|  |
| --- |
| **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)** |
| **1** | Biomacromolecules; Basic four types, their structures and functions; Focus mainly on lipids (including steroids) and saccharides; mutual interactions of these four types of molecules in a cell (for example: lipids-proteins in membranes; nucleic acids-proteins in chromatin or lipid-proteins in transcription factors (including examples); Transcription factors, types, functions, interactions nucleic acid-protein, examples... |
| **1** | Lecture: 2. Biomacromolecules; (Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 3 Biological Membranes; Lecture: 3. Biomembranes and transport across membranes) |
| **2** | **Proteins, basic structural organization; Domain structure of proteins; Basic functions of proteins; Protein families; Examples** |
| **2** | Proteins, basic structural organization (use some protein (e.g. Haemoglobin) as an example); Domain structure of proteins (choose some example to explain); Basic functions of proteins (examples); Protein families, examples (Aminoacyl-tRNA synthetases or translation initiation factors (eIF) involved in proteosynthesis, globin family - protein component of haemoglobin...) |
| **2** | Lecture: 2. Biomacromolecules; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 9 Translation; Lecture: 6. Gene expression and its regulation - protein synthesis |
| **3** | **Nucleic acids, basic structure and functions; Differences and similarities between DNA and RNA; NA interactions with proteins** |
| **3** | Nucleic acids - basic structure and functions (DNA, RNA: mRNA, rRNA, tRNA, non-coding regulatory RNAs (miRNA), ribonucleoproteins - examples); Differences and similarities between DNA and RNA; NA interactions with proteins (transcription factors,...), examples; (Possible topics to involve: ribosomes, SRP, telomerase (as ribonucleoproteins ) |
| **3** | Lecture: 2. Biomacromolecules; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 6-8 The Eukaryotic Genome, DNA Replication, Transcription ; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 4. Cell nucleus, human genome, DNA replication |
| **4** | **Biomembranes, basic structure, properties and functions** |
| **4** | Structure, components (description, structure - lipids and proteins: their function, interactions, examples...); Bilayer arrangement, asymmetry, mosaic model; Can be added: membranes in pro- and eukaryotic cells; vesicular transport |
| **4** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 3 Biological Membranes; Lecture: 3. Biomembranes and transport across membranes |
| **5** | **Transport across biomembranes, types, examples** |

|  |  |
| --- | --- |
| **5** | Selective permeability of membranes, passive transport (types, examples), diffusion, facilitated diffusion (types, examples), transport of water (channels, osmosis); Active transport - types and examples (! Transport of glucose is an extra question 6); Vesicular transport |
| **5** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 13+14 Basic Concepts of Transport + Active Transport; Materials - practicles: Transport across membranes; Lecture: 3. Biomembranes and transport across membranes |
| **6** | **Glucose transport in celis** |
| **6** | Passive glucose transport (glucose transporters - GLUTs), examples, role of insulin; Active transport of glucose, examples: intestinal glucose absorption and its principle, (sodium-glucose transport proteins - SGTPs) and release of this glucose to blood |
| **6** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 15 Glucose transport |
| **7** | **Cell; Comparison of eukaryotic and prokaryotic celis, with a speciál emphasis on** |
| **structure of a typical eukaryotic and prokaryotic gene and its expression** |
| **7** | Structures of both types of cells (PRO and EU), and their organelles and intracellular structures including general comparison; Description (on DNA / molecular level) of typical EU and PRO transcription units, and their regulations (mechanisms that regulate gene expression). This involves operon (including examples), and a typical eukaryotic protein-coding gene structure; their comparison |
| **7** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 4+5 Cytoskeleton+Organelles; Materials - practicles: pro- and eukaryotic cells; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; Lecture: 1. Basic functional organization of cells |
| **8** | **Prokaryotic cell, structure, examples; Classification according to the cell shape and cell wall structure (staining); Examples of pathogens, diseases; Antibiotics** |
| **8** | All structures that can be found in a typical prokaryotic cell (scheme); Bacterial cell wall (gram positive/negative), its staining; Classification of bacteria, examples of prokaryotes incl. some pathogens and diseases; Antibiotics - cell structures they influence, final effect; sensitivity to ATB (principle, test); Cyanobacteria - structure of cells...including if or how they can influence human health |
| **8** | Materials - practicles: prokaryotic cells; <https://micro.magnet.fsu.edu/cells/bacteriacell.html> |
| **9** | **Eukaryotic cell; Comparison of animal and plant cells; Membrane and non-membrane structures** |
| **9** | All structures that can be found in a typical eukaryotic cell (scheme); Organelles and their structure, functions, localization/number in cell, and differences between animal and plant cells; Non-membrane structures: nucleolus + ribosomes, cytoskeleton components, and plant cell wall (also structure and functions; associated proteins); highlight differences |

