GENETICS

COURSE CONTENT

COMPETENCIES

The first year medical student should be able to understand and explain the normal and abnormal structure of chromosomes , basic genetic techniques, modes of inheritance and numerical chromosomal aberrations and prenatal diagnosis.

HISTORICAL ASPECTS

Level 2: Mendel's experiments (1865), Chromosomal basis of inheritance (Sutton and Boveri, 1903); Inborn errors of Metabolism (Garod, 1908); DNA structure (Watson and Crick, 1953); Genetic code(Khorana, 1968)
Level 3: Evolution (Darwin, 1859); Eugenics and Polygenic inheritance (Galton, 1875); Blood groups (Landsteiner, 1900); One gene-one enzyme (Beadle and Tatum, 1941) Radiation and mutation (Müller, 1946); Sex chromatin (Barr and Bertram, 1949); Population genetics (Hardy and Weinberg); Genetic control of enzyme synthesis (Jacob and Monod)

MENDELISM

Statement of laws
Level 2: Detail, correlation of Mendel's laws with meiosis; Exception to law - linkage

CYTOGENETICS (NORMAL)

Structure and function of chromosomes, Cell cycle, Cell divisions, Spermatogenesis, Oogenesis
Level 2: Supercoiling of chromosomes, Significance and differences
Level 3: Methods of study

MOLECULAR GENETICS (NORMAL)

Gene, Genetic code, Structure and types of DNA, Structure of RNA, Protein synthesis
Level 2: Jumping genes, Split genes, DNA repair, Operon concept

MODES OF INHERITANCE

Basis and critera for: Single gene inheritance, Multifactorial inheritance, Polygenic inheritance, Mitochondrial inheritance, Pedigree charts with symbols
Level 2: Examples with pedigree charts
Level 3: Factors affecting expression and genetic counselling

GENETIC BASIS OF VARIATION

Mutation, Polymorphism (Blood groups - ABO, Rh), Multiple allelism, Pleiotropy, Linkage, Association, Anticipation, Interaction, Sex-limited traits, Sex-controlled traits, Genetic heterogeneity, Penetrance, Expressivity, *Formé frusté*
Level 2: Types; Factors influencing mutational load
Level 3: Methods of calculation; Caution in counselling of various genetic diseases

POPULATION GENETICS

Hardy-Weinberg law, Factors affecting it
Level 2: Mathematical proof with explanation, Eugenics and its effects
Level 3: Shift of equilibrium with changing prognosis

APPLIED GENETICS

Blood group genetics
ABO, Rh blood groups; Principles : Dominant / Recessive, Codominance; Multiple allelism, H and h genes, Se and se genes; Association, Linkage, Marker genes; Naturally occurring antibodies; Linkage in *cis* and *trans*, double backcross method; Gene mapping
Level 2: Bombay phenotype, Nail patella syndrome

Immunogenetics
HLA, H-Y antigens, and transplantation, Immune deficiency, Autoimmune disease
Level 2: Utility in tissue grafting
Level 3: In vitro matching tests for donor, selection

DEVELOPMENTAL GENETICS

Genetic basis of development, Sex differentiation, Role of sex chromosomes and gonads; Details of X and Y chromosomes, Androgen insensitivity; Lyon's hypothesis; Intersex; XX male and XY female; Hermaphroditism and pseudohermaphroditism; Multiple births, Genetic basis of teratogenesis
Level 2: Details; Genetic markers (zygosity); Abnormalities - Pure and mixed gonadal dysgenesis, Adrenogenital syndrome - Androgen insensitivity; Radiation - External and Internal effects: Somatic, localised
Level 3: Genetic counselling

MEDICAL GENETICS

Clinical genetics: History taking; Pedigree charting; Clinical examination

Chromosomal basis of disease: Numerical, structural; Clinical syndromes— Down, Cri-du-chat, Turner, Klinefelter; Clinical features
Level 2: Effect of meiosis on transmission, Cytogenetics, Dermatoglyphics, Risk of recurrence
Level 3: Counselling

Genetic basis of disease

Biochemical genetics:
Principles of inborn errors of metabolism and pathogenesis:
Amino acid metabolism—Phenylketonuria, Alkaptonuria, Albinism, Cretinism; Lipid metabolism—Tay-Sach's, Niemann-Pick; Mucopolysaccharidosis—Hurler, Hunter; Marfan; Purine-pyrimidine metabolism—Lesch-Nyhan; Copper metabolism—Wilson; Enzyme—G6PD; Haemoglobinopathies—HbA, HbS, Thalassemia
Level 2: Clincal features, Consequences, Exact site and nature of defect
Level 3: Treatment, Counselling

Pharmacogenetics: Definition
Level 2: Anticoagulants (Coumarin); Anaesthetic agents (Halothane, Succinyl choline); Primaquine; Isoniazide(INH); Hydrogen peroxide
Level 3: Clinical application

Models of genetic basis in human disease
Level 2: Cancers, Behavioural disorders
Level 3: Application

Prenatal diagnosis and treatment
Maternal serum sampling; Fetal USG; Fetal amniocentesis; Fetal chorion villus sampling
Level 2: Details; Risks involved; Other methods: cord blood sampling (cordocentesis); Fetoscopy
Level 3: Advantage of one over another; Utility in screening

Genetic Counselling and Eugenics: Definition; Conditions when asked to counsel
Level 2: Prevention; Screening; Coping; Treatment including gene therapy
Level 3: Clinical application

LABORATORY GENETICS

Buccal smear (Chromosome)*, Dermatoglyphics (Chromosome)*, Karyotype*
Level 2: Explanation of Lyonization; Variation in genetic disease; Banding patterns
Level 3: Exceptions to Lyonization; Clinical application in diagnosis; Interpretation in diagnosis

TOOLS OF HUMAN MOLECULAR GENETICS

Level 2: Molecular cloning; Monoclonal antibodies; Protein analysis; Nucleic acid analysis
Level 3: DNA clone, probe, ligation, restriction endonucleases; Southern blot; Northern blot; Polymerase chain reaction (PCR); Western blot; Amino acid sequencing; Reverse genetics

Gene map and linkage: Principles
Level 2: Double back cross method (in *cis* and *trans*), centimorgan

Protein (Hormone / Enzyme) manufacture: Principles of recombinant DNA technology
Level 2: Details with examples insulin, growth hormone
Level 3: Human Genome Project, Treatment of deficiency disorders

*** Preferably in the form of practicals (A visit to a genetic centre)**

LECTURES

- Mendel's laws
- Cell cycle, normal chromosomes
- Chromosomes - structural abnormalities
- Chromosomes - numerical abnormalities
- Molecular genetics - Protein synthesis
- Molecular genetics - Mutation
- Modes of inheritance - Autosomes
- Modes of inheritance - Sex chrosomes
- Immunogenetics; Biochemical genetics; Population genetics
- Prenatal diagnosis
- Genetic counselling
- Tools of human molecular genetics

Topics for integration

Intrauterine diagnosis of genetic disorders

Gregor Johann Mendel
(1822 – 1884)

He was an Augustinian priest and scientist, and is often called the "Father of Genetics" for his study of the inheritance of certain traits in pea plants.

Mendel showed that the inheritance of these traits follows particular laws, which were later named after him.

The significance of Mendel's work was not recognized until the turn of the 20th century.

Its rediscovery prompted the foundation of the discipline of genetics.