Module 1B – Questions to the Final Exam

1. The eukaryotic and prokaryotic cell, its basic structure and function
(Cell composition, structure and function; methods of study of cells and tissues; characterization of basic cell types; bacterial genetics.)

2. Chemical composition of the cell
(Structure of the cell chemical constituents and their detection by cytochemical and immunohistochemical methods.)

3. Catalyzers of reactions taking place within the cell
(Enzymes and vitamins, classification, importance; enzyme kinetics; the role of enzymes in cell signaling; catalytic histochemistry; inborn enzyme defects and their heritability.)

4. Exertion of energy in cells
(Nutritional types of organisms; Gibb’s energy, endergonic and exergonic reactions, chemical equilibrium; high-energy [macroergic] compounds, their origination, role in metabolism; structure of mitochondria, intracellular transport ;cilia and flagella.)

5. Function and metabolism of carbohydrates in the cell
(Entrance of glucose into cells; glycolysis, glycogen synthesis, degradation, and detection in the cell; gluconeogenesis; adaptation of epithelia to glucose absorption [brush border]; diabetes (type II) as an example of polygenic heredity.)

6. Function and metabolism of lipids in the cell
(Blood transport of lipids; beta-oxidation, synthesis of fatty acids, synthesis and degradation of triacylglycerols; ketone bodies; white and brown fat tissues; polygenic heredity, atherosclerosis as an example of)

7. Structure and function of proteins
(Structure, physicochemical properties, functions in the organism; protein exporting cells; glands, types of secretion; immunoglobulins -structure and function; the influence of mutations on protein function.)

8. DNA , structure and function
(Structure of purine and pyrimidine bases; nucleosides and nucleotides; DNA replication and reparation; DNA as a carrier of genetic information; structure of the gene; chromosome morphology, karyotype, numerical chromosomal abnormalities
GB: Morphology of chromosomes, karyotype; chromatin in the light [LM] and electron [EM] microscopy.)

9. Structure and function of the cell nucleus
(Chromatin and chromosomes; the nucleus and its visualization with LM and EM; nuclear compartments; structural chromosomal abnormalities, chromosomal abnormalities in tumors.)

10. From DNA to proteins
(From DNA to RNA from RNA to proteins; RNA and the origin of life; transcription, RNA splicing, alternative splicing, translation and ribosomes, posttranslational modification; genetic mechanisms of evolution.)
11. **Mechanisms of gene regulation in prokaryotic and eukaryotic cells**
   (A comparison of the eukaryotic and prokaryotic genome; structure of the nucleus in the resting, proteosynthetically active and dividing cell; gene regulation in the process of formation of immunoglobulins and T receptors in lymphocytes.)

12. **Genetic variability and its resources**
   (The sources of genetic changes, sexual reproduction and reorganization of genes; meiosis; impact of the primary structure of proteins on their properties and functions; isoenzymes – definition, properties, function, examples; immunoglobulins – structure, classification and function; cell differentiation in embryogenesis and adult organisms [e.g. gametogenesis and erythropoiesis]; genetic determination of sex, sex-linked heredity; genomic imprinting.)

13. **DNA diagnostics and technology**
   (DNA analysis, PCR, RFLP, hybridization, DNA cloning, gene engineering; biotechnology, genetically modified organisms [GMO].)

14. **Biological membranes**
   (Lipid bilayer, membrane proteins, membrane modifications; structure of the membrane lipids; chemical properties of membranes; membrane proteins – structure and function; membrane receptors; signal transfer through the membrane; surface membrane specializations, myelin sheath; membrane molecules of cells of the immune system.)

15. **Membrane transport of substances**
   (Transport proteins, ion channels and membrane potential; types of the transport; relationship between the structure of a compound and the mechanisms of its transport across the membrane; the importance of cell membranes; intercellular junctions, synapsis, cells transporting ions; phagocytosis as a mechanism of immune reaction; genetically conditioned defects of membrane proteins)

16. **Mitochondria** (oxidative phosphorylation, electron-transporting chains)
   (The structure and types of mitochondria; mitochondrial compartments; oxidative phosphorylation, electrontransporting chains; citric acid cycle, respiratory chain – importance, regulation and its interconnections with catabolic pathways; extranuclear heredity; mitochondrial disorders.)

17. **Intracellular compartments and transport between them**
   (Organelles, segregation, transport and secretion of proteins; the importance of compartmentalization of biochemical processes, subcellular localization of main metabolic pathways and their interconnections, their meaning in metabolism; cell organelles in LM and EM, inclusions; evolution of the eukaryotic cell from the prokaryotic cell, endosymbiosis.)