|  |  |
| --- | --- |
| **9** | Materials - practicles: eukaryotic cells; Lecture: 1. Basic functional organization of cells; <https://micro.magnet.fsu.edu/cells/plantcell.html>; <https://micro.magnet.fsu.edu/cells/animalcell.html> |
| **10** | **Cytoskeletal system of eukaryotic cells, components, their structures and functions;** |
| **Focus in detail on intermediate filaments; Comparison of cytoskeleton (eukaryotic/human) with prokaryotic cells** |
| **10** | Cytoskeletal system of eukaryotic cells, its components; Structure (proteins), organization, functions, dynamics, associated proteins, presence in plant/human cells; Their interaction with membrane/ECM; Comparison with cytoskeleton of prokaryotes (main proteins and their functions) |
| **10** | Materials - practicles: eukaryotic cells; Lecture: 9. Cytoskeleton, ECM and cell motility; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 4 Cytoskeleton |
| **11** | **Microtubules (structure, functions, localization, dynamics), microtubule associated proteins; Substances influencing their dynamics** |
| **11** | Microtubules (MT) (structure, proteins forming microtubules, functions, localization, dynamics), microtubule associated proteins; Substances influencing MT dynamics; Mitotic spindle; Flagella, cilia, centrosome, basal bodies |
| **11** | Materials - practicles: eukaryotic cells; Lecture: 9. Cytoskeleton, ECM and cell motility; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 4 Cytoskeleton |
| **12** | **Microfilaments (structure, functions, localization, dynamics), microfilament associated proteins; Intermediate filaments (structure, functions, localization, dynamics)** |
| **12** | Microfilaments (MF) (structure, proteins forming MF, functions, localization, dynamics), associated proteins; Microvilli, filopodia, cytokinesis, cell motility |
| **12** | Materials - practicles: eukaryotic cells; Lecture: 9. Cytoskeleton, ECM and cell motility; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 4 Cytoskeleton |
| **13** | **Extracellular matrix, composition, relevance, receptors for extracellular matrix; Examples; Cell adhesion, cell junctions** |
| **13** | Extracellular matrix, its components (proteoglycans, fibrous proteins, adhesive proteins...); their synthesis and incorporation into ECM; Tissues rich in ECM; Relevance, receptors for extracellular matrix; Examples (collagen: synthesis, structure..., elastin...; diseases - for example: Osteogenesis imperfecta AD, Marfan syndrome - fibrillin-1 AD); Fibronectin, laminin; Cell adhesion, cell junctions, cell adhesion molecules (cadherins, integrins ) |
| **13** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 2: Extracellular Matrix and Cell Adhesion; Lecture: 9. Cytoskeleton, ECM and cell motility; Materials - practicles: eukaryotic cells |
| **14** | **Plastids and mitochondria, structure, function, origin; Two basic functions of mitochondria** |

