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| SUBJECT: | **The biological tools of modern chemistry** (KMEN015E) |
| DEPARTMENT | Department of Inorganic and Analytical Chemistry |
| RESPONSIBLE TEACHER | Dr. Béla Gyurcsik, associate professor |
| CREDITS | 4 |
| PRECONDITIONS | - |
| HOURS PER WEEK | 2 |
| TYPE OF THE COURSE | Lecture |
| TYPE OF EXAM | Oral Exam |

**The main goal of this course** is to provide knowledge for chemistry students to allow them to formulate their complex, interdisciplinary projects in chemistry, drug design, understanding biological processes, the mechanism of drug action, etc. - all projects involving marcomolecules such as proteins and DNA. It will enable the students to effciently discuss with collaborators from biology, pharmacology and medicine field of sciences, by understanding each others' professional language. Students will learn about basics of molecular biology tools that can be applied in advanced chemical and biochemical research –always having in mind the principles of chemistry.

**Competences to achieve**
Upon successful finishing the course the students:

- Denominate modern procedures, by the help of which macromolecules of biological importance (DNA, RNA, protein) can be synthesized.
- Select the appropriate procedure for the purpose of the detection, identification and purification of DNA or protein molecules.
- Summarize the newly introduced/ acquainted methods suitable to study the properties of biological macromolecules.
- Make effort to apply the interdisciplinary approach in their study and research.
- The students communicate with researchers representing biology and other scientific disciplines to solve a complex interdisciplinary problem.
- Evaluate the capability of biological and chemical procedures in the separation and investigation of biological macromolecules.

**Course content:**

*The overlap of the chemical and biological sciences.*
The effect of molecular biology on the development of chemistry and vice versa. Biomolecular chemistry.
The role of given metal ions and metalloenzymes within the organisation of living cell, and in the biochemical processes.
Examples of the role of the metalloenzymes, metalloproteines, and the “free” metal ions. Examples of industrial, pharmacological and research applications.

*The basics of recombinant gene technology.*
DNA synthesis within the cell. The genetic code.
The polymerase chain reaction. The design and synthesis of artificial DNA vectors. Plasmids, as DNA carriers.
Bacteria in DNA cloning.

The analysis of DNA, sequence determination.
The different pathways of the enzyme or protein modifications, examples. The design of new macromolecules.

*The basics of proteomics.*
The synthesis of proteins by chemical and biological, “in vitro” vs. “in vivo” methods.
Solid phase peptide synthesis.
Protein synthseis in the cell.
The methods for identification and purification of proteins. HPLC, antibody-, metal ion-affinity chromatography.
The application of polyacrilamide gel elektrophoresis.

*The investigation methods of molecular biology.*
Historical overview. Electrophoresis.
The determination and visualization of protein strucure: theory and practice.
The study of the amino acid sequence.
The calculation of the secondary structure. Investigation methods.

*Applications.*
Artificial proteins, (metallo)enzymes - design and activity.
Future trends.

**Recommendend readings:**

1. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson: The molecular biology of the cell, Garland Publishing Inc, New York, London, 1989.
2. The lecture is, beside the above book based on the handbooks used in molecular biology laboratories, as well as on the scientific papers published in international journals. These new results allow for the continuous modernization of the topics.
3. Electronic learning tool at CooSpace.

**General learning outcomes:**

| **Knowledge** | **Skills** | **Attitude** | **Autonomy-responsibility** |
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| The students define the possibility of the overlap of biology and chemistry, list the appropriate borderline research fields. | The students analyse the possibilities of the collaboration with researchers representing various scientific disciplines. | The students pay attention to the precise application of the chemistry and molecular biology terminology. | The students independently apply the proper terminology of chemistry and molecular biology, and explains the terminology to either chemistry or biology orientated colleagues. |
| The students know the biological tools suitable to solve the given complex interdisciplinary problem. | The students communicate with researchers representing biology and other scientific disciplines to solve a complex interdisciplinary problem. | The students make effort to apply the interdisciplinary approach in their study and research. | Facing an interdisciplinary problem, the students independently develop their knowledge on the borderline scientific areas. |
| The students summarize the newly introduced/ acquainted methods suitable to study the properties of biological macromolecules. | The students select the appropriate procedure for the purpose of the detection, identification and purification of DNA or protein molecules. | The students help the colleagues from the biology field in understanding the methods of chemical approach to a biological experiment. | The students collaborate with colleagues from biology or various research areas upon recognizing an interdisciplinary research problem. |
| The students denominate modern procedures, by the help of which macromolecules of biological importance (DNA, RNA, protein) can be synthesized. | The students evaluate the capability of biological and chemical procedures in the separation and investigation of DNA or protein molecules. | The students are motivated to acquire new information on diverse scientific fields. | The students understand that the complex research project has to be conducted in collaboration with researchers from other scientific disciplines. |
| The students list the opportunities of applications of the tools of molecular biology in the field of chemistry research. | The students carry out the targeted modification of a protein molecule based on its genetic code in theory and practice. | The students are critical during the evaluation of the literature. | The students can critically evaluate the results of the complex experiments including high number of the degree of freedom. |
| The students understand the overlap of the | The students efficiently discuss with collaborators | | |

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| various scientific disciplines. | from biology, pharmacology and medicine field of sciences. | | |
| The students explain the effect of molecular biology on the development of modern chemical research. | The students formulate their interdisciplinary projects in bioinorganic chemistry, drug design, understanding biological processes, the mechanism of drug action, etc. - all projects involving macromolecules such as proteins and DNA. | | |
| The students know the methods of examination used in molecular biology. | The students select the appropriate molecular biology tools that can be applied in advanced chemical and biochemical research to solve the given complex problem. | | |
| The students are aware of the background and application opportunities of various microscopic methods. | The students select the appropriate methods to investigate the amino acid composition, amino acid sequence. | | |
| The students know the theory and practice of the molecular biology tools for studying the structure of protein molecules. | The students explain the role of the metal ions in biological systems including examples for the role of the free metal ions, metalloproteins and metalloenzymes. | | |