FACULTY OF CHEMISTRY WUT

Courses taught in English (academic year 2024-2025)

Winter semester: (1st October – 15th February; exams: 30th January -15th February)*
Summer semester: (24th February – 30th June; exams: 15th June – 30th June)*
***- estimated dates, exact dates will be given after publication of academic calendar for 2024-2025**

Lp	semester	Course code	Course title	Number of ECTS	Number of hours
1	winter	1020-BIBST-MS0-A200	Economics and Management – lecture	2	30
2	winter	1020-BIBST-MS0-A201	Implantable Medical Devices – lecture	3	30
3	winter	1020-BIBST-MS0-A202	Microbioanalytics – lecture	3	30
4	winter	1020-BIBST-MS0-A204	Seminary of Applied Biotechnology - seminary	1	15
5	winter	1020-BIBST-MS0-A203	Separation Processes in Biotechnology - lecture (30h)+ exercises (15h)	4	45
6	winter	1020-BIBST-MS0-A205	Characterization of Biomaterials (Biocompatibility) – lecture (15h) + exercises (15h)	2	30
7	winter	1020-BIOBZ-MSP-0006	Bioinorganic Chemistry - lecture (elective*)	2	30
8	winter	1020-TCMME-MSA-TU1	Electrochemistry - lecture (elective*)	4	30
9	winter	1020-TCMME-MSA-TU2	Solid State Chemistry - lecture (elective*)	6	60
10	winter	1020-TCMME-MSA-TU3	Physics for Materials Engineering - lecture (elective*)	4	30
11	winter	1020-TCMME-MSA-TU4	Ionics in Electrochemistry - lecture (elective*)	4	30
12	winter	1020-BIOBZ-MSP-0011	Transport Phenomena - lecture (elective*)	2	30
13	winter	1020-TCMME-MSA-TU5	Calculations in Chemistry and Chemical Engineering - exercises (elective*)	2	30
14	winter	1020-TCMME-MSA-TU6	English and Scientific Publication Writing - exercises (elective*)	2	30
15	winter	1020-TCMME-MSA-TU7	Laboratory Practice – laboratory (elective*)	6	90
1	summer	1020-BIBST-MS0-A101	Clean Technologies – lecture	2	30
2	summer	1020-BIBST-MS0-A102	Bioinformatics – lecture	2	30
3	summer	1020-BIBST-MS0-A103	Data Treatment in Chemical Analysis for Biotechnology – lecture (30h) + exercises (30h)	4	60

4	**summer**	1020-BIBST-MS0-A109	**Bioethics - lecture**	**2**	**30**
5	**summer**	1020-BIBST-MS0-A125	**Laboratory of Applied Biotechnology - laboratory**	**5**	**60**
6	**summer**	1020-BIBST-MS0-A124	**Analytical Methods in Biotechnology – lecture (15h) + laboratory(15h) + Project (30h)**	**5**	**60**
7	**summer**	1020-BIBST-MS0-A122	**Environmental Biotechnology – lecture**	**3**	**30**
8	**summer**	1020-BIBST-MS0-A123	**Introduction to Bioreactors – lecture**	**3**	**30**
9	**summer**	1020-BIBST-MS0-A126	**Synthetic bio-tools for industrial biotechnology - laboratory**	**4**	**45**
10	**summer**	1020-BIBST-MS0-A301	**Sensors and Biosensors – lecture (15h) + tutorials (15h)**	**2**	**30**
11	**summer**	1020-TCOBL-MSP-3001	**Modern Technologies of Polymer Synthesis – lecture**	**2**	**30**
12	**summer**	1020-TCTHK-MSP-1011	**Raw Materials for the Chemical Technology – lecture**	**1**	**15**

Course Details:

WINTER SEMESTER

1. **Economics and Management – lecture (30 h, ECTS 2)** course code: 1020-BIBST-MS0-A200, winter semester
   Prof. nzw. dr hab. Radosław Koszewski, Wydział Administracji i Nauk Społecznych PW
   The course introduces students to the knowledge of basic economic categories and principles of functioning of modern market economy. After the course they shall have the ability to analyze and interpret economic processes and use of economic theory to evaluate the activities of companies and the functioning of the national economy. The content: • Introduction to economics. • Economic systems. • Market - basic categories; Elasticity of demand and supply. • Fundamentals of the enterprise. • Basic models of the market. • The functioning of the labor and the capital markets. • Money and inflation. • Gross domestic product (GDP); Economic growth; The economic cycle. • Country budget. • The role of international trade in economic development. Literature: N. Gregory Mankiw, Principles of Economics, 6th Edition, Harvard University 2011 https://financeasim.files.wordpress.com/2014/01/principles-of-macroeconomics-n-gregorymankiw.pdf

2. **Implantable Medical Devices – lecture (30 h, ECTS 3)** course code: 1020-BIBST-MS0-A201 winter semester
   Prof. dr hab. inż. Tomasz Ciach/ dr inż. Michał Wojasiński, Wydział Inżynierii Chemicznej i Procesowej PW