18. **The cytoskeleton**
   (Microfilaments, intermediate filaments, microtubules and their function; abnormalities of mitotic and meiotic division and abnormal fertilization.)

19. **Cell cycle and resting cells**:
   (Phases of the cell cycle, changes of chromosomes; cell cycle in the picture of LM and EM, gametogenesis.)
20. **Mechanisms of regulation of the cell cycle**

(Activation and progression; genetic aspects of carcinogenesis, the tumor cell.)

21. **Cellular proliferation during ontogenesis, tissue restitution and functioning of the organism**

(Stem cells; cleavage; cell renewal systems, repair of tissue damage; activation and proliferation of immune cells.)

22. **Mutagenesis and its consequences**

( Types of mutations and types of mutagens; mutagenesis and reparation; activation of carcinogens [biotransformation, reactive oxygen species]CB: Oncogene activation and antioncogene inactivation

23. **Signal transmission within the cell**

(Kinases, second messengers, ion concentration.; regulation of metabolism on the cell level – activation and inhibition of regulatory enzymes of the main metabolic pathways; antigen activation of the immune system, cytotoxic mechanisms of immune cells.)

24. **Apoptosis**

(Fundamentals and meaning, mechanisms of induction and realization; apoptosis as one of the basic morphogenetic processes proliferation vs. apoptosis; the role of apoptosis in immune system.)

25. **Cell to cell communication**

(The principles of cell signalization, signal molecules, receptors coupled with proteins and enzymes; signal transduction from the membrane receptor into the cell, G-proteins, second messengers; an example of the regulation of a metabolic pathway [hormone – the change of enzyme regulatory activity]; cell contacts, the structure of cells emitting signals, neurocrine, paracrine, and endocrine secretion; cytokines and adhesive molecules and their role in immune reaction.)

26. **Epigenetic regulation of gene expression, determination and differentiation**

(The picture of the non-differentiated and differentiated cell; gene expression in embryogenesis; PEV, X-inactivation, genomic imprinting and its meaning.)

27. **Basic morphogenetic processes**

(The principles of morphogenesis.; embryonic growth, differentiation, and ageing; from gametogenesis to notogenesis, the blastocyst, implantation and its disturbances; failure of fertilization, assisted reproduction; factors that influence adversely morphogenesis – teratogens.)

28. **Blood**

(Blood cells, their visualization, origin, structure and function; regulation of hematopoiesis; heme metabolism; blood group heredity, genetically conditioned blood disorders.)

29. **Connective tissues**

(Cellular components of the connectives, ossification, chondrogenesis; cell-to-cell contacts and adhesion; the extracellular matrix and its constituents; genetically conditioned disorders of the connective tissue [examples of AD heredity]. )
30. Mechanisms of immune reaction
(Inventory, structure and function of cells of the specific and non-specific immunity; inflammation, blood complement, immunogenetics; transplantation laws, transplantation in humans.)

31. Mechanisms of cell transformation
(Oncogenes and antioncogenes, their activation and inactivation; immunohistochemical detection of tumor cells origin; prevention of cell transformation.)

32. Epithelial tissues
(General structure and properties of epithelia, the arrangement and function of the basal lamina; diffusion and osmosis; transport of ions across the membrane; mutagenicity of UV radiation, repair and its failures, xeroderma pigmentosum.)

33. Muscle tissue
(Somitogenesis; elements and characteristics of particular types of muscle tissue; the principles of muscle cell contraction; genetically determined disorders of the muscle system [examples of X-linked recessive heredity].)

34. Nerve tissue
(Neurons, glial cells; metabolism of the nerve tissue cells; action potential and its transmission, synapses and mediators; genetically determined disorders of the nervous system [dynamic mutations: FRAXA, Huntington disease].)

35. Foundations of common genetics
(Hybridological analysis, mendelian principles; gene linkage, gene interactions; HLA polymorphism – role in antigen presentation.)

36. Ecology
(Global ecological problems; xenobiotics; human ecology)

37. Molecular biology of viruses
(Constitution, structure of the genome, interaction with the host cell; genetics of viruses; visualization with EM;)

38. Evolution and its meaning
(Population genetics.)

39. Detoxification, principles of genotoxicology
(Detoxification apparatus of the cell; biotransformation of xenobiotics; methods used in genotoxicology; working with laboratory animals.)

40. Methods detecting hereditary diseases
(DNA methods, cytogenetic methods, biochemical methods; prenatal and postnatal diagnosis.)