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| **Medical Biology and Genetics – Part I: BIOLOGY** | |
| **1** | Biomacromolecules; basic four types, their structures and functions, mutual interactions in a cell; transcription factors (including examples) |
| **2** | Proteins – basic structural organization; Domain structure of proteins; Basic functions of proteins; Protein families; Examples |
| **3** | Nucleic acids - basic structure and functions; differences and similarities between DNA and RNA; NA interactions with proteins |
| **4** | Biomembranes – basic structure, properties and functions |
| **5** | Transport across biomembranes; types, examples |
| **6** | Intestinal glucose absorption - basic transport mechanisms; Intestinal niche – cells, signals, and relevance |
| **7** | Cell. Comparison of eukaryotic and prokaryotic cells, with a special emphasis on structure of a typical eukaryotic and prokaryotic gene and its expression |
| **8** | Prokaryotic cell. Structure. Examples. Classification according to the cell shape and wall structure (staining). Examples of pathogens, diseases; Antibiotics |
| **9** | Eukaryotic cell. Comparison of animal and plant cells, membrane and non-membrane structures |
| **10** | Cytoskeletal system of eukaryotic cells; components, their structures and functions; comparison with prokaryotic cells |
| **11** | Microtubules (structure, functions, localization, dynamics), microtubule associated proteins; substances influencing their dynamics |
| **12** | Microfilaments (structure, functions, localization, dynamics), microfilament associated proteins; Intermediate filaments (structure, functions, localization, dynamics) |
| **13** | Extracellular matrix - composition, relevance, receptors for extracellular matrix; examples |
| **14** | Plastids and mitochondria, structure, function, origin. Two basic functions of mitochondria |
| **15** | Endoplasmic reticulum and Golgi complex – structure and function; Secretion pathway and vesicular transport; examples |
| **16** | Lysosomes, peroxisomes. Structure and function; Autophagy; Diseases |
| **17** | Intracellular transport and molecular motors; types, examples |
| **18** | Cell nucleus – structure and function; chromatin organization; why is it problematic to hold that cell nucleus contains chromosomes? |
| **19** | Gene expression – regulation in eukaryotes |
| **20** | DNA synthesis, repair and degradation |
| **21** | Make a schematic drawing of a typical human protein coding gene; explain functions of all its parts |
| **22** | Gene expression – regulation in prokaryotes |
| **23** | Telomeres, telomerase and immortalization |
| **24** | Transcription - basic outlines, relevance and regulation, differences between prokaryotic and eukaryotic transcription |
| **25** | RNA processing and degradation; Why it is not always true: one gene → one protein → one trait?; Nonsense-mediated decay – relevance for human diseases |
| **26** | Non-coding RNAs, their types, structure and functions; focus on regulatory RNAs |
| **27** | Ribosomes – structure, function, biogenesis, cellular locations; protein trafficking |
| **28** | Genetic code, synthesis of proteins - translation |
| **29** | Protein modifications, protein folding, molecular chaperones and cellular response to protein misfolding and endoplasmic reticulum stress |
| **30** | Intracellular degradative processes of proteins; two basic compartments of their degradation; examples |
| **31** | Signal transduction - basic types of signalling; molecules and molecular complexes involved in particular types; Cell responses to these signals; Examples |
| **32** | Signal transduction - kinases and phosphatases. Examples and relevance to human diseases |
| **33** | Make a schematic drawing of a typical signal transduction pathway |
| **34** | Signal transduction - second messengers and G-proteins. Examples and relevance to human diseases |
| **35** | Steroid hormones, their signal transduction and malfunction in human diseases |
| **36** | Negative feedback in signal transduction, and DNA damage response pathways - examples; Focus on the main cell cycle checkpoint, and describe these processes on the molecular level |
| **37** | Cell cycle and its regulation (focus on molecular level), main checkpoints |
| **38** | Cyclins and cyclin dependent kinases, CDK inhibitors |
| **39** | Mitosis - relevance, course of basic events, and possibilities of pharmacologic interventions |
| **40** | Cell death - basic types and their comparison on morphological and molecular level |
| **41** | Intrinsic and extrinsic pathway of apoptosis initiation; physiologic and pathologic apoptosis and its consequences |
| **42** | Caspases |
| **43** | Identification and clearance of apoptotic cells and apoptotic bodies and its malfunction in human diseases |
| **44** | Immune system, its role in the organism; basic terms; two basic types of immune responses; production of cells of the human immune system |
| **45** | Innate and adaptive immunity, highlight differences. Focus on innate immunity mechanisms - cellular and humoral components |
| **46** | Innate and adaptive immunity, highlight differences. Focus on adaptive immunity mechanisms - cellular and humoral components; TCR and BCR receptors |
| **47** | Viruses – life cycle and molecular biology; Examples of viruses and viral diseases |
| **48** | DNA and RNA viruses - structure, genome, life cycle; 2 life cycles of bacteriophages |
| **49** | Retroviruses; life cycle and molecular biology, examples |
| **50** | Cell and tissue cultures of human cells - basic types, relevance; Laboratory work with them; Stem cells |

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| **Medical Biology and Genetics – Part II: GENETICS** | |
| **1** | History of genetics; Model organisms in genetic analysis. Inbred mouse and rat strains, transgenic organisms. |
