Plant molecular and cell biology

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

General topics:

1. Overview of structural components of the plant cell. Structural and functional characteristics of individual cell components. Comparison of plant cell structure with other eukaryotic lineages. Endosymbiotic theory. Basic methods of cell and molecular biology.
2. Compartmentation of the metabolism. Basic features, localization of metabolic processes and communication between compartments. The biological membrane model; membrane lipids and associated proteins. Membrane processes - membrane potential, channels, carriers, pumps. Peroxisomes - metabolic variability and protein import.
3. The endomembrane system. Characteristics and transformations of membrane compartments. Exocytosis and endocytosis, vesicle trafficking. Fates of proteins in the secretory pathway - addressing, posttranslational modifications. The vacuole - types, functions. Genetic analysis of the endomembrane system and secretory pathway in Arabidopsis.
4. The cell wall. Structure, components (cellulose, pectins, cell wall proteins ...), properties. Primary and secondary wall. The connection between the cytoplasm, plasmalemma and cell wall. Biogenesis and precursors of the main wall components. The cuticle. Cellulose biosynthesis. Cell growth - types, polarity, mechanisms. Relationship between the cell wall and cortical microtubule cytoskeleton.
5. The cytoskeleton. Components, evolutionary origin, general principles of assembling fibres from monomers. Actin, tubulin, molecular motors and other proteins associated with the cytoskeleton and regulating its dynamics. Cargo transport along the cytoskeleton. Organelle movements. Genetic analysis of the plant cytoskeleton in Arabidopsis.
6. The nucleus - structure, function. Plant genome, it's content and evolutionary dynamics. Transport processes between the nucleus and the cytoplasm. Regulation of gene expression on transcriptional and posttranslational level - mechanisms and examples. Regulation of gene expression by small non-coding RNAs. Epigenetic regulation of gene expression.
7. Mitochondria. Functional architecture and basic metabolic processes. Endosymbiotic theory. Organization and expression of the mitochondrial genome, RNA editing. Regulation of mitochondrial transcription and translation, communication between the nucleus and mitochondria. Import of nucleus-encoded proteins into mitochondria. Nucleocytoplasmic (in) compatibility.
8. Plastids. Endosymbiotic theory, primary plastids and higher-order plastids. Functional architecture of plastids, basic plastid metabolic processes. Polymorphism of plastids and their transformations. Organization and expression of the plastid genome, RNA editing. Regulation of transcription and translation, the dominance of translational regulation in plastids, redox state of plastids and regulation of translation. Communication between the nucleus and plastids. Import of proteins into plastids.
9. Cell cycle. Phases of the cell cycle (CC). General principles of CC regulation in eukaryotes. Regulation of plant CC by phytohormones and metabolites (esp. saccharides). Endoreduplication of nuclear DNA. Karyokinesis and cytokinesis. Cell death.
10. Signalling and communication within and among cells. Basic signalling mechanisms, typical examples of signalling pathways - receptors and complexes interacting with them, receptor kinases, two-component His-kinases, second messengers (calcium, etc.), MAP kinase cascades, GTPase signalling modules. Regulatory ubiquitination and proteolysis. Integration of signalling pathways at the level of signal transduction as such or transcription. Intercellular communication, plasmodesmata.