomics. Seventh Edition. Worth Publisher, New York, 2010. (ISBN-10: 1429218878)
Recommended readings:
Kaufman, Roger T.: Student Guide and Workbook for Use with Macroeconomics. Worth Publisher, New York, 2007. (ISBN: 0-7167-6132-7)

Introduction to Business
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: -
Lecturer: Szanyi, Miklós

Topics: 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.
After fulfilling the course, students will be able to identify and analyse the situation of the businesses, and to identify the functional areas of the firms. Building on the knowledge they received, students will be able to communicate these issues consequently.

Compulsory readings:
Nickels, William G. – McHugh, James M. – McHugh, Susan M. (2008): Understanding Business. Eighth edition, McGraw-Hill/Irwin, New York, pp.1-87, 116-147, 180-319, 348-543, ISBN 978-0-07-310597-0
Recommended readings:
Ferrell, O. C. – Hirt, Geoffrey (1993): Business – A Changing World. Irwin, Homewood, pp.1-29, 80-471, 502-633, ISBN 0-256-11683-0
Skinner, Steven J. – Ivancevich, John M. (1992): Business for the 21st Century. Irwin, Homewood, pp.1-121, 188-701, 736-771, ISBN 0-256-09222-2

Quality Management
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: -
Lecturer: Kotsis, Ágnes

Topics:This course introduces the participants into the philosophy, the theories of quality management. Students get an overview about the history of quality management and the development of quality approach. They can acquire the concept of quality relating to services and products, and different management techniques how companies operations be organized. New trends of management methods (lean tools, six sigma) will be introduced.

Compulsory reading:
Foster S. Thomas [2010]: Managing Quality. 4th edition. Pearson Prentice-Hall, New-Jersey. ISBN 13: 978-0-130507819-8
Recommended readings:
Philip B. Crosby [1995]: Quality Is Still Free: Making Quality Certain in Uncertain Times, McGrawHill Inc., New York, ISBN 0-07-014532-6
W. Edwards Deming [2000]: Out of Crisis. MIT Press Cambridge, Massachusetts, London, England. ISBN: 9780262541152
Donna C. S Summers [2009]: Quality Management. Creating and Sustaining Organizational Effectiveness. Pearson Education Inc, Upper Saddle River, New Yersey. ISBN 13: 978-0-13-608742-7

Management of Value Creating Processes
Credits: 2
Class/week: 2 hours of lecture

Prerequisites: -
Lecturer: Kotsis, Ágnes

Topics: This course introduces the participants into the philosophy, the theories and the basic calculations of operations management. Seminars give opportunity to discuss the lectures and to get practice in basics of operations management through solving exercises. The most important topics of the course are: the organisational and market context of operations management; competitiveness, strategy, productivity; product design, capacity planning; process selection; facility layout; quality management; supply chains and value chains; scheduling; projects; LEAN operations.

Compulsory readings:
Stevenson, J. William (2009): Operations Management. 10th edition. McGraw-Hill Irvin, London, ISBN 978-0-07-009177-1.
Recommended readings:
Beckman, Sara L. – Rosenfield, Donald Barry (2008): Operations Strategy: Competing in the 21st Century. McGraw-Hill Irvin, London, ISBN 9780071274081.
Fitzsimmons, James A. – Fitzsimmons, Mona J. (2011): Service Management: Operations, Strategy, Information Technology, 7th Edition. McGraw-Hill Irvin, London, ISBN 0073403350.
Krajewski, Lee J. – Ritzman, Larry P. – Malhotra, Manoj K. (2012): Operations Management: Processes and Supply Chains: Global Edition, 10/E. Pearson Higher Education, New York, ISBN 9780273766834.

Marketing
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: -
Lecturer: Erdey László

Topics: The course is an introduction to the language and issues of marketing with an emphasis on learning to develop responsive marketing strategies that meet customer needs. The course focuses on basic marketing concepts, the role of marketing in the organization, and the role of marketing in society. Topics include market segmentation, product development, promotion, distribution, and pricing. Other topics, which will be incorporated into the course, are external environment (which will focus on integrative topics with marketing, such as economics, politics, government, and nature), marketing research, international/global marketing with relevance to cultural diversity, ethics, the impact of technology on marketing, and careers in marketing.

Compulsory readings:
Philip Kotler – Gary Armstrong: Principles of Marketing with MyMarketingLab: Global Edition, 14/E, ISBN-10: 0273752502, ISBN-13: 9780273752509, Pearson
Recommended readings:
Tracy Tuten—Michael R. Solomon (2013): Social Media Marketing, ISBN-10: 0132551799, ISBN-13: 9780132551793, Pearson
Kevan Williams (2010): Brilliant Business Plan: What to know and do to make the perfect plan, ISBN-10: 0273742523, ISBN-13: 9780273742524, Pearson

Civil Law I.
Credits: 2
Class/week: 2 hours of lecture

Prerequisites: -
Lecturer: Frézer, Tamás

Topics: The primary purpose of the course is to give basic knowledge about selected topics of the Hungarian and European private law. Classes deal with topics that might be useful for students establishing innovations to the market, being employed in their professional field or contracting with others for licensing, developing, researching, etc. In order to fulfill the above mentioned goals the most important topics of the course are the followings: civil law systems vs. common law systems; private law codifications in Europe; legislative competence of the European Union; legal capacity in private law; personality right protection; law of intellectual property; business associations. Classes follow the Socratic method, an interactive, participation encouraging method. By the end of the course students will have a general look at the private law system in Hungary and Europe and they can identify the most important legal problems connecting to their profession.

SAUTER, Wolf – SCHEPEL, Harm: *State and Market in European Union Law: The Public and Private Spheres of the Internal Market before the EU Courts*, Cambridge University Press, London, 2009. 270. p. ISBN 978-0521857758
TWIGG-FLESNER, Christian (ed.): *The Cambridge Companionto European Private Law*, Cambridge University Press, London, 2010. 380. p.ISBN 0521736153
BUSSANI, Mauro – WERRO, Franz: *Europen Private Law: A Handbook*, Carolina Academic Press, London, 2009. 600. p. ISBN 978-1594605550

EU Studies
Credits: 1
Class/week: 1 hours of lecture
Prerequisites: -
Lecturer: Czimre, Klára

Topics: The lectures concentrate on the economic, legal and political emergence of the European Union. The history of the European Union is an excellent example for the intensification of integration processes all over the world. Accordingly, the students on this course get an introduction to the theories and stages of the integration process. The history and making of the European Union is discussed through the main milestones paving the path for the integration. The dynamic interrelationship between the supranational and the intergovernmental character of the EU Institutions is highlighted and described in details. The influence and achievements of the EU is compared with those of the other world powers. The enlargement processes accelerating in the new millennium had an important role in the development of the various EU policies. The changes and elements of the agricultural, regional, social, environmental, etc. policies are discussed. The students get acquainted with the most important elements and parts of the Treaties of the European Union, including for example the Paris Treaty, Rome Treaties, Merger Treaty, Single European Act, Maastricht Treaty, Amsterdam Treaty, Nice Treaty and Lisbon Treaty. The aspects of the economy (internal market, competition, monetary union, energy, infrastructure, agriculture, environment), education, health care and foreign relations are also discussed in order to understand the role of the European Union as an international actor.

Bomberg, E. – Peterson, J. – Corbett, R. (2012): The European Union. How does it work? (New European Union Series) Oxford University Press, USA. 3rd edition. 310p.
Cini, Michelle (ed.) (2009): European Union Politics. Oxford University Press, 3rd edition. 520p.
Dinan, Desmond (2006): Origins and Evolution of the EU (New European Union Series). Oxford University Press, USA. 384p.

Civil Law II.
Credits: 2
Class/week:

Prerequisites: -
Lecturer: Fézer, Tamás

Topics: The primary purpose of the course is to continue the discussion on Hungarian and European private law. Classes deal with topics that might be useful for students establishing innovations to the market, being employed in their professional field or contracting with others for licensing, developing, researching, etc. In order to fulfill the above mentioned goals the most important topics of the course are the followings: property law; formation of a contract; performance and breach of a contract; general and special contractual warranties; consumer contracts; contracts in the field of R&D; tort law. Classes follow the Socratic method, an interactive, participation encouraging method. By the end of the course students will have a general look at the private law system in Hungary and Europe, especially contractual situation and the law of torts, and they can identify the most important legal problems connecting to their profession.

