**Molecular biology sub-specialization**

1. Thermodynamic and bioenergetics’ basics. The role and characteristics of ATP and other “macro-erg” compounds, the importance of energy coupling. The energy provision of life phenomena (functional symmetry of chloroplast and mitochondrion).


4. Methods of producing recombinant proteins (strength and weaknesses of different techniques), and their uses. Investigation of molecular interactions using gene technology tools as well as biochemical and cellular level methods.


7. The thermodynamic and kinetic description of enzyme function, the essence of biocatalysis. Single molecule enzyme kinetic techniques. The use of proteins in therapeutics.

8. The architecture of metabolism, catabolic and anabolic processes, the regulation mechanisms in the metabolism and their systems biology characteristics.


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1 Abbreviations: BI, Bioinformatics; CST, Molecular logic of cellular signaling; GT, Gene technology; MB, Molecular biology – selected topics; MP, Motor proteins; PB, Physical biochemistry; PBI, Protein bioinformatics; PS, Protein science; SB, Systems biology
10. Energy transformation in macromolecular machineries: the characteristics of the mechanochemistry of ATP-synthase, the catalytic steps in myosin and their relation to its structure, the role of actin. The comparison of the two systems.

**Immunology sub-specialization**

11. The structure and function of antibodies, therapeutic use of monoclonal antibodies.

12. The general characterization of T-lymphocytes, their development, and role in the immune response.

13. The general characterization of B-lymphocytes, their development, and role in the immune response.

14. Characterisation of the immune response developed to extra- and intracellular bacteria.

15. Characterisation of the immune response developed against unicellular and other parasites.

16. Characterisation of the immune response developed against viruses (e.g. influenza, HIV).

17. Development of immunological tolerance, autoimmunity, autoimmune diseases.

18. Mechanisms of the IgE-mediated allergic reaction, characterization of the effector cells.

19. Relationship of tumours and the immune system, immune therapy.

20. Characterisation of the innate and acquired immune deficiencies.

**Microbiology sub-specialization**

21. Co-evolution of prokaryotes and the biosphere, the three-domain system of life, systematics and taxonomy (species definition in the prokaryote domains, identification and determination, phenotypic characterization, chemo- and genotaxonomy, polyphasic techniques).

22. Classical and special culture methods to explore the microbial diversity. Light and electron microscopic techniques. Principles of culture-independent molecular biological methods and their application. In situ methods to determine microbial activity.

23. Applying genomics, metagenomics, transcriptomics and metatranscriptomics to study species diversity and community metabolism. Amplicon sequencing and shotgun metagenomics. Significance of hidden diversity and limits of its exploration.


26. Microbial partners of the human body (microbial communities of the skin, eye, mouth, teeth, respiratory system, digestive tract, urinary system and reproductive organs), the human microbiome. The role of microbes in maintaining human health. Human vaccination system in Hungary.


29. Biotechnological processes in the food and environmental industries and in agriculture. Methods of environmental microbiology and microbial risk assessment.

30. Microbiological treatment strategies for the elimination of different soil and water pollutions. Microbial degradation of xenobiotics in the nature, bioremediation strategies (biostimulation, bioaugmentation, biotransformation, co-metabolism). The fate of genetically modified microbes in the nature.