Syllabus for Ph.D. Entrance Test

Unit-I

Cell Biology

1.1 Cell: Structure and Organization.
1.2 Nucleus: Structure and Function.
1.3 Plasma Membrane: Structure, function and transport.
1.4 Cytoskeleton: Microtubules, microfilaments and intermediate filaments.
1.5 Mitochondria: Structure and function.
1.6 Endoplasmic Reticulum: Structure and function.
1.7 Overview of Cell cycle
1.7.1 Mitosis: Phase and Consequences of Mitosis
1.7.2 Meiosis: Phases, crossing over and Genetic Consequences.
1.8 Cell cycle and its regulation
1.8.1 Cyclin and Cyclin dependent kinases.
1.8.2 Regulation of Cyclins, sister Chromatids, Cohesion Remodeling
1.8.3 Centrosome Cycle
1.8.4 Cell cycle check points
1.9 Role of Rb and p53 protein in cell cycle regulation

UNIT II

Endocrinology and Human Embryology

2.1 Physiology
2.1.1 Pituitary Gland
2.1.2 Thyroid Gland
2.1.3 Parathyroid gland
2.1.4 Islets of Langerhans

2.2 Embrology
2.2.1 Mechanism of Human Fertilization
2.2.2 Establishment of BodyAxis
2.2.3 Implantation
2.2.4 Development of human embryo upto three germinal layers
2.2.5 Development of embryonic disc, notochord formation & Neurulation
2.2.6 Chronic formation & development of placenta

UNIT III

DNA and its Expression

3.1 DNA as Genetic Material, structure, types and functions of DNA
3.2 DNA Replication in Prokaryotes & Eukaryotes.
3.3 RNA: structure, types and functions.
3.4 Mechanism of Transcription (Prokaryotes & Eukaryotes), post transcriptional

modifications.
3.5 Mechanism of Translation, its regulation and post translational modifications.
3.6 DNA mutations and Repair.
3.7 Transposable elements in Prokaryotes and Eukaryotes.

UNIT IV

Human Cytogenetics

4.1 Mendelian Genetics: Laws and exceptions to mendelism.
4.2 Structure and landmarks of human chromosomes.
4.3 Sex determination in Human.
4.4 Cytogenetic techniques for disease detection: Lymphocyte culturing, G-banding, FISH, SKY, CGH, GISH.
4.5 Structural and Numerical Abnormalities of Human Chromosomes
4.6 Neural tube defects: Anencephaly, Encephalopathy, Hydranencephaly, Spina bifida including myelomeningocele and others.
4.7 Genomic Imprinting: Prader-Willi Syndrome, Angelman Syndrome, Beckman Weidworth Syndrome.
4.8 Effect of mutagenic and Teratogenic exposures in early pregnancy.
4.9 Effects of chromosomal instability on human health.
4.10 Genetic mapping and LOD score analysis.
4.11 Human Artificial chromosomes.

UNIT V

Human Molecular Genetics:

5.1 Rules for nomenclature of mutations and databases of mutation.
5.2 Epigenetics and its role in Human diseases.
5.3 DNA hybridization assays.
5.3.1 Exome sequencing
5.3.2 Whole Exome Sequencing
5.4 Pathogenicity associated with repeated sequence
5.5 Animal models for the study of human genetic diseases: Drosophila, Mouse
5.6 Molecular Techniques:

- **5.6.1** Electrophoretic techniques
- **5.6.2** Centrifugation: Principle and Types
- **5.6.3** PCR and its types
- **5.6.4** DNA Finger printing
- **5.6.5** DNA Sequencing: Maxam-Gilbert (Chemical) Sanger sequencing method.
- **5.6.6** Massive parallel sequencing (NGS and pyrosequencing).
- **5.6.7** Molecular diagnostics and therapeutic interventions in cancers.

