Final Closing Exam – Biology BSc - 2025

Topics A

1. The structure and function of the neuron. Nerve fibre types. Mechanism of nerve impulse conduction

Keywords: perikaryon, Nissl body, vesicle, dendrite, axon, uni-, bi- and multipolar neurons, sensory, motor and interneurons, Remak fibre, Schwann cells and myelin sheath fibre, action potential, decremental and saltatory conduction

2. Synapse structure, function and neurochemistry

Keywords: electrical and chemical synapses, presynaptic and postsynaptic events, docking, local synaptic potentials, ionotropic and metabotropic receptors, major neurotransmitter families and their receptors

3. Cell-conecting structures, intercellular communication, signal transduction

Keywords: anchoring and communicating cellular junctions, tight junction, zonula and fascia adherens, desmosome, haemidezmosome, focal junction, gap junction, autocrine, paracrine and endocrine (neuroendocrine) signalling, cytosolic and nuclear receptors, receptor tyrosine kinases, Wnt and Notch signalling

4. Organisation, dynamics and role of the cytoskeleton in signal transduction mechanisms

Keywords: microfilaments, intermediate filaments, microtubules, microvill, cilia, motor proteins, cell division, cell motility, anterograde and retrograde transport

5. Sensory functions of the mammalian nervous system

Keywords: types of sensory receptors, modality specificity; receptor potential; frequency and population code; stimulus threshold; receptive field; adaptation; lateral inhibition; afferent nerves and pathways from receptors to cortex; body maps

6. General characterisation of the active system of movement. Skeletal muscles. Gross anatomy of the sceletal muscle. Structure of the muscle fibre. Molecular mechanisms of muscle contraction

Keywords: origin, tendon, muscle body, endo-, epi- and perimysium, sarcolemma, sarcoplasm, sarcoplasmic reticulum, T-tubule, triad, myofibrils, myofibrils, sarcomere, sliding filament theory and the role of titin

7. General characterisation of hormones in invertebrates and vertebrates and of neuro-endocrine regulation. The hypothalamo-hypophyseal system of vertebrates

Keywords: neurosecretum, glandular hormone, cellular and tissue hormones, relationship between chemical composition and mechanism of action, membrane receptors, cytosolic and nuclear receptors, regulatory circuits and feedback mechanisms, hypothalamic large and small cell nuclei, adeno- and neurohypophyseal compartments, portal circulation of the pituitary, direct acting hormones and trophormones, tissue hormones

8. Material transport. Changes in the forms of mass transport during phylogeny. Comparative overview of the vertebrate heart. The pacemaker and conduction system of the mammalian heart, functional characteristics

Keywords: plasma flow, cellular mass transport, intestinal tract, open and closed circulation, types of circulation, position of the heart, cavities and their arrangement, sinus node, atrioventricular node, His bundle. Tawara branches and Purkinje fibres, fibrous skeleton of the heart, nodal and ventricular cardiac muscle tissue, nodal pacemaker potential, slow and fast action potential, propagation of action potential and muscle contraction

9. Blood and the immune system

Keywords: blood as a connective tissue: cellular elements, blood plasma; haematocrit, quantitative and qualitative blood count, respiratory gas transport, haemoglobin, Hamburger shift; haemostasis: vascular reaction, biochemical reaction, thrombolysis; the role of blood in immunological processes: innate and acquired immunity, cellular and humoral immune response, complement system, lymphatic system, lymphatic circulation

10. Evolution of the digestive tract, the mammalian digestive system

Keywords: evolutional strategies of food intake, enteral and parenteral nutrition, gastrovascular systems, three-chambered alimentary canal, cellular and extracellular digestion, oral organ, large digestive glands, digestive fluids and their composition: Saliva, gastric juice, pancreatic juice, bile, intestinal juice, the process of absorption: circulatory system of the intestinal wall, anatomy of the liver, structure and circulatory system of the hepatic lobules, bile ducts, function of the large intestine

11. Phylogeny of the excretory system, the mammalian excretory system

Keywords: ammonotele, ureotele and uricotele organisms; modes of elimination of decomposition products, ectodermal, endodermal and mesodermal excretory organs; pro-, meso- and metanephros; structure of the nephron; nephron types: Glomerular, aglomerular, cortical, juxtamedullary nephrons; ultrafiltration, reabsorption, secretion, urine formation; ureter, bladder, urethral function, urinary system

12. Volumetric, osmo- and ionic regulation in animals

Keywords: osmoregulatory and osmoconforming organisms, function of the salivary glands, homeostasis; isovolaemia; isosmosis; isohydria; central and peripheral osmoreceptors; renal osmoregulatory function: tubular ion transport mechanisms; juxtaglomerular apparatus; renin-angiotensin-aldosterone system; antidiuretic hormone; atrial natriuretic peptide; thirst mechanisms

