

**Contents of the end-of-course examination
for the discipline "Biology"
for 1st-year international students studying Pharmacy**

1. The nature of life, the role of proteins and nucleic acids in the organization of living systems.
2. Organization levels of living matter.
3. Human as a biological and social being. The role of biology in medical education.
4. Organization of hereditary material in viruses, prokaryotes and eukaryotes. Organization levels of genetic material in eukaryotes (gene, chromosome and genome levels).
5. Gene organization level of hereditary material. The main functions of gene. Properties of genes. Structure of deoxyribonucleic acid (DNA).
6. Watson and Crick postulates.
7. Evidence for the role of DNA in the transmission of hereditary information (transformation and transduction). Ribonucleic acid (RNA) and its types.
8. Chromosome organization level of hereditary material. DNA condensation in eukaryotes. Chromatin remodeling. Euchromatin and heterochromatin.
9. Genome organization level of hereditary material. Nuclear genes and cytoplasmic genes. Cytoplasmic inheritance.
10. The nature of genetic information. Genetic code and its properties. Housekeeping and tissue-specific genes.
11. Human genome: protein-coding genes, RNA genes, non-coding sequences (repeats, introns, junk DNA). DNA transposons and retrotransposons.
12. Lac and trp operons. Polycistronic RNA.
13. Regulation of transcription in eukaryotes: preinitiation complex. Enhancers, silencers.
14. Epigenetic mechanisms of controlling gene expression: histone modifications, cytosine methylation, CpG-islands, regulatory systems of non-coding RNA.
15. International human genome research projects: Human genome, ENCODE, Roadmap.
16. Analysis of genetic material. Methods of DNA analysis: gel electrophoresis, restriction analysis, hybridization of nucleic acids, DNA microarrays.
17. Polymerase chain reaction (PCR), reaction components, stages of the method. PCR variants: qPCR, RT-PCR (reverse transcription), nested PCR, multiplex PCR, methylation-sensitive PCR.
18. DNA sequencing: Sanger sequencing, next generation sequencing (NGS): pyrosequencing, nanopore sequencing, bisulfite sequencing.
19. The concept of bioinformatics. Phylogenetic analysis. Genome editing tools: CRISPR/Cas 9, TALEN.
20. Perspectives for medicine and bioethical problems of genomic editing. Internet databases and online services containing information about nucleotide sequences (Blast, NCBI).

21. Personalized medicine. Pharmacogenetics. Gene therapy. Molecular genetic markers for tumors. Cancer genetic diagnostics.

22. Aims, objectives and stages of genetic engineering. Methods allowing to obtain genes for transgenesis. Recombinant DNA. Construction of vectors, their types: plasmids, cosmids, viral and phage vectors, phasmids, shuttle vectors.

23. Introduction of recombinant DNA into a recipient cell. Selection of transformed cells. Selective and reporter genes.

24. Medical applications of genetic engineering: production of protein products, monoclonal and polyclonal antibodies, recombinant antigens. DNA probes. Biotechnology and its significance in medicine. Genetically modified organisms (GMO). Food products containing GMOs.

25. Cytology. Methods of cytology (light microscopy, fluorescence microscopy, electron microscopy and histochemistry and immunohistochemistry, differential centrifugation, autoradiography, morphometry, etc.).

26. The method of light microscopy. The structure of light microscope. The instructions for working with a microscope.

27. Cell as the least structural and functional unit of life. General characteristics of viruses prokaryotes and eukaryotes.

28. Models of plasma membrane. The structure, properties and functions of plasma membrane. Transport across the membrane: passive transport (simple diffusion, facilitated diffusion, osmosis), active transport (ion channels, their functions), endocytosis, exocytosis.

29. Cytosol. Cytoskeleton: microtubules, intermediate filaments, microfilaments. Vesicular transport. Nuclear localization signal.

30. Assimilation and dissimilation. Ribosomes. Endomembrane system (nucleus, endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes, endosomes, vesicles).

31. Photosynthesis and chemosynthesis, fermentation and respiration. Stages of catabolism, mitochondria, enzymes of mitochondria.

32. Disorders caused by impairments of cellular activities (mitochondrial diseases, lysosomal storage diseases, peroxisomal disorders and prion diseases).

33. The structure and functions of nucleus.

34. Types of chromosomes. Rules of chromosomes. Karyotype and idiogram. Nomenclatures of human chromosomes.

35. The Central Dogma of Molecular Biology. Semi-conservative mechanism of DNA replication. Replicon.

36. Transcription. Transcription factors. Eukaryotic mRNA synthesis: primary transcript, pro-mRNA processing, splicing. Alternative splicing. Transcriptome. Reverse transcription.

37. Aminoacyl-tRNA synthetases. Translation: initiation, elongation and termination. Proteome. Metabolome.

38. Posttranslational modifications of proteins. Protein folding. Chaperones. Utilization of proteins in cell. Proteasomes. Ubiquitin.

39. Types of cell division. Cell cycle regulators (cyclins and cyclin-dependent kinases). Cell proliferation and cell death. Necrosis and apoptosis. Caspases.

40. Genetics. The subject, methods and tasks of Genetics. Hybridological analysis.
41. Monohybrid crossing. Hypothesis of Purity of Gametes. Test cross. Backcrossing.
42. Polyhybrid cross. Limitations of Mendel's laws. Pleiotropy.
43. Intra-allelic interaction (complete and incomplete dominance, superdominance, codominance and allelic exclusion). Multiple alleles. Inheritance of blood groups (ABO, MN, Rh).
44. Inter-allelic interaction (complementary gene action, inhibitory gene action, polymeric gene interaction and position effect). Bombay blood group.
45. T. Morgan's experiments. Genetic linkage. Complete and partial linkage. Crossing-over and genetic recombination. Linkage groups. Chromosomal Theory of inheritance. Genetic and cytological chromosome maps.
46. Sex as a biological trait. Sex-limited, sex-influenced, sex-linked and holandric inheritance.
47. Determination and development of sex in ontogenesis.
48. Peculiarities of sex determination in humans: physical, intermediate and socio-psychological determinants.
49. Genetic mechanisms of gonadogenesis in humans.
50. Barr body, Mary Lyon's hypothesis of X chromosome inactivation.
51. Hermaphroditism. Disruption of sex formation in humans. Ethical aspects associated with sex, disorders of sex development, sex change and transsexualism.
52. Variability. Types of variability. Phenotypic plasticity. Morphosis. Phenocopies. Medical aspects of phenotypic plasticity.
53. Genotypic variability. Combinative variability and its mechanisms. Genetic variation caused by mutations.
54. Causes of mutations: Replication errors, unequal crossing over, mutagens.
55. Mechanisms of mutagenesis. Genocopies. Physical, chemical and biological mutagens. Supermutagens. Genetic hazards of environmental pollution with mutagens. Classification of mutations.
56. Genome stability and DNA repair. Types of DNA repair: excision repair, double-strand break repair, direct reversal repair. Antimutagens. Medical aspects of DNA repair.
57. Carcinogenesis. Oncogenes and tumor suppressor genes.
58. Current tasks of human genetics. Human being as a specific object of genetic analysis.
59. The main methods human genetics: pedigree analysis, twin study, cytogenetic techniques, the methods of population genetics, biochemical diagnostic techniques, the methods of molecular genetics.
60. Methods used for diagnosis of genetic disorders: direct sequencing, PCR, restriction fragment length polymorphism (RFLP) analysis, single-strand conformation polymorphism (SSCP) analysis, DNA-microarrays.
61. Methods used for diagnosis of numerical and structural chromosomal abnormalities: karyotyping, SKY, FISH and SNP array-based karyotyping.

62. Rapid diagnostic tests: Guthrie bacterial inhibition assay, detection of sex chromatin.

63. Neonatal screening of monogenic disorders. Screening programs in the Republic of Belarus.

64. Reproduction of living things. Sexual and asexual reproduction, their forms and biological roles. Hermaphroditism and dioeciousness. Lateral gene transfer.

65. Oogenesis and spermatogenesis in humans. Regulation of gametogenesis. Characteristics of human gametes. Insemination. Peculiarities of fertilization in humans.

66. Assisted reproductive technologies (ART) in overcoming infertility in humans: artificial insemination; in vitro fertilization (IVF) and its variations (intracytoplasmic sperm injection (ICSI), oocyte donation; surrogacy; assisted hatching; cytoplasmic transfer).

