Topics of the final examination 2022

Topics – A

1. The neuron: structure and types. Synapses, terminal and interneuronal; electric and chemical. Types of nerve fibers. Conduction of the neuronal signals.
2. Function and neurochemistry of synapses: receptors, ion channels and local potentials. Signal transduction.
3. Sensory and motoric functions of the nervous systems. The somatosensory system. Afferents to the spinal cord and their route further to the brain. General rules of sensory processing: modality, specificity, signal processing in the peripheral and central nervous system.
4. The active elements of motion. Skeletal muscles. Morphology of a typical muscle. Muscle fibers. The molecular mechanism of the muscle contraction. Hierarchic neural control of movements.
5. The hormonal system of the vertebrates and invertebrates. General rules of hormonal regulation. Development and shedding/molting of insects, and the role of hormones in this process. The hypothalamo-hypophyseal system of humans.
6. Evolution of nutrients and gas transport in animals (cyclosis, amoeboid cells of sponges, gastrovascular systems, open and closed circulation) Comparison of the anatomical organization of the heart in vertebrates. The myogenic rhythm generating system of the heart.
7. The properties and physiological roles of the red blood cells. Thrombocytes, and their physiological roles. Blood clotting.
8. Feeding, digestion and absorption of nutrients in the animal phyla (phylogenetic overview). Anatomy and physiology of the human alimentary canal (parts, digestive fluids and enzymes). Mechanism of absorption. Anatomy and function of the liver (portal circulation, organization of the liver lobules, secretory products).
9. Neural and humoral regulation of the alimentary canal. Uptake and discharge of Exchange of materials. Intracellular metabolism of carbohydrates, lipids and proteins.
10. Excretion and excretory end-products. Evolution of the excretion and excretory system in the animal kingdom. Anatomy and physiology of the human excretory system. Morphology and histology of the nephron. Ultrafiltration, reabsorption, secretion, urine production.
11. Osmo- and ion regulation in evolution. Isovolemia, isosmosis and their hormonal regulation (renin-angiotensin, aldosterone,vasopressin, atrial natriuretic peptide).
12. Breathing and respiration. Diffuse and localized gas exchange. The gas exchange organ of humans. Mechanics of breathing. Pulmonary volumes.
13. The somatomotor system. Pyramidal and extrapyramidal systems (reflexes, posture). The cerebellum.
14. Cardiac functions. Peripheral circulation and its hormonal and nervous regulation. Autoregulation, lymphoid system and liquor cerebrospinalis.

15. Vision and hearing: anatomy and physiology.
16. Biological membranes, cellular transport, endo-and exocytosis.

17. Enzymes: the main characteristics of enzyme catalysts. Michaelis–Menten type rapid equilibrium kinetics. Regulation of enzymes: coenzymes, prosthetic groups. Enzyme catalogue.
18. Carbohydrate metabolism in the cells: glycolysis; citric acid cycle; terminal oxidation; pentose phosphate pathway. The glycosidic bonds in sucrose, cellulose and starch.
19. The metabolism of triacylglycerols: the catabolism and synthesis of glycerol and fatty acids.
20. The biosynthesis of amino acids: the source of nitrogen for the synthesis of amino acids. The nitrogen cycle. The summary of amino acid synthesis. The degradation of amino acids: the main reaction types in amino acid catabolism. Degradation of the carbon skeleton of amino acids in the citric acid cycle. Nitrogen excretion: urea cycle.
21. The structure and function of the nucleus in eucariotic cells. DNA: important experiments (Griffith, Avery, Hershey and Chase, Watson and Crick, Meselson-Stahl), the genetic code, characteristics of the eukaryotic genome.
22. Expression of genetic information, protein biosynthesis (eukaryotic gene regulation, transcription and translation)
23. The basics of recombinant DNA technology: restriction enzymes, cloning vectors, gene libraries, clone identification (DNA hybridization, PCR, DNA chip).
24. Transgenic plants and animals: production and use in basic research and biotechnology.
25. Intercellular communication and signal transduction.
26. Mendelian genetics and its extensions.
27. Chromosomal theory of inheritance, linkage, genetic mapping.
28. Mutations: classification of mutations, gene and chromosome mutations, occurrence of mutations, spontaneous and induced mutations.
29. Replication, recombination and repair: the replication fork, the Holiday-cross and important repair mechanisms and the association of the three aforementioned processes.
30. One gene-one enzyme hypothesis and the demonstration of colinearity.
31. Peptide and protein biosynthesis (signal peptides and secretory pathways, vesicular transport). Formation of lysosomes (processing, transport and secretion of lysosomal enzymes).
32. The cytoskeleton: molecules, organization, dynamics, role in the organization of the cells.
33. Structure and function of mitochondria and chloroplasts.
34. Cell division, differentiation and aging. Mechanisms of cell death. Possible role of reactive oxygen species.
35. Oocytes in mammalians. Fertilisation and cleveage. Formation of germinal layers, differentiation and specification into organs in mammalian species.