   1. Introduction to biomedical engineering and tissue engineering. Legal and regulatory aspects of testing and marketing of implantable medical devices. Introduction to the human anatomy and physiology. Presentation of main mammalian tissues properties. Cell

signalling process and signalling molecules. Biology of the mammalian cell division process and cell ageing phenomenon.
2. Materials applied in implantable medical devices. a) Interaction of cells and foreign body implanted in the organism. Proteins and cells adhesion to various materials and surfaces, biology of the foreign body response process. Blood contacting surfaces, platelet activation process and activation markers. b) Non-biodegradable materials: metals, polymers and ceramic. c) Biodegradable natural and synthetic materials applied in implants, biodegradable polymers available on the market. d) Hydrogels, material that mimics properties of the natural tissue.
3. Principles of regenerative medicine. a) Regeneration process, stimulation of the tissue regeneration process. b) Stem cells; their origin and properties. Stem cells harvesting, multiplication and differentiation. c) In situ recruitments of cells.
4. Examples of the existing implantable medical systems. a) Implantable drug delivery systems, particles, pumps and other. b) Bone implants, biodegradable bone implants and non-biodegradable bone and joints prosthesis. c) Implantable heart prosthesis and heart pacemakers. d) Vascular grafts and urine ducts. e) Coronary stents. f) Implantable hearing aid. g) Surgical sutures – biodegradable and non-biodegradable. h) Dental implants, breast implants.
5. Future of regenerative medicine and artificial organs.

3. **Microbioanalytics – lecture (30 h, ECTS 3)** course code: 1020-BIBST-MS0-A202, winter semester
Prof. dr hab. inż. Michał Chudy, Instytut Biotechnologii, Wydział Chemiczny PW

Definition of microbioanalytics and miniaturised analytical systems Ideas of miniaturization (integrated systems vs. modular architecture). Basic sample treatment in microsystems (dosing, pumping, separation, analytical reactions, detection). Technologies for microanalytical systems. Application of miniaturized systems for various bioanalytical procedures (medical diagnostics, genomics and proteomics, food analysis and environmental monitoring and pollution control). Design, fabrication and tests of a simple microanalytical module/system (microdetector, microreactor, heating system etc.). Presentation of the results, discussion and evaluation.
Literature: 1. Z. Brzózka, Miniaturyzacja w analityce, Oficyna Wydawnicza PW 2005 (in Polish). 2. Z. Brzózka, Mikrobioanalityka, Oficyna Wydawnicza PW 2009 (in Polish). 3. M. Madou, Fundamentals of Microfabrication, CRC Press, Inc. 2002. 4. A. Manz, N. Pamme, D. Lossifidis, Bioanalytical Chemistry, Imperial College Press, Language: English. 5. A. Van Den Berg, Lab-On-A-Chip: Miniaturized Systems for (Bio)Chemical Analysis and Synthesis, Elsevier Science.

4. **Seminary of Applied Biotechnology - seminary (15 h, ECTS 1, student's presentation),** course code: 1020-BIBST-MS0-A204, winter semester
Prof. dr hab. inż. Michał Chudy, Instytut Biotechnologii, Wydział Chemiczny PW

Students will be given scientific articles in the field of applied biotechnology (e.g. microbial cultures, biosensors, biocompatible materials, bioprocesses) as a base for the case study and presentation preparation. After given cases studies students in small groups (2-3 person) will prepare the presentation of the given topic. Literature: Scientific Journals, Conference Proceedings

5. **Separation Processes in Biotechnology - lecture + exercises (30 h + 15 h, ECTS 4)** course code: 1020-BIBST-MS0-A203, winter semester
   dr hab. inż. Paweł Sobieszuk, prof. uczelni, mgr inż. Karol Ulatowski, Wydział Inżynierii Chemicznej i Procesowej PW

   1. Introduction to separation processes in biotechnology. 2. Mechanical processes of solid particles separation. Motion of solid particles in liquids. Sedimentation. Flocculation and coagulation. Filtration. Centrifugation. 3. Cell disruption. Elements and properties of cell walls of bacteria, yeast, mould, plant cells and mammalian cells. Cell disintegration techniques: mechanical, chemical and biological. 4. Membrane processes. 5. Adsorption. Liquid chromatography. 6. Extraction. Distillation and rectification. 7. Precipitation. Crystallization. Drying of bioproducts. 8. Advanced separation processes 9. Separation in Bioreactors 10. Separation of enantiomers 11. Affinity separation 12. Membrane chromatography 13. Advanced oxidation 14. Hybrid processes Literature: 1. R.G. Harrison et all., Bioseparation Science Engineering, Oxford University Press, Oxford 2003. 2. A. Kołtuniewicz, E. Drioli, Membranes In Clean Technologies, Theory and Practice, WILEY VCH, 2008.