|  |  |
| --- | --- |
| **14** | Plastids, proplastids, types (leuco-, chromo-, chloroplasts), structure, genome, origin, main functions, cells they are present in; Mitochondria, structure, genome, origin, main functions, cells they are present in; Mitochondrial functions (in metabolism and ATP production - respiration, oxidative phosphorylation, and other metabolic functions; in cell survival/death: apoptosis - see this question); Mitochondrial inheritance (you can add info about mitochondrial genome, inheritance, and related diseases) |
| **14** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 5 Organelles; Materials - practicles: eukaryotic cells; Lecture: 1. Basic functional organization of cells; Ian D. Young: Medical Genetics, Oxford University Press, 2010 p. 216 |
| **15** | **Endoplasmic reticulum and Golgi complex, structure and functions; Secretion** |
| **pathway and vesicular transport; Examples** |
| **15** | Endoplasmic reticulum - structure and functions (of rough + smooth; Synthesis of proteins for export - SRP, protein modifications, folding); Golgi complex, structure and functions (types of modifications, sorting, packaging; proteins for lysosomes); Secretion pathway and vesicular transport (into and out of the cell); Examples |
| **15** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 5+11 Organelles+Protein trafficking; Materials - practicles: eukaryotic cells; Lecture: 1. Basic functional organization of cells |
| **16** | **Lysosomes, peroxisomes, their structure and function; Autophagy; Diseases** |
| **16** | In which cells they are present, number, localization, structure and functions; Autophagy - description, types; Diseases caused by dysfunction of these organelles (for example: Zellweger syndrome (organelle, gene, proteins coded and their function, consequence, type of inheritance, briefly symptoms and prognosis); Lysosomal storage diseases (generally; what is affected (protein and its function), and one example of a particular disease (for example: Tay-Sachs disease/Gaucher syndrome/Fabry disease, gene, protein coded, and its function, consequence, type of inheritance, briefly symptoms and prognosis) |
| **16** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 5+11 Organelles+Protein trafficking; Materials - practicles: eukaryotic cells; Lecture: 1. Basic functional organization of cells; Ian D. Young: Medical Genetics, Oxford University Press, 2010 p. 214-17 |
| **17** | **Intracellular transport and molecular motors; Types, examples** |
| **17** | Vesicle transport, including secretion pathway; Endocytosis, exocytosis, types, examples; Molecular motors, their general scheme, their association with cytoskeleton components, important cellular processes they are involved in; Molecular motors in cilia and flagella (axoneme structure and function),  |
| **17** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 4+5+11 Cytoskeleton, Organelles + Protein trafficking; Materials - practicles: eukaryotic cells; Lecture: 1. Basic functional organization of cells; Lecture: 9. Cytoskeleton, ECM and cell motility |

|  |  |
| --- | --- |
| **18** | **Cell nucleus, structure and function; Chromatin organization; Why is it problematic to hold that cell nucleus contains chromosomes?** |
| **18** | Cell nucleus, in which cells can be found, particular parts, their structure (made of ...) and their functions (nucleolus, lamina, pores...); Chromatin organization (DNA, associated proteins, epigenetic modifications, levels of condensation...); Eu- x heterochromatin; Chromatin/nucleus during the cell cycle; When chromosomes appear; Structure of coiled chromosomes... |
| **18** | 4. Cell nucleus, human genome, DNA replication; Lecture: 1. Basic functional organization of cells; Lecture: 2. Biomacromolecules; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 6-8 The Eukaryotic Genome, DNA Replication, Transcription |
| **19** | **Gene expression, regulation in eukaryotes** |
| **19** | Generally process of gene expression; Eukaryotic and human genome structure, typical eukaryotic chromosomes, and transcription units, description of these units on the DNA / RNA levels, and its regulation including examples; Cellular localization of all steps of the expression, levels of its regulation (including translation levels); Possible brief comparison with prokaryotic cell highlighting differences (including epigenetic regulation) |
| **19** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 6-8 The Eukaryotic Genome, DNA Replication, Transcription ; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 4. Cell nucleus, human genome, DNA replication; Lecture: 2. Biomacromolecules |
| **20** | **DNA synthesis, repair and degradation** |
| **20** | Replication within the cell cycle, all steps of DNA replication including enzymes; Leading and lagging strand replication; Replication of telomeres; Hayflick limit; DNA control and repair (types of DNA repair systems), DNA degradation (enzymes involved in ...) |
| **20** | Lecture 4. Cell nucleus, human genome, DNA replication; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 6-7 The Eukaryotic Genome, DNA Replication |
| **21** | **Make a schematic drawing of a typical human protein coding gene; Explain functions of all its parts** |
| **21** | Typical human protein-coding gene, its structural/functional parts on level of DNA, function of these parts during gene expression (transcription and translation), molecules they interact with; Use an example of a protein-coding gene (globin coding genes - haemoglobinopathies - genetics, or any other we spoke about during biology/genetics) |
| **21** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 8 Transcription ; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 4. Cell nucleus, human genome, DNA replication |
| **22** | **Gene expression, regulation in prokaryotes** |

