Contents of the end-of-course examination for the discipline "Medical Biology and General Genetics" for 1st-year international students studying Dentistry

1. The nature of life; the role of proteins and nucleic acids in the organization of living systems.
2. Levels of organization of living matter.
3. The role of biology in medical education.
4. Humans as biological and social beings.
5. Cell Theory.
6. Subject, objectives, and methods of cytology (light, electron, and fluorescence microscopy; histochemical and immunohistochemical analysis; differential centrifugation; autoradiography; morphometry; etc.).
7. Light microscopy: method, microscope structure, and operating rules.
8. Viruses; Prokaryotes and Eukaryotes.
9. Models of the elementary biological membrane.
10. Structure, properties, and functions of the plasmalemma.
11. Membrane transport: passive and active transport. Ion channels and their functions.
12. Cytosol. Cytoskeleton: microtubules, intermediate filaments, and microfilaments. Intracellular transport of substances.
13. Anabolism and catabolism (assimilation and dissimilation). Ribosomes. Anabolic processes in the cell.
14. The cell's endomembrane system (nuclear membrane, ER, Golgi apparatus, lysosomes, peroxisomes, endosomes, vesicles).
15. Stages of cellular energy metabolism. Mitochondria and their enzyme systems.
16. Human diseases caused by cellular-level dysfunctions (lysosomal and peroxisomal storage disorders).
17. Structure and functions of DNA. Chargaff's Rules. Evidence for the role of DNA in the transmission of hereditary information.
18. Organization of genetic material in acellular and prokaryotic life forms.
19. Structure and functions of the cell nucleus.
20. Organization of eukaryotic genetic material (gene, chromosomal, and genomic levels).
21. Packaging of eukaryotic genetic material.
22. Structure of metaphase chromosomes. Euchromatin and heterochromatin. Chromosome types and rules.
23. Karyotype and idiogram. Classification of human chromosomes. Plasmagenes. Cytoplasmic inheritance.
24. The Cell Cycle and Interphase.
25. Semiconservative DNA replication mechanism. Replicon.
26. Cell cycle regulators (cyclins and cyclin-dependent kinases).
27. Types of cell division: bacterial binary fission, amitosis, mitosis, endomitosis, and polyteny.
28. Mitosis: phases, genetic material distribution, and biological significance.
29. Meiosis: phases, genetic material distribution, and biological significance.
30. Cell proliferation and cell death: Necrosis, apoptosis, and caspases.
31. The Central Dogma of Molecular Biology.
32. The gene: its properties and functions.
33. Ribonucleic acid (RNA): types and functions.
34. The genetic code and its properties.
35. Transcription. Transcription factors. Eukaryotic mRNA synthesis: primary transcript and pre-mRNA processing.
36. Recognition. Translation: initiation, elongation, and termination.
37. Post-translational modifications of proteins and protein folding (chaperones).

38. Characteristics of the human genome. Genome redundancy and its significance.
39. The human transcriptome, proteome, and metabolome.
40. International human genome projects: Human Genome Project, ENCODE, and Roadmap.
41. Gene classification (structural and functional genes; housekeeping and tissue-specific genes).
42. The operon. Lactose and tryptophan operons. Polycistronic RNA.
43. Regulation of eukaryotic transcription: pre-initiation complex, enhancers, and silencers.
44. Epigenetic mechanisms of gene regulation: histone modifications, cytosine methylation, CpG islands, and regulatory non-coding RNA systems.
45. DNA analysis methods: gel electrophoresis, restriction analysis, nucleic acid hybridization, and DNA microarrays.
46. PCR and its variants: quantitative PCR (qPCR), reverse transcription PCR (RT-PCR), and multiplex PCR.
47. Genome sequencing methods: Sanger sequencing, pyrosequencing, nanopore sequencing, and bisulfite sequencing.
48. Genetic engineering: goals, objectives, and stages.
49. Methods for obtaining genes for transgenesis.
50. Recombinant DNA. Vector construction and types: plasmids, cosmids, phage vectors, and phagemids.
51. Introduction of recombinant DNA into recipient cells. Selection of transformed cells. Selective and reporter genes.
52. Biotechnology and its significance in medicine. Genetically modified organisms (GMOs). Food products containing GMOs.
53. Genetics as a science. Hybridization analysis and its essence.
54. Inheritance patterns in monohybrid crosses. Bateson's hypothesis of gamete purity. Test crosses: direct and backcross.
55. Inheritance patterns in polyhybrid crosses.
56. Conditions limiting the expression of Mendelian laws. Pleiotropy (pleiotropic gene action).
57. Intra-allelic gene interactions (complete and incomplete dominance, overdominance, codominance, and allelic exclusion).
58. Multiple alleles. Inheritance of blood groups (ABO, MN, and Rh factor systems).
59. Interallelic gene interactions (complementarity, epistasis, polymeric inheritance, and position effect).
60. Thomas Morgan's experiments. Gene linkage: complete and incomplete. Linkage groups.
61. The Chromosomal Theory of Inheritance.
62. Genetic and cytological chromosome maps.
63. Sex as a biological trait. Sex-limited, sex-influenced, sex-linked, and holandric traits.
64. Theories of sex determination. Sex differentiation and re-determination in ontogenesis. Gene regulation of gonadogenesis in humans.
65. Peculiarities of sex determination in humans: physical, intermediate, and socio-psychological determinants.
66. Disorders of sex development (DSDs) in humans. Ethical and legal aspects of altering morphological and legal sex.
67. X-chromatin. Mary Lyon's hypothesis of female mosaicism regarding sex chromosomes.
68. Variability and its types. Phenotypic variability and phenocopies.
69. Genotypic variability. Recombination and its mechanisms of origin.
70. Mutational variability. Genocopies. Causes of mutations: DNA replication errors, unequal crossing over.
71. Mutagenic factors: physical, chemical, and biological. The genetic risk of environmental mutagen contamination.
72. Classification of mutations.
73. Stability and repair of genetic material. Antimutagens.