13. Evolution of the respiratory system, the mammalian respiratory system

Keywords: diffuse and localized respiration, types of respiratory organs of epithelial and intestinal origin, characteristics of the vertebrate airways and respiratory epithelium, mechanics of mammalian respiration, inspiratory and expiratory muscles, respiratory volumes, intrapleural and intrapulmonary pressures, central and peripheral regulation of mammalian respiration

14. Somatomotor functions in mammals

Keywords: hierarchical organisation of the motor system, principle of the final common pathway; structure of the extrapyramidal and pyramidal systems; reflex and voluntary motor functions; spinal and brainstem reflexes, posture, gait; cerebellar and cortical voluntary motor functions; cortical somatoptopy

15. Evolution of the circulatory system, the mammalian circulatory system

Keywords: diffuse and open circulatory systems, closed circulatory system; structure and characteristics of the different sections of the vertebrate circulatory system (arteries, capillaries, veins); development of aortic arches, main venous system, empty venous system, neural and humoral regulation of heart rate and volume and blood circulation; local regulation of blood flow to organs, autoregulation

16. Evolution of the visual system, the mammalian visual system

Keywords: light-sensing spots, simple, camera-type, and compound eyes; structure of the vertebrate bladder eye; types of bladder eye, optical characteristics, envelopes and refractive media of the vertebrate bladder eye; structure and cellular connectivity of the mammalian retina, yellow spot and blind spot; vertical and horizontal information propagation, photoelectric signal transduction, central visual processes: optic nerve and visual pathway; colour vision; motion and depth perception; primary and higher cortical visual functions

17. Evolution of the auditory and vestibular sensory system, mammalian auditory and vestibular sensory systems

Keywords: Mechanical sense organs in invertebrates; lateral line organ of fish; auditory organs of terrestrial vertebrates: external ear, middle ear, inner ear, cochlea, organ of Corti, hair cells, mechanoelectric signal transduction, auditory nerve, auditory pathway, auditory cortex functions; structure of the vestibular apparatus (semicircular canals and otolith organ), vestibular brainstem projections and reflex functions

18. Autonomic nervous system functions and their regulation

Keywords: components, structure and function of the sympathetic and parasympathetic autonomic nervous system; neurochemistry of the autonomic nervous system; concept of homeostasis, set of primary driving forces, role of the hypothalamus in maintaining homeostasis

19. The structure of biological membranes. Membrane transport processes, endo- and exocytosis

Keywords: cell membrane constituents: lipid, carbohydrate and protein membrane constituents; formation of the liquid mosaic membrane model, glycerophosphatides, sphingophosphatides, glycolipids, cholesterol, lipid rafts, simple and facilitated diffusion, primary and secondary active transport, types of phagocytosis and pinocytosis, docking of transport vesicles

20. Intermediate metabolism of carbohydrates, lipids, proteins and biochemical hormonal regulation of chemical and biological processes

Keywords: anabolism, catabolism, glucose, acetyl-CoA, intermediate compounds, ketone bodies, urea, glycolysis, Krebs cycle, glycogenesis, glycogenolysis, glyconeogenesis, lipolysis, beta oxidation, lipogenesis, proteolysis, urea cycle, protein synthesis, insulin, glucagon, adrenaline, ghrelin, leptin, cortisol, growth hormone, thyroid hormones (T3, T4)

21. Organization of the nucleus and chromatin: structure and formation of chromosomes. Intranuclear suborganelles

Keywords: eukromatin and heterochromatin, nucleoskeleton, chromosome territories, metaphase chromosome structure and types, karyogram and idiogram, nucleolus, Cayal bodies, PML bodies, speckles

22. Structure and function of the energy-converting cellular organelles (plastid, mitochondria) of eukaryotic cells

Keywords: leukoplasty, chloroplasty: outer, inner and thylakoid membrane structure, light-dependent and light-independent reactions of photosynthesis, characterization of the outer and inner membrane of the mitochondrion, mechanisms of chemosensitive coupling

23. Cell division, differentiation and ageing. Types of cell death

Keywords: cyclic and linear cell lines, mitosis, meiosis, telomere structure and function, tissue stem cells, totipotent/omnipotent and unipotent cell lines, necrosis, programmed cell death (autophagy and apoptosis)

24. Types and formation of gametes (ovogenesis, spermiogenesis)

Keywords: ovaries, fallopian tubes, uterus, follicle, ovum, oocyte, estradiol, progesterone, testis, epididymis, Sertoli cell, Leydig cell, spermatogonium, acrosome, meiosis

