Plant anatomy and physiology

The rough estimation of the topics that may be discussed during the exam.

General topics:

1. Definition and evolutionary position of plants. Physiological characteristics of Embryophytes (land plants). The importance of plants for life on the Earth. The importance of plants for the human race. Crucial milestones in the history of plant science.
2. Photosynthesis. Autotrophy and heterotrophy. Plant and energy. Spectra of photosynthetically active radiation. Leaf as the main organ of photosynthesis. Photosynthetic apparatus. The photochemical phase of photosynthesis – acyclic and cyclic electron transfer, chemiosmotic theory, products of the primary phase of photosynthesis and their utilisation. The synthetic phase of photosynthesis – Calvin cycle, photorespiration, C3, C4, CAM plants. Gross and net photosynthesis. Photosynthesis regulation by external factors.
3. Respiration. Glycolysis, pentose cycle, Krebs cycle, respiratory chain. ATP production – substrate and oxidative phosphorylation. Energetic utilisation of lipids. Compartmentation of the respiratory events. Respiration resistant to cyanide – alternative oxidase.
4. Water management in plants. Mechanisms and water movement pathways in plants – water uptake and loss in plants, symplastic and apoplastic transport ways, important physical and chemical properties of water and water solutes. Water potential. Transpiration, the function of stomata and the regulation of transpiration. Root pressure, plant behaviour during water deficiency and ecophysiological adaptations to drought. The importance of plants for water and energy cycles in nature.
5. Plant mineral nutrition. Essential chemical elements – macroelements, microelements. Uptake and transport of mineral compounds in plants. Membrane transporters. The function of individual minerals. N – the sources, forms (including the N_2 fixation from the air), N metabolism in plant. Carnivorous plants. K, P, S, Ca, Mg, Fe, microelements – importance, function, sources.
6. Transport and distribution of assimilates and storage compounds. Synthesis, transport and metabolic utilisation of sucrose and starch. Source and sink. Phloem transport of assimilates.
7. Life cycle, ontogenesis and regulation of developmental processes by endogenous factors. Alternation of generations (metagenesis), organogenesis, functions of meristems. Juvenile and generative phases. Pollination and fertilisation. Embryogenesis and seed development. Genetic methods for studying ontogenesis (examples).
8. Classical phytohormones (auxin, cytokinins, ABA, ethylene, gibberellins) and other endogenous signalling compounds (brassinosteroids, jasmonates, peptides, etc.) – origin, functions, fate, signalling pathways.
9. Plant developmental and physiological responses to physical, chemical and biotic environmental factors. Light as a regulator, plant pigments and photoreceptors. Photomorphogenesis. Vernalisation. Regulation of flowering. Biorhythms and plant movements – tropisms, nastic movements.
10. Stress physiology. Abiotic and biotic stress. Defence reactions and adaptations. Interactions with other organisms – pathogens, herbivores, plant interactions with other organisms. Secondary metabolites.
11. Plant biotechnologies. Tissue and organ cultures, somatic embryogenesis and organogenesis in vitro. Genetically modified organisms and principles of their preparation, ulilization of transgenic plants in basic research and practical applications.

12. Tissues, intercellular communication, plasmodesmata. Symplast and apoplast. Meristems – structure, localisation, function. Simple permanent tissues – types, localisation, functions. Composed permanent tissues – vascular, dermal and basic tissues.
13. Secondary structure of plant organs – secondary growth/thickening in plants.
14. The root. Root evolutionary origin, functions, types of roots. Typical root structure. Root apical meristem organisation. Root system architecture and its dependence on external environmental factors. Lateral root initiation. Root modifications.
15. Stem and shoot. The modular structure of the shoot. Apical meristem – its structure, function, organogenesis, phyllotaxis. The anatomical structure of the stem – variability in diverse plant groups, vascular system structures. Stem modifications.
16. The Leaf. Typical anatomy of assimilation leaf, leaf epidermis, stomata, trichomes, cuticle. The differences in leaf structure of grasses, dicots, monocots, gymnosperms, C3 and C4 plants. Ecophysiological acclimations/adaptations, leaf modifications.
17. Plant reproduction – sexual and asexual. Specialised organs for vegetative reproduction. Sexual reproduction organs. Metagenesis. Male and female gametophyte in angiosperms. The flower of a typical angiosperm plant. Structure and the model for the organ identity determination within the flower. Pollination and fertilisation in plants, embryo, endosperm, seed development. Fruits. Seed germination.
18. The role of plants in biogeochemical cycles. Symbioses of plants with other organisms, root symbioses. Climate change and plants, factors of climate changes and their effects on plants, plants in a solution of global problems of human civilisation.