|  |  |
| --- | --- |
| **22** | Generally process of gene expression, prokaryotic genome structure, typical prokaryotic transcription unit, description of this unit on the DNA / RNA level and its regulation including examples; Cellular localization of all steps of the expression, levels of its regulation; Possible brief comparison with eukaryotic cell highlighting differences |
| **22** | Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 4. Cell nucleus, human genome, DNA replication |
| **23** | **Telomeres, telomerase and immortalization** |
| **23** | Chromosomes, replication (steps on leading and legging strands), end replication problem; Telomeres, their structure and function; Replication of telomeres; Telomerase -structure, components and function; Hayflick limit, aging, cell senescence / cell death |
| **23** | Lecture 4. Cell nucleus, human genome, DNA replication; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 6-7 The Eukaryotic Genome, DNA Replication |
| **24** | **Transcription, basic outlines, relevance and regulation; Differences between prokaryotic and eukaryotic transcription** |
| **24** | Transcription of eukaryotic (human) genes, its parts (generally parts of a human gene), and their function/interaction during transcription; Transcription factors and polymerases; Regulation of transcription on DNA/RNA levels; Comparison of pro- and eukaryotic transcription unit transcription (structure of a transcription unit; enzymes, regulation, localization in the cell ) |
| **24** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 8 Transcription; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 4. Cell nucleus, human genome, DNA replication |
| **25** | **RNA processing and degradation; Why is it not always true: one gene one protein** |
| **one trait? Nonsense-mediated decay and its relevance for human diseases** |
| **25** | Processing of mRNA, rRNA and tRNA (splicing; trimming, editing, base modifications); Alternative splicing including an example; One gene - more proteins; RNA degradation (in nucleus/cytosol), enzymes degrading NAs; Nonsense-mediated decay = NMD, its process, which RNA is degraded by NMD; how mRNA is identified, its degradation (process on molecular level, enzymes); consequence of dysfunction of NMD (positive / negative, what can be influenced in disease pathology by NMD) |
| **25** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 8 Transcription; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; |
| **26** | **Non-coding RNAs, their types, structure and functions; Focus on regulatory RNAs** |