25. Structure, fertilisation and cleavage of the mammalian ovum. Formation, differentiation and derivatives of germ layers in mammals. Extraembryonic organs

Keywords: zona pellucida, corona radiata, granulosa cell, Graaf follicle, oligolecital ovary, telolecital ovary, acrosomal reaction, cortical reaction, polispermia blockade, ectoderm, endoderm, mesoderm, morula, blastula, gastrula, chorion, amnion and scrotum

26. Enzymes and factors affecting their activity and their effects

Keywords: the main features of enzyme catalysis, The Michaelis-Menten "rapid equilibrium" kinetics. Coenzymes, prosthetic groups. International classification of enzymes

27. Carbohydrate metabolism in the cells

Keywords: glycolysis, pentose phosphate cycle, gluconeogenesis, allosteric and hormonal regulation

28. The biosynthesis of amino acids in cells

Keywords: different forms of nitrogen incorporation, summary characterisation of amino acid biosynthesis. Degradation of amino acids, main types of reactions. Relationship of amino acid degradation and synthesis processes to the citrate cycle. Characterisation of nitrogen efflux - urea cycle

29. Structure and function of DNA

Keywords: the main experiments (Griffith, Avery, Hershey and Chase, Watson and Crick, Meselson-Stahl), the genetic code, the eukaryotic genome

30. Mechanisms of eukaryotic gene organisation and regulation

Keywords: expression of genetic information, protein synthesis, cis- and transregulatory elements, transcription factors, transcription initiation - termination

31. The basics of recombinant DNA technology

Keywords: restriction enzymes, cloning, vectors, gene libraries, hybridisation, PCR, DNA-chip

32. Transgenic plants and animals: production and use in basic research and biotechnology.

Keywords: promoter, transformation, chimera, totipotent cell, overexpression, gene silencing, Bt toxin, herbicide resistance, molecular farming

33. Mendelian genetics and its extensions.

Keywords: Forms of dominance - Lethality, pleiotropy - Multiple allelism-gene interactions: modified mendelian number ratios, complementation, epistasis - Penetrance and expressivity

34. Chromosomal theory of inheritance, linkage, genetic mapping.

Keywords: Parallels between the behaviour of genes and chromosomes - Proof of sex-linked inheritance and chromosome theory - Linkage: coupling and repulsion - Classical interpretation of crossing-over and recombination - Two- and three-point mapping - Map function

35. Mutations: classification of mutations, gene and chromosome mutations, occurrence of mutations, spontaneous and induced mutations.

Keywords: loci, point mutations, deletion, duplication, inversion, translocation, tautomeric transformation, repeat sequences, slipped mispairing, deamination, physical and chemical mutagenesis, transposon mutagenesis

36. Replication, recombination and repair: the replication fork, the Holiday-cross and important repair mechanisms and the association of the three aforementioned processes.

Keywords: DNA polymerases, leading strands, lagging strand, Okazaki fragments – branch migration, – Base excision repair (BER), Nucleotide excision repair (NER), Mismatch repair, SOS-repair, recombination repair

37. One gene-one enzyme hypothesis and the demonstration of colinearity.

Keywords: Inborn errors of metabolism – Auxotrophy and prototrophy – Alteration of genes by mutations and phenotype – Gene disruption, mutation hotspots, cistron – Colinearity

38. Possible sources of reactive oxygen species in plants. Oxidative stress induced by abiotic and biotic influences, processes to prevent and mitigate its effects

Kulcsszavak: ROS, antioxidant, eustress, distress, Selye

39. Mechanisms of prokaryotic gene organisation and regulation

Keywords: sigma factor, repressor and activator proteins, attenuation, termination, Lac and Trp operon

Topics B

1. Introduction to the main morphological and molecular features of viruses

Keywords: Baltimore classification, hosts, replication specificity, DNA viruses, RNA viruses

2. Characterisation of cellular structure and spore formation in bacteria (eubacteria)

Keywords: cell appendices, cell wall, structure of bacterial genetic material, special prokaryotic organelles, endo- and exospore formation

3. Introduction to the main species of Gram-negative and Gram-positive bacteria

Keywords: Escherichia, Legionella, Pseudomonas, Treponema, coccus, Bacillus, Clostridium

4. Characterisation of the cell structure and life history of the Chytridiomycota, Zygomycota and

Keywords: cell attachments, cell wall, plasma membrane, septum, vacuoles, dimorphism,

5. Characteristics, organisation and role of blue-green algae, green algae and lichens in the biological systems

Keywords: phyla and classes, cell organisations, types of structural organization, life cycles, environmental indication

6. Morphology and histology of vegetative plant organs. Examples of morphological and histological adaptation to different environmental conditions.

