



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Fundamentals of chemistry for bioinformatics

### Course

Field of study

Bioinformatics

Area of study (specialization)

-

Level of study

First-cycle studies

Form of study

full-time

Year/Semester

1/1

Profile of study

general academic

Course offered in

Polish

Requirements

compulsory

### Number of hours

Lecture

30

Laboratory classes

15

Other (e.g. online)

0

Tutorials

15

Projects/seminars

0

### Number of credit points

4

### Lecturers

Responsible for the course/lecturer:

dr hab. inż. Bogdan Wyrwas

Responsible for the course/lecturer:

e-mail: bogdan.wyrwas@put.poznan.pl

phone +48 61 665 27 07

Faculty of Chemical Technology

Berdychowo 4, 60-965 Poznan

### Prerequisites

W1) The student has theoretical knowledge at high school level regarding general and inorganic chemistry, and in particular: knows the basic laws, concepts and chemical quantities as well as the names and symbols of chemical elements.

W2) The student has high school knowledge regarding physics, especially knows the basics of matter structure and identifies the components of the atomic nucleus and atom.

W3) The student has knowledge at high school level in mathematics, especially regarding building proportions and using them in simple chemical calculations.



W4) The student has a positive attitude to acquiring knowledge in the field of chemistry as a science subject, which is the basis for thorough education in many engineering professions.

W5) The student is aware of useful chemical processes and, at the same time, is sensitive to environmental problems.

### Course objective

The aim is to expand and consolidate the knowledge and skills in the field of basic chemistry for bioinformatics. To acquire practical skills and learn the safety rules related to work in a chemical laboratory. To familiarize the students with the organization of laboratory work and the basic techniques used in laboratory work. The goal is to prepare the students for research and analytical laboratory work in research institutions and industry.

### Course-related learning outcomes

#### Knowledge

1 The student has extended knowledge of chemistry useful to formulate and solve simple bioinformatics tasks, including basic notions and laws of chemistry, of the structure of matter, identifies components of matter and characterizes interactions between them, knows the structure of atoms and genesis of their formation, defines and explains laws governing interactions of matter components.

2. identify the properties of elements resulting from the electron configuration of their atoms and their position in the periodic table, and in particular know and explain the relationship between the electron configuration of atoms and the reactivity of elements

3. name reactions involving chemical compounds. Describe, explain and characterise how they occur and what effects they have. List and describe selected groups of bioactive compounds, their biochemical properties and effects on cells and living organisms, including the most important harmful effects of some elements and compounds on the environment, as well as identify the most important sources from which they are emitted into the environment.

K\_W04, K\_W08

#### Skills

1. The student is able to acquire information from literature, databases and other properly selected sources, also in English

2. The student is able to integrate and interpret acquired information, as well as to draw conclusions and to formulate and justify his opinions

3. the student analyzes and interprets the content of calculation tasks and performs chemical calculations (mainly in the field of concentration conversion, stoichiometry and the basics of chemical reaction thermodynamics)



4. The student is familiar with the periodic table of elements and can use it as a basic source of information on physicochemical properties of elements and their compounds
5. Uses the current nomenclature of chemical compounds, in particular is able to combine the correct name of a compound with its correct sum formula (stoichiometric), which he can write down correctly, and on this basis prepare its structural formula
- 6) Writes down and correctly balances chemical reactions between inorganic reagents (also with the participation of simple organic compounds); predicts the direction of the course of chemical reactions of any type (including reactions of oxidation and reduction) and is able to quantitatively characterize the equilibrium state of the reaction (is able to calculate the equilibrium constant of a chemical reaction)
7. Uses basic laboratory techniques in synthesis, isolation and purification of chemical compounds
8. Knows the rules of safety behavior and work in chemical laboratory

K\_U01, K\_U02, K\_U03, K\_U04, K\_U05, K\_U07, K\_U16

#### Social competences

1. The student is aware of the constant, quick increase of his knowledge and skills, and on this background - the level of his knowledge in the field, which causes an active attitude in further learning and willingness to assimilate new knowledge on his own initiative.
- 2 The student is aware of the necessity of cooperation and work in a group, taking various roles in it.
3. is aware that the knowledge of chemistry is widely used in industry and economy, science, therefore, understands and counts with the necessity of practical use in the future of acquired knowledge and skills, and is aware of the responsibility associated with it.
4. is able to take responsibility for his/her own and others' safety at work; take appropriate action in case of emergency.

K\_K01, K\_K02, K\_K06

#### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Progress in acquiring knowledge during lectures, exercises and laboratories is monitored on an ongoing basis. After the end of a specific batch of material, the tutor organizes written colloquial work at predetermined dates - the pass mark is 50% of points. A report is required after the laboratory classes. The student also has the opportunity to earn additional points during each class. The final form of progress monitoring is a written exam.

#### Programme content

Lecture:

1. Division of chemical compounds and their nomenclature.



2. Chemical calculations. Various types of concentrations. Percentage concentration. Mole and molar concentration. Converting concentrations. Stoichiometric calculations.
3. The structure of matter. Big bang. Isotopes. Chemical processes in the stars. The distribution of elements. Atom. Periodic table and periodicity of changes in the physicochemical properties of elements. The regularities of the periodic table.
4. Chemical bonds. Electronegativity. Ionic bond. Atomic bond - Lewis structures. Dipole moment - polarization of the atomic bond. Coordination atomic bond. Metallic bond. Van der Waals forces. Hydrogen bond. Chemical bonds and the properties of compounds.
5. Acids and bases. Electrolytic dissociation. Strong and weak electrolytes. Concentration and activity - activity coefficients, ionic strength. Acid and base theories. Ion products of water and the pH scale. The power of acids and bases. Acid-base indicators. Degree vs acid constant. Buffer solutions. Ampholytes. Alkacymetry. Reaction of aqueous solutions of acids, bases and salts. Hydrolysis. PH measurement.
6. Precipitates. Structure of compounds and solubility. The solubility product. Solubility. Common ion effect. Salt effect. Influence of pH on dissolution and selective precipitation. Solubility of compounds and their toxicity. Water hardness - hardness removal.
7. Complex relationships - structure and types. Equilibria in complex solutions - gradual formation of complexes. Constant of durability and instability of the complex. Influence of pH on complexation reactions. The solubility of precipitates and the formation of complexes. Application of complexes in analytics.
8. Oxidation and reduction (redox) reactions. Basic concepts. Half-reactions, equilibrium constant of redox reactions, Nernst equation, normal potential, balancing redox reactions. Strong oxidizing agents and reducing agents in aqueous solutions. Discussion regarding the chemical properties of the basic elements on the basis of the potential-pH diagram.
9. Mechanisms of iron corrosion and technologies of its protection.
10. Environmental pollution, water protection and biological and non-biological methods of water treatment.

Exercises:

1. Exercises based on the periodic table (names and symbols of elements, electronic configurations, summary and structural formulas of compounds, nomenclature);
2. Converting concentrations (concentration types, percentage and molar concentration, solution density and molar/molecular weight in calculations);
3. Stoichiometric calculations (sum formula and percentage composition of the compound, product yield, substrate purity, obtaining data from the reaction);



4. Electrolyte solutions (writing dissociation and hydrolysis reactions, reactions of cations as acids and anions as bases, water as a solvent - water ion product and pH scale, calculation of the pH of aqueous solutions of acids, bases, salts and buffer solutions, acid dissociation constant and dissociation degree);
5. Precipitates (relationship between the product of solubility and solubility - calculation of the solubility of the compound, cation and anion);
6. Oxidation and reduction reactions (balancing redox reactions, predicting the direction of redox reactions on the basis of redox potentials, drawing Pourbaix diagrams and discussing the properties of elements on their basis).

Laboratory:

1. pH scale and acid-base reactions
2. Buffer solutions and reaction of salt water solutions
3. Complexation reactions
4. Determination of water hardness
5. Reduction reactions
6. Selected simple analytical reactions

**Teaching methods**

1. Interactive lecture: multimedia presentation, illustrated with additional examples on the blackboard and demonstrations of simple experiments, exchange of insights and points of view, discussion.
2. Exercises: solving tasks given by the lecturer. Indication of tasks and issues for independent development by students. Computational problem tasks related to contemporary aspects of life.
3. Laboratory: the classes are practical in nature, students carry out exercises included in the plan of the subject on their own. The exercises are performed in accordance with the attached instructions. The lecturer personally shows and explains how to carry out the activities and operations that students meet for the first time. The lecturer constantly monitors the student's behavior in the laboratory and the way in which he or she performs individual tasks. After the exercises, a report is required (with proper preparation of research results, their correct interpretation and conclusions).

**Bibliography**

Basic

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3. G. Charlot, Analiza nieorganiczna jakościowa, PWN, Warszawa 1976



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5. A. Śliwa, Obliczenia chemiczne, PWN, Warszawa 1987
6. K. M. Pazdro, Zbiór zadań z chemii, Oficyna Edukacyjna 2007
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#### Additional

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3. M.J. Sienko, R.A. Plane, Chemia. Podstawy i zastosowania, WNT, Warszawa 2002
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5. G.W. van Loon, S. J. Duffy, Chemia środowiska, PWN, Warszawa 2008
6. B. Wyrwas; Metodologiczne aspekty biodegradacji związków powierzchniowo czynnych w warunkach laboratoryjnych i w środowisku, Wydawnictwo Politechniki Poznańskiej, nr 472, 2012.

#### Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam) <sup>1</sup>	40	1,5

<sup>1</sup> delete or add other activities as appropriate