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| **Medical Biology and Genetics - Part II: GENETICS** |
| **1** | **History of genetics; Model organisms in genetic analysis.** |
| **1** | Start from Gregor Johann Mendel - Hugo de Vries - William Bateson - Reginald Crundall Punnett - Thomas Hunt Morgan - Oswald Avery - James D. Watson and Francis Crick - leading to " central dogma of molecular biology", Victor Almon McKusick. For these famous people - what they found, model organisms they used and important facts they found/discovered. Model organisms used in genetic analysis; Inbreeding: what it is and its consequence. |
| **1** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gen (Mendelian) inheritance; Lecture 2 + 3: Mendelian genetics + The chromosomal basis of inheritance and gene linkage |
| **2** | **Mendelian genetics; Mendel's laws; Examples in human genetics** |
| **2** | Mendelian genetics: J.G. Mendel and his experiments: model organism, description of his experiments and conclusions. Mendel principle ("laws"), examples of monogenic ("Mendelian") diseased in human (e.g. AD: familial hypercholesterolaemia, Huntington disease, Marfan syndrome, neurofibromatosis...; AR: Cystic fibrosis, galactosaemia, phenylketonuria, sickle cell anaemia, Tay-Sachs disease, thalassemias, ...); In the chosen "example" disease: gene, type of mutation, protein coded-affected (= mechanism on molecular level), onset and spectra of symptoms... |
| **2** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gen (Mendelian) inheritance; Lecture 2 + 3: Mendelian genetics + The chromosomal basis of inheritance and gene linkage |
| **3** | **Allelic heterogeneity and allelic interactions; Examples and relevance in human disorders** |
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| **3** | What is a gene and allele; What is the allelic heterogeneity, and allelic interactions; Examples of monogenic traits/diseases where the allelic heterogeneity can be explained; Relevance in human disorders (trait/disease demonstrating complete/incomplete dominance, recessiveness, codominance); Extreme allelic heterogeneity - example; In case of "example" traits, focus on the mechanism on molecular level - type of mutation - inheritance - consequence for protein structure and function... |
| **3** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gen (Mendelian) inheritance; Lecture 2 + 3: Mendelian genetics + The chromosomal basis of inheritance and gene linkage |
| **4** | **Basic types and relevance of DNA polymorphisms; Examples** |
| **4** | Explain terms polymorphism and mutation, compare and highlight differences; Basic types of DNA polymorphisms (single nucleotide polymorphisms = SNPs; Restriction fragment length polymorphisms (RFLPs), minisatellites - VNTR polymorphisms, microsatellites - STRs - short tandem repeats); Examples (e.g. ABO blood groups, HLA/MHC antigens, ...); Relevance of polymorphisms in DNA analysis/diagnostics |

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| **4** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 6 Identifying genes for Mendelian inheritance + chapter 7 Genes and populations; Lecture 2: Introduction to molecular genetics, types of mutations + 7 Population genetics + 11 Genetics and molecular biology of progressive neurological diseases |
| **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"** |
| **5** | Basic types of mutations distinguished by cell type having a mutation (somatic and germ cells), relevance for human diseases (which cells are affected; consequence for the organism; Mosaicism; Traits/diseases caused by somatic/germ cell mutations, examples (for particular syndrome/trait/disease: mechanism on molecular level, mutation/polymorphism and its consequence on DNA/RNA/protein structures and function, basic symptoms/phenotype; Explain the difference between the terms "mutation" and "polymorphism" and state examples |
| **5** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 -3 Common chromosome disorders + 4 Single gene (Mendelian) inheritance + Chapter 5 Identifying genes for Mendelian inheritance +10 Genes and cancer Single-gen (Mendelian) inheritance; Lecture 1: Introduction to molecular genetics, types of mutations + Lecture 10: Cancer genetics and molecular biology |
| **6** | **Basic types of mutations distinguished by the change in DNA sequence and consequences on** |
| **the expression and primary structure of the encoded protein, relevance for human diseases** |
| **6** | Basic types of mutations distinguished by the change in DNA sequence and consequences on the expression and primary structure of the encoded protein (deletion, insertion, duplication, substitution, silent mutation, in frame mutation, missense and nonsense mutations); Relevance for human diseases - some particular diseases, e.g. Huntington disease, fragile X- syndrome, sickle cell anaemia, thalassemias, Duchenne vs. Becker muscular dystrophies...); For "example" diseases - include their molecular mechanism (gene - protein - mutation - consequence on molecular level, onset, symptoms/prognosis) |
| **6** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gene (Mendelian) inheritance; Lecture 1: Introduction to molecular genetics, types of mutations; Lecture 11: Genetics and molecular biology of progressive neurological diseases; Lecture 12: haemoglobin diseases - genetics and molecular biology |
| **7** | **Basic types of mutations distinguished by an impact on function of the encoded protein,** |
| **relevance for human diseases; Haploinsufficiency** |

