

BIOLOGY – TOPICS FOR THE ENTRANCE EXAM

GENETICS

BASIC PRINCIPLES OF GENETICS

- Monohybrid cross

(gene, allele, homozygous / heterozygous, dominant / recessive allele, genotype, phenotype)
- Mendel's first law (principle of segregation)
- Test cross
- Dihybrid cross
- Mendel's second law (principle of independent assortment)
- Non-Mendelian inheritance:
 - ✓ incomplete dominance
 - ✓ codominance
 - ✓ polygenic inheritance
 - ✓ epistasis (9:7, 13:3, 15:1, 12:3:1, 9:3:4 and 9:6:1 ratios)

GENE LINKAGE

- Linked genes
- Genetic map unit

MUTATIONS

- Definition and types of mutation
(germinal / somatic mutation, spontaneous / induced mutation, point mutation)
- Classification of gene mutations:
 - ✓ Base substitutions
 - missense mutation
 - nonsense mutation
 - neutral mutation
 - silent mutation
 - ✓ Frameshift mutation
 - ✓ Dynamic mutations

POPULATION GENETICS

- Genetic structure of population
- Hardy–Weinberg principle
- Factors that alter Hardy-Weinberg equilibrium
 - ✓ Mutations
 - ✓ Natural selection
 - ✓ Gene flow
 - ✓ Genetic drift
 - ✓ Nonrandom mating

BLOOD GROUPS

- ABO blood group system
(multiple alleles)
- Rh blood group system

NUMERICAL CHROMOSOMAL ABERRATIONS

- Polyploidy
- Aneuploidy
(primary and secondary nondisjunction, mosaicism)
- Human chromosomal disorders
 - ✓ Down sy.
 - ✓ Patau sy.
 - ✓ Edwards sy.
 - ✓ Turner sy.
 - ✓ Klinefelter sy.
- Prenatal diagnosis

STRUCTURAL CHROMOSOMAL ABERRATIONS

- Unbalanced aberrations
 - ✓ Deletion
(Cri du chat sy.)
 - ✓ Duplication
- Balanced aberrations

- ✓ Inversion
- ✓ Reciprocal translocation
- ✓ Robertsonian translocation

PATTERNS OF INHERITANCE

- Autosomal dominant inheritance
(variable penetrance and expressivity)
 - ✓ Human autosomal dominant diseases
(polydactyly, syndactyly, brachydactyly, clinodactyly, achondroplasia, Huntington disease, Familial hypercholesterolaemia)
- Autosomal recessive inheritance
 - ✓ Human autosomal recessive diseases
(phenylketonuria, albinism, cystic fibrosis, alkaptonuria, Tay-Sachs disease)
- X-linked recessive inheritance
 - ✓ Human X-linked recessive diseases
(hemophilia A or B, Daltonism, Duchenne muscular dystrophy)
- X-linked dominant inheritance
- Y-linked (holandric) inheritance

MOLECULAR BIOLOGY

NUCLEIC ACIDS AND PROTEINS

- DNA
- RNA
- Eukaryotic chromosomes
- Proteins

DNA REPLICATION

- Semiconservative model
- Leading/lagging strand (Okazaki fragments)
- Proteins involved in DNA replication
- Proofreading activity
- Primers

TRANSCRIPTION

- RNA polymerases
- Structure of eukaryotic gene
- Promoter
- Exons and introns
- RNA processing

TRANSLATION

- Genetic code
- Aminoacyl-tRNA (aminoacyl-tRNA synthetase)
- Initiation
- Elongation
- Termination
- Signal peptide

REGULATION OF GENE EXPRESSION

- Regulation of chromatin condensation
 - ✓ Epigenetic mechanisms
(methylation of DNA, histone acetylation, genomic imprinting)
- Transcriptional control
 - ✓ Cis-elements
(promoter, enhancer, silencer, response element, insulator)
 - ✓ Trans-elements
(general and specific transcription factors)
- Posttranscriptional control
 - ✓ Alternative RNA splicing
 - ✓ Posttranslational modification
(chaperones)