UNIT VI

Medical Biotechnology with Nanotechnology

6.1 Gene Therapy: Types and Vectors used

6.2 Gene Editing (CRISPR)

6.3 Pharmacogenomics: Concepts of Pharmacogenomics, Pharmacogenomics in Cancer and drug development.

6.2 NanoTechnology: Role in drug delivery and its biomedical applications

6.3 Stem Cells: Types, Culturing of stem cells and its potential use.

6.4 Prenatal diagnostics:

6.4.1. Invasive techniques- Amniocentesis, Fetoscopy, Chorionic Villi Sampling

6.4.2. Non- invasive techniques- Ultrasonography, maternal fetal serum and fetal cells in the maternal blood, NIPT

UNIT VII

Genetic Testing and Genetic Counseling

7.1 Genetic Testing

7.1.1. Pre-natal diagnostic techniques (Regulation and Prevention of Misuse) Act, 1994.

7.1.2. Pre conception Pre-natal diagnostic techniques (Prohibition of sex selection) Act.

7.1.3. Regulation of prenatal diagnostic techniques.

7.1.4. Registration & regulation of genetic counseling centers, genetic laboratories & genetic clinics

7.1.5. Appropriate authority & advisory committee Offences and Penalties.

7.1.6. Medical termination of pregnancy Act.

7.2 Genetic Counseling

7.2 .1 Genetic counseling in Mendelian disorders and non- Mendelian disorders

7.2.2 Psychosocial and behavioral aspects of Genetic Counseling

7.2.3 Pedigree Charting: Essential for Genetic Counseling.

7.2.4 Ethos of Genetic services and genetic counseling, Indications of Genetic counseling.

7.2.5 Dilemmas faced by counselors

UNIT: VIII

Genetic Disorders and their Diagnosis

8.1 Single Gene disorders: Hemophilia Cystic Fibrosis, Sickel Cell Anemia, Huntington Disease, Fragile-X syndrome

8.2Multifactorial Disorders: Diabetes mellitus, Obesity, Cardiovascular Disorders, Hyperthyrodism.

8.3Rare Genetic Disorders: Tay Sach's Disease, Krabbe's Disease, Phenylketonuria, Alkaptonuria, Progeria, Werewolf syndrome.
8.4 Behavioral Disorders: Schizophrenia, Bipolar disorders, Alcoholism.
8.5 Immunodiagnostics & Biochemical diagnostics.
8.6 Treatment of Genetic Diseases, fetal treatment

UNIT IX
Population Genetics

9.1 Human Migration and diseases: Founder effect, bottle neck effect, genetic drift.

9.2 Calculation of allele and genotype frequencies.

9.3 Hardy Weinberg Equilibrium

9.4 Genetic Polymorphism and Inherited variations.

UNIT X
Research Methodology

10.1 Biostatistics

10.1.1 Measures of central tendency and measures of dispersion, probability and its types: permutation, combination, probability computations.

10.1.2 Theoretical distributions: Binomial, Poisson and Normal, hypothesis testing; two types of errors.

10.1.3 Tests of significance; Z-test, t-test, chi-square test, one way and two way analysis of variance.

10.1.4 Simple correlation and regression.

10.1.5 Hypothesis and Testing : Population and sample size, Null and alternative hypothesis, Odds Ratio.

10.2 Bioinformatics.

10.2.1 Biological Databases; Primary, Secondary & Composite databases, UCSC Genome brower. Nucleotide Sequence Databases; GenBank, ENSEMBL, DDBJ

10.2.2 Protein Sequence Databases; SWISS PROT, protein sequence database, Translated EMBL (TrEMBL), UniProt, PROSITE, Pfam, KEGG pathway

10.2.3 Structural Databases; Protein Data Bank (PDB), Molecular

10.2.4 Modelling Database (MMDB), NucleicAcid Database (NDB).

10.2.5 Expression data set Single cell gene expression GTEX, ENCODE.

10.2.6 Clinical Database: Gene cards, OMIM