HISTORY OF MODERN BIOLOGY

Each chapter begins with an explicit statement of the learning objectives and scientific competencies that students should pursue. These guidelines are intended to help students identify key concepts and use them at various levels of learning, including comprehension, application, analysis, and synthesis. They also serve as powerful study tools when reviewing material for coursework and exam preparation.

1. Introduction: historical events, luck, prejudices, personalities, patents, publications

OUTLINE

- The scientific method, publications, patents
- Who determines what the research focuses on?
  - Historical context, social factors, luck, prejudices
  - Relationship of biology with other scientific disciplines, scientific context

LEARNING OUTCOMES

Students learn the basics about the scientific research approach, and the typical course of a scientific discovery, which can be published in a scientific journal or patented. This framework is necessary to understand some of the stories that will be presented in the rest of the course. Other factors that can affect research, such as historical events (e.g. war), and availability of techniques from disciplines other than biology, are also outlined, as another theme which also governs the following lectures.

2. The position of biology in the sciences and its conceptual structure

OUTLINE

- Why do we study the history of biology?
- The nature of science
- The scientific method
- Special characteristics of living organisms

LEARNING OUTCOMES

Students learn about:

- The history of the sciences of living beings from antiquity to the present day
- How the concepts and models used by modern biologists were shaped
- The controversies that concern the science of biology in the light of the historical perspective

3. Diversity and its inheritance

OUTLINE

- Early crossbreeding theories and experiments
- Ancient theories of heredity
- Character transfer
- Mendel's experiments

LEARNING OUTCOMES

Students learn about:

- The theory of panspermia
- The theory of spontaneous generation
- The experiments of hybridizers and improvers of plants
- The blending theory of inheritance
- The theory of particulate inheritance

4. The nature of heredity

OUTLINE

- Soft vs. hard inheritance
- Inheritance of acquired characters
- Preformationism
- Germ-plasm and somatic cell theory
- Theory of pangenesis
- Pangenes theory

LEARNING OUTCOMES

Students learn about:

- The theories, experimental approaches and modern understanding of the nature of heredity

5. History of the study of evolution

OUTLINE

- Lamarck's theory of evolution
- Charles Darwin's scientific career
- The processing and formulation of the theory of natural selection
- The concept of adaptation

LEARNING OUTCOME

Students learn about:

- The fundamental components of evolutionary theory
- The unifying role that evolutionary theory plays in interpreting the diversity of living beings
- The mechanism of evolution through natural selection
- The modern synthesis theory in biology

6. History of molecular biology, biotechnology and genomic modifications

OUTLINE

- Discovery of DNA, its components and the double helix structure
- Deciphering the genetic code, formulating the Central Doctrine of Biology
- Discovery of plasmids, restriction enzymes, recombinant DNA technology
- Creation of Biotechnology companies, production of pharmaceutical proteins
- Genomic modifications in transgenic animals
- Genomic modifications with CRISPR/CAS9

- Applications in gene therapy

LEARNING OUTCOMES

Students learn about:

- The pioneers of the discovery of DNA, its structure and the genetic code (Levene, Chargaff, Franklin, Crick, Watson, Nirenberg)
- The pioneers of Molecular Biology (Arber, Smith, Nathans, Berg, Cohen, Boyer)
- The historical context and techniques that allowed the creation of recombinant DNA technology
- The conditions for the creation of the first biotechnological company for the production of pharmaceutical proteins
- The tools of gene modification in animal cells and applications in gene therapy

7. Breakthroughs in Immunology

OUTLINE

- Introduction to the types of immunity, innate and adaptive
- Discovery of antibodies
- The first vaccines
- Discovery of penicillin, the first antibiotic
- Production of monoclonal antibodies and applications in the diagnosis and treatment of diseases

LEARNING OUTCOMES

Students learn about:

- the founders of innate and adaptive immunity (Mechnikov, Ehrlich, von Behring)
- the history of the first vaccines
- the work of Louis Pasteur in disproving the theory of spontaneous generation by proving the germ theory, in pasteurization but also for his contribution to the creation of the first vaccines against fowl cholera, rabies and anthrax
- Alexander Fleming's contribution to medical practice with the discovery of penicillin
- the production technology of monoclonal antibodies and their applications in the diagnosis and treatment of diseases

8. History of the extraction of biomolecules

OUTLINE

- First microscopic observations and the concept of the cell
- Nucleus, protoplasm, membrane
- Proteins, amino acids, carbohydrates, sugars
- DNA, isolation and connection to heredity, chromosomes, mitosis

LEARNING OUTCOMES

Students learn about:

- the pioneers of microscopy (Hooke, van Leeuwenhoek, Brown)
- the formulation of cell theory by Schwann

- the isolation of nuclein by Miescher, the further study of the chemical structure of DNA (Kossel, Levene) and the proof that DNA is the genetic material (Walter Flemming, Griffith, Avery, Chargaff, Watson & Crick)
- the experimental distinction of the cytoplasmic membrane by Overton and the formulation of the model of the lipid bilayer by Gorter & Grendel
- Fischer's work on the structure of purines, sugars, amino acid identification and polypeptide synthesis, the description of the peptide bond and the lock-and-key model

9. History of biomolecule sequencing techniques and bioinformatics

OUTLINE

- Isolation of amino acids
- Protein sequencing
- DNA sequencing
- Bioinformatics

LEARNING OUTCOMES

Students learn about:

- the discovery of amino acids gradually from 1810 (cysteine) to 1936 (threonine)
- the Sanger protein sequencing technique
- the Sanger DNA sequencing technique
- the principles of bioinformatics, the first databases and the first sequence alignment algorithms

Laboratory practicals

Laboratory practicals aim to deepen the understanding of the concepts and applications presented in the theory through the presentation of group assignments. Also, through educational visits to research centers and other institutions, students will be given the opportunity to enrich their knowledge with the history of Biology within Greece.