SAUTER, Wolf – SCHEPEL, Harm: *State and Market in European Union Law: The Public and Private Spheres of the Internal Market before the EU Courts*, Cambridge University Press, London, 2009. 270. p. ISBN 978-0521857758
TWIGG-FLESNER, Christian (ed.): *The Cambridge Companion to European Private Law*, Cambridge University Press, London, 2010. 380. p. ISBN 0521736153
BUSSANI, Mauro – WERRO, Franz: *Europen Private Law: A Handbook*, Carolina Academic Press, London, 2009. 600. p. ISBN 978-1594605550
FÉZER, Tamás: *Adjudging moral damages for personal injuries in the Dutch Civil Code*, Evroperska Iuridicna Osvita I. Nauka, Kiev, Ukraine, 2007. pp. 127-131.
EGTL: Principles of European Tort Law: Text and Commentary, Springer, Vienna, 2005. 294. p. ISBN 978-3211230848

Mathematics I.
Credits: 5+2
Class/week: 4 hours of lecture and 3 hours of pratice
Prerequisites: -
Lecturer: Muzsnay, Zoltán

Topics: Real and complex numbers, basic notions of combinatorics. The calculus of functions of one variables: limits, continuity, derivative applications and interpretations. Series in one variable with emphasis on Taylor series. An introduction to the principles and methods for solving first order ordinary differential equations. The calculus of functions of several variables with an introduction to vector calculus: limits, continuity, partial derivatives, gradients, differentials. Riemann integration, applications to area, volume, etc., and basic methods for conversion of integrals including change of variable, substitutions, partial fractions, integration by parts,improper integrals. Multiple integrals. Vector spaces, basis and dimension, rank of a system. Matrix algebra including basic algebraic operations, determinants, inversion, rank. Solution of systems of linear equations. Linear transformations, eigenvalues, and eigenvectors.
Mathematics Seminar I: problem-solving seminar. The topics of the seminars follow exactly the program of the lecture.

D. S. Sivia, S.G. Rawlings: Foundations of Science Mathematics, Oxford Science Publication,
K.A. Straud: Engineering Mathematics, Industrial Press Inc. New York,
K.A. Straud: Advanced Engineering Mathematics, Palgrave MacMillan

Mathematics II.
Credits: 2+3
Class/week: 2 hours of lecture and 3 hours of pratice
Prerequisites: -

Lecturer: Muzsnay, Zoltán

Topics: Series in several variables with emphasis on Taylor series. The calculus of vector valued functions of several variables: limits, continuity, partial derivatives, gradients, differentials. Inverse and implicit function theorem. An introduction to the principles and methods for solving partial differential equations. Multiple integrals, applications to area, volume. Euclidean vector space, inner product, norm, orthogonality, orthonormal basis. Vector analysis: vector algebra and calculus, gradients, rotation, divergence, line and surface integrals, conservative fields and potential functions, Stokes, Gauss and Green's theorem. The basic concepts and methods of probability and an introduction to statistics. Elementary combinatorics, fundamentals of probability, families of discrete and continuous probability distributions. The central limit theorem. The uses of probability and statistics in engineering areas are illustrated.
Mathematics seminar II.: problem-solving seminar. The topics of the seminars follow exactly the program of the lecture.

D. S. Sivia, S.G. Rawlings: Foundations of Science Mathematics, Oxford Science Publication,
K.A. Straud: Engineering Mathematics, Industrial Press Inc. New York,
K.A. Straud: Advanced Engineering Mathematics, Palgrave MacMillan

Introduction to Physics
Credits: 3
Class/week: 2 hours of lecture and 1 hours of pratice
Prerequisites: -
Lecturer: Szabó, István

Topics: Introduction to the main concepts and methods of physics: classical mechanics: kinematics and dynamics of motion, equation of motion. Heat, temperature and the statistical mechanics of an ideal gas. Ellasticity and the wave propagation in continious media. Geometrical and wave optics. Electromagnetic forces and fields. Fundamentals of quantum mechanics and nuclear physics. Proper application of physical units of measurements and formulas. Application of physical modells and mathematical tools for the description of natural phenonena.

1. College Physics, Openstax college, 2011, ISBN 978-1-938168-00-0, http://openstaxcollege.org/textbooks/college-physics
2. 1. Holbrow, C.H., Lloyd, J.N., Amato, J.C., Galvez, E., Parks, M.E. Modern Introductory Physics , Springer 2010, ISBN 978-0-387-79079-4
3. University Physics, Hugh D. Young, Roger A. Freedman, Pearson, 2012, ISBN 978-0-321-76219-1

General Chemistry
Credits: 4+1+3
Class/week: 3 hours of lecture, 2 hours of seminar 3 hours of pratice
Prerequisites: -
Lecturer: Lente, Gábor and Kállay, Csilla

Topics: 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. Einstein's equation on mass-energy equivalence. The law of definite proportions, the law of multiple proportions, law of combining gas volumes, Avogadro's law. Development of Dalton's atomic theory and its influence on chemistry. 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. Valency and

oxidation number. Oxidation number in inorganic compounds. Types of chemical reactions. Latin names of compounds. 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. Phase diagrams, critical temperature and pressure. Phase diagrams of water, sulfur and carbon dioxide. Thermodynamic temperature. 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. Thermochemical equation, heat of reaction, Hess's law. The importance of heat of formation. Heat changes characteristic of changes of state. Heat of reaction and bond energies. The direction of spontaneous chemical reactions: internal energy, enthalpy, free energy and entropy. 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. Different theories of acid-base reactions (Arrhenius, Brønsted, Lewis). Characterization of aqueous solutions, electrolytic dissociation. Strength of acids and bases. Amphoteric substances. The definition and calculation of pH. Buffer solutions and acid-base indicators. Acid-base properties of salts. Complex ion equilibria. Pearson's hard-soft theory. Solubility equilibria, solubility product. Temperature dependence of solubility. Gas-liquid and liquid-liquid equilibria. Extraction. 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. Experimental background of the atomic theory, discovery of the nucleus. 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. Discovery and basic properties of subatomic particles (electron, proton, neutron). The mass defect. Isotopes. Types and properties of radioactive radiation. Laws of radioactive decay, decay series. Medical and other practical importance of radioactive isotopes. Nuclear energy, nuclear fission and fusion. 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. Electronegativity, ionization energy, electronaffinity, atomic and ionic radii and their change across the periodic table. The ionic bond. Calculation of the lattice energy. The covalent bond. Basic characteristics of the molecular orbital theory and its application for diatomic molecules. The valence shell electron pair repulsion model. The shape of molecules, bond angles, bond orders, hybridization. Polarity of covalent bonds, polar and nonpolar molecules. Metallic bonding. Intermolecular forces. Hydrogen bond and its importance in inorganic and organic chemistry. General characterization of molecular, ionic, metallic, and network atomic solids. The band theory of solids. Characteristics of insulators, semiconductors and conductors. Dielectric and magnetic properties: dia-, para- and ferromagnetic materials. Principles and application of mass spectrometry. Electromagnetic spectra, atomic and molecular spectroscopies. Principles and application of infrared spectroscopy. The chemical importance of NMR and ESR spectroscopies. Diffraction methods. Theoretical models of solid materials: band theory and its applications to metals. Superconductivity and its applications. Commercial methods of metal production.

Compulsory/Recommended Readings:

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

Organic Chemistry I.
Credits: 4
Class/week: 2 hours of lecture, 1 hours of seminar
Prerequisites: General chemistry
Lecturer: Patonay, Tamás and Kónya, Krisztina

Topics: Summary of the basic phenomenon of organic chemistry. The bondsystem, nomenclatures, preparation and reaction of alkanes, alkenes, alkynes, mono- and polycyclic, homo- and hetero aromatic hydrocarbons, halogen derivatives and organometallic compounds. Visiting the seminar events is obligatory.

1. T. W. Graham Solomons, Craig Fryhle, Organic Chemistry, 10th Edition, ISBN-10: 0470556595; 2009; Wiley&Sons
2. Leroy G. Wade: Organic Chemistry; 8th Edition; ISBN-10: 0321768140; 2012; Pearson
3. Francis Carey, Robert Giuliano: Organic Chemistry; 8th Edition; ISBN-10: 007735477X; 2010; McGraw-Hill

Biochemistry I.
Credits: 2+1
Class/week: 2 hours of lecture, 2 hours of practise
Prerequisites: General chemistry
Lecturer: Kerékgyártó, János

Topics: Protein structure and function; Oxygen-transporting proteins; Enzymes and mechanisms of enzyme action; Structure and function of biological membranes; Carbohydrate metabolism: glycolysis, glyconeogenesis, glycogen synthesis, glycogenolysis, pentose phosphate pathway. The citric acid cycle; Electron transport and oxidative phosphorylation; Fatty acid metabolism; Amino acid metabolism; Hormone action and metabolic control mechanisms.
Biochemistry Practicals: Proteins: salting-out of proteins. Purification of proteins: dialysis, gel-filtration chromatography. Quantitative determination of proteins by means of photometry. Carbohydrates: quantitative determination of the reducing sugar content of plant samples. Quantitative determination of vitamin C of different samples. Nucleic acids: experiments with RNA. Hydrolysis of yeast RNA. Detection of chemical components of RNA. Quantitative determination of phosphorus content by means of photometry.

Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Biochemistry, W. H. Freeman and Company, New York, 2002. ISBN 0-7167-3051-0.
Lubert Stryer, Biochemistry, W. H. Freeman and Company, New York, 1988. ISBN 0-71671920-7.
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) Handouts

Biochemistry II.
Credits: 2
Class/week: 1 hour of lecture
Prerequisites: Biochemistry I.
Lecturer: Barna, Teréz

Topics: the aim of this course is to widen the understanding of main metabolic processes such as nucleotide metabolism, and to provide deeper view of protein structure explaining molecular recognition in enzyme action as well as revealing the regulation strategy that

controls enzyme activity. *Via* explaining the biological redox activity the student will be introduced in the basic principles of photosynthesis.
The detailed thematics:
The role of nucleotides in metabolism. The *de novo* biosynthesis of pyrimidine and purine nucleotides in prokaryotes and eukaryotes focusing the main regulatory steps. The synthesis of dezoxiribonucleotide by ribonucleotide reductase, the role of tetrahidrofolate derivative in nucleotide metabolism. Catabolism and Salvage of pyrimidine and purine nucleotides. The Role of the Amino Acid Sequence in Protein Structure, The properties of the peptide bond, Forces Influencing Protein Structure, The levels in protein Structure, Thermodynamics of Folding, Molecular Chaperones. Understanding enzyme action. Thermodynamics of enzyme reactions. Enzyme kinetics. Classes of Inhibition: Competitive inhibition, Noncompetitive inhibition, Uncompetitive inhibition and Irreversible inactivation. Controls over Enzyme Activity: Allosteric Regulation, zymogens, Covalent Modification, modulator proteins. Redox reactions in biological systems: the redox potencial and redox cofactors. The photosynthesis: the conversion of light energy into chemical energy. The energy transforming machinery in the thylakoid membrane, electron transfer in the eukaryotic photosystems: PSI (P700) and PSII (P680). NADPH generation by Ferredoxin-$NADP^+$ Reductase. Photo-phosphorylation; CF_1-CF_o ATP synthase; Oxygen evolution via the manganese center of PS II. The dark reactions of photosynthesis- the Calvin Cycle, the double activity of a RUBISCO enzyme. The role of transketolases and aldolases in the regeneration of ribulose 1,5-bisphosphate. Environmental conditions that influence the activity of the Calvin Cycle.

Berg-Tymoczky-Stryer: Biochemistry (W.H. Freeman Sixth Edition, 2007) ISBN-13:978-0-7167-8724-2
David L. Nielson and Michael M. Cox: Lehninger Principles of Biochemistry; (W. H. Freeman; Fourth Edition (2005) ISBN 13: **9780716743392**
Carl Branden, John Tooze: Introduction to Protein Structure; Garland Science; second edition (1999); ISBN-13: 978-0815323051
Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell; Publisher: Garland Science; Fifth edition (2007); ISBN-10: 0815341059

Introduction to Cell Biology
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: -
Lecturer: Revákné Dr. Markóczi , Ibolya

Skills: foundation of subsequent biological knowledge, to increase of fundamental knowledge of cellbiology of students with different biological aware capacity.
Lecture: Comparison of prokaryotic and eukaryotic cells. Endosymbiotic theory. Plant and animal cell types. The chemical basis of life. Water and its properties. Organic compounds. Carbohydrates, lipids, proteins and nucleic acids. Cellular organization. Biological membrans. Energy in living systems. Chemical reactions and energy. The eneregy currency of the cell-ATP. Enzymes: chemical regulators. Aerobic and anaerobic catabolism. Photosynthesis. Chromosomes, mitosis and meiosis. DNA, RNA and protein synthesis. Gene regulation. Recombinant DNA. Structure, function and significance of viruses, bacterias and fungus.

Villee, C.A., Solomon, E. P., Martin, C. E., Martin, D. W., Berg, L. R., & Davis, P. W (1989). *Biology*.Philadelphia: Saunders College Publishing, 27-415. ISBN 0-03-023417-4
Watson, J. D. (2008). Moleculat Biology of the Gene (6th Edition). USA: Benjamin Cummings, 5-300. ISBN 978-080539592-1
Levine, M. (2010). Biology. USA: Prentice Hall. ISBN-13: 978-0133669510

General Microbiology and Mycology
Credits: 4
Class/week: 3 hours of lecture and 1 hour of practice
Prerequisites: -
Lecturer: Pócsi, István and Emri, Tamás

Aim of the course (partial/complete skills and competencies):
The students become familiar with the basics of general microbiology and mycology. The course highly supports further studies in the fields of microbial ecology, industrial microbiology, medical microbiology and biotechnology.
Topics:
We put emphasis on the history and development of microbiology as a discipline and the transmission of appropriate and up-to-date knowledge in the fields of microbial physiology and taxonomy.
Major topics covered in general microbiology and bacteriology: History and basic concepts of microbiology; general characterization of micro-organisms. Microbes in the domains of *Bacteria*, *Archaea* and *Eukarya* – a general and comparative cell biological and physiological introduction. The metabolism of micro-organisms; biochemical pathways typical of the microbes. Detailed bacteriology: the most important taxonomical groups in the domains *Archaea* and *Bacteria* (phyla *Deinococcus - Thermus*, *Chloroflexi*, *Chlorobi*, *Cyanobacteria*, *Chlamydiae*, *Spirochaetes*, *Spirochaetes*, *Proteobacteria*, *Firmicutes* and *Actinobacteria*), including the introduction of the most typical genera and species in the selected phyla.
The best-known human and plant pathogenic viruses and bacteriophages. Human pathogenic prions and protozoa.
Major topics covered in mycology: The diversity of true fungi (regnum Fungi) and fungus-like organisms ("fungi" in the regna Protozoa and Chromista) – basics in the taxonomy of fungi. Fungal structure and ultrastructure, sexual, asexual and parasexual reproductions, spore dormancy and spore dispersal, specific features of fungal metabolism. The most important fungus-plant symbioses and the pathogenesis of the most significant fungal diseases of plants, insects and humans. Mycotoxicoses and mycetisms.

Compulsory literature:
Syllabus provided by the educator.
Recommended literature:
Prescott, L.M., Harley, J.P. and Klein, D.A. (2005) Microbiology, 6th Edition, McGraw-Hill Higher Education, Boston
Deacon, J.W. (2006) Fungal Biology, 4th Edition, Blackwell Publishing, Oxford

Bioinformatics
Credits: 3
Class/week: 1 hour of lecture and 2 hours of practice
Prerequisites: Genetics I.
Lecturer: Sipiczki, Mátyás

Topics:
1. Introduction to bioinformatics

2.1. Introduction to mining scientific literature, 2.2. Scirus, 2.3. PubMed, 2.4. AGRICOLA
3.1. Introduction to sequnce search, 3.2. ENTREZ, 3.3. Other Sequence Search Tools
4.1. Pairwise Alignment
    4.2. Global vs local
    4.3. Distances and Scoring Matrixes
    4.4. Methods of producing pairwise alignments
5. Dot plots for pairwise sequence alignment
6.1. Dynamic programmes for pairwise sequence alignment
    6.2. The Needleman-Wunsch algorithm
    6.3. The Smith-Waterman algorithm
7.1. Word programming for pairwise sequence alignment, 7.2. FASTA, 7.3. FASTA Format, 7.4. BLAST
8.1. Multiple alignment
    8.2. The CLUSTAL algorithm
    8.3. Step by Step Instructions for running CLUSTAL W
9.1. Similarity search introduction
    9.2. Databases
    9.3. Smith Waterman Searching
    (9.4. Attachment:The probability value and the expectation value)
    9.5. FASTA searching
    9.6. BLAST searching
10.1. Computational phylogenetics
    10.2. UPGMA
10.3. Maximum parsimony

Lesk AM: Introduction to bioinformatics. Oxford University Press 2002
Orengo C, Jones D, Thornton J: Bioinformatics. Bios 2003
Dear PH: Bioinformatics. Scion Publishing 2007
Reece RJ: Analysis of Genes and Genomes. Wiley, 2004

Organic chemistry II.
Credits: 4
Class/week: 2 hours of lecture and 1 hours of seminar
Prerequisites: Organic Chemistry I.
Lecturer: Patonay, Tamás and Juhász, László

Topics: in continuation of „Organic Chemistry I." lecture structure, preparation and reactivity of organic compounds possessing heteroatomic functional groups are discussed: halogenated hydrocarbons; organometallic compounds; alcohols, phenols, ethers and their thio analogues; amines, nitro compounds; diazoniumsalt; aldehydes and ketones; carboxylic acids and their derivatives; substituted carboxylic acids and carbonic acid derivatives.

