MSC IN MOLECULAR BIOLOGY
FINAL EXAM

„A" THEME QUESTIONS

1. Biological membranes, the organization and function of the cytoskeleton and extracellular matrix. Methods to study the cytoskeleton. Transport mechanisms through the plasma membrane and the intracellular membranes. Symmetric and asymmetric cells in cellular transport processes. Characteristics of transport processes through cell layers.

2. The nature and organization of the molecules carrying hereditary information. DNA, RNA, prions. Structure of the eukaryotic chromosome. The organization of the cell nucleus. The process and importance of nucleic acid methylation. Methods to isolate and study genomic DNA (Southern blot, RFLP, microarray techniques).

3. The biochemistry of protein synthesis. Methods to study protein synthesis. Post-translational modifications. The structure of proteins. Chaperons. The biochemistry of stress response. Expression of recombinant proteins.

4. Cellular energy production. Photosynthesis, chemosynthesis, fermentation. Aerob and anaerob respiration, components of the electron transport system, terminal electron acceptors. Hormones affecting the energy homeostasis and their mechanisms of action. Experimental analysis of hormone effects.

5. Characteristics of the mitochondrium. The role of the mitochondria in energy production. Mitochondrial genome and mitochondrial diseases. The importance of mitochondria in cell death. Estimation of evolutionary distances by the analysis of the mitochondrial genome.

6. Regulation of prokaryotic and eukaryotic gene expression. Exons, introns. Exonic polymorphisms and their possible effect on gene expression. RNA interference and its utilization. Transcription factors, promoter and enhancer regions. The process of RNA maturation. Experimental techniques for RNA isolation, northern blot, RT PCR, preparation of cDNA libraries.

7. DNA replication and repair systems. The role and mechanisms of proof-reading. Transcription. Sequence and variability of the human genome. Evolutionary genome biology. The role of hereditary factors in the most common complex human diseases.

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8. Mechanisms altering the genetic information. Mutation, neocombination, recombination. Molecular mechanisms of recombination. Suppression. Generation of transgenic animal model systems, and general considerations in evaluating the information derived from such systems. DNA sequencing, mutations, polymorphisms.

9. Insertion sequences, transposons, molecular mechanism of transposition, plasmids, episomes, resistance factors. Utilization of mobile genetic elements in the molecular biology laboratory. Gene families, homologs, paralogs, orthologs. Cloning.

10. Organization of the bacterial genome. The operon theory. Conditions of bacterial growth. Most important methods for culturing bacteria. Bacterial transfection, selection of transfected bacteria. Bacterial plasmids and protein expression systems.

11. Replication of the viral genome and different pathways of mRNA synthesis in viruses. The role of virion associated enzymes in the replicative cycle. Conditions of viral replication and culturing. Production and utilization of vaccines. Utilization of viral vectors in biotechnology: production methods of viral vectors, fields of utilization, safety considerations. Potential therapeutical approaches based on viral gene delivery.

12. Characteristics of the different types of cellular division. Mitosis and meiosis. Regulation of the cell cycle. Cancer cell division, oncogenes and tumor suppressor genes. Methods to study the cell cycle, experimental approaches to study tumorigeneicity. In situ hybridization techniques, FISH and CGH.

13. The structure and in vitro culturig of plant cells. Chloroplasts and photosynthesis. Organization of the plant genome.

14. Components of the immune system. Characteristics of B and T lymphocytes. Basics of innate immunity. Characteristics and processing of antigenes. Experimental production of antibodies and the possible applications of antibodies in molecular biology. Monoclonal and polyclonal antibodies. Theory and practice of western blot, ELISA and immunohistochemistry.

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15. Neuronal regulation of cellular functions. The role of cellular depolarizations in the physiological regulation. Charateristics and physiological functions of the electrotonic potential. Charateristics and propagation of the action potential. Overview of the synaptic transmission. Neuronal networks: organization and physiological functions. Experimental methods to measure and analyse the membrane potential and cellular ion transport.

16. Mechanisms of hormone action, characteristics of hormone receptors. Second messsengers and intracellular signalling mechanisms. Reporter assays and systems. Methods to determine the intracellular Ca-ion concentration.

17. Muscle cell types and their electrophysiological characteristics. Physiology of skeletal muscle and smooth muscle contraction. Structure and function of the neuromuscular junction. Molecular mechanisms of muscle contraction in the striated and smooth muscle cells. Experimental analysis of muscle function.

18. Theory of using radioactive substances in biological research (characteristics of isotopes, most important isotopes, half-life, radiation types). Safety measures for using ionizing radiation. Irradiation therapy. Utilization of isotope technology in molecular biology. Methods based on radioactive tracers.

19. Biology databases, with special emphasis on medline. Informatics tools suitable for identifying the relationships between human diseases and their genetic background (e.g. the Online Mendelian Inheritance in Man database). SNP analysis.

20. Searching and accessing data about nucleic acids. Searches in databases of nucleic acid sequences, identification of genes based on sequences. Analysis of potential homology among nucleic acid sequences. Identification of restriction sites in a given sequence. Designing the PCR reaction conditions: tools, softwares, instruments and applications of PCR. Prediction of the amino acid sequence of proteins based on the nucleic acid sequence. Homology based analysis of the amino acid sequence.