|  |  |
| --- | --- |
| **26** | Non-coding RNA (= non-coding proteins) = ncRNA (all but mRNA); rRNA and tRNA (their synthesis, processing, roles in the cell); Ribonucleoproteins (SRP, snRNAs, snoRNAs, telomerase...); regulátory RNAs (small (e.g. miRNA, siRNA, ...) and long ncRNAs (e.g. circular ncRNAs, linear ncRNAs, antisense RNA...), generally roles of ncRNAs in the cell, describe one example - miRNA (biogenesis and general function) |
| **26** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 8 Transcription;Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 6. Gene expression and its regulation - protein synthesis |
| **27** | **Ribosomes, structure, function, biogenesis, cellular locations; Protein trafficking** |
| **27** | Ribosomes, structure, biogenesis including genes for rRNA, nucleolus, rRNA synthesis and processing, localization; Comparison eukaryotic x prokaryotic x mitochondrial; Function (proteosynthesis, sites E, P, and A); Eukaryotes: proteins synthetized on ribosomes according to their destination in the cell = protein trafficking; Examples of such proteins |
| **27** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 8+9 Transcription+Translation; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 6. Gene expression and its regulation - protein synthesis; Materials - practicles: eu- and prokaryotic cells |
| **28** | **Genetic code, synthesis of proteins - translation** |
| **28** | Genetic code, its general features; RNAs involved in proteosynthesis; Amino acids. Codons and anticodons; tRNA charging; Translation in steps: initiation (initiation complex), elongation, termination including proteins involved (eIF, RF.), regulatory RNAs (for example: miRNA); mRNA degradation |
| **28** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 8+9 Transcription+Translation; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 6. Gene expression and its regulation - protein synthesis; Materials - practicles: eu- and prokaryotic cells |
| **29** | **Protein modifications, protein folding; Molecular chaperones and cellular response to** |
| **protein misfolding** |
| **29** | Proteins - where are synthetized, where modified and where folded; Structure of proteins; Protein modifications (types and examples of modifications, example of protein modified); protein folding and molecular chaperones, their structure / molecular mechanism of actions (role), and cellular response to protein misfolding (what happens with misfolded proteins) |
| **29** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 9: Translation;Lecture: 6. Gene expression and its regulation - protein synthesis; Materials - practicles: eukaryotic cells (lysosomes) |
| **30** | **Intracellular degradative processes of proteins; Two basic compartments of their** |
| **degradation; Examples** |

|  |  |
| --- | --- |
| **30** | Proteins: briefly the structure and localization of the synthesis and processing. Which proteins are degraded; chaperones. Compartments of degradation: 1. Lysosomes (structure, function, autophagy: macro-, micro- and chaperone mediated autophagy); 2. Proteasomes - structure, function, localization; ubiquitin; examples of proteins degraded and/or protein accumulation in the cell (some disease, for example thalassemia, Huntington disease... ) |
| **30** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 12 Protein degradation; Lecture: 6. Gene expression and its regulation - protein synthesis; Materials - practicles: eukaryotic cells |
| **31** | **Signal transduction, basic types of signalling; Molecules and molecular complexes involved in particular types; Cell responses to these signals; Examples** |
|  | Intercellular communication/signalling, basic types (based on type of signal, or on distance - endocrine, juxtracrine, paracrine, autocrine, synaptic, cell junctions), their characterization on molecular level (peptides, steroids, amino aid derivatives, small inorganic molecules, ions...); Molecules and molecular complexes involved in these particular types; Cell responses to these signals; Examples |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 17-19 G protein signalling + Catalytic receptor signalling + Steroid receptor signalling; Lecture: 7. Cell signalling - protein kinases, single pass transmembrane receptors and steroid receptors + Lecture: 8 Cell signalling - G-protein signalling and second messengers |
| **32** | **Signal transduction - kinases and phosphatases; Examples and relevance to human** |
| **diseases** |
|  | Signal transduction involving kinases and phosphatases (what molecules they are, and their role in the cell generally (e.g. MAPK, cell cycle regulation), and in cell signalling particularly); Receptor signalling (Receptors with intrinsic tyrosin-kinase activity, receptor structure, mechanism of signalling, ...); Examples (growth factors, insulin...), and relevance to human diseases (mutations in BRAF - cancer); Receptors without intrinsic tyrosine kinase activity - cytokine receptors (receptor, kinases, JAK - STAT pathway) |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 17-19 G protein signalling + Catalytic receptor signalling + Steroid receptor signalling; Lecture: 7. Cell signalling - protein kinases, single pass transmembrane receptors and steroid receptors + Lecture: 8 Cell signalling - G-protein signalling and second messengers |
| **33** | **Make a schematic drawing of a typical signal transduction pathway, explain** |
|  | Schematic drawing of a typical signal transduction pathway (mechanism of action of hydrophilic and lipophilic signalling molecules); Explanation - from the signal to the final effect; Examples (e.g. growth factors, insulin, testosterone....) |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 17-19 G protein signalling + Catalytic receptor signalling + Steroid receptor signalling; Lecture: 7. Cell signalling - protein kinases, single pass transmembrane receptors and steroid receptors + Lecture: 8 Cell signalling - G-protein signalling and second messengers |
| **34** | **Signal transduction involving second messengers and G-proteins; Examples and** |
| **relevance to human diseases** |