6. **Characterization of Biomaterials (Biocompatibility) - lecture + exercises (15 h + 15 h, ECTS 2)** course code: 1020-BIBST-MS0-A205, winter semester
   dr hab. inż. Dominik Jańczewski, prof. PW, Katedra Chemii i Technologii Polimerów Wydział Chemiczny PW

   The goal of the course is to provide students with the knowledge of biomedical materials and their properties (physical properties, surface properties, biocompatibility and biodegradability). The lecture covers three main groups of biomedical materials: metals and their alloys, ceramics and their composites and polymers, co-polymers and their composites. The main areas of application and requirements for biomaterials will be given. Literature: 1. M. Blicharski, Wstęp do inżynierii materiałowej, WNT, Warszawa 2003. 2. R. Pampuch, Materiały ceramiczne, PWN, 1988. 3. H. Saechtling, Tworzywa sztuczne – poradnik, WNT,1995. 4. D. Żuchowska, Polimery konstrukcyjne, WNT, 2000. 5. B. D. Ratner, A.S. Hoffman, Biomaterials Science, an Introduction to Materials in Medicine, Academic Press, London, 1996. SEMESTER 3 (summer semester)

7. **Bioinorganic Chemistry - lecture (elective*) (30 h, ECTS 2)** course code: 1020-BIOBZ-MSP-0006, winter semester
   Prof. Wojciech Bal

   1. Essentials of chemistry of metal ions: A. Thermodynamics and complex formation. B. Reactivity and kinetics. 2. Biomolecules as ligands for metal ions: A. Building blocks: amino acids, nucleosides and nucleotides, sugars and sugar derivatives (sugar acids, amino-sugars) B. Macromolecules: proteins, nucleic acids, polysaccharides, lipid assemblies C. Special case - peptides 3. Investigations of structures and reactivity of metal ion complexes with bioligands A. Spectroscopic methods in solution (UV-vis, CD, fluorescence, NMR, EPR). B. Crystallography and XAS C. Thermodynamic methods (calorimetry, potentiometry, microscale thermophoresis) D. Stopped-flow and other method of rate constant determination 4. Experimental strategies in bioinorganic chemistry A. Determination of

metal binding site structures by direct and indirect methods B. Determination of metal binding site affinities: direct and competitive titrations 5. Biological main group metals: sodium, potassium, magnesium and calcium 6. Biological transition group metals: vanadium, iron, cobalt, nickel, copper 7. Biological d10 metals: zinc and cadmium 8. Essential, non-essential and toxic metals – concept and examples. Bioavailability 9. Biometal catalyzed reactions: hydrolysis and hydrolytic enzymes 10. Biometal catalyzed reactions: redox processes and redox enzymes 11. Structural metal ions. A. Zinc fingers and other structural zinc binding sites B. Magnesium and RNA structures 12. Metal ion toxicology A. Acute toxicity B. Carcinogenesis C. Neurotoxicity D. Allergy 13. Metals in medicine A. Metal-based drugs B. Metal complexes in diagnostics 14. Special topics A. Effect of biological volumes on reaction equilibrium B. Stable isotope effects C. Essential metal ions and neurodegeneration D. Metal ions in biotechnology 15. Final examination

8. **Electrochemistry - lecture (elective*) (30 h, ECTS 4)** course code: 1020-TCMME-MSA-TU1, winter semester
   Dr inż. Regina Borkowska, Katedra Chemii Nieorganicznej, Wydział Chemiczny PW

   1. Redox reactions, redox couples, balancing redox reactions, calculations vs. real mechanisms
   2. Thermodynamical principles, Nernstian equation, spontaneous and forced redox reactions
   3. Redox at electrodes, electrical properties of phase boundary
   4. Electrolysis and galvanic cells, general rules
   5. Electrochemical measurements : potentiometry, current-voltage in 2 and 3-electrode systems, potentiostat,
   6. Kinetics of electrode reactions, current-voltage (overpotential) dependences, multi-stage character, rate limiting stages
   7. Steady state and transient methods – general concepts
   8. Electroanalysis – historical aspects
   9. Analytical description of electrode process : defining the problem, finding possible mathematical and numerical solutions
   10. Voltammetry, short remarks on other methods
   11. AC in electrochemical circuits, impedance of an electrode process
   12. Electrochemical impedance spectroscopy
   13. Industrial electrochemistry : chlor-alkali, electrowinning Cu and Al, electroplating (optional)
   14. Galvanic cell „From Nernst ‘s eq to working device (Zn-MnO2 and Ni- MeH) (optional)

9. **Solid State Chemistry - lecture (elective*) (60 h, ECTS 6)** course code: 1020-TCMME-MSA-TU2, winter semester
   dr hab. inż. prof. WUT Anna Krztoń-Maziopa (koordynator przedmiotu)/ dr hab. inż. Piotr Guńka, Katedra Chemii Nieorganicznej, Wydział Chemiczny PW