67. Preimplantation genetic diagnosis. Medical research using human embryos, and associated ethical problems.

68. Periodization of ontogenesis. Determination of phenotype by genetic and environmental factors in ontogenesis.

69. Prezygotic period of ontogenesis. Prenatal period of ontogenesis. Genetic control of prenatal development.

70. Significance of ooplasmic segregation, totipotency of zygote, selective gene expression.

71. Interactions between parts of developing embryo. Embryonic induction, positional information of embryonic cells.

72. Critical periods of human prenatal ontogenesis, teratogenic factors.

73. Genomic imprinting. Diseases of genomic imprinting.

74. Periodization of postnatal ontogenesis in humans. Genetic control of postnatal ontogenesis.

75. The influence of external and internal factors on postnatal ontogenesis.

76. Growth and development of the organism and their regulation. Acceleration.

77. Human constitution and habitus. Critical periods of postnatal ontogenesis.

78. Molecular and genetic basis of aging.

79. Gerontology and Geriatrics.

80. Clinical and biological death. Resuscitation and its biological aspects. Moral and ethical problems of euthanasia.

81. Population. Ecological and genetic characteristics of populations. Gene pool.

82. Ideal population. Hardy-Weinberg equilibrium. Factors disturbing Hardy-Weinberg equilibrium.

83. Natural selection. Mutations. Migration. Genetic drift, founder effect, bottleneck effect.

84. Non-random mating, inbreeding, assortative mating, inbreeding coefficient.

85. Population structure of humanity. Large populations, demes and isolates. Peculiarities of gene pool of isolates. Effects of elementary evolutionary factors on human populations.

86. Human genetic polymorphism, its biological, medical and social aspects. Genetic burden, its biological essence and medical significance.

87. The main systems of biosphere-biogeocenotic organization level of life: community, ecosystem (biogeocenosis), biosphere. The main stages of the biosphere's evolution. Noosphere.

88. Human ecology and its objectives. Ecological differentiation of mankind: adaptive types, their morphophysiological characteristics.

89. Rational use of renewable and nonrenewable natural resources. Problems of anthropogenic pollution of environment and ways of its prevention.

90. Valeology. Main factors of health: rational lifestyle, getting rid of bad habits, active lifestyle, full and physiologically balanced nutrition. The role of doctors in preserving health and developing ecological consciousness and thinking of the population.

91. Parasitism as an antagonistic form of symbiosis. Parasitocoenosis. Microbiome. Medical parasitology, its goals and objectives. Classification of parasitic diseases.

92. Classification of parasites. Classification of hosts.

93. Characteristics of the parasite-host system. Transmission routes of parasites.

94. Pathogenic action and specificity of parasites. Morphophysiological and biological adaptations of parasites.

95. Responses of the host organism to the invasion of parasites. Parasitic system.

96. Poisonousness and venomousness is a universal phenomenon in living nature.

97. The concept of poisons, venoms and toxins. Classification of poisonous and venomous animals.

98. Poisonous fungi: micro- and macromycetes. Mycotoxins, their characteristics, mechanisms of action. Poisonings by mycotoxins, measures for their prevention.

99. Poisonous plants, their classification. Phytotoxins, their characteristics, mechanisms of action.

100. The picture of human poisoning by poisonous algae, clavines, horsetails, ferns, gymnosperms and coleopterous plants. Prevention of poisoning by poisonous plants.

101. Poisonous plants as a source of medicinal plant raw materials and their protection.

102. The value of poisonous plants as a source of materials for pharmacy and medicine.

103. Poisonous animals of the phylum: *Coelenterata*, *Arthropoda* and *Chordata* (*Chondrichthyes*, *Osteichthyes*, *Amphibia*, *Reptilia*).

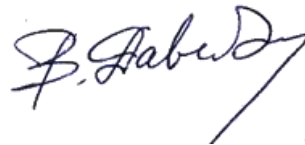
104. Physiological characteristics of the toxins of invertebrates (jellyfishes, spiders, hymenopterans), their effect on humans; first aid and prevention of bites and stings.

105. Physiological characteristics of the toxins of vertebrates (fishes, amphibians, reptiles), their effect on humans; first aid and prevention of bites and stings and poisonings.

106. The value of poisonous and venomous animals as a source of materials for pharmacy and medicine.

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

Head of the Department of Biology

A handwritten signature in blue ink, appearing to read 'V.V. Davydov', with a stylized, sweeping flourish at the end.

V.V. Davydov