74. Types of DNA repair. Types of excision repair, double-strand break repair. Photoreactivation. The role of repair mechanism defects in human pathology.
75. Carcinogenesis: the concept of oncogenes and tumor suppressor genes.
76. Population. Ecological and genetic characteristics of populations.
77. Ideal populations. Hardy-Weinberg Law.
78. Factors disturbing allele and genotype equilibrium in a population: natural selection, mutations, migration, and genetic drift.
79. Distinguishing features of human populations. Types of marriages. Inbreeding. Assortative mating. Coefficient of inbreeding.
80. Large populations, demes, and isolates. Characteristics of the gene pool in isolates. Founder and bottleneck effects.
81. The influence of elementary evolutionary factors on human populations.
82. Genetic load: its biological essence and medical significance.
83. Human genetics. Medical genetics and its objectives.
84. Humans as a unique subject of genetic analysis.
85. Classification of human genetics methods.
86. Key methods in human genetics: genealogical, twin, cytogenetic, biochemical, and others.
87. Diagnostic methods for human chromosomal disorders: conventional, FISH, SKY, and SNP karyotyping.
88. Rapid diagnostic methods: microbiological, X- and Y-chromatin detection, biochemical, and dermatoglyphic analysis.
89. Prenatal methods for detecting inherited pathologies (alpha-fetoprotein determination, ultrasonography, chorionic villus sampling (CVS), amniocentesis, placentocentesis, cordocentesis, and fetoscopy). Prenatal screening in the Republic of Belarus. Ethical and moral aspects of prenatal diagnosis. National policy regarding induced abortion.
90. Medical-genetic counseling: goals, objectives, and stages. Indications for genetic counseling. Clinical diagnosis, prognosis, and genetic risk calculation. Assessment of medical and social consequences of human inherited pathology. Ethical, moral, and legal issues in genetic counseling. Medical and family confidentiality.
91. Reproduction as a universal characteristic of life. Forms of asexual reproduction and their biological significance.
92. Forms of sexual reproduction and their biological significance. The sexual process. Hermaphroditism.
93. Gametogenesis (oogenesis and spermatogenesis) in humans.
94. Regulation of gametogenesis in humans.
95. Morphological and functional characteristics of mature human gametes.
96. Insemination. Peculiarities of human fertilization.
97. Overcoming human infertility. Artificial insemination, in vitro fertilization (IVF), and its variants.
98. Preimplantation genetic diagnosis (PGD).
99. Ethical issues in scientific research using human embryos.
100. Ontogenesis: types and periodization.
101. The embryonic period: characteristics of stages (prezygotic period, zygote, cleavage, gastrulation, histo- and organogenesis).
102. Interaction of developing organism's parts. Embryonic induction, morphogenetic fields, and the gradient of physiological activity.
103. Critical periods of human intrauterine development.
104. Periodization of postnatal ontogenesis in humans.
105. Gene control of postembryonic development. Human growth and development and their regulation. Acceleration.
106. Human constitution and habitus, and their medical significance.
107. Critical periods of postnatal ontogenesis.

