Biology Masters Course – Closing examination topics

Molecular, Immune- and Microbiology specialization

2020

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).

2. The molecular machineries and energetics of replication, transcription and translation. The characteristics of the genetic code. The regulation of pro- and eukaryote gene expression: transcription and translation level, RNA interference, chromatin structure, epigenetics.

3. Molecular cloning, host-vector system. The PCR and its application. DNA sequencing, genome projects. Performing gene knockout and gene silencing. Generation of transgenic organisms and their use. The role of bioinformatics in gene technology.

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.

5. Amino acids and peptides. Levels of protein structure. Structural biology techniques, structural bioinformatics. Methodologies of protein studies. Isolation and analysis of proteins (chromatography and electrophoresis), chemical modifications. Spectroscopic techniques, reporter groups, fluorescence methods. In-vitro and in-vivo investigation of protein interactions.

6. The mechanisms and driving forces of protein folding, in-vivo folding. Relations of structure and function. Intrinsically disordered proteins. Misfolded proteins. Biochemical and gene technology possibilities in investigation structure - function interactions.

7. The thermodynamic and kinetic description of enzyme function, the essence of bio-catalysis. 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.

9. Omics' sciences and system biology. High-throughput techniques, databases. The proteome and the proteomics. The interactome. The structure of protein network: physical and functional interactions. Logics of signal transduction networks. The investigation of molecular interaction at network level.

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. *(AI)*

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

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

14. Characterisation of the immune response developed to extra- and intracellular bacteria. *(II)*

15. Characterisation of the immune response developed against unicellular and other parasites. *(II)*

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

17. Development of immunological tolerance, autoimmunity, autoimmune diseases. *(AI, IP)*

18. Mechanisms of the IgE-mediated allergic reaction, characterization of the effector cells. *(IP)*

19. Relationship of tumours and the immune system, immune therapy. *(IP)*

20. Characterisation of the inherited and acquired immune deficiencies. *(AI, IP)*

* *Learning material for the examination topics include the textbook Molecular and Cellular Immunology (ed.: A. Abbas et al.) and the compulsory lecture Immunology.*
In addition, the following elective subjects are indicated for the topics: AI – Adaptive immune response; II – Infectional immunology; IP – Immunopathology

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.

24. Cooperative and antagonistic interspecific relationships. Microbe-microbe interactions. Organisation and characteristics of biofilms. Syntrophy.

25. Plant- and animal-microbe interactions (Plant-bacterium interactions: exo- and endophytic microbes, plant growth promoting microorganisms, etc. Symbionts of arthropods, special animal symbioses, disease vectors. Biological pest control).

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.

27. Pathogenic microorganisms, infectious diseases and principles of epidemiology (Parasitism, pathogenicity, virulence, infectivity, invasivity, toxigenity, endemic, epidemic and pandemic. Control of epidemics). Basics of diagnostics.

28. Microbiology of aquatic habitats. Principles of water qualification (chemical and biological water qualification). Types of wastewaters, biological wastewater treatment, sewage sludge treatment. Microbiology of ultra-pure waters. Microbial induced corrosion.

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.

31. Molecular methods in taxonomy. Chemotaxonomy and its relation with phylogeny. Universal and group-specific chemotaxonomic characters. MIDI. The advantage of whole-cell analytic methods in bacterial taxonomy. Identification based on MALDI-TOF analysis.