| **2** | Mendelian genetics; Mendel’s laws; Examples in human genetics |
| **3** | Allelic heterogeneity and allelic interactions; Examples and relevance in human disorders |
| **4** | Relevance and basic types of DNA polymorphisms; examples |
| **5** | Basic types of mutations distinguished by cell type having a mutation, relevance for human diseases; explain the difference between the terms "mutation" and "polymorphism" |
| **6** | Basic types of mutations distinguished by consequences on the expression and primary structure of the encoded protein, relevance for human diseases |
| **7** | Basic types of mutations distinguished by an impact on function of the encoded protein, relevance for human diseases; Haploinsufficiency |
| **8** | Basic types of mutations distinguished by location of a mutation within a gene, relevance for human diseases |
| **9** | Epigenetics - types, biological mechanisms and relevance of epigenetic changes to human biology and diseases, examples |
| **10** | Chromosome structure, classification and nomenclature; Basic methods of chromosome analysis, karyotyping; Karyotype designation |
| **11** | Genomic mutations, causes and consequences in human |
| **12** | Chromosomal mutations, types, sources, consequences, examples |
| **13** | Nondisjunction and its consequences |
| **14** | Germinal and somatic karyotypic changes, examples and biological explanation of resulting human syndromes |
| **15** | Gene linkage and its use for gene mapping. |
| **16** | Gene interactions, types, examples |
| **17** | Meiosis - course and relevance. Describe meiosis using the variables C and n |
| **18** | Genetic determination of sex, basic molecular processes and their potential disturbances |
| **19** | Gene dosage compensation – relevance and basic molecular mechanisms |
| **20** | Gametogenesis, comparison of spermatogenesis and oogenesis. Fertilization, basic molecular processes; What are the main differences in the contribution of egg and sperm to the zygote? Why parthenogenesis is not possible in mammals? |
| **21** | Monogenic diseases - criteria for distinguishing basic types of inheritance in pedigrees |
| **22** | Sex-related inheritance; types, pedigrees, examples |
| **23** | Dominant diseases - examples of pedigrees and types of mutations that may underlie them |
| **24** | Recessive diseases - examples of pedigrees and types of mutations that may underlie them; Inbreeding and its genetic consequences. Can we use inbreeding in experimental animal models? |
| **25** | Cystic fibrosis – genetics and molecular biology |
| **26** | Penetrance and expressivity - examples and possible underlying mechanisms |
| **27** | Basic principles of pedigree drawing and its significance in medicine, distinguishing features of basic inheritance patterns. Locus heterogeneity - how could it be identified in human genetic diseases? Cite examples. |
| **28** | Risk assessment and genetic prognosis. In what circumstances would genetic prognosis be preferred over DNA diagnostics? |
| **29** | Population genetics; Hardy-Weinberg law and processes changing allelic frequencies |
| **30** | Complex diseases and heritability, examples; Phenocopy and genotype-environment interactions - examples; Twin studies and their importance in medical genetics |
| **31** | Genetic predisposition to cancer; Benign and malignant tumours and their characteristics; acquired capabilities of malignant tumours (=Hallmarks of Cancer) |
| **32** | Tumour suppressor genes and molecular alterations found in them in tumours; examples; Loss of heterozygosity - its causes and consequences |
| **33** | Oncogenes, proto-oncogenes and types of mutations found in them in tumours; examples; Philadelphia chromosome |
| **34** | Modifier genes - examples in human genetics or animal models |
| **35** | Immunogenetics and MHC antigens (basic two classes and their comparison - structure, function…) and their interactions; Their genes and haplotypes; Consequences of allogeneic transplantations |
| **36** | T- and B-lymphocyte interaction during the antibody synthesis and its malfunction during the genetic diseases of immunity; Antigen presentation (MHC restriction) |
| **37** | Antibodies - basic structure, their production and function, and principles of generation of antibody diversity; monoclonal and polyclonal antibodies and their use in medicine |
| **38** | Blood group systems, their genetic determination, comparison, examples and their clinical relevance; Basic immunologic differences between blood group systems AB0 and Rh; Bombay phenotype |
| **39** | Autoimmune diseases and immunodeficiencies – examples, genetics and molecular biology |
| **40** | Structure of haemoglobin, globin genes, their organization and regulation, regulation of haemoglobin synthesis during development, role of chaperone AHSP, basic classification of hemoglobinopathies |
| **41** | Diseases due to structural haemoglobin changes – examples, genetics and molecular biology |
| **42** | Thalassaemias – classification, genetics, types of mutations, and molecular biology |
| **43** | Pharmacogenetics; Xenobiotic metabolism and its phases; Enzymes; Personalized medicine; Examples |
| **44** | Pharmacogenetics; Warfarin metabolism; Enzymes; drug interactions |
| **45** | Unstable repeat disorders – examples, genetics and molecular biology; Genetic anticipation |
| **46** | Polycystic kidney disease – genetics and molecular biology |
| **47** | PCR method; definition, types, particular steps; results; use in human genetics / medicine |
| **48** | Repetitive sequences, microsatellites and their exploitation in human genetic mapping studies and DNA diagnostics |
| **49** | DNA diagnostics. Basic types and their advantages and disadvantages, sources of errors |
| **50** | Genome, with focus on human genome - its size and structure |