108. Molecular and genetic bases of aging. Gerontology and geriatrics. Clinical and biological death. Resuscitation and its biological aspects. Ethical and moral issues of euthanasia.
109. Parasitism: antagonistic symbiosis. Criteria of parasitism. Microbiome. Parasitocenosis. Medical parasitology: goals and objectives.
110. The parasite-host system. The parasitic system.
111. Classification of parasites and their hosts.
112. Routes of parasite entry into the host organism. Mechanisms of parasitic disease transmission.
113. Pathogenic effects and specificity of parasites.
114. Morphophysiological and biological adaptations of parasites.
115. Host organism's responses to parasite invasion.
116. Classification of parasitic diseases.
117. General characteristics of the Kingdom Protista.
118. Life cycle of human malaria pathogens. Species of Plasmodium causing human malaria; their morphological characteristics in a thin blood smear.
119. Mechanisms and routes of human malaria infection, pathogenic effects of pathogens, symptoms, and diagnosis of malaria.
120. Toxoplasma: morphological and life cycle characteristics, mechanisms and routes of human infection, pathogenic effects. Diagnosis and prevention of toxoplasmosis.
121. Oral and dysenteric amoebae (e.g., Entamoeba histolytica): morphological and life cycle characteristics, mechanisms and routes of human infection, pathogenic effects. Symptoms, diagnosis, and prevention of amoebiasis.
122. Trichomonas: structural and reproductive characteristics, mechanisms and routes of human infection, pathogenic effects. Symptoms, diagnosis, and prevention of trichomoniasis.
123. Biological bases for the prevention of protozoal diseases.
124. The cat liver fluke (e.g., Opisthorchis felineus): morphological and life cycle characteristics, mechanisms and routes of human and animal infection, pathogenic effects. Symptoms, diagnosis, and prevention of opisthorchiasis.
125. The armed tapeworm (Taenia solium): morphological characteristics, mechanisms and routes of human and animal infection, pathogenic effects. Symptoms, diagnosis, and prevention of taeniasis and cysticercosis.
126. Human roundworm (Ascaris lumbricoides): morphological and biological characteristics, mechanisms and routes of human infection, pathogenic effects of larvae and adult worms. Symptoms, diagnosis of migratory and intestinal ascariasis, and prevention of ascariasis.
127. Pinworm (Enterobius vermicularis): morphological and biological characteristics, mechanisms and routes of human infection, pathogenic effects. Symptoms, diagnosis, and prevention of enterobiasis.
128. Sarcoptidae mites as human disease causative agents: their morphological and biological characteristics.
129. Lice: morphological and biological characteristics. Lice as causative agents and vectors of human diseases, and control measures.
130. Organ and tissue regeneration. Physiological regeneration as a mechanism for maintaining homeostasis. Classification of cells by their regenerative capacity.
131. Reparative regeneration: types and methods. Regulation of regeneration. The significance of regeneration for biology and medicine. Regenerative medicine.
132. Organ and tissue transplantation: types (autotransplantation, allotransplantation, homotransplantation, and xenotransplantation). Tissue and species specificity of proteins. Immunological mechanisms of tissue incompatibility and strategies for overcoming it. The concept of transplantation immunity. The HLA system.
133. Cell and tissue culture (in vitro). Tissue preservation. Stem cells. Cell lines in biological and medical experiments. Artificial organs. Growing human organs in animals and decellularization, therapeutic cloning, 3D bioprinting.

134. Ethical, moral, and legal aspects of tissue and organ transplantation: declaration of death, the concept of brain death, donation, and its commercialization.
135. Toxicity as a universal phenomenon in living nature. The concept of poisons and toxins. Classification of venomous animals.
136. Venomous and poisonous animals, representatives from phyla: Cnidaria, Arthropoda, and Chordata (classes Chondrichthyes, Osteichthyes, Amphibia, and Reptilia).
137. Physiological characteristics of invertebrate toxins (jellyfish, arachnids, hymenopterans), their effects on humans; first aid and prevention of bites and intoxications.
138. Physiological characteristics of vertebrate toxins (fish, amphibians, reptiles), their effects on humans; first aid and prevention of bites and intoxications.
139. Poisonous fungi and plants: characteristics.
140. The significance of poisonous and venomous organisms as sources of raw materials for pharmacy and medicine.
141. Individual and historical development of biological systems. Karl Ernst von Baer's Laws. Recapitulation. Phylogenesis as the evolution of ontogenies. The Biogenetic Law. Concepts of cenogenesis and palingenesis. A.N. Severtsov's theory of phyloembryogenesis.
142. Evolution of vertebrate organ systems: the skull and digestive system. Ontophylogenetic basis of skull and digestive system malformations.

The list of questions was approved at the Department Meeting, Protocol No. 5 of December 18, 2025.

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