|  |  |
| --- | --- |
|  | Signal transduction involving second messengers and G-proteins. What are G-proteins (Heterodimeric G-proteins and RAS superfamily G proteins; Which enzymes are regulated by G-proteins, what are second messengers, and their role in signalling (e.g. cAMP, calcium ...); Kinases; Biological response to these signals; G-protein-coupled receptors activated by peptide hormones; Signal transmission inside the cell through second messengers; Activation of protein kinase A (PKA) by the second messenger - cAMP molecule; Inhibitors/activators of G-proteins; Examples (e.g. ADH, insulin ...), and relevance to human diseases (e.g. choleratoxin) |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 17-19 G protein signalling + Catalytic receptor signalling + Steroid receptor signalling; Lecture: 7. Cell signalling - protein kinases, single pass transmembrane receptors and steroid receptors + Lecture: 8 Cell signalling - G-protein signalling and second messengers |
| **35** | **Steroid hormones, their signal transduction and malfunction in human diseases** |
|  | Signalling involving lipophilic signalling molecules: Steroid hormones (steroid hormones, where they are produced and what they do generally/target tissues), their signal transduction on a molecular level - cell entry, binding to their receptors (localization of inactive/active receptors in the cell), and steps to the final effect; Focus on nuclear steroid signalling; Examples of malfunction in human diseases/syndromes (testicular feminization - androgen receptor) |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 17-19 G protein signalling + Catalytic receptor signalling + Steroid receptor signalling; Lecture: 7. Cell signalling - protein kinases, single pass transmembrane receptors and steroid receptors + Lecture: 8 Cell signalling - G-protein signalling and second messengers |
| **36** | **Genome, with focus on human genome, its size and structure** |
|  | What is a genome; Genome size and number of genes generally; Human genome - size, number of nucleotides, genes (protein-coding, ncRNA coding), chromosomes; Coding and non-coding regions, types, comparison; Example of human protein-coding gene (structure/function) (e.g. globin coding genes can be used or any other...) |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 6-7 The Eukaryotic Genome, DNA Replication ; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations; 4. Cell nucleus, human genome, DNA replication |
| **37** | **Cell cycle and its regulation (focus on molecular level); Main checkpoints** |