1. T. W. Graham Solomons, Craig Fryhle, Organic Chemistry, 10th Edition, ISBN-10: 0470556595; 2009; Wiley & Sons
2. Leroy G. Wade: Organic Chemistry; 8th Edition; ISBN-10: 0321768140; 2012; Pearson
3. Francis Carey, Robert Giuliano: Organic Chemistry; 8th Edition; ISBN-10: 007735477X; 2010; McGraw-Hill

Organic chemistry III.
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Organic Chemistry II.
Lecturer: Somsák, László and Vágvölgyiné Dr. Tóth, Marietta

Topics: discussion of the chemistry of the most important natural products: amino acids (peptides and proteins), carbohydrates, nucleic acids, flavonoids, alkaloids, antibiotics, isoprenoids and porphyrins. Methods for structure elucidation of organic compounds, discussion of principles and applications of the physical methods for molecular structure determination.

1. T. W. Graham Solomons, Craig Fryhle, Organic Chemistry, 10th Edition, ISBN-10: 0470556595; 2009; Wiley & Sons
2. Leroy G. Wade: Organic Chemistry; 8th Edition; ISBN-10: 0321768140; 2012; Pearson
3. John McMurry: Organic Chemistry: A Biological Approach; 2nd Edition; ISBN-10: 1408009714; 2010; Brooks/Cole
4. Paul M. Dewick, Medicinal Natural Products: A Biosynthetic Approach; 3rd Edition; ISBN-10: 0470741678; 2009; Wiley

Organic Chemistry IV.
Credits: 3
Class/week: 3 hours of practice
Prerequisites: General chemistry, Organic chemistry I.
Lecturer: Somsák, László and Kónya, Krisztina

Acquirement of basic organic chemistry laboratory techniques. Test tube experiments for the identification of different compound classes. Application of basic purifying techniques. preparation of different organic compounds.

1. Organic Laboratory Techniques and Manuals. http://szerves.science.unideb.hu/OLTM.pdf
2. Reinhart Keese, Martin P. Brändle, Trevor P. Tube Practical Organic Synthesis: A Student's Guide, Wiley, ISBN: 978-0-470-02966-4

Microbiology
Credits: 2
Class/week: 1 hour of lecture and 2 hours of practice
Prerequisites: General Microbiology and Mycology
Lecturer: Pócsi, István and Emri, Tamás

Aim of the course (partial/complete skills and competencies):
Based on previous courses in biochemistry, microbiology and mycology, this course lets the students gain a deeper insight in the basically important biochemical pathways and physiological processes of the micro-organisms. The course highly supports further courses in the fields of microbial physiology, biotechnology and fermentation technology.
Topics:
The lectures cover the following major topics: exoenzyme production of bacteria and fungi, transport-systems of microbes, the most significant anabolic and catabolic processes, the most important groups of secondary metabolites. Special emphasis is placed on the cell wall biosyntheses of bacteria and fungi. In each chapter, we transmit detailed knowledge concerning the selected biochemical and physiological processes *via* taking into consideration their bioenergetic aspects and regulatory mechanisms as well. After discussing metabolic pathways, we also introduce the most significant global regulatory networks and signal transduction pathways in both prokaryotic and eukaryotic micro-organisms. Finally, the molecular background of bacterial chemotaxis, sporulation and cell differentiation will be shown.

Compulsory literature:
Syllabus provided by the educator.

Recommended literature:
1. Lengeler, J.W., Drews, G. and Schlegel, H.G. (1999) Biology of the Prokaryotes, Georg Thieme Verlag, Stuttgart
2. Gow, N.A.R. and Gadd, G.M. (1995) The Growing Fungus, Chapman&Hall, London, 1995

Microbial Physiology
Credits: 4
Class/week: 2 hours of lecture and 2 hours of practice
Prerequisites: Microbiology
Lecturer: Karaffa, Levente and Fekete, Erzsébet
Aim of the course:
We wish to provide an insight into the biological and pysiological basis of industrially important microorganisms.
Description of the course:
General classification of microorganisms. Morphology (Prokaryotes, Eukariotes and Viruses). Flow of energy in the biological world. Classification of microorganisms by their carbon and energy sources. Cycling of matter in the biological world (carbon and oxygen cycle, nitrogen cycle, sulphur cycle). Thermodynamic concepts in the analysis of biological systems (chemical work and energy, free energy of formation of some biochemical compounds, free energy change of some biochemical reactions). Chemical energy: production, conservation and utilization in the cell (energy coupling through ATP system, energy coupling through NADP system and other coenzyme system. ATP systems. Production of ATP. Utilization of ATP. Regulation of ATP production. Transport. Respiratory-chain phosporylation. Oxidation/Reduction reactions. Photosynthesis.
Description of the practical course:
Laboratory-scale (2 L), submerged, batch fermentation of a bacteria will be monitored and analysed. Time-profiles of carbon source consumption, oxygen uptake rate, biomass, carbon dioxid and ATP/ADP rate are determined by standard bioanalytical equipments (HPLC, GC, ion-exchange chromatography).

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

25. Genetics I.
Credits: 7
Class/week: 3 hours of lecture and 2 hours of practice
Prerequisites: Biochemistry I.
Lecturer: Sipiczki, Mátyás

Topics:
I. Storing of genetic information
- I.1. Genetic material
- I.2. Structure of DNA
- I.3. Supercoiling of DNA
- I.4. The organisation of DNA in the cell I: DNA packaging
- I.5. The organisation of DNA in the cell II: Chromosomal level
- I.6. The organisation of DNA in the cell III: Chromosomal level
- I.7. The organisation of DNA in the cell IV: Chromosomal level

- I.8. The organisation of RNA as genetic material

II. Transmission of genetic information from generation to generation
- II.1. Replication
- II.2. Repair

III. Expression of genetic information
- III.1. Transcription
- III.2. Posttranscriptional modifications

IV. Providing possibilities for stable, heritable changes in the genetic material
- IV.1. Neocombination I: Basic principles
- IV.2. Neocombination II: Life cycles
- IV.3. Neocombination III: Meiosis
- IV.4. Mendelian genetics I: The principle of segregation
- IV.5. Mendelian genetics II: Patterns of single-gene inheritance
- IV.6. Mendelian genetics III: The principle of independent assortment
- IV.7. Sex determination
- IV.8. Sex-linked inheritance
- IV.9. Recombination I: Meiotic recombination
- IV.10. Recombination II: Mitotic recombination Griffith, Wessler, et al.: Introduction to genetic analysis. Freeman, 2005

Griffith, Wessler, et al.: Introduction to genetic analysis. Freeman, 2005
Weaver, Hedrick: Genetics. Wm. C. Brown Publishers, 1997
Hartl, D: Genetics. Jones and Bartlett Publishers, 2005

Methods in Molecular Biology
Credits: 5
Class/week: 2 hours of lecture and 2 hours of practice
Prerequisites: Introduction to cellbiology
Lecturer: Gálné Dr Miklós, Ida

Aim: To introduce the students to the most basic techniques of molecular biology.
Topics:
Restriction enzymes, recognition sites, types of the enzymes, types of cutting. Vectors: plasmids, viral vectors, cosmids and artificial chromosomes. Cloning vectors and expression vectors. Ligation: covalent linking of two ends of DNA molecules using DNA ligase. Gel electrophoresis. Separation of large DNA molecules: pulsed field gel electrophoresis. Transformation: bacteria, yeast, higher eukaryotic cells. Selection and screening.
PCR. Synthesis of complementary DNA (cDNA). DNA libraries. DNA sequencing: basic methods. Detection of specific sequences: Southern blot, western blot, northern blot. Microarrays to measure the expression of large numbers of genes simultaneously. Applications of the methods.

Topics of the practice:
Genomic DNA isolation from yeast. Plasmid isolation from E.coli.
Digestion with restriction enzymes. Restriction map.
Gelecectrophoresis. Separation of large DNA molecules. Ligation.
Transformation.