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| **7** | Basic types of mutations distinguished by an impact on function of the encoded protein (loss of function, hypomorphic, gain-off function, neomorphic, hypermorphic); Haploinsufficiency, dominant negative mutations, lethal alleles; Gene translocation, amplification, fusion genes; Relevance for human diseases - examples of diseases (generally, and some particular diseases, e.g. familial hypercholesterolemia, adult polycystic kidney disease (APKD), achondroplasia, Huntington disease, Marfan syndrome, sickle cell anaemia, cystic fibrosis, thalassemias, mutations of tumour suppressor genes (retinoblastoma), mutations of proto-oncogenes...); For "example" diseases - include their molecular mechanism (gene - protein - mutation - consequence on molecular level, onset, symptoms/prognosis) |
| **7** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gene (Mendelian) inheritance; Lecture 1: Introduction to molecular genetics, types of mutations; Lecture 11: Genetics and molecular biology of progressive neurological diseases; Lecture 12: Haemoglobin diseases - genetics and molecular biology |
| **8** | **Basic types of mutations distinguished by location of a mutation within a gene, relevance for** |
| **human diseases** |
| **8** | Structure of a typical human (eukaryotic) protein-coding gene - its parts; Based on this - consequences of mutations present in these parts; Mutations that can appear; Examples of diseases caused by mutations in these parts (e.g. haemoglobinopathies, fragile X-syndrome, Huntington disease, ...), including effect on quantity/quality of protein produced; Effects on the level of RNA synthesis/ processing/ translation, and protein stability/function |
| **8** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gene (Mendelian) inheritance; Lecture 1: Introduction to molecular genetics, types of mutations; Lecture 11: Genetics and molecular biology of progressive neurological diseases; Lecture 12: Haemoglobin diseases - genetics and molecular biology |
| **9** | **Epigenetics, types of epigenetic changes, biological mechanisms and relevance of epigenetic changes to human biology and diseases; Examples** |
| **9** | What is epigenetics; Epigenetic regulation of gene expression - types (levels), biological mechanisms (on the level of chromatin/transcription histone/DNA modifications...); Epigenetic changes and their relation to the human biology and diseases - examples (X- chromosome inactivation, tumours...) |
| **9** | Materials - Practicles in genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gen (Mendelian) inheritance; Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Lecture 4. Cell nucleus, human genome, DNA replication; Lecture: 5. Gene expression and its regulation - transcription and posttranscriptional regulations |

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| **10** | **Chromosome structure, classification and nomenclature; Basic methods of chromosome** |
| **analysis, karyotyping; Karyotype designation** |
| **10** | Chromosome structure (telomeres, centromeres, arms, locuses), classification and nomenclature; Basic methods of chromosome analysis, karyotyping (method description, banding methods - staining of all chromosomes or specific structures), FISH; Karyotype designation - step by step including examples of normal and aberrated karyotypes (numerical and structural aberrations, syndromes) |
| **10** | Materials - practices: Karyotyping + Cytology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 + 3 Chromosomes and cell division + Common chromosome disorders |
| **11** | **Genomic mutations, causes and consequences in human** |
| **11** | Genomic mutations, explanation of terms euploid, aneuploid, polyploid...; Causes of genomic mutations (which "mistake" during which event during formation of gametes/zygote);Karyotypes; Consequences in human |
| **11** | Materials - practicles: Karyotyping + Cytology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 + 3 Chromosomes and cell division + Common chromosome disorders |
| **12** | **Numerical chromosomal mutations, types, sources, consequences, examples** |
| **12** | Chromosomal mutations - types (numerical and structural); Numerical chromosomal mutations (aneuploidies) - their particular types (trisomy, monosomy,..., partial...), sources during formation of gametes/zygote (nondisjunction...), consequences in human, examples of numerical aberrations, and syndromes they cause, including karyotypes |
| **12** | Materials - practicles: Karyotyping + Cytology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 + 3 Chromosomes and cell division + Common chromosome disorders |
| **13** | **Structural chromosomal mutations, types, sources, consequences, examples** |
| **13** | Chromosomal mutations - types (numerical and structural); Structural chromosomal mutations - their particular types (deletion, duplication, ), their sources during formation ofgametes/zygote (chromosomal brakes, illegal crossing over...), consequences in human, examples of structural aberrations, and syndromes they cause, including karyotypes |
| **13** | Materials - practicles: Karyotyping + Cytology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 + 3 Chromosomes and cell division + Common chromosome disorders |
| **14** | **Nondisjunction and its consequences** |
| **14** | Nondisjunction: describe the process (or include the scheme) of mitotic/meiotic nondisjunction, compare consequences of nondisjunction during the first and second meiotic divisions; Consequences of nondisjunction including particular syndromes/karyotypes caused by these nondisjunctions |

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| **14** | Materials - practicles: Karyotyping + Cytology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 + 3 Chromosomes and cell division + Common chromosome disorders |
| **15** | **Germinal and somatic karyotypic changes, examples and biological explanation of resulting** |
| **human syndromes** |
| **15** | Germinal and somatic karyotypic changes - change in germinal cell (gamete), consequence in zygote and organism, which cells are affected, diseases/syndromes caused by germinal mutations; Change in somatic cell, consequence in the organism, which cells are affected, diseases/syndromes caused by somatic mutations; Compare both - germinal and somatic karyotypic changes |
| **15** | Materials - practicles: Karyotyping + Cytology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 + 3 Chromosomes and cell division + Common chromosome disorders |
| **16** | **Gene linkage and its use for gene mapping** |
| **16** | What is gene linkage; Which genes are linked; History and basic experiments (scientists, model organisms); Linkage groups; Strengths of linkage (Morgan number, Bateson number); Genetic and physical maps; Example of human genes linked (e.g HLA (MHC) genes) |
| **16** | Materials - practicles: Gene linkage; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gene (Mendelian) inheritance; Lecture 3: The chromosomal bases of gene inheritance and gene linkage |
| **17** | **Gene interactions, types, examples; Modifier genes - examples in human genetics or animal models** |
| **17** | What is a gene interaction, relations between interacting genes; Particular types of gene interactions - their impact on genotypes/phenotypes; Gene additivity/multiplicity, which genes are duplicated/multiplicated in human genome; Major genes, minor genes, modifier genes; Examples; Modifier genes - examples in human genetics or animal models |
| **17** | Lecture 6: Gene interactions, genetics of complex traits |
| **18** | **Meiosis, its course and relevance; Describe meiosis using the variables C and n** |
| **18** | Meiosis - which cells are produced by meiosis; Course of the whole meiotic division (differences between: spermatogenesis and oogenesis / mitotic and meiotic cell division / the first and second meiotic divisions); Relevance of meiosis. Description of meiosis using the variables C and n |
| **18** | Materials - practicles: Meiosis; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 Chromosomes and cell division |

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| **19** | **Genetic determination of sex, basic molecular processes and their potential disturbances** |
| **19** | Genetic determination of sex, basic molecular processes (involves: description of X and Y chromosomes, PAR regions, heterologous/homologous parts; SRY gene, TDF, SOX 9, AMH, androgens, androgen receptors) and their potential disturbances (e.g. gene mutations - which genes; Numerical chromosomal aberrations; Consequences of illegal crossing over between X and Y chromosomes) |
| **19** | Materials - practicles: Meiosis; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 Chromosomes and cell division; Lecture 6: Genetic sex determination |
| **20** | **Gene dosage compensation, its relevance and basic molecular mechanisms** |
| **20** | Explain what gene dose is (particularly in relation to chromosome X), and why must be compensated, in which cells; Complete molecular mechanism of gene dose compensation (involves: description of X and Y chromosomes, PAR regions, heterologous/homologous parts; random/skewed X chromosome inactivation, Barr body, mosaic, XIC, XIST, TSIX, long antisense RNA) |
| **20** | Lecture 6: Genetics of sex determination; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single-gene (Mendelian) inheritance |
| **21** | **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** | Gametogenesis - describe the cell division that produces gametes; Comparison of spermatogenesis and oogenesis; Description of the fertilization - basic molecular processes; Explain what the main differences are in the contribution of egg and sperm to the zygote; Explain what parthenogenesis is and why it is not possible in mammals |
| **21** | Materials - practicles: Meiosis; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 2 Chromosomes and cell division |
| **22** | **Monogenic diseases, criteria for distinguishing basic types of inheritance in pedigrees** |
| **22** | Monogenic diseases - criteria for distinguishing basic types of inheritance in pedigrees (pedigree: symbols, generations, pedigree drawing; Types of inheritance (AR, AD, GR, GD, mitochondrial....), characteristics of each type; Examples of diseases (e.g. familial hypercholesterolemia, adult polycystic kidney disease (APKD), achondroplasia, Huntington disease, Marfan syndrome, osteogenesis imperfecta, Incontinentia pigmenti, sickle cell anaemia, cystic fibrosis, galactosaemia, phenylketonuria, thalassemias, colour blindness = daltonism, Duchene/Becker muscular dystrophy, haemophilia, androgen insensitivity, fragile X syndrome...) |
| **22** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |

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| **23** | **Sex-related inheritance; Types, pedigrees, examples** |
| **23** | GD/GR diseases in pedigrees (characteristics), who is affected/carrier; Types of mutations causing usually GD/GR diseases (loss-of-function, hypomorphic, haploinsufficiency/gain-of- function, hypermorphic, neomorphic); A few examples of GR diseases including their molecular mechanism (gene - protein - mutation - consequence on molecular level, onset, symptoms/prognosis)(e.g. colour blindness=daltonism, Duchene/Becker muscular dystrophy; haemophilia, androgen insensitivity, fragile X syndrome, glucose-6-phosphate dehydrogenase deficiency ); GD diseases/traits including their molecular mechanism (gene - protein -mutation - consequence on molecular level, onset, symptoms/prognosis)(e.g. Incontinentia pigmenti, Xga blood group antigen) |
| **23** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |
| **24** | **Dominant diseases, examples of pedigrees and types of mutations that may underlie them** |
| **24** | AD/GD diseases in pedigrees (characteristics), who is affected; Types of mutations causing usually AD/GD diseases (gain-of-function, hypermorphic, neomorphic); A few examples of AD diseases including their molecular mechanism (gene - protein - mutation - consequence on molecular level, onset, symptoms/prognosis) (e.g. familial hypercholesterolemia, adult polycystic kidney disease (APKD), achondroplasia, Huntington disease, Marfan syndrome, osteogenesis imperfecta, ); GD diseases/traits including their molecular mechanism (gene - protein - mutation - consequence on molecular level, onset, symptoms/prognosis)(e.g. Incontinentia pigmenti, Xga blood group antigen) |
| **24** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |
| **25** | **Recessive diseases, examples of pedigrees and types of mutations that may underlie them; Inbreeding and its genetic consequences.** |
| **25** | AR/GR diseases in pedigrees (characteristics), who is affected/carrier; Types of mutations causing usually AR/GR diseases (loss-of-function, hypomorphic, haploinsufficiency); A few examples of AR diseases including their molecular mechanism (gene - protein - mutation - consequence on molecular level, onset, symptoms/prognosis)(e.g. sickle cell anaemia, cystic fibrosis, galactosaemia, phenylketonuria, thalassemias, ...); A few examples of GR diseases including their molecular mechanism (gene - protein - mutation - consequence on molecular level, onset, symptoms/prognosis)(e.g. colour blindness=daltonism, Duchene/Becker muscular dystrophy; haemophilia, androgen insensitivity, fragile X syndrome, glucose-6-phosphate dehydrogenase deficiency...); What is inbreeding and its genetic consequences |
| **25** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |

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| **26** | **Cystic fibrosis, genetics and molecular biology** |
| **26** | Cystic fibrosis - molecular mechanism - gene affected - mutations, their frequency in population; Protein coded, role of this protein - consequences of mutations; Inheritance; Who is affected, onset and spectra of symptoms; Expressivity - main sources of variable expressivity (genetic and non-genetic), modifier genes |
| **26** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |
| **27** | **Penetrance and expressivity, examples and possible underlying mechanisms** |
| **27** | Explain what penetrance is (complete / incomplete); Explain what expressivity is (variable); Sources of incomplete penetrance and variable expressivity; Examples of traits/diseases with complete/incomplete penetrance (e.g. familial hypercholesterolemia, adult polycystic kidney disease (APKD), achondroplasia, Huntington disease, ...) including molecular mechanism, symptoms, prognosis; Examples of traits/diseases with variable expressivity (e.g. cystic fibrosis, familial hypercholesterolemia, fragile X syndrome; spinocerebellar ataxia, neurofibromatosis (NF1), thalassaemia, mitochondrial diseases (e.g. LHON); Incontinentia pigmenti, muscular dystrophies, haemophilia ...) including molecular mechanism, symptoms, prognosis |
| **27** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |
| **28** | **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** | Basic principles of pedigree drawing and its significance in medicine, distinguishing features /characteristics of basic inheritance patterns (AD, AR, GR, GD, holandric, mitochondrial );examples of such diseases in pedigrees (can include late onset/incomplete penetrance and variable expressivity); Locus heterogeneity - how could it be identified in human genetic diseases? Cite examples - diseases with known locus heterogeneity (e.g. familial hypercholesterolemia, polycystic kidney disease (ADPKD), compound vs. double heterozygotes |
| **28** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |
| **29** | **Risk assessment and genetic prognosis; In what circumstances would genetic prognosis be** |
| **preferred over DNA diagnostics?** |
| **29** | Risk assessment and genetic prognosis - examples/explanation of calculations for different types of monogenic diseases (mainly from manual - practicles); Risk assessment in complex diseases. In what circumstances would genetic prognosis be preferred over DNA diagnostics? (comparison/use of prognosis/DNA diagnostics in practice) |
| **29** | Manual "Practicals in Genetics", Lecture 6: Gene interactions, genetics of complex traits; Ian D.Young: Medical Genetics, Oxford University Press, 2010 - Chapter 13 Clinical skills and scenarios |

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| **30** | **Population genetics; Hardv-Weinberg law and processes changing allelic frequencies** |
| **30** | Population genetics; Definition of population, human population, characteristics of the population in which Hardy-Weinberg law is valid; Hardy-Weinberg law - formulas and explanation (for 2 max. 3 alleles); processes changing allelic frequencies in common population and consequences in genotype/phenotype frequencies |
| **30** | Manual "Practicals in Genetics", Lecture 7: Population genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter7 Genes and population |
| **31** | **Complex diseases and heritability, examples; Phenocopy and genotype - environment** |
| **interactions including examples; Twin studies and their importance in medical genetics** |
| **31** | Complex diseases - monogenic versus complex diseases, differences; Heritability - how can be estimated; Examples of complex diseases; Phenocopy and genotype-environment interactions - examples; Twin studies and their importance in medical genetics |
| **31** | Manual "Practicals in Genetics", Lecture 6 Gene interactions, genetics of complex traits: Population genetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 6 + 7 Polygenic inheritance and complex diseases + Genes and population |
| **32** | **Genetic predisposition to cancer; Benign and malignant tumours and their characteristics; Acquired capabilities of malignant tumours (= Hallmarks of Cancer)** |
| **32** | Genetic predisposition to cancer; What is cancer; Benign and malignant tumours and their characteristics; Acquired capabilities of malignant tumours (= Hallmarks of Cancer); Which mutations and in which cells are usually responsible for cancerogenesis; Examples (DNA repair genes, oncogenes, tumour suppressor genes, genes involved in metabolism...) - explain the molecular mechanism in the chosen example |
| **32** | Lecture 10: Cancer genetics and molecular biology + Lecture 10: Cell cycle and its regulation +Lecture 1: Mutations; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 10 Genes and cancer |
| **33** | **Tumour suppressor genes and molecular alterations found in them in tumours; Examples; Loss of heterozygosity, its causes and consequences** |
| **33** | Tumour suppressor genes and molecular alterations found in them in tumours; Type of mutations, two hit model, consequence; Examples - genes/mutation/disease; Loss of heterozygosity - its causes and consequences; Examples (Familial retinoblastoma, Li-Fraumeni syndrome, ...); Epigenetic changes |
| **33** | Lecture 10: Cancer genetics and molecular biology + Lecture 10: Cell cycle and its regulation +Lecture 1: Mutations; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 10 Genes and cancer |
| **34** | **Oncogenes, proto-oncogenes and tvpes of mutations found in them in tumours; Examples; Philadelphia chromosome** |
| **34** | Oncogenes, proto-oncogenes and types of mutations found in them in tumours; Molecular mechanism - consequences of these mutations - changes in gene regulation or structure - describe; State examples (e.g. colorectal and breast cancers, melanoma, acute myeloid leukaemias, lung cancers ...); Philadelphia chromosome - what it is, mutation forming this chromosome, mechanism, phenotype (chronic myeloid leukaemia) |

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| **34** | Lecture 10: Cancer genetics and molecular biology + Lecture 10: Cell cycle and its regulation +Lecture 1: Mutations; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 10 Genes and cancer |
| **35** | **Mendelian and non-Mendelian inheritance - comparison; Examples of non-Mendelian** |
| **inheritance - in pedigrees, diseases/syndromes** |
| **35** | Mendelian inheritance (AD, AR...), non-Mendelian inheritance - **mitochondrial** (mitochondrial genome and its inheritance, protein-coding genes, tRNA + rRNA genes, mutations, consequences, example of diseases (Leber's hereditary optic neuropathy (LHON), Mitochondrial myopathy, MERRF syndrome...) homoplasy/heteroplasmy, threshold effect; sources of variable penetrance and expressivity of mitochondrial diseases; **Gene imprinting** (what it is and mechanism; maternal and paternal imprinting; Examples: Angelman syndrome, Prader-Willi syndrome - briefly describe); Uniparental disomy - explain; (Trinucleotide repeat expansions can be added - with explanation) |
| **35** | Manual "Practicals in Genetics", Lecture 5: Basic types of pedigrees, basic types of disease inheritance; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 4 Single- gene (Mendelian) inheritance |
| **36** | **Immunogenetics and MHC antigens (basic two classes and their comparison - structure,** |
| **function...) and their interactions; Their genes and haplotypes; Consequences of allogeneic transplantations** |
| **36** | Immunogenetics and MHC antigens (basic two classes MHC I and MHC II and their comparison - structure, function.) and their interactions; Their genes / alleles, and their haplotypes;Antigen presentation (cell type, antigen presented to..., epitope, TCRs; Autologous vs. allogeneic transplant; Consequences of allogeneic transplantations |
| **36** | Lecture 13: Immune system; Colour atlas of genetics - chapter "Immune system" - available on- line via library |
| **37** | **T- and B-lymphocyte interaction during the antibody synthesis and its malfunction during the genetic diseases of immunity; Antigen presentation (MHC restriction)** |
| **37** | T- and B-lymphocytes - description (including description of TCR and BCR), and roles of these cells in the immune system. Where are produced in the body. T- and B-lymphocyte interaction (on molecular and cellular levels) during the antibody synthesis, and its malfunction during the genetic diseases of immunity; Antigen presentation (MHC restriction) |
| **37** | Lecture 13: Immune system; Color atlas of genetics - chapter "Immune system" - available on- line via library |
| **38** | **Antibodies - basic structure, their production and function, and principles of generation of antibody diversity; Monoclonal and polyclonal antibodies and their use in medicine** |
| **38** | Antibodies - basic structure (all parts of their molecules, types of antibodies), their production (where, how), and function; Principles of generation of antibody diversity; Monoclonal and polyclonal antibodies (definition), and their use in medicine (Monoclonal - diagnostics (e.g. ELISA, fluorescence microscopy, immunohistochemistry, western blotting...), treatment of cancer and autoimmune diseases (so called "MAbs", e.g. bevacizumab); Polyclonal antibodies - viral and toxin neutralization, and replacement therapy in patients with immunoglobulin deficiencies) |

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| **38** | Lecture 13: Immune system; Color atlas of genetics - chapter "Immune system" - available on- line via library |
| **39** | **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** | Blood group systems - examples trained in Practicles: ABO, Rh, MN, ...(type of inheritance, genes, alleles; In detail ABO and Rh systems: genes, alleles, what is coded and how the antigen is formed/synthetized; where it is present; Clinical significance - presence/formation of antibodies, agglutination, compatibilities, ...; Include also genes H and Se; Bombay phenotype; Comparison od ABO and Rh systems/antigens |
| **39** | Manual "Practicals in Genetics" |
| **40** | **Fragile X syndrome and Huntington disease** |
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| **40** | Fragile X Syndrome and fragile X associated disorders (gene, mutation/premutation, number of repeats normal/pathologic, consequence on the molecular level - gene expression, onset of symptoms, spectrum of symptoms, inheritance, genetic transmission, pedigree); Huntington disease (gene, mutation, penetrance, number of repeats normal/pathologic, consequence on the molecular level - gene expression, onset of symptoms, spectrum of symptoms, inheritance, genetic transmission, pedigree), repeat instability (expansion), genetic anticipation |
| **40** | Manual "Practicals in Genetics", Lecture 11: Genetics and molecular biology of progressive neurological diseases; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 5 Identifying genes for Mendelian diseases |
| **41** | **Structure of haemoglobin, globin genes, their organization and regulation, regulation of** |
| **haemoglobin synthesis during development, role of chaperone AHSP, basic classification of hemoglobinopathies** |
| **41** | Structure of haemoglobin - primary to tertiary, globin genes and globin clusters (beta and alfa...), their organization and regulation, regulation of haemoglobin synthesis during development, globin subunits, types of haemoglobin, role of chaperone AHSP, basic classification of haemoglobinopathies; Hereditary persistence of foetal haemoglobin |
| **41** | Lecture 12: Haemoglobin diseases - genetics and molecular biology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 8 Genes and haemoglobin |
| **42** | **Diseases due to structural haemoglobin changes - examples, genetics and molecular biology** |
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| **42** | Briefly Hb structure necessary for explanation of these structure changes, their consequences, examples of diseases (sickle cell anaemia - gene - protein, frequency, heterozygotic advantage;Consequence of protein mutations, Hb S, Hb E, Hb C, Hb M, Hb Lepore..); Inheritance, homo/heterozygotes; composed heterozygotes |

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| **42** | Lecture 12: Haemoglobin diseases - genetics and molecular biology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 8 Genes and haemoglobin |
| **43** | **Thalassaemias - classification, genetics, types of mutations, and molecular biology** |
| **43** | Briefly Hb structure necessary for explanation; What are thalassaemias, their frequency, classification, genetics (gene clusters and genes they contain), mutations (in which genes, which types), molecular mechanism that causes the disease; Consequences for people having one or more mutations, inheritance, homo/heterozygotes, genotypes, symptoms, prognosis; Hereditary persistence of foetal haemoglobin; You can add interactions of haemoglobin genes |
| **43** | Lecture 12: Haemoglobin diseases - genetics and molecular biology; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 8 Genes and haemoglobin |
| **44** | **Pharmacogenetics; Xenobiotic metabolism and its phases; Enzymes; Personalized medicine; Examples** |
| **44** | Pharmacogenetics and pharmacogenomics - definition and main topics; Pharmacokinetics, ADME; Xenobiotic metabolism and its phases (1. and 2.); Organs and/or tissues important for drug metabolism; Enzymes and reactions they catalyse in the 1. and 2. phases; Excretion; Personalized medicine; Examples (enzyme - drug - phenotype); Pharmacogenetics of anticancer therapy - targeted therapy |
| **44** | Lecture 13: Pharmacogenetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 12 Genes, drugs, and treatment |
| **45** | **Pharmacogenetics; Warfarin metabolism; Enzymes; Drug interactions** |
| **45** | Pharmacogenetics what it is, and main topics; Pharmacokinetics, ADME; Xenobiotic metabolism - Enzymes and reactions they catalyse in the 1. and 2. phases; Excretion of metabolites/drugs. Drug interactions (examples); Metabolism of warfarin as an example of allelic heterogeneity (pharmacogenetics), and also drug with many drug interactions |
| **45** | Lecture 13: Pharmacogenetics; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 12 Genes, drugs, and treatment |
| **46** | **Unstable repeat disorders - examples, genetics and molecular biology; Genetic anticipation** |
| **46** | Repeats in human genome; Repeat number instability (expansion/contraction), molecular mechanism of this instability, tandem repeat disorders: where the mutation can appear in the eukaryotic gene, which consequences they cause on the protein level; Risk of expansions, **coding repeat expansions** - example spinocerebellar ataxias 1,2,3 (inheritance, genetic transmission, pedigree) or Huntington disease (see question No 39); **noncoding repeat expansion disorders** - example Friedreich ataxia or Fragile X Syndrome and the fragile X associated disorders (gene, mutation/premutation, number of repeats normal/pathologic, consequence on the molecular level - gene expression, onset of symptoms, spectrum of symptoms, inheritance, genetic transmission, pedigree - see question No 39); Genetic anticipation |

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| **46** | Manual "Practicals in Genetics", Lecture 11: Genetics and molecular biology of progressive neurological diseases; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 5 Identifying genes for Mendelian diseases |
| **47** | **Polycystic kidney disease - genetics and molecular biology** |
| **47** | Polycystic kidney disease - types (ADPKD and ARPKD) genetics and molecular biology (gene - mutation - protein - consequence on molecular/cell level) and comparison of both types; Symptoms (onset and spectra), phenotypic variability (factors influencing penetrance, expressivity) |
| **47** | Manual "Practicals in Genetics", Lecture 14: Genetics and molecular biology of polycystic kidney syndromes; Ian D. Young: Medical Genetics, Oxford University Press, 2010 - Chapter 5 Identifying genes for Mendelian diseases;<https://pmc.ncbi.nlm.nih.gov/articles/PMC2983067/pdf/JCB_201006173.pdf>; <https://en.wikipedia.org/wiki/Polycystic> kidney disease |
| **48** | **PCR method; Definition, types, particular steps; Results; Use in human genetics / medicine** |
| **48** | PCR (Polymerase chain reaction) method; Definition, types (end point PCR, multiplex PCR, real- time PCR (qPCR)...), particular steps in PCR cycle; Results (product of PCR) - use of PCR reaction products (sequencing, electrophoresis,...); Use PCR in human genetics / medicine (e.g. sex determination and Y chromosome microdeletion analysis, SNPs, STR polymorphism); NGS (Next Generation Sequencing) |
| **48** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 1 Gene structure and function ; Lecture: 9. Basic methods and experimental approaches of cell and molecular biology; Lecture 4. Cell nucleus, human genome, DNA replication; Manual "Practicals in Genetics" |
| **49** | **Repetitive sequences, microsatellites and their use in DNA diagnostics/forensic medicine** |
| **49** | Repetitive sequences in human genome, types of repetitive sequences; Microsatellites in human genome/disease; Polymorphism; In which way/for which purpose can be these microsatellites used in diagnostics/forensic medicine; Include laboratory methods (PCR, electrophoresis - question 48) |
| **49** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 1 Gene structure and function ; Lecture: 9. Basic methods and experimental approaches of cell and molecular biology; Lecture 4. Cell nucleus, human genome, DNA replication; Manual "Practicals in Genetics" |
| **50** | **DNA diagnostics. Basic types and their advantages and disadvantages, sources of errors** |
| **50** | DNA diagnostics; Basic types (direct/indirect) and their advantages and disadvantages, compare both methods; Sources of errors; Laboratory methods used in DNA diagnostics - PCR, sequencing, RFLP, VNTR, electrophoresis, southern blotting, microarray, NGS . |
| **50** | Lippincott Illustrated Reviews: Cell and Molecular Biology, Chapter 1 Gene structure and function ; Lecture: 9. Basic methods and experimental approaches of cell and molecular biology; Lecture 4. Cell nucleus, human genome, DNA replication; Manual "Practicals in Genetics" |

**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; e.g. = for example = it means chose one or two of particular cases and speak about it/both in detail ;

you don't have to speak about all of the suggested examples

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