|  |  |
| --- | --- |
| **37** | Cell cycle, its phases (with description of main events), cell cycle regulation on molecular levels (events that stop the cell cycle; Molecular signals; Interaction (activation/deactivation) of these molecules); Which molecules are main drivers of the cell cycle; Their levels and interactions; Main checkpoints (when during the cell cycle and which molecules/processes are involved in) consequence of DNA damage; Which human cells continuously/frequently divide; Processes in the nucleus (chromatin) and in the cytoplasm (centrosome and mitotic spindle); (Explanation should include words: transcription factors, tumour suppressor genes, MPF mitosis promoting factor complex, APC anaphase promoting complex; securin, separase) |
| **37** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 20 The cell cycle; Lecture: 10. Cell cycle and its regulation; 7. Cell signalling - protein kinases; Materials - practicles: cell cycle, mitosis |
| **38** | **Cyclins and cyclin dependent kinases; Cellular CDK inhibitors** |
| **38** | Characterization of cyclins and cyclin dependent kinases (CDKs), their role in the cell, interaction, activation, inhibition, expression, degradation; Cell cycle regulation on molecular levels (events that stop the cell cycle; Molecular signals; Interaction (activation/deactivation) of these molecules); Which molecules are main drivers / inhibitors of the cell cycle; Main checkpoints; Describe the processes on the molecular level (include cyclins, kinases, phosphatases, and kinase inhibitors); (Cell cycle explanation should include words: transcription factors, tumour suppressor genes, MPF = mitosis promoting factor complex, APC = anaphase promoting complex; securin, separase) |
| **38** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 20 The cell cycle; Lecture: 10. Cell cycle and its regulation; 7. Cell signalling - protein kinases; Materials - practicles: cell cycle, mitosis |
| **39** | **Mitosis, relevance, course of basic events; Possibilities of pharmacologic interventions targeting mitotic spindle** |
| **39** | Mitosis as a part of the cell cycle, relevance, course of basic events during mitosis in nucleus/cytosol (explanation should include words: MPF mitosis promoting factor complex, APC anaphase promoting complex; securin, separase); possibilities of pharmacologic interventions - which diseases, what can be influenced and in which way - examples of mitotic poisons and medicines used (mechanism of action of microtubule- targeting agents as colchicine, vinca alkaloids, taxanes, ...) |
| **39** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 20 The cell cycle; Lecture: 10. Cell cycle and its regulation; 7. Cell signalling - protein kinases; Materials - practicles: cell cycle, mitosis; Ian D. Young: Medical Genetics, Oxford University Press, 2010 Chapter 2: Chromosomes and cell division |
| **40** | **Cell death, basic types and their comparison on morphological and molecular level** |

|  |  |
| --- | --- |
| **40** | Cell death - generally, types of cell death (necrosis, programmed death - apoptosis, autophagy); Describe basic characteristic (on morphological and molecular level) of necrosis and apoptosis highlighting the major differences and consequences; Relevance of programmed cell death; Removal of apoptotic cells; Examples can be used |
| **40** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 23 Cell death; Lecture: 11. Cell death |
| **41** | **Intrinsic and extrinsic pathway of apoptosis initiation; Physiologic and pathologic** |
| **apoptosis and its consequences** |
|  | Apoptosis (general description, relevance); Apoptotic signals; Intrinsic pathway, what triggers this pathway, mechanism on the molecular level (including p53 and Bax proteins, cytochrome c, apoptosome, caspases, Apaf-1); Extrinsic pathway, what triggers this pathway, mechanism on the molecular level (including death receptors, caspases); Bcl-2 protein family; |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 23 Cell death; Lecture: 11. Cell death |
| **42** | **Caspases** |
|  | Caspases - molecule description, characteristic, function, activation, classification; Initiator caspases (8, 9) and effector caspases (3, 6, 7); They roles in intrinsic and extrinsic pathway of apoptosis - cascade of their activations; Targets of caspases (substrates); Result of their activity; |
|  | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 23 Cell death; Lecture: 11. Cell death |
| **43** | **Identification and clearance of apoptotic cells and apoptotic bodies, and its** |
| **malfunction in human diseases** |
| **43** | Apoptosis (general description, relevance); Pro- and antiapoptotic signals; What is an apoptotic body, mechanism on the molecular level how it is formed, the fate of the apoptotic body in the organism; Eat-me signal; Apoptosis malfunction in human diseases (excessive up- or down-regulation of apoptosis and its health consequences - tumours, neurodegenerative diseases, ...) |
| **43** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 23 Cell death; Lecture: 11. Cell death |
| **44** | **Immune system, its role in the organism; Basic terms; Two basic types of immune responses; Production of cells of the human immune system** |
| **44** | Immune system (its role, organs and systems involved in immunity; Immune cells, types, their roles, MHC antigens), basic terms (antigen, epitope, antibody, autoantigen/exoantigen, allergy, autoimmune reaction); Two basic types of immune responses (cellular and humoral); Production of cells of the human immune system (stem cell differentiation into a different types of leukocytes...) |
| **44** | Lecture 13: Immune system; Color atlas of genetics - chapter "Immune system" - available on-line via library |
| **45** | **Innate and adaptive immunity, highlight differences; Focus on innate immunity mechanisms, cellular and humoral components** |