   Part I (30h, Piotr Guńka)
   1. Introduction to Materials Chemistry, electronic structure of atoms.
   2. Bonding in chemical compounds.
   3. Coordination compounds (typical ligands, typical complexes).
   4. Structure, isomerism and stability of coordination compounds.
   5. Molecular orbital theory of transition metal complexes.
   6. Crystal field theory of transition metal complexes.
   7. Electronic spectra of transition metal complexes.
   8. Thermodynamic and related aspects of ligand fields

9. Chemical reactions, the concept of chemical equilibrium.
   Part II, (30h Anna Krztoń-Maziopa)
10. Introduction to crystal structures. Bonding in Solids and Electronic Properties
11. Mechanisms and kinetics of solid-state reactions
12. Sintering
13. Non-stoichiometric materials
14. Diffusion in solid state
15. Physical Methods for Characterizing Solids
16. Physical properties and applications of various solid materials in energy storage and conversion fields:
17. Semiconductors (ceramic materials for solar cells, photocatalytic splitting of water, transparent electrodes, thermoelectrics, varistors and gas sensors)
18. Solid ionic conductors (intrinsic and extrinsic ionic conductors, superionic conductors)
19. Dielectric materials (insulators, ferroelectrics, capacitors, piezo- and pyroelectrics)
20. Superconductors (characteristics and applications)

10. **Physics for Materials Engineering - lecture (elective*) (30 h, ECTS 4)** course code: 1020-TCMME-MSA-TU3, winter semester
    dr hab. inż. Paweł Zabierowski, Wydział Fizyki PW

1. Bonds vs. bands : metals, semiconductors, insulators
2. Electronic structure of solids, ideal crystal lattice, reciprocal lattice, k-vector, Bloch theorem, Brillouin zone,
3. Holes and electrons in semiconductors, effective mass, examples of E(k) diagrams
4. Electrical properties of solids : conductivity, doping,
5. Optical properties of solids: absorption, reflection, emission
6. Non-equilibrium phenomena: generation, recombination, diffusion
7. P-n junctions, heterojunctions, metal-semiconductor contacts, transistors
8. Optoelectronic applications: photodetectors, solar cells, LEDs, semiconductor lasers
9. Low-dimensional structures, superlattice, applications.

11. **Ionics in Electrochemistry - lecture (elective*) (30 h, ECTS 4)** course code: 1020-TCMME-MSA-TU4, winter semester
    Prof. dr hab. inż. Władysław Wieczorek, Katedra Chemii Nieorganicznej, Wydział Chemiczny PW

1. Ionic conductivity – basic theoretical aspects
2. Conductivity in solutions, dissociation, thermodynamics, equilibria
3. Transference numbers, methods for determination
4. Ionic associations, methods for detection
5. Rules in formulation of electrolytes
6. Designing new salts and additives
7. Electrolyte components confronted with stability windows of electrodes
8. Designing components governing the Solid Electrolyte Interface
9. Examples of ionic conductors : types of electrolytes: liquid, gel, solid, polymeric
10. Methods in physicochemical characterization of electrolytes
11. Examples of application of different electrolytes in batteries, fuel cells, supercapacitors
12. Methodology of physical- chemical characterization of electrolytes

13. Examples of application of different type electrolytes in batteries, fuel cells, supercapacitors

12. **Transport Phenomena - lecture (elective*) (30 h, ECTS 2)** course code: 1020-BIOBZ-MSP-0011 winter semester
    Prof. dr hab. inż. Eugeniusz Molga, Wydział Inżynierii Chemicznej i Procesowej PW

Laminar and turbulent flow of fluids in systems of simple geometry. Principles of heat transfer – steady and un-steady state heat conduction as well as natural and forced convection in systems of different geometry. Methods to determine heat transfer coefficients. Principles of mass transfer – steady and un-steady state diffusion as well as natural and forced convection in systems of different geometry. Methods to determine mass transfer coefficients. Mass transfer in dispersed and porous systems. Mass transfer with simultaneous chemical reaction in heterogeneous fluid-fluid and fluid-solid state systems.

13. **Calculations in Chemistry and Chemical Engineering - exercises (elective*) (30 h, ECTS 2)** course code: 1020-TCMME-MSA-TU5, winter semester
    dr inż. Maciej Marczewski, Katedra Chemii Nieorganicznej, Wydział Chemiczny PW

The class will deal with the most important mathematical methods for chemists and will illustrate their application to problems drawn from basic chemistry. After the course Students will be able to solve chemistry-related mathematical problems using traditional and computational (supported by computer) techniques.

1. Chemical equations, calculus for synthesis, yield
2. Equilibria - constants for different types of reactions,
3. Redox balance, electrolysis, EMF,
4. Reaction rates, activation energy Arrhenius dependence
5. Basic thermodynamics, heat effects of reactions

14. **English and Scientific Publication Writing (30 h, ECTS 2)** course code: 1020-TCMME-MSA-TU6, winter semester
    dr inż. Piotr Jankowski, Katedra Chemii Nieorganicznej, Wydział Chemiczny PW

Mastering of correct presentation of research results, reviewing of data stream for a given topic, analysing and planning of research projects. Enhancing scientific and technical vocabulary as well as specific syntax. The lecturer presents selected scientific texts concerning: i) chemical synthesis; ii) spectroscopic, electrochemical and structural characterization; iii) device fabrication. Then he presents in detail a set of new scientific data which constitute the basis for writing a paper. In the next step students are divided into groups of four (or five) and write a common scientific paper under the supervision of the lecturer. After completing the paper, they write a cover letter. During each meeting the lecturer discusses with members of each group all linguistic and scientific errors found in each particular part of the text i.e. Abstract; Introduction, Experimental, Results and Discussion; Conclusions; Letter to Editor. By summation of partial grades the final grade is obtained. Since students work in groups, the same grade has to be attributed to each member of a given group.

15. **Laboratory Practice – laboratory (elective*) (90 h, ECTS 6)** course code: 1020-TCMME-MSA-TU7, winter semester

Coordinator- dr inż. Maciej Marczewski, Katedra Chemii Nieorganicznej, Wydział Chemiczny PW

1. Part I – Physic-chemical techniques used for characterisation of typical materials for energy storage and conversion : structural studies of polymers, solid state phase.

2. Part II – Electrochemical measurement techniques – electroanalytical methods, electrochemical impedance spectroscopy, used to characterise performance and activity of electrolytes, electrode materials and assembled cells.

3. Part III – Mini-research units – complex lab tasks, compilation of previously acquired skills and techniques. The goal is to perform short studies on a given group of electrolytes or electrode materials, or batteries, to get acquainted with planning and executing research missions.

The set of lab units is modified each year, part I and II staying rather unchanged, whereas tasks in Part III may vary, following the current topics in research performed at the Faculty. Students work in small groups (not more than 5, preferably 3-4, depending of the number of students in the class).

SUMMER SEMESTER (February – June)

1. **Clean Technologies – lecture (30 h, ECTS 2, written exam)** course code: 1020-BIBST-MS0-A101, summer semester
   Prof. dr hab. inż. Andrzej Kołtuniewicz (Faculty of Chemical Engineering)
   The lecture presents practical methods and new opportunities for the technical implementation of modern production. New technologies of production of pharmaceuticals, food, feed, polymers, and all kinds of chemicals must comply with sustainable development, so as not to pollute and degrade (in any way) the natural environment, but thrive in harmony with nature. This is possible by adjusting to the natural cycles of matter and energy on Earth. To do this, give up entirely from fossil fuels and replace them with renewables , which are derived from the so-called . biomass. It is a concept of Biorefineries. At the same time must be reduced to the maximum extent the amount of waste substances and wastewater. All products must be biodegradable, and the components of the manufacturing process, as catalysts, solvents, the media must be kept constantly recycled. During production must apply the principle of so-called Green Chemistry , which proposes an optimization of the production at the molecular level, and all macro-scale processes must be optimized by recycling of substrates, catalysts and energy. An additional method of implementation of clean technologies is to integrate different technologies into a single network, in which the sewage emitted by some are raw materials used by other technologies. The most important methods for the implementation of the recycling materials are modern, efficient methods of separation, and among them the hybrid processes combining in parallel physically different techniques. The lecture will include in its scope the following components:
   1. Threats of civilization in our ecosphere (pollution, global warming, acid rain , desertification, soil , monoculture)
   2. Sustainable development (story development , principles, inevitability)
   3. Green Chemistry (rules)
   4. Modern methods of separation (membrane hybrid processes, resolution of enantiomers)
   5. The use of biotechnology in the production (photosynthesis, algae, microorganisms, enzymes)
   6. Biorefineries (rules, bio-based resources, bio , bio-based production)
   7. Methods for the production of biofuels (bioethanol , biodiesel, bio - hydrogen)

8. Production of biopolymers (from biomass and crops, wastes)
9. Production of various biochemicals
10. Production of pharmaceuticals
11. Summary: factors driving and impeding the introduction of clean technologies.

Literature:

1. A.B. Koltuniewicz, Sustainable Process Engineering – Prospects and Opportunities, DE GRUYTER 2013, ISBN 978-3-11-030875-4, http://www.degruyter.com/view/product/204407
2. Koltuniewicz, A.B. and Drioli E., Membranes in Clean Technologies - Theory and Practice, vol. 1&2, 890 pages, WILEY 2009, ISBN978-3-527-32007-3 http://eu.wiley.com/WileyCDA/WileyTitle/productCd-3527320075.html
3. A.B. Koltuniewicz, Integrated Membrane Operations in various Industrial Sectors, chapter 4.05.1, pp.109-154, ELSEVIER 2010, ISBN978-0-444-53204-6 http://www.sciencedirect.com/science/article/pii/B9780080932507000293 in: Comprehensive Membrane Science and Engineering, ed.E.Drioli and L. Giorno, http://www.sciencedirect.com/science/referenceworks/9780080932507
4. A. B. Koltuniewicz, Process Engineering for Sustainability, Chapter 6.34 7.1, in: Encyclopedia of Life Support Systems, Ed. Badran, A., UNESCO 2011,ISBN0 9542989-0- X, http://www.eolss.net/ebooklib

2. **Bioinformatics – lecture (30 h, ECTS 2, written exam)** course code: 1020-BIBST-MS0-A102, summer semester
dr hab. Dariusz Plewczyński (Centre of New Technologies, University of Warsaw)

The lecture will address various databases and algorithms used in bioinformatics, genetics, genomics, molecular biology and biotechnology, and the linkage between types of data. Basic operations on a single and multiple sequences or three-dimensional biomolecular structures will be discussed along with methods allowing pair comparison and searching databases with nucleotide, amino acid sequences and protein structures. During the lecture we will assess the concept of protein families, sequence motifs related to function, cell compartments segregation of signals, comparison of genomes for different organisms, population genetics and system level modeling of a single cell. Advanced methods for finding sequence-level and structural similarity and assessing both sequence and structural variability between proteins, genes and whole genomes will also be presented. The lecture will further describe methods for genome sequencing, distinguishing between coding and noncoding DNA sequences (ab initio methods and homology based methods), genome annotations, and comparative and functional genomics at the genomic level. Finally the lecture will address theories of protein and genome folding, tools exercised by molecular graphics, modeling of protein structures and genomic domains, structure of biopolymers, protein-protein interaction networks, types of biological networks, functional motifs in proteins and genomes, and the analysis of various -omics data taken from -omics experiments data, with basic concepts in systems biology.

3. **Data Treatment in Chemical Analysis for Biotechnology - lecture + exercises (30h + 30 h, ECTS 4, written exam)** course code: **1020-BIBST-MS0-A103**, summer semester
Prof. dr hab. inż. Artur Dybko, Faculty of Chemistry WUT

Ability to plan experiments and to process, analyze, plot and present the obtained data. Planning of experiments, treatment and transformation of experimental data, statistical data

analysis, modeling of dependencies, presentation of data, elements of chemometrics Exercises: Statistical tests, error analysis, estimation of uncertainty, regression analysis.

4. **Bioethics - lecture (30 h, ECTS 2, written exam**) course code: **1020-BIBST-MS0-A109**, summer semester
   Mgr Justyna Szatan, Wydział Administracji i Nauk Społecznych PW

   1. Identify ethical issues in medicine, health care and life science.
   2. Recognize, compare and contrast the general ways of thinking in bioethics.
   3. Approach and analyse bioethical problems in written. The purpose of the course is to introduce students to bioethics as an interdisciplinary subject throught critical thinking. The bioethical thinking is a melding of biology and various moral ideas. Interdisciplinary thinking in bioethics is rooted in the processes of scientific and philosophical thinking.
   Literature:
   1. Giordano J.J., Scientific and Philosophical Perspectives in Neuroethics, Cambridge 2010.
   2. Monney C., Bioethics, Lucent Books, 2009.
   3. Steinbock B., The Oxford Handbook of Bioethics, Oxford, New York 2010.

5. **Laboratory of Applied Biotechnology - laboratory (60 h, ECTS 5, average of partial marks obtained by the students for each laboratory module**) course code; 1020-BIBST-MS0-A125, summer semester
   dr hab. inż. Michał Chudy Prof. PW, Instytut Biotechnologii, Wydział Chemiczny PW

   Subjects of laboratory modules (e.g. microbial cultures, biosensors, biocompatible materials, bioprocesses) are flexible and they will be collected by the head of the laboratory and presented to the students at the beginning of the classes. Students will work individually or in groups on given biotechnological subjects in laboratory. The subject of the course will be focused on processes, their control and optimization and application of modern laboratory facilities (bioreactors, microscopes, clean technologies) for better understanding and solving of given biotechnological problem.

6. **Analytical Methods in Biotechnology - lecture + laboratory + Project (15 h+15 h+30 h, ECTS 5, Project 50 %, laboratory 20% and oral presentation 30% of total points)** course code: 1020-BIBST-MS0-A124, summer semester
   dr hab. inż., prof. WUT Mariusz Pietrzak Instytut Biotechnologii, Wydział Chemiczny

   Project - Students select one of the proposed subjects presented as an analytical problem to solve. They are expected to design analytical procedure (on the basis of literature) in aim to determine or identify chosen compound(s) with the special emphasis on matrix composition. The report containing analytical procedure is obligatory for admission of student to an experimental part. The project will include following problems: - determination of metals, amino acids or other components in biological tissue, - determination of metals, dyes or preservatives in food, - determination of bioactive components in drugs.
   Laboratory - Experiments will be carried out by students with minimal control of assistant (short training and safety precautions only). Simple instrumental and classic analytical methods will be proposed as optional in frame of the project: - Volumetric analysis - Spectrophotometry - Capillary electrophoresis - Liquid chromatography - Potentiometry -

Voltammetry Seminary - As a summary students are required to present the aim of the project, procedure, results and conclusions in the form of oral presentation.
Literature: Analytical and biotechnological journals from data bases like Elseviere and Springer

7. **Environmental Biotechnology – lecture (30 h, ECTS 3, final test)** course code: 1020-BIBST-MS0-A122, summer semester
dr hab. inż. Arkadiusz Przybysz, Warsaw University of Life Sciences

Development of discipline and state of art. Definition of bio- and phytoremediation and area of application. Phytoremediation of heavy metals (HM) from the soil. Plant defense mechanism against HM. Phytoremediation of noble metals. Plant species with high phytoremediation capabilities. Bio/phytoremediation of organic pollutants from the soil Mycoremediation of oil spill from the water and soil. Mechanism(s) of detoxification/degradation of organic pollutants by plants organism. Air phytoremediation of gaseous pollutants: benzene, NO2, CO, O3 and particulate matter. Indoors air phytoremediation in houses, offices and public places. Phytoremediation of sites with high salinity, polluted by radionuclides or explosive materials. Actual regulations and arising area of research and application with new pollutants: pharmaceutical, contraceptive, cosmetics. Necessary information and condition for undertaking decision of phytoremediation application. Effect of heavy metals (Pb^{2+}, $Cd^{2+}$and Cu^{2+}) on germination and growth of mustard and corn. Level of salinity and pH in soil samples collected from sites of de-icing roads in Warsaw, Effect of soil salinity on vegetation. Capacity of Canna × generalis and Coleus blumei plants for degradation of organic pollutants (RBBR dye). Utilization of mushroom Pleurotus ostreatus for bioremediation of oil pollution. Deposition of particulate matters (PM10 and PM2,5) on leaves of several tree species (Quercus rubra, Taxus baccata and Carpinus betulus) or plant samples from students neighborhoods or apartments Amount of waxes on leaves of plants (Hedera helix, Ficus benjamina, Schefflera arboricola) assigned for indoor phytoremediation.
Literature:
1. S.C. McCutcheon, J.L. Schnoor, Phytoremediation- Transformation and Control of contaminants, Wiley –Interscience, New Jersey, USA 2003.
2. S.W. Gawronski, Biotechnologia środowiskowa – Fitoremediacja, rozdzial: 7.9 p. 455- 461, w: S. Malepszy, Biotechnologia roślin, PWN2001.

8. **Introduction to Bioreactors – lecture (30 h, ECTS 3, written exam)** course code: 1020-BIBST-MS0-A123 summer semester
dr hab. inż. prof WUT Magdalena Jasińska, Wydział Inżynierii Chemicznej i Procesowej PW

Description: Modelling of Basic types of bioreactors Scaling up Selection of bioreactors Predicting dynamics of bioreactors Course content: The course deals with bioreactor design, based on the kinetics of the microorganism growth, kinetics of biochemical reactions and reactor hydrodynamics. Program contains: discussion of interactions between cell population and medium, characteristics of cell population, models of growth (segregated, structural), design and analysis of ideal bioreactors (chemostat, semibatch bioreactor, plug flow bioreactor, bioreactors with recirculation, systems of bioreactors), mixed microbial populations (classification of pairwise interactions, dynamics of mixed microbial populations), problem of stresses in biotechnology, characteristics of different bioreactors (mixed tank,

bubble column, air-lift reactor, packed column), rules of bioreactor selection, scale-up, enzyme-catalyzed reactions, immobilized enzyme kinetics.

Literature:

J. Bałdyga, M. Henczka, W. Podgórska Obliczenia w Inżynierii Bioreaktorów, Oficyna Wydawnicza Politechniki Warszawskiej, 1996

J.E. Bailey, D.F. Ollis Biochemical Engineering Fundamentals 2nd ed., Mc Graw-Hill, 1986

S. Aiba, A.E. Humphrey, N.F. Mills Inżynieria Biochemiczna, WNT 1977

W.W. Kafarow, A.J. Winarow, L.S. Gordiejew Modelowanie Reaktorów Biochemicznych, WNT 1983 T.K. Ghose Bioprocess Computations in Biotechnology, Ellis Horwood Limited 1990 A.H. Scragg Bioreactors in Biotechnology. A practical approach, Ellis Horwood Limited 1991 H.J. Rehm, G.Reed Biotechnology. Vol.4. Measuring, Modelling and Control, VCH 1991 M.L.Shuler, F.Kargi Bioprocess Engineering: Basic Concepts, Prentice Hall 1992 K.van't Riet, J. Tramper Basic Bioreactor Design, Marcel Dekker 1991

9. **Synthetic bio-tools for industrial biotechnology (45 h laboratory, 4 ECTS**) course code: 1020-BIBST-MS0-A126, summer semester

dr hab. inż. prof WUT Małgorzata Adamczyk, Faculty of Chemistry WUT

The aim of the course is to gain experience in microbial protein expression, protein design and engineering, recombinant protein purification, standard protein analysis methods, and activity assays. Student will have ability to independently design and execute informative experiments and interpret results. This course will prepare a student for a position of a protein scientist in R&D sector. Lectures and practical course will focus on troubleshooting.

1) Synthetic systems design and engineering (synthetic biology, molecular biology, promoter types, tag systems, functional domains etc.)
2) Expression (protein stability, secretion machinery)
3) Purification (broaden spectrum of techniques in affinity chromatography)
4) SDS-PAGE and Western-blot (visualization techniques, labelling)
5) EMSA assay (protein-DNA interactions assays in molecular biology and biophysics)

Each group of students will be given a different synthetic construct (or will be asked for designing its own). Students will have to recognise the overproduced and purified proteins as well as to perform on them activity tests. Literature: Laboratory instructions and links to videos and publications will be provided by the tutor Additional innformation: There are no separate experimental modules. The practical course is designed as a project, so your presence at each class is obligatory. Knowledge assessment will be based on your performance during the course (activity), entry test, homework and the final report from your project. Teaching method: flipped classroom

10. **Sensors and Biosensors – (lecture 15 h + tutorials 15 h, ECTS 2)** course code: 1020-BIBST-MS0-A301, summer semester

Dr hab. inż. Mariusz Pietrzak, prof. PW, Instytut Biotechnologii, Wydział Chemiczny PW

Lecture: 1. Introduction to (bio)sensors. 2. (Bio)recognition of analytes. 3. Types of recognition layers. 4. Transducers and measurement systems (electrochemical, optical, etc.,). 5. Working parameters and factors affecting response of (bio)sensors. 6. Chemical sensors for bioanalyte determination. 7. Application of (bio)sensors in analytical control of bioprocesses, medical diagnostics, environmental protection, etc. 8. Trends in (bio)sensors developments.

Excercises: excercises will introduce students to construction and utilization of sensors and biosensors with different transducers: optical and electrochemical.

Literature: 1. Z. Brzózka, W. Wróblewski, Sensory chemiczne, Oficyna Wydawnicza Politechniki Warszawskiej, 1998. 2. U.E. Spichiger-Keller, Chemical Sensors and Biosensors for Medical and Biological Applications, Wiley-VCH, 1998. 3. B. Eggins, Biosensors, John Wiley & Sons, 1996. 1. Diploma seminar - 15 h 2. Diploma laboratory - 180 h 3. M.Sc. Thesis writting – 150

11. **Modern Technologies of Polymer Synthesis – (lecture 30 h ECTS 2)** course code: 1020-TCOBL-MSP-3001, summer semester
Prof. hab. inż. Paweł Parzuchowski Katedra Chemii i Technologii Polimerów, Wydział Chemiczny PW

The aim of the course is to master the methods of conducting polymerization and polycondensation processes, taking into account the reaction mechanisms, catalysts, equipment, processing methods and environmental impact. The item includes the following substantive content: general scheme of installations for the production of polymers, technologies for the production of polyolefins, technologies for the production of rubber elastomers, metathesis reactions in the production of polymers, technologies for the production of polyesters, production technologies polyamides, technologies for the production of biodegradable plastics, technologies for the production of polyurethanes and polyurethanes for eyeglasses, including isocyanate-free methods, technologies for the production of plastics for optical applications, technologies for the production of fibre-forming plastics, technologies for the production of selected special plastics.

Literature: W. Szlezyngier „Tworzywa Sztuczne” WO FOSZE 1998 Z. Floriańczyk , S. Penczek „ Chemia Polimerów” OW PW 1998 W. Kuran, „Procesy Polimeryzacji Koordynacyjnej” OW PW 2000

12. **Raw Materials for the Chemical Technology – (lecture 15 h ECTS 1)** course code: 1020-TCTHK-MSP-1011, summer semester
Dr hab. inż., prof. PW Paulina Wiecińska Katedra Technologii Chemicznej, Wydział Chemiczny PW

The course covers the use of water, air, coal and oil in chemical technology, as well as the methods of purification and enrichment of raw materials. Inorganic raw materials (sulphur, phosphate and salt raw materials), raw materials for the construction and refractory materials industry, raw materials for the fine and advanced ceramics industry will be presented. The subject also includes a discussion of recyclable, plant and animal raw materials (starch, cellulose, oils), methods of waste management and material recycling

Literature: 1. P. Wyszomirski, K. Galos, Surowce mineralne i chemiczne przemysłu ceramicznego, AGH Uczelniane Wydawnictwa Naukowo-Dydaktyczne, Kraków 2007 2. A.Bolewski, M.Budkiewicz, P.Wyszomirski, Surowce ceramiczne, Wydawnictwo geologiczne, Warszawa, 1991 3. E.Bortel, H.Koneczny, Zarys technologii chemicznej, Wydawnictwo Naukowe PWN, Warszawa