36. Possible multiplication types in plants (sexual, asexual, vegetative). Morphology of flowers, seeds and fruit in flowering plants (with exampoles).

37. Gene regulation in prokaryotic organisms: sigma actors, repressor and activator proteins, *lac* and *trp* operon regulation, termination of transcription.

Topics – B

1. 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.

2. 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.

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

4. 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.

5. Lipid biosynthesis in plants. Synthesis of polar and storage lipids. Lipid catabolism and its role in seed development. Terpenoid biosynthesis, terpenoid groups and their significance (examples).

6. Roles of mineral nutrients in plants (groups, examples of biochemical and physiological roles). Nitrogen assimilation in plants, nitrogen containing biomolecules, nitrogen containing special metabolites.

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

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

9. 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.

10. General characterization of viruses: morphology, molecular structure, multiplication and detection.

11. General characterization of bacteria: size, morphology (cell membrane, special organelles) and spore formation processes. Role of environmental factors (pH, oxygen,temperature) in population growth.

12. General characterization of fungi: morphology, anastomosis, somatic hybridization. The three important groups of fungi: zygomycotes, ascomycotes and basidiomycotes; characterisation and examples.
13. Morphology and histology of vegetative plant organs. Examples of morphological and histological adaptation to different environmental conditions.
14. Generative and vegetative reproduction of plants. Morphology of the flowers and fruits of Angiosperms.
15. Classification of plants and plant-like organisms, the eight-kingdom system, Plantae. Grouping criteria and main taxonomic units among Chromista and Plantae.
16. Classification and taxonomy of Gynmosperms and Angiosperms: origin and phylogeny, reproduction and life cycle, ecology and economy of the main taxonomic units.
17. Tasks and methods of zootaxonomy and zoosystemathics, fundamentals of phenetic and cladistic taxonomy.
18. Taxonomical division of animal species. Grouping of phyla, charcterisation of Radiata and Bilateria. Examples of Radiata groups.
19. Division of Protostamata and Deuterostamata, characterization of important phyla.
20. Major problems of environmental and nature protection: water, air, soil, energy, waste, habitats and endangered species.
21. Niche. Fundamental and realized niche, niche–width and niche-overlap, interpretation and measurements.
22. Interactions between populations (intra and interspecific competition, predation, mutualistic connections.
23. Definition of populations and general population models (characteristics, rules, growth types, logistical eqution of Werhulst). Metapopulations and their types.
24. Strategies for obtaining nutrients (optimalisation models, types of predators, optimal choice of prey). R/K selection theory (components, cost of reproduction).
25. Importance of biodiversity, types, measaurements. Global distribution of species and endangering crisumstances.
26. Cohabitation in space and time. Types of interactions, consequences of space constrains. Cohabitation in homogenic, inhomogenic and heterogenic environments (with examples). Changes in communities in time: dynamics of patches, primary and secondary succession, secular succession.
27. Evolution. Scientific evidence supporting the theory of evolution. Natural and sexual selection. The ideal population, the Hardy-Weinberg equilibrium. Levels of variability. Driving forces of evolution. Adaptations. Speciation. Synthetic evolutionary theory. Neutralist versus selectionist theories.
28. Concepts, fundamental questions, reference systems and the four main principles of ecology: Central hypothesis-fact-problem. Limitation, indication, complementation and the multiplural environment.

29. Changes in population sizes (migration, dispersal) and population interactions (intra- and interspecific competition, herbivory, predation, coprophagy, parasitism, diseases, mutualism).
30. Area, natural flora migration, introduction, invasion. Hungarian and international examples.
31. Main areas of environmental protection: water management and water quality, air quality protection, waste management and soil protection.
32. Areal dynamics (dispersion: types, stages, physical and ecological barriers) and its evolution (expansion, regression, disjunction, extinction).
33. Importance of biodiversity. Types, measurements global distribution and endangering conditions. Importance of conservation biology: methods and evaluations.
34. Biologicalincasions. Dinamics and the roleof plantproperties in the success of invasion.