1. Ed.: Walker, J. M.: Methods in Molecular Biology**,** ISSN: 1064-3745, Humana Press

2. EdAusube F.M.: Current Protocols in Molecular Biology, Wiley online library, Online ISBN: 9780471142720, DOI: 10.1002/0471142727

3. Ed: Galas D.J.: Genomic Technologies: Present and Future. 2002 ISBN**:** 978-0-9542464-2-6.

Physical chemistry
Credits: 3+1
Class/week: 2 hours of lecture and 2 hours of practice
Prerequisites: Mathematics I., General chemistry lectures
Lecturer: Póta, György

Topics: the lectures present the main physical chemistry laws that govern the chemical, biochemical phenomena. The main topics are: thermodynamics and its applications, phase transitions, mixtures, chemical equilibria, transport phenomena, electrochemistry, reaction kinetics, surface and colloid chemistry and elements of structure of matter. The lectures help the students to understand and model the different phenomena and to reveal the common underlying features in them.
The seminars explain and augment the material presented in the physical chemistry lectures and help the students to solve the most important quantitative problems

Compulsory:
1. György Póta: Lecture Notes, Debrecen, 2012
2. P. Atkins, J. de Paula: The Elements of Physical Chemistry, W. H. Freeman; 4th edition, 2005, 576 pages, ISBN-10: 0716773295
Recommended:
3. P. Atkins, J. de Paula: Physical Chemistry for the Life Sciences, W H Freeman & Co, 2th edition, 2011, 590 pages, ISBN-10: 1429231149
4. G. G. Hammes: Physical Chemistry for the Biological Sciences, Wiley, 2007, 388 pages, ISBN: 978-0-470-12202-0

Bio-Physical Chemistry
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Physical Chemistry
Lecturer: Joó, Ferenc and Ősz, Katalin

The topic of the lecture is a selection of physical chemical phenomena used in biological system such as: use of the first and second laws of thermodynamics in biological systems especially for ATP; primary, secondary, tertiary and quaternary structures of peptides, nucleic acids and DNA, interactions determining the structures, the effect of water; concentration dependence of the free enthalpy; use of chemical potential in reactions and transport processes, macroscopic and microscopic dissociation constants, Hughes-Klotz and Scatchard plot, Hill coefficient, polydentate ligands; self-ionization of water, Arrhenius and Bronsted acids, definition of pH and its use in biological systems, isoelectric focusing, buffer systems, ion transport; electrochemistry, Nernst equation, measurement of pH with potentiometry; properties of solutions, colligative properties, osmosis, water transport in plants, membrane potential and Donnan equilibrium, proton pumps; ideal and real solution systems, activity coefficients; chemical kinetics, temperature and pH dependence of reaction rates, enzyme catalysis, Michaelis-Menten mechanism; multi-substrate enzyme kinetics, Dixon plot, industrial use of enzymes, enzyme immobilization, enzyme catalysis in non-aqueous medium, regio- and enantioselectivity; coupled processes in biochemistry, kinetic and thermodynamic control, metabolic control analysis.

Atkins & de Paula: **Physical Chemistry**, 9th edition, Oxford University Press, ISBN: 0199543372
Peter R. Bergethon: **Biophysical chemistry : molecules to membranes**, Springer-Verlag, ISBN: 0387970533
Charles R. Cantor: **Biophysical chemistry**, W. H. Freeman, ISBN: 0716710420

Colloid and Surface Chemistry
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Physical Chemistry
Lecturer: Bányai, István and Novák, Levente

This subject is about the physical chemistry of particles between 1-500 nm in size, approached from fundamental angle.The main topics are: the subject of colloid chemistry and type of colloids; molecular interactions; surface tension and wetting; adsorption; surfaces and charged surfaces, electrokinetic phenomena; colloid stability; foams; emulsions; macromolecular colloids; association colloids, basics of rheology.
Discussing the topics students will acquire the followings: principles of making and breaking colloids, the role a large specific surface in behavior of matter; the adsorption isotherms; self-assembly and micelles; surfactant detergent behavior; stability and industrial and everyday application of colloid dispersions; analytical methods based on surface chemistry (chromatography, zeta potential, electrophoresis); industrialpainting, coating, creating monomolecular layer; viscosity and deformation of coherent and incoherent materials; basics of nano science and technology.
They will understand the behavior of complex biotechnological matters will be able to handle, separate and clean heterogeneous and micro-heterogeneous fluids and gels.

R.M.Pashley and M.E. Karaman: AppliedColloid and SurfaceChemistry, (John Wiley and Sons 2004) ISBN 0 470 86882
G. Barnes and IanGentle: Interfacial Science (Oxford University Press 2006) ISBN 0 199 278822
textsforreading:
D.J. Shaw IntroductiontoColloid and SurfaceChemistry (4th ed. Butterworth-Heineman, Elsevier 2000) ISBN 0 7506 1182 0
M. Fanun: ColloidsinBiotechnology (CRC Press, Taylor and Francis 2010) ISBN 978 1-4398 3080 2)
N. C. Price, R. A. Dwek, R. G. Ratcliffe, M. R. Wormald: OhysicalChemistryforBiochemists (3rd ed., Oxford University Press 2001) ISBN 0 19 879281 6

Informatics for Engineers
Credits: 2
Class/week: 2 hours of practice
Prerequisites:
Lecturer: Kuki. Ákos

Topics: application of word processors: equation editing. Application of spreadsheets: mathematical operations, equations, charts, curve fitting, least-squares fitting, numerical integration, solving of nonlinear equations, linear regression, introductions to statistics.
Basics of process simulation. Engineering resources on the web, databases, papers, books. Softwares and hardwares needed for quality presentations: drawing chemical structures with computer, making figures and charts, presentations.

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

Methods in Spectroscopy
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Organic Chemistry II.

Lecturer: Kövér, Katalin and Kurtán, Tibor and Kiss, Attila

Topics: **Nuclear Magnetic Resonance** (*NMR*) spectroscopy - Angular momentum and nuclear magnetization. Interaction of magnetic dipoles with external magnetic field. Population of energy levels. Macroscopic magnetization. The nuclear shielding, origin and measurement of chemical shifts. Origin of the spin-spin coupling. First order spectrum analysis. Properties of scalar couplings. One-bond- and three-bond couplings. Shielding of heavier nuclei (13C).
Mass spectrometry (*MS*) - Ionisation of molecules. Main mass spectrometric phenomena: nitrogen rule, isotope distribution. Ionisation techniques. GC-LC-MS techniques. Mass analysers, methods for measuring mass/charge. Detectors in mass spectrometry. Fragmentation rules. Fundamental calculations based on mass spectra (Number of C atoms, RD, Resolution)
Molecular spectroscopy (*UV-Vis, IR*) - Basic terms of spectroscopy: vibrational and rotational spectra of diatomic molecules. Formation of UV spectra. UV-Vis terms: chromophores, auxochromes, conjugations, solvent effect, designation of bands. Woodward-Fieser rules. Lambert-Beer law. UV-Vis properties of conjugated chromophores. Formation of vibrational spectra: fundamental vibrations, characteristic bond and group frequencies and intramolecular factors affecting their values.
Steric and conjugation effects in UV-Vis spectra.

1. P.J. Hore, Nuclear Magnetic Resonance, Oxford Univ. Press, 2002
2. R.S. Macomber, A Complete Introduction to Modern NMR Spectroscopy, Wiley, 1998
3. R.K. Harris, Nuclear Magnetic Resonance Spectroscopy, Longman, 1997
4. http://www.cis.rit.edu/htbooks/nmr/inside.htm
5. H. Günzler, H.-U. Gremlich; IR spectroscopy Wiley-VCH Verlag GmbH, Weinheim, 2002
6. Jag Mohan; Organic Spectroscopy; principles and applications CRC Press LLC, Boca Raton, 2000

Computer Modeling of Chemical Technology Systems I.
Credits: 2
Class/week: 2 hours of practice
Prerequisites: -
Lecturer: Kuki, Ákos

ChemCAD is a chemical process simulation software which enables the drawing of flow charts and the simulation of industrial processes. The aim of the course is that students acquire the knowledge of using the ChemCAD software package.
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.

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)

Computer Modeling of Chemical Technology Systems II.
Credits: 2
Class/week: 2 hours of practice
Prerequisites: 34. Computer Modeling of Chemical Technology Systems I.
Lecturer: Kuki, Ákos

Topics: application of the ChemCAD process simulation software for designing and simulation of mass transfer operations (distillation, rectification, extraction, absorption, adsorption, drying). Pipe system sizing, pumps. Economic calculations.
Through using the software the students can broaden their knowledge in the field of industrial devices and processes, besides they can learn novel, up to date industrial and environmental technologies.