Keywords: true and modified roots, woody stem types, herbaceous stem types, leaf types, leaf blade morphology, modified stems and leaves, hydromorphic and xeromorphic characteristics

7. Reproductive modes in the plants (generative, vegetative). Morphology of flowers, seeds and fruits in flowering plants, with examples

Keywords: flower symmetry, vegetative and reproductive parts of the flower, racemose, and cymose simple inflorescences, compound inflorescences, dry dehiscent, dry indehiscent, simple fleshy-, aggregate and multiple fruits

8. Aspects of the classification of plant taxa, position of plants and plant-like organisms in the eight-kingdom system, characterization and interpretation of higher taxa

Keywords: historical systems, the eight-kingdom system, autogenous and endosymbiotic theories, autotrophy and mixed feeding, the importance of cladistics

9. Description and characterisation of bryophyte, fern and clubmoss taxa, their biological significance with examples

Keywords: phyla and classes, leaf types, spore types, spore-producing organs, life cycles, habitat preference and indication

10. Description and characterisation of Gynmosperms and Angiosperms with examples of their biological significance

Keywords: phyla and classes, similarities and differences between the vegetative organs, taxonomic role of differences in flower and seed formation

11. Tasks and methods of zootaxonomy and zoosystematics. Basics of phenetic (numerical) and cladistic (evolutionary) systematics, comparison of their principles and methodology

Keywords: artificial vs natural system, OTU, mono-, para-, polyphyletic groups, phenogram, cladogram, elementary monophyletic unit, enkaptic hierarchy, plesiomorphic, apomorphic traits, homoplasy, principle of parsimony

12. Evolution of the concept of species, difficulties of species identification, morphological and biological species concepts, taxonomic categories, taxonomic nomenclature rules

Kulcsszavak: speciation: allo-, syn- and parapatric, double nomenclature, classical and molecular species identification methods, logical operations of systematics, synonymy, homonymy, type specimen

13. Taxonomical division of animals, introduction of phylogenetic groups, characterisation of Radiata and Bilateria, examples of the Radiata phylogenies

Keywords: the formation of tissues Parazoa vs Eumetazoa, the formation of body symmetry, anatomical planes and directions

14. Division of Protostamata and Deuterostamata, characterization of important phyla

Keywords: blastulation, germinal plates, evolution of the body cavity, segmentation, the importance of cephalisation, species-rich phyla of Lophotrochozoa and Ecdizozoa

15. The concept of area, the stages of establishment, general characteristics of biological invasion, notable hypotheses. Plant characteristics determining the success of invasion (examples)

Keywords: native, archaeo-, neobiota, tens' rule, niche, barrier, competition, Novel weapons hypothesis (NWH), Rich get richer hypothesis, Enemy released hypothesis (ERH), r-K strategy, reproduction modes

16. The dynamics (factors, modes, stages, physical and ecological barriers to dispersal), history and evolution of areas. Evolution of the Pannonian biota in the Holocene (main theories)

Keywords: climate change, barriers, bottle-neck effect, founder effect, expansion, regression, disjunction, extinction, endemic species, relict species, biogeographic regions of Europe, refugium, the origin of Holocene flora in the Pannonian basin, Illirian-Dacic migratory routes, flora continuity theory

17. Definition of ecological niche, fundamental and realised niche. Concept and measurement of niche width and niche overlap, niche segregation

Keywords: limitation principle; resource use and niche curve; resource allocation

18. Population interactions (intra- and interspecific competition, predation interactions, mutualistic relationships)

Keywords: Lotka-Volterra models and their refinement, more realistic models; competitive exclusion principle, niche segregation mechanisms, facultative and obligatory mutualism

19. The concept of population and the general population model (population characteristics, population laws, types of population growth). The concept and basic types of metapopulation

Keywords: reproduction rate; equilibrium number; Verhulst equation; density-dependent control; R = f(Nt-T)FG), spatial distribution and dispersion of the population

20. Feeding strategies (optimisation models, predator typing, optimal food type choice) and life history strategies (life history components, cost of reproduction)

Keywords: trait, optimization models, traid off, fecundity, reproductive value, eye parity, iteroparity, r-K selection

21. Coexistence in space and time: from species preferences to the formation of associations

Keywords: inhibition, facilitation, neutral relationships, basic types of interactions, species richness, Arrhenius model, texture, cotexture, coalition, association, resource partitioning, timing strategies, competition-colonization exchange, cyclical changes, directional changes, monoclimax, polyclimax, patch dynamics, primary and secondary succession, secular succession