|  |  |
| --- | --- |
| **45** | Innate (innate immune system = nonspecific immune system = non-adaptive immune system) and adaptive immunity, highlight differences. Focus on innate immunity mechanisms: cellular and humoral components (antigens and cells involved; macrophages: phagocytosis, receptors...), antigen presentation (MHC), activation of cells in adaptive immune part); Complement, cytokines (interferons, interleukins...), interferons and their functions |
| **45** | Lecture 13: Immune system; Color atlas of genetics - chapter "Immune system" - available on-line via library |
| **46** | **Innate and adaptive immunity, highlight differences; Focus on adaptive immunity mechanisms - cellular and humoral components; TCR and BCR receptors** |
| **46** | Innate (innate immune system = nonspecific immune system = non-adaptive immune system) and adaptive immunity, highlight differences. Focus on adaptive immunity mechanisms - cellular and humoral components (T cells and B-cell, antigen presentation, their activation, antibodies); TCR (T cell receptor) and BCR (B cell receptor), presence and structure of these receptors, what they recognize; antibodies: types, production, structure of antibody (immunoglobulin - chains and domains); Molecular biology of immunoglobulin synthesis |
| **46** | Lecture 13: Immune system; Color atlas of genetics - chapter "Immune system" - available on-line via library |
| **47** | **Viruses, life cycle and molecular biology; Examples of viruses and viral diseases** |
| **47** | Viruses, discovery, description, types, structure (NA, capsid, nucleocapsid) naked and enveloped; Viral genome (type of nucleic acid,..), size; Viral proteins (functional + structural); Life cycle of viruses; |
| **47** | Lecture: 12. Molecular biology of viruses; <https://micro.magnet.fsu.edu/cells/virus.html> |
| **48** | **DNA and RNA viruses, their structure, genome, life cycle; Two types of life cycle of bacteriophages** |
| **48** | Baltimore classification of viruses (according their NAs), examples of particular classes; DNA and RNA viruses - structure, genome, life cycle; Diseases caused by DNA/RNA viruses; Bacteriophages, which cell they infect; ; Two types of life cycle of bacteriophages (lytic and lysogenic - describe it and its consequences for the cell) |
| **48** | Lecture: 12. Molecular biology of viruses; <https://micro.magnet.fsu.edu/cells/virus.html> |
| **49** | **Retroviruses; Life cycle and molecular biology; Examples** |
| **49** | Retroviruses - genome, structure, examples; Unique life cycle - step by step on molecular level (reverse transcription), and comparison with lifecycle of the other classes of viruses; Provirus |
| **49** | Lecture: 12. Molecular biology of viruses; <https://micro.magnet.fsu.edu/cells/virus.html>; [https://www.niaid.nih.gov/diseases- conditions/hiv-replication-cycle](https://www.niaid.nih.gov/diseases-conditions/hiv-replication-cycle) |

|  |  |
| --- | --- |
| **50** | **Cell and tissue cultures of human cells, basic types, relevance; Laboratory work with them; Stem cells** |
| **50** | Types of cell cultures, cell lines, growth curve of cell lines; Basic manipulation with the cells (passaging), cell culture lab equipment; Stem cells and cancer cells |
| **50** | Materials on Moodle; Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 1 Stem Cells and Their Differentiation |

**BLACK - the exam question**

**BLUE** - **main** facts/topic that should be involved in the answer to this question; You can add any other relevant correct information related to the question

**GREEN** - **main** recommended sources, but any other relevant can be used