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)

Analytical Chemistry I., II.
Credits: 8
Class/week: Analytical Chemistry I.: 3 hours of lecture and 1 hour seminar and 3 hour practice Analytical Chemistry II.: 3 hours of practice
Prerequisites:-
Lecturer: Kövér, Katalin and Farkas, Etelka and Buglyó, Péter and Gáspár, Attila

Topics:
LECTURE: Sampling, sample preparation methods. Basics of qualitative analysis. Quantitative description of equilibria in solution (aqueous) phase: acid-base equilibria, complex formation, precipitation reactions, redox equilibria. Basics of titrimetry: acid-base, redox, precipitation and potentiometric titrations. Heterogeneous equilibria (separation techniques) in analytical chemistry: gravimetry, extraction, various chromatographic methods. Evaluation of experimental results: statistical analysis. Errors (systematic, random) in chemical analysis.
Continuous analysis (Contiflow), pH-metry, spectrophotometry (UV/VIS), potentiometry, X-ray fluorescence (XRF), thin layer chromatography (TLC), gas chromatography (GC), liquid chromatography (LC), flame emission spectrometry (FES), atomic absorption spectrometry (AAS). Electrometric methods of analysis. Potentiometry. Types of electrodes. pH measurement. Potentiometric methods: direct potentiometry, potentiometric titration. Measurements. Basic concepts of polarography. The potential of the dropping mercury electrode. Current types in polarography. Polarographic instruments. Derivative polarography. Square wave polarography. Alternating current polarography. Amperometric titrations. Dead stop titration. Electrogravimetry. Coulometry. Conductometry. Conductometric titration. Oscillometry. Dielectrometry. Methods of thermal analysis. Differential thermal analysis. Differential Scanning Calorimetry. Thermogravimetry. Derivatography. Atomic spectrometry: basic theory. Emission spectral analysis, qualitative and quantitative analysis. Flame spectrometry. Atomic absorption spectrometry. Methods of molecular spectroscopy. Ultraviolet and visible spectrophotometry. The laws of light absorption. Procedure of UV-vis analysis: qualitative and quantitative aspects. Infrared spectroscopy. Fluorescence analysis. Chemical and biological sensors. Piezoelectric sensors. Determination of gases and components dissolved in water. Biosensors. Use of optical fibres, instruments and analytical procedures.

PRACTICE (I): Classical quantitative analytical methods: volumetric titrations based on acid-base equilibria, complex formation, precipitation reactions and redox equilibria; gravimetric analyses.

PRACTICE (II): Instrumental analytical methods. Electroanalytical methods: conductimetry, pH measurements or potentiometry, polarography (dead stop endpoint indication) (analysis of 3 samples); spectroscopic methods: UV-VIS spectrometry, atomic absorption spectrometry (demonstration of + ICP-AES technique) (analysis of 2 samples); chromatographic separations and quantitative analyses: gas chromatography, HPLC, thin-layer chromatography (3 measurements).

Compulsory/Recommended Readings:

1. G. Svehla: Vogel's Qualitative Inorganic Analysis, John Wiley and Sons, New York, 1994
2. D.A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Analytical Chemistry: An Introduction, 7th edition, Harcourt Inc., 2000,
3. D. C. Harris, Quantitative Chemical Analysis, 6th edition, W.H. Freeman and Company, New York, 2003
4. Willard H.H., Merritt Jr. L.L., Dean J.A., Settle Jr. F.A.: Instrumental Methods of Analysis, Wadsworth Publ. Co. (1998)
5. Kellner R., Mermet J.M., Otto M., Widmer M.M.: Analytical Chemistry, Willey-VCH (1998)
6. Braun, R. D.: Introduction to Instrumental Analysis, Marcel Dekker Inc. New York, 1987
7. Fifield, F. W., Kealey, D.: Principles and Practice of Analytical Chemistry, Blackie Academic and Professional, London, 1995

Process Control I
Credits: 2+2
Class/week: 2 hours of lecture and 2 hours of practice
Prerequisites: Unit operations I.
Lecturer: Gulyás, Lajos

The substance of process control science. Open- and closed loop control systems. Feed back and feed forward control. Feed forward control of batch processes. Bode algebra. Control with PLC. Automatic, continuous fixed set point control. Simple control system or loop and block diagram. Signal flow diagram. Linear systems and the principle of superposition (block in series; block in parallel, summation of signal, etc.). Feed forward- and feedback control schematic block diagram. Examples: Control of volumetric flow of liquid, Control of temperature and Control of level of liquid. Description of elements of control loop (process, controller, actuator, etc.), time-, Laplace- and frequency domain. Nyquist- and Bode diagram. Equivalent transfer functions of control loop. Development of empirical dynamic model from step response data. Identification of step response. P, I, PI, PD and PID controllers. Examination of open- and closed loop control systems. Nyquist- and Bode stability criterion.

1. D. W. Green – R. H. Perry: Perry's Chemical Engineers' Handbook. 8th Edition, McGraw-Hill 2008. ISBN 978-0-07-142294-9
2. B. Wayne Bequette: Process Control, Modeling, Design and Simulation. Prentice Hall 2008. ISBN 0-13-353640-8
3. D. E. Seborg; T. F. Edgar; D. A. Mellichamp: Process Dynamic and Control. Second Edition. Wiley 2004. ISBN 978-0-471-00077-8
4. Thomas E. Marlin: Process Control, Design Processes and Control Systems for Dynamic Performance, 2nd Edition, McGraw Hill 2000. ISBN 978-0-07-039362-2

Process Control II.
Credits: 2
Class/week: 2 hours of practice
Prerequisites: Process Control I.
Lecturer: Gulyás, Lajos

Knowledge of process control with chemical engineering examples. Using Matlab Control SystemToolbox and Simulink for process control. Mathematical modeling of chemical processes. Linearization of nonlinear models. Description of Linear Time-invariant Systems with Differential equations. Constructing models: State-space models, Transfer functions, Zero-pole-gain models and Frequency response models. SISO and MIMO systems. Solution of state-space equation in time-, Laplace- and frequency domain. Sampled data systems. Syntheses of control loop. Designing compensators. Two-position controlling.

1. D. W. Green – R. H. Perry: Perry's Chemical Engineers' Handbook. 8th Edition, McGraw-Hill 2008.
   ISBN 978-0-07-142294-9
2. B. Wayne Bequette: Process Control, Modeling, Design and Simulation. Prentice Hall 2008. ISBN 0-13-353640-8
3. D. E. Seborg; T. F. Edgar; D. A. Mellichamp: Process Dynamic and Control. Second Edition. Wiley 2004. ISBN 978-0-471-00077-8
4. Thomas E. Marlin: Process Control, Design Processes and Control Systems for Dynamic Performance, 2nd Edition, McGraw Hill 2000. ISBN 978-0-07-039362-2

Mathematics III.
Credits:3
Class/week: 2 hours of lecture
Prerequisites: Mathematics II
Lecturer: Pintér, Ákos

Fundamental concepts in biomathematical modelling. Continuous, discrete and stochatis population dynamics for single and interacting populations. Eznyme kinetics with single substrate models, cooperative and suicide substrates. Dynamics of epidemics: SI, SIS, SIR, SIRS models. Population genetics, spread of favored allele in haploid and diploid genetics. Evolutional game theory and its applications. Overview of modern areas of mathematical research in biological systems modelling.

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)

Bioprocess Engineering I.
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Microbiology
Lecturer: Karaffa, Levente and Fekete, Erzsébet

Aim of the course: We wish to provide an insight into the biological and technological basics of bioengineering by teaching the major and most substantial processes and operations as well as the qualitative and quantitative nature of interactions between them.
Description of the course: Economic significance of biotechnology, major products, production statistics and trends. Microbial (viral, procaryotic, yeast and fungal) growth kinetics – parameters of growth and analysis of growth data. The isolation, preservation and improvement of industrial microorganisms. Microbial stochiometry. Media for industrial fermentations. The development of inocula for industrial fermentations. Batch, fed-batch and continuous flow cultures. Multistage systems, feedback systems. The application of continuos culture in industrial processes, strain isolation and improvement. Application of fed-batch culture. Design of a fermenter. Agitation and aeration. Fluid rheology. Foaming and its control. The packed tower, the Waldhof-type, the cyclone column, the air-lift, deep-jet and rotating disc fermenter. Acetators and cavitators. Sterilization of fermenters and vessels, liquid media and gases. Aseptic operation and containment.

Stanbury PF and Whitaker A: Principles of Fermentation Technology. Pergamon Press, Oxford, UK.

McNeil B, Harvey LM: Fermentation: a Practical Approach. IRL Press, Oxford, UK.
Pirt, SJ: Principles of Microbe and Cell Cultivation. Blackwell Scientific Publications, Oxford, UK.
Wang DIC, Cooney CL, Demain AL, Dunnill P, Humphrey AE, Lilly MD: Fermentation and Enzyme Technology. John Wiley & Sons, New York, U.S.A.

Bioprocess Engineering II.
Credits: 6
Class/week: 2 hours of lecture and 3 hours of practice
Prerequisites: Bioprocess Engineering I.
Lecturer: Karaffa, Levente and Fekete, Erzsébet and Németh Zoltán

Aim of the course: To provide additional basic knowledge in bioengineering science not discussed in Part I. In addition, via a compact lab course attached to this lecture set, we want to ensure that our student understand the most crucial and widespread techniques of bioengineering in practical terms, too.
***Description of the course*:** Fermenter instrumentation and control. Sensors. Control systems – manual and automatic control. On-line analysis. Cell morphology and its impact on product formation. The recovery and purification of fermentation products. Filtration, centrifugation, cell disruption, liquid-liquid extraction, solvent recovery, chromatography, crystallization, whole-broth processing. Effluent treatment – physical, chemical and biological treatment. Aerobic and anaerobic treatment. Fermentation economics: producing costs, market potential. Processes and operations using enzymes. Enzyme isolation. Classification of enzymes of industrial importance. Kinetics of enzymes. Enzyme reactions in homogenous and heterogenous phase. Principles of enzyme and whole-cell based bioconversions. Enzyme immobilization.
***Description of the practical course**:* Laboratory-scale (10 L), submerged, batch fermentation of a filamentous fungus will be monitored and analysed. Time-profiles of carbon source consumption, oxygen uptake rate, biomass, carbon dioxid and product formation rate are determined by standard bioanalytical equipments (HPLC, GC, ion-exchange chromatography). Demonstration of certain downstream processing techniques such as adsorption evaporation, filtration and dialysis. Qualitative and quantitative analysis of alcohol production by yeast.

Stanbury PF and Whitaker A: Principles of Fermentation Technology. Pergamon Press, Oxford, UK.
McNeil B, Harvey LM: Fermentation: a Practical Approach. IRL Press, Oxford, UK.
Pirt, SJ: Principles of Microbe and Cell Cultivation. Blackwell Scientific Publications, Oxford, UK.
Wang DIC, Cooney CL, Demain AL, Dunnill P, Humphrey AE, Lilly MD: Fermentation and Enzyme Technology. John Wiley & Sons, New York, U.S.A.

Basic Engineering
Credits: 3
Class/week: 2 hours of lecture and 1 hour of seminar
Prerequisites: -
Lecturer: Tiba, Zsolt

Topics: 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 and the rules of elaboration of the workshop drawing.
In seminar there are six tasks to elaborate: to elaborate the workshop drawing of different machine elements and components. Endurance technical definitions. 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 and their technology in chemical industry. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis. Alloy

steel and non-ferrous metals. Modification of based properties by annealing. Static and metallographic investigation of metals. Breaking of materials. 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. Diffusion of energy in space and time. Efficiency.

J. H. Perry: Chemical Engineer's Handbook, McGraw-Hill Book Company, 8. Edition, New York, 2007.

Unit Operations I.
Credits: 5
Class/week: 2 hours of lecture and 3 hours of practise
Prerequisites: Mechanical Engineering
Lecturer: Gulyás, Lajos

Topics: the substance 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 Benedek-László'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.

1. Waren L. McCabe; Julian C. Smith; Peter Harriott: Unit Operation of Chemical Engineering. Seventh Edition, McGraw Hill Higher Education. 2005. ISBN 007-124710-6
2. Christie J. Geonkoplis: Transport Processes and Separation Processes Principles. (Includes Unit Operations). Forth Edition, 2008. ISBN 0-13-101367-X
3. Yanus A. Cengel – John M. Cimbala: Fluid Mechanics Fundamantals and Applications. Second Edition. McGraw Hill Higher Education, 2010, ISBN 978-0-07-352926-4
4. H. Scott Fogler: Elements of Chemicel Reaction Engineering. Forth Edition, 2006.Personal Education International 2006. ISBN 0-13-127839-8
5. D. W. Green – R. H. Perry: Perry's Chemical Engineers' Handbook. 8th Edition, McGraw-Hill 2008. ISBN 978-0-07-142294-9

Unit Operations II.
Credits: 5
Class/week: 2 hours of lecture and 3 hours of practise
Prerequisites: Unit Operations I.
Lecturer: Gulyás, Lajos

Topics: general characterization of transfer processes. Classification of transfer processes.
Heat transfer. General characterization of heat transfer. Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat-transfer by convection. Heating and cooling. Heat transfer at standard- and changeable temperature difference. Unsteady- and steady state transfer of heat. The logarithmic mean temperature difference. Heat exchangers.
Evaporation and crystallization. Evaporators and crystallizers. Cooling and coolers.
Mass transfer processes. Mass transfer across a phase boundary, the two-film theory. Common interpretation of the operating line and the equilibrium curve. Mass transfer in the columns, the transfer units. Mass transfer in the cascades, the equilibrium units.

1. Waren L. McCabe; Julian C. Smith; Peter Harriott: Unit Operation of Chemical Engineering. Seventh Edition, McGraw Hill Higher Education. 2005. ISBN 007-124710-6
2. Christie J. Geonkoplis: Transport Processes and Separation Processes Principles. (Includes Unit Operations). Forth Edition, 2008. ISBN 0-13-101367-X
3. Yanus A. Cengel – John M. Cimbala: Fluid Mechanics Fundamantals and Applications. Second Edition. McGraw Hill Higher Education, 2010, ISBN 978-0-07-352926-4
4. H. Scott Fogler: Elements of Chemicel Reaction Engineering. Forth Edition, 2006.Personal Education International 2006. ISBN 0-13-127839-8
5. D. W. Green – R. H. Perry: Perry's Chemical Engineers' Handbook. 8th Edition, McGraw-Hill 2008. ISBN 978-0-07-142294-9

Unit Operations III.
Credits: 5
Class/week: 2 hours of lecture and 3 hours of practise
Prerequisites: Unit Operations II.
Lecturer: Gulyás, Lajos

Topics: mass transfer processes. Absorption. Evaporation. Distillation. Rectification. Extraction. Adsorption. Draying. Crystallization.
Chemical reaction engineering. Chemical reactors. Classification of reactors and choice of reactor type in the industry. Chemical kinetics. Residence time and distribution of residence time. Batch reactors and continuous reactors. Influence of heat of reaction on reactor type. Isothermal, adiabatic polytrophic reactors.
Mechanical operations. Size reduction of solids. Methods of operating crushers: coarse-, intermediate-, fine crushers and colloid mills. Classification of solid particles and settling. Blending of solid particles. Waren L. McCabe; Julian C. Smith; Peter Harriott: Unit Operation of Chemical Engineering. Seventh Edition, McGraw Hill Higher Education. 2005. ISBN 007-124710-6

1. Waren L. McCabe; Julian C. Smith; Peter Harriott: Unit Operation of Chemical Engineering. Seventh Edition, McGraw Hill Higher Education. 2005. ISBN 007-124710-6
2. Christie J. Geonkoplis: Transport Processes and Separation Processes Principles. (Includes Unit Operations). Forth Edition, 2008. ISBN 0-13-101367-X
3. Yanus A. Cengel – John M. Cimbala: Fluid Mechanics Fundamantals and Applications. Second Edition. McGraw Hill Higher Education, 2010, ISBN 978-0-07-352926-4
4. H. Scott Fogler: Elements of Chemicel Reaction Engineering. Forth Edition, 2006.Personal Education International 2006. ISBN 0-13-127839-8
5. D. W. Green – R. H. Perry: Perry's Chemical Engineers' Handbook. 8th Edition, McGraw-Hill 2008. ISBN 978-0-07-142294-9

Mechanical Engineering
Credits: 3
Class/week: 1 hour of lecture and 2 hours of seminar
Prerequisites: -
Lecturer: Zsigmond, Endre and Jakó, Anikó

Topics: the formal requirements of technical drawing, representation of projections. Text and Dimensioning on the technical drawings, rules of dimension-structures. Basic concepts of technical tolerances. Systems of relationships between the elements. Elements which forwarding energy flow within the machine-system. Elements which forwarding material flow within the machine-system: pipes, pipe-fittings, tanks, etc.
Structural materials used in the chemical industry and technologies. Structure of pure metals. The Fe-C binary system, crystallization and transformation. Alloy steels, non-ferrous metals. Basic Properties modification by heat treatment. Metallic materials strength and metallographic examination. The fracture of materials. Non-destructive testing. Steel marking system, steel selection. Creating of

welded joints with fusion procedures. Testing of the welded joints with destructive and non-destructive testing.
Chemical machinery: concept of machine, classification, structural essence. Types of energy and energy resources. Energy flow distribution in time and space. Efficiency.

D.L. Goetsch, W.S. Chalk, J.A. Nelson, R.L. Rickman: Technical Drawing, ISBN: 1-4018-5760-4
B. Agrawal, C.M. Agrawal: Engineering Drawing, ISBN 978-0-07-066863-8
R.K. Bansal: A textbook of theory of Machines, ISBN 81-7008-418-0
J.S. Rao, R.V. Dukkipati: Mechanism and Machine Theory, ISBN 81-224-0426-X
R.K. Sinnott: Chemical Engineering Design, ISBN 0 7506 6538 6
J.M. Coulson, J.F. Richardson: Chemical Engineering, ISBN 0 7506 4445 1

Safety
Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Basic Engineering
Lecturer: Deák, György

Topics: basic definitions. Safety in a workplace, legal and organization issues. Accident-free work and safety. Health-protection at workplaces, working conditions. Influence of Environmental effects and the personality on safety at work. Safety issues of handtools, machinery and electricity. Chemical safety and safety in the chemical industry. Man protection tools. Fire protection: definition of, appliances of and the rules in case of a fire, legal issues. Rules and safety measures in a chemical laboratory.

