**ANDHRA PRADESH**

**RECRUITMENT OF ASSISTANT PROFESSORS IN THE UNIVERSITY**
**SYLLABUS FOR THE SCREENING TEST**

**GENETICS AND GENEOMICS**
**SUBJECT CODE – 75**

**UNIT-1 (CONCEPTS OF GENETICS):**

History and milestones in genetics; Importance and applications of genetics; Terminology of genetics; Model organisms (*E. coli*, yeast, *Arabidopsis*, Drosophila, C. elegans, Homo sapiens) general outline of life cycle, model organisms importance in Genetic analysis; Laws of inheritance (Mendel's Laws) - concept of dominance, segregation, independent assortment; Extensions of Mendel's principles; Allelic and non-allelic interactions**;** Concept of alleles, types of dominance, lethal alleles, multiple alleles; complementation; Epistasis; pleiotropism; Penetrance; