COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fundamentals of chemistry for bioinformatics [S1Bioinf1>CHEM]

Course

Field of study
Bioinformatics

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

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 work in research institutions and laboratories.

Course-related learning outcomes

Knowledge:
1. The student has extended knowledge of chemistry, useful to formulate and solve simple bioinformatics tasks, including the structure of matter, identifies the components of matter and characterizes the interactions between them, knows the structure of atoms and the genesis of their formation, defines and explains the laws governing the interactions of matter components.
2. Shows the properties of elements resulting from the electronic configuration of their atoms and the position in the periodic table, and especially knows and explains the relationship between the electronic configuration of atoms and the reactivity of elements.
3. Knows reactions involving chemical compounds. Describes, explains and characterizes their course and the accompanying effects.
4. Knows and describes the most important harmful effects of some elements and compounds on the environment, and identifies the most important sources from which they are emitted to the environment.
K_W04, K_W08, K_W22

Skills:
1. The student analyzes and interprets the content of the calculation tasks and performs chemical calculations (mainly in the field of concentration conversion, stoichiometry and basics of thermodynamics of chemical reactions)
2. Uses the periodic table of elements and can use it as the basic source of information regarding the physicochemical properties of elements and their compounds
3. Uses the current nomenclature of chemical compounds, and is especially able to combine the correct name of a compound with its correct summarized (stoichiometric) formula, is able to draw its structural formula
4. Records and correctly balances chemical reactions between inorganic reagents (also with the participation of simple organic compounds); predicts the course of chemical reactions of any type (including oxidation and reduction reactions) and knows how to quantitatively characterize the equilibrium state of a reaction (can calculate the equilibrium constant of a chemical reaction).
5.The student is able to acquire information from literature, datebases and other properly selected sources.
6. Knows the safety rules of behavior and work in a 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, rapid increase in knowledge and skills, and the level of his knowledge in this field, which resultts in an active attitude towards further study and acquiring new knowledge on his own initiative.
2. Is aware that knowledge in the field of chemistry is widely used in industry and economy, science, understands therefore and takes into account the necessity to use the acquired knowledge and skills in practice in the future, and is aware of the related responsibility.
K_K01, K_K02, K_K06

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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. 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

Course topics

Lectures in the subject will cover issues related to the naming of chemical compounds and stoichiometric calculations and conversion of concentrations (percentage, molar). In addition, topics related to the structure of matter, the Big Bang, the formation of isotopes and chemical processes occurring in stars will be discussed. Students will expand their knowledge of quantum mechanics, atomic orbitals, electron configuration, periodicity of the UO and chemical bonds: covalent, ionic, metallic, intermolecular interactions - hydrogen bonds, van der Waals forces. Students will be familiarized with issues from the scope of: electrolytic dissociation, types of electrolytes, theory of acids and bases. Subsequent issues will present: the ionic product of water and the pH scale, the strength of acids and bases, acid-base indicators, the degree and constant of acid, buffer solutions, alkalimetry, hydrolysis, pH measurement. Attention will be paid to the solubility product, the common ion effect, the salt effect, the effect of pH on the dissolution and selective precipitation of precipitates, the solubility of compounds and their toxicity, water hardness and its removal.

The next point will be complex compounds - structure and types, equilibria in solutions of complexes - gradual formation of complexes, the stability and instability constant of the complex and the effect of pH on complexation reactions, the solubility of precipitates and the use of complexes in analytics.

In addition, students will be familiarized with oxidation and reduction (redox) reactions, the equilibrium constant of the redox reaction, the Nernst equation, the normal potential, balancing redox reactions. The chemical properties of basic elements based on the potential-pH diagram, iron corrosion mechanisms and technologies for its protection, as well as aspects of environmental protection and various biological and non-biological methods of water treatment will be discussed. The exercises will include: solving problems based on the periodic table (names and symbols of elements, electron configurations, summary and structural formulas of compounds, nomenclature).

The next stage will be the conversion of concentrations and preparation of solutions (types of concentrations, percentage and molar concentration, solution density and molar/molecular mass in calculations), stoichiometric calculations (summary formula and percentage composition of the compound, product yield, substrate purity, obtaining data from the reaction), electrolyte solutions (writing dissociation and hydrolysis reactions, reactions of cations as acids and anions as bases, water as a solvent - ionic product of water and pH scale, calculating pH of aqueous solutions of acids, bases, salts and buffer solutions, acid dissociation constant and degree of dissociation).

Projects related to sediments: relationship between solubility product and solubility - calculating the solubility of a compound, cation and anion.
In addition, oxidation and reduction reactions (balancing redox reactions, predicting the direction of redox reactions based on oxidation-reduction potentials.
The laboratory will be a practical use of issues related to:
the pH scale and reactions in the acid-base system. Buffer solutions and the reaction of aqueous salt solutions. In addition, complexation reactions, determination of water hardness, redox reactions and selected analytical reactions.

Teaching methods

1. Interactive lecture: multimedia presentation, illustrated with additional examples on the blackboard and demonstrations of simple experinets, 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

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Additional
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Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50