1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.
2. R.E. Kirk-Othmer: Kirk-Othmer Encyclopedia of Chemical Technology, 5. Edition, Volumes: 1-27, JohnWiley & Sons, New York, 2001-2007.
3. D.A. Crowl and J.F. Louvar: Chemical process safety, Pearson, Boston, 2011

Environmental Technology

Credits: 4
Class/week: 2 hours of lecture and 2 hours of seminar
Prerequisites: General Chemistry
Lecturer: Deák, György

Topics: environmental effects of industrial production. Waste-poor technologies. General theories of waste management. Classification of wastes. Types of environmental protection: additive, integrated to the process, integrated to the product. Pollution of the most important industries. Gas, liquid and solid phase industrial wastes, handling and amount reducing. Dangerous wastes: types, handling. Communal wastes: types, handling. Waste deposits and burning.

1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.
2. Muhlynov I.: Chemical Technology I-II.
3. J.M. Coulson, J.F. Richardson and R.K. Sinnot: Chemical Engineering, Volume 6., Pergamon Press (1983)
4. P. T. Williams: Waste Treatment and Disposal, John Wiley and Sons Ltd, Chicester (2005)
5. V. Goodship: I*ntroduction to plastics recycling, Smithers Rapra,Shawbury (2007)*

Visits to Biotech Companies
Credits: 1
Class/week:2 hours of practice
Prerequisites: -
Lecturer: Karaffa, Levente

Aim of the course*:* Chemical, pharmaceutical and fermentation companies of regional or national importance will be visited upon to gain an insight into some of the production processes that occur there. In addition, the course wishes to facilitate communication between our senior students looking for a job and the companies seeking suitable applicants.
Description of the course*:* 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).

Plant Biochemistry and Molecular Biology

Credits: 5
Class/week: 3 hours of lecture and 2 hours of practice
Prerequisites: Biochemistry II.
Lecturer: Mészáros, Ilona

Topics: biochemical and biophysical properties of plant membranes. Transport processes through plant membranes.
Gene Expression and Signal Transduction in plants.
Biosynthesis of plant photosynthesizing pigments. Compatible solutes and role under stress. Secondary metabolites and plant defense. Production and scavenging of reactive oxygen forms in plant cells under stress.
Practical classes are connected to the lectures that help the students to gain deep knowledge and practice in planning and doing experiments in plant biochemistry.

Taiz, L., Zeiger, E. (1998) Plant Physiology. Sinauer Assocoates, Inc., Publishers, Sunderland, Massachusetts.
Heldt, H. W. 2005: Plant biochemistry. Elsevier Academic Press. Amsterdam

Plant Physiology I.
Credits: 3
Class/week: 2 hours of lecture and 2 hours of practice
Prerequisites: -
Lecturer: Mészáros, Ilona and Máthé, Csaba

Topics: plant water relations. Definition of water potential. Factors Contribute to Cell Water Potential, osmotic potencial and pressure potential. Laws and driving force of water transport within the soil-plant-atmosphere continuum. Water absorption by roots. Water transport and loss of water. The Cohesion–Tension Theory for explaination of water transport in the xylem. Water movement from leaf to the atmosphere. Regulation of stomatal movements: effects of environment and hormones on guard cells. Mineral nutrition of plants: essential nutrients and deficiency. Mycorrhizal fungi and facilitatation of nutrient uptake by Roots Assimilation of nitrogen and sulphur and connection with photosynthesis. Photosynthesis: light reactions, light harvesting and light use efficiency. Molecular components and function of PS1 and PS2. Photochemical reactions. Pathways and regulation of CO_2 assimilation. Plant respiration: photorespiration and dark respiration processes. Localization and function of oxidative penthose phosphate pathway in plant cell.
Two-semester practical classes are connected to the lectures where the students can obtain experience in doing experiments on plant metabolic properties and hormonal regulation of growth.

Taiz, L., Zeiger, E. (1998) Plant Physiology. Sinauer Assocoates, Inc., Publishers, Sunderland, Massachusetts.
Lambers, H., F. Stuart Chapin III, F.S., Pons, T.L. 2008: Plant Physiological Ecology. Springer, New York.

Plant Physiology II.
Credits: 3
Class/week: 2 hours of lecture and 2 hours of practice
Prerequisites: Plant Physiology I.
Lecturer: Mészáros, Ilona and Máthé, Csaba

Topics: translocation of solutes in the phloem system. Precesses of phloem uploading and unloading. Growth and development. Phytochrome and Light Control of Plant Development. The phytochemical and biochemical properties of phytochrome. Characteristics of phytochrome-induced plant responses. Blue-Light photoreceptors and responses: stomatal movements. Auxin and plant growth. Biosynthesis, metabolism, transport and functions of auxins. Gibberellins: regulators of plant height. Chemical properties, metabolism of gibberelins. Effects of gibberelins on growth and development. Cytokinins: regulators of cell division. Ethylene: the gaseous plant hormone. Biosynthesis and developmental and physiological roles of ethylene. Abscisic acid: role in seed dormancy and during stress. Control of flowering. Plant stress physiology. Responses of plants to drought, floodings, high light, heavy metals.
Two-semester practical classes are connected to the lectures where the students can obtain experience in doing experiments on plant metabolic properties and hormonal regulation of growth.

Taiz, L., Zeiger, E. (1998) Plant Physiology. Sinauer Assocoates, Inc., Publishers, Sunderland, Massachusetts.
Lambers, H., F. Stuart Chapin III, F.S., Pons, T.L. 2008: Plant Physiological Ecology. Springer, New York.

Research Techniques in Plant Biology
Credits: 3
Class/week: 1 hours of lecture and 2 hours of seminar
Prerequisites: -
Lecturer: Mikóné Dr. Hamvas, Márta

The subject intents to direct students' attention to diversity of the kingdom of plants, their role in the development/formation and maintance of the present forms of life on earth.
The series of lectures throws light on the fact that plants are of vital importance to all of us in everyday life, providing us not only with food and oxygen, but also with timber, medicines, fibres, and even protection against high-energy radiation from space. It is well known, that most of the early discoveries of cell biology were made in studies of plants, and many enzyme systems were first isolated from plants. We show several important research techniques in laboratory and field experiments.
The topics can change year by year depending on the new trends in plant biology and the actual field of research of lecturer.
Topics: Land use, conservation management and vegetation dynamics - the use of long-term field experiments. Soil seed banks, propagule transport and their significance for conservation. New aspects of plant classification. Role of plants in global carbon cycle. Research techniques in ecophysiology. The special features of the plant cell and methods of plant cell biology. Plant tissue cultures and their importance in fundamental and applied research. The most important plants for food industry. Interesting aspects of medical plant biology. Current investigations in plant histology. Plants in biotechnology. Waterbloom, toxins produced by algae and cyanobacteria.

Mauseth, J.D.: Botany : an introduction to plant biology, Jones and Bartlett Publishers, Boston, Toronto, London, Singapore, 2003. ISBN 0-7637-2134-4
Thompson, K., Bakker, J., Bekker, R. 1997. *The soil seed banks of North West Europe: methodology, density and longevity.* Cambridge University Press ISBN 0-521-49519-9 (recommended)
Lambers, H., F. Stuart Chapin III, F.S., Pons, T.L. 2008: Plant Physiological Ecology. Springer, New York.

Numerical mathematics
Credits: 3
Class/week: 1hour of lecture and 2 hours of seminar
Prerequisites: Mathematics III.
Lecturer: Pintér, Ákos

Preliminaries of numerical analysis: error types, characterization and spread, floating point representation of numbers, condition number, vector and matrix norms. Interpolation: linear, polynomial interpolation, method of least squares. Numerical solution of equations and systems: iteration methods, bisection method, secant, tangent and Newton methods, fixed point iteration. Numerical differential calculus: finite difference approximation. Numerical integration: trapezoidal rule, Simpson's method, Newton-Cotes and Gauss quadrature rules. Numerical solution of ordinary differential equations: Euler, Heun and higher order Runge-Kutta methods.

Mathematical modelling of biological systems
Credits: 3
Class/week: 2 hours of lecture an 2hour of seminar.
Prerequisites: -
Lecturer: Pintér, Ákos

Foundations of mathematical modelling: basic questions of model making, analogy between abstract mathematical objects and observed processes, variable separation, parameter estimates, local and global methods, validation. Population dynamics: continuous, discrete and random population models, capacity, predation, age and gender structure, interaction, competition and symbiosis. Reaction kinetics: law of mass action, Monod equation, chemostat, enzyme kinetics, Michaelis-Menten equation, single and multi-substrate models, suicid and cooperative substrates. Epidemic models: SI, SIR, SIS, SIRS. Population genetics. Dynamic systems in biology.