22. Importance, types, measurement, global distribution and threats to biodiversity

Keywords: species-individual diversity; ecological diversity; types of alpha diversity and diversity orders; biodiversity hotspots; anthropogenic impacts

23. Aim and methods of conservation biology assessment

Keywords: extensive and intensive monitoring, cost-benefit analysis (CBA), minimum viable population (MVP), effective population size, minimum dynamic area (MDA), population viability analysis (PVA)

24. Conservation strategies (active and passive, species and habitat protection) and the importance of sustainable development

Keywords: ecological overshooting, maximum sustainable yield; international conventions; national parks; SLOSS; keystone species, umbrella species, flagship species

25. Main environmental and conservation issues in the 21st century: water, air, energy, waste, habitats, species vulnerability and protection

Keywords: water resources, water scarcity, chemical and physical water pollution; smog; recycling: 3Rs initiative, composting, landfill gas; alternative, renewable and green energy types, solar and nuclear energy; habitat fragmentation, species of greatest concern, IUCN categories, red list, black list, legal protection: types of protected areas, protected species, laws, regulations, Natura 2000 network

26. The effect of environmental factors on the reproduction of microorganisms, grouping microbes according to the environmental conditions favourable to them

Keywords: temperature, pH, oxygen, water, UV radiation

27. The role of temperature and light in plant development. Phytochrome, cryptochrome system, photoperiodic and non-photoperiodic photomorphogenesis. Plant movement patterns and their physiological role

Keywords: Phytochromes, cryptochromes, photomorphogenesis, photoperiodic photomorphogenesis, non-photoperiodic photomorphogenesis

28. Photosynthesis: light reactions. Light harvesting by chlorophyll and accessory pigments. Conversion of light energy to chemical energy. The Z-scheme, redox functions of the two photosystems. Proton transfer coupled to electron transfer. Photophosphorylation (cyclic and linear), and its significance.

Keywords: PSI, PSII, pigments, electron transport, antennas

29. Uptake of water and mineral nutrients in plants. Water potential and its significance in regulating water uptake. The route of water in plants. Transpiration. Transport and accumulation of mineral elements, ion transport. Phytochelatins.

Keywords: diffusion, mass flux, osmosis, turgor, active transport, passive transport, phytochelatins, root pressure, transpiration, adhesion, cohesion

30. Physiology of stomata movements. Factors affecting stomata opening and closure. Biochemical aspects of stomata movements. The role of abscisic acid in plant stress response.

Keywords: primary messenger, secondary messenger, phytotropins, respiration, transspiration, chemical potential

31. Plant carbohydrate metabolism. The C3 pathway of carbon dioxide reduction (the three main steps of the Calvin-Benson cycle, their start and end products only). Monosaccharides, sugar phosphates, di-saccharides. Biosynthesis and catabolism of saccharose. Carbohydrate transport. Biosynthesis and catabolism of starch and cellulose. Fructans.

Keywords: Rubisco, Calvin cycle, GA3P, DHAP, fructose-2,6-bisphosphate, callose, source cell - target cell

32. Metabolism of fatty acids and terpenes in plants. Formation and degradation of neutral lipids, phospholipids, sphingolipids and galactolipids. Role of lipids in development. Classification of terpenes and their role in plant life.

Keywords: polyketides, lipids, membranes, lipase enzyme, KAS, FAS, ACP, oxidative degradation, mevalonic acid synthesis pathway, isoprene

33. The role of important nutrients in plant physiology. The importance, uptake and metabolism of essential elements, biogenic elements, osmotic potential regulating elements. Nitrogen metabolism, sulfur metabolism and phosphorus metabolism.

Keywords: micronutrients, macroelements, nutrient deficiency, assimilation, endogenous nitrogen cycle, limiting concentration, rhizosphere, Liebig, eutrophication, endogenous nitrogen cycle

34. Hormonal regulation in plants. The five main phytohormones and their biosynthesis (main steps only), localization, transport and physiological roles. Synthetic plant growth regulators.

Keywords: cytokinins, gibberellins, abscisic acid, salicylic acid, strigolactones

35. Plant growth and development. Seed germination, flowering, fruit development, senescence. Movements of plants and their role in plant physiology.

Keywords: hormones, cell division, cell differentiation, regulatory factors

36. Plant responses to biotic and abiotic stress conditions. The role of temperature and light in development; phytochrome and chryptochrome systems, periodic and non-periodic photomorphogeneses.

Keywords: hormones, DAMP, PAMP, pathogenic strategies