RECOMBINANT DNA TECHNOLOGY

- Restriction endonucleases
- Cloning vector
- Nucleic acid hybridization

EMBRYOLOGY

MEIOSIS

- Meiosis I
(diploid/haploid cell, homologous chromosomes)
 - ✓ Prophase I
 - leptotene
 - zygotene (synaptonemal complex, bivalents)
 - pachytene (crossing over)
 - diplotene (chiasmata)
 - diakinesis
 - ✓ Metaphase I
 - ✓ Anaphase I
 - ✓ Telophase I
- Meiosis II

GAMETOGENESIS

- Spermatogenesis
 - ✓ Spermiogenesis
 - ✓ Seminiferous tubule
 - ✓ Hormonal control of the spermatogenesis
- Oogenesis
 - ✓ Sequence of events
 - ✓ Folliculogenesis
 - ✓ Hormonal control of menstrual cycle
- Types of eggs
 - ✓ oligolecithal and isolecithal
 - ✓ mesolecithal and moderately telolecithal
 - ✓ macrolecithal and highly telolecithal
 - ✓ macrolecithal and centrolecithal

FERTILIZATION

- Modes of reproduction
- Acrosome reaction
- Block to polyspermy
- Fusion of pronuclei

CLEAVAGE

- Blastula
- Patterns of cleavage
 - ✓ Holoblastic cleavage
 - in sea urchin
 - in frogs
 - ✓ Meroblastic cleavage
 - discoidal
 - superficial
- Cleavage in mammals

GASTRULATION

- Gastrula
- Types of cell movements
 - ✓ Invagination
 - ✓ Epiboly
 - ✓ Ingression
 - ✓ Delamination
 - ✓ Involution
- Sea urchin gastrulation
- Birds gastrulation
- Formation of mesoderm (primitive streak)
- Mammals gastrulation

NEURULATION

- Neurula
- Formation of the neural tube
- Neural crest
- Differentiation of mesoderm

EXTRAEMBRYONIC MEMBRANES

- Yolk sac
- Amnion
- Chorion
- Allantois
- The formation of extraembryonic membranes in birds
- The formation of extraembryonic membranes in mammals

PLACENTA

- Chorionic villi
- Classification
 - ✓ choriovitelline / chorioallantoic placenta
 - ✓ diffuse / cotyledonary / zonary / discoid placenta
 - ✓ epitheliochorial / endotheliochorial / hemochorial placenta
 - ✓ nondeciduous / deciduous placenta

CYTOLOGY

PROKARYOTIC versus EUKARYOTIC CELL

- Differences between prokaryotes and eukaryotes

PLASMA MEMBRANE and CELL TRANSPORT

- Structure of plasma membrane (fluid-mosaic model)
- Transport across a cell membrane
- Passive transport
 - ✓ diffusion (osmosis, facilitated diffusion)
- Active transport
 - ✓ sodium-potassium pump
- Vesicular transport
 - ✓ endocytosis / exocytosis

NUCLEUS

- Nuclear envelope
- Nucleoplasm
- Chromatin
 - ✓ nucleosomes
 - ✓ chromatin fibril
- Nucleolus

CYTOPLASM and ORGANELLES

- Cytoplasm
- Organelles
 - ✓ Rough endoplasmatic reticulum
 - ✓ Smooth endoplasmatic reticulum
 - ✓ Golgi aparatus
 - ✓ Mitochondria
 - ✓ Lyzosomes
 - ✓ Nonmembranous organelles
 - ribosomes
 - centrosomes
 - proteasomes
- Inclusions
- Cytoskeleton

CELL CYCLE and MITOSIS

- Cell cycle
 - (Interphase: G1, S, G2)
 - ✓ Levels of chromatine packing
- Mitosis
 - ✓ prophase
 - ✓ metaphase
 - ✓ anaphase
 - ✓ telophase
 - ✓ cytokinesis