McDaniel College Budapest

BIO 2100 – Molecular Design of Life

Professor: László Nyitray PhD DSc

Contact information

Availability
Before or after class time or by e-mail

Course description
This is an introductory molecular biology course for non-biology majors. Chemical and physical basis of living systems will be introduced to students. Major topics include: role of water, ions, small and macromolecules in life. Relationship of structure, function and complexity. Flow of information within the cell: from DNA to proteins. Flow of energy through living systems and the fundamental role of ATP. Topics also include gene technology and molecular biology of cancer and synthetic biology. The laboratory block includes "hands-on" basic biochemistry and molecular biology techniques.

Course objectives

- The scientific method will be introduced to students. They should understand basic chemistry and thermodynamics in order to understand the principles of living systems, biomolecules, bioenergetics, and the major molecular biology processes.
- Understanding the central role of informational macromolecules in life and the flow of information from DNA to proteins is essential to appreciate the complexity of life. Presenting the relationship between structure and function of macromolecules and the importance of self-organization in the macromolecular worlds.
- Proteins are the workhorses of life – this is a key objective of the course to explain the quintessential role of proteins in all life processes. Working of the cell will be described as a "well-organized city" full of molecular machines made from protein parts.
- Understanding that living cells represent an open system maintained in a highly complex (low entropy) state by continuous flow of energy and matter through it.
- Studying the molecular design of life should lead to better understanding of the working of the human body at the molecular level.
- Understanding that molecular biology knowledge is gained through laboratory experimentation. Hands-on work in a molecular biology laboratory will help students to appreciate the importance of experimental approach.

Learning outcomes

- Students would be able to distinguish real science from pseudo-science or non-scientific questions or theories.
- Students will be able to describe the most important chemical composition of life with emphasis on the four major macromolecular classes.
- Students will understand the relationship between structure and function of biomolecules, as well as how they recognize and communicate with each other
- Students could describe and understand the storage and flow of information in living systems, the role of DNA, proteins and other macromolecules.
- Students will be able to describe the major components and the major molecular biology processes of the cells, as well as cell division and cell differentiation.
- Students should understand the energy flow through the cells and the fundamentals of bioenergetics, the major metabolic pathways and the energy currency role of ATP.
- Students will understand basics of inheritance, human genetics, genetic diseases and gene technology (including GMOs).
- Students will improve their research, arguing and referencing skills by writing an essay about a molecular biology topic that is either important for the wellbeing of human

society, for the advancement of human knowledge through molecular biology research. Students are encouraged to choose topics that are controversial in public view and they could learn to argue for the pro side and benefits

Required texts and materials

Students are supposed to write **lecture notes** (lectures are the main source of exam questions). 26 pages of handout will be distributed to students.

Suggested books (partially readable on Google Books) :

Solomon et al.: Biology (Tenth edition, 2015) Brooks/Cole, Cengage Learning

Parts 1-3 (The Organization of Life, Energy Transfer Through Living Systems, The Continuity of Life: Genetics) covers most of the topics.

Assignments & grading

Course requirements: mid-term and final written tests (multiple-choice), one essay-type short research paper (min. 5 pages) and its presentation, and active participation in class discussions (including short quizzes).

Final grades are calculated based on: the mid-term written exam (25%), final written exam (25%), research paper (25%), class and laboratory activity including quizes (25%).

Honor code

Students are expected to adhere to the McDaniel College Honor Code.

Course policies

Attendance of classes is required and the College's policy of class attendance will be strictly enforced.

Semester schedule/Topics covered

Week 1 Biology, science of life. The cell concept. Diversity of life.
DNA: the carrier of genetic information. Proteins: life's workhorses

Week 2 General chemistry. Importance of water.

Week 3 Chemical composition of life. Hierarchy of molecular organization.
Macromolecules: polysaccharides, lipids, proteins, nucleic acids. Viruses

Week 4 Principles and origin of life. Thermodynamics of life.

Week 5 Cellular organization of life – prokaryotes and eukaryots.

Week 6 Structure, function and regulation of proteins. Proteins of the immun- and nervous system.

Week 7MID-TERM EXAM

Week 8 Energy transfer through living systems. Role of ATP. Cellular respiration and photosynthsis.

Week 9 DNA replication and repair. Mutations. The genetic code.
Expression of genetic information: Transcription and translation. Genes and development. Molecular bases of cancer.

Week 10 The cell cycle and cell division. Mitosis and meiosis.
Principles of heredity. Mendel's laws. Human genetics.

Week 11 The Human Genome Project. Recombinant DNA technology.
Cloning of molecules and organisms.

Week 12 "Hands-on" laboratory practices I.
DEADLINE TO SUBMIT AN ESSAY

Week 13 "Hands-on" laboratory practices II.

Week 14 "Hands-on" laboratory practices III
Presentation of essay papers

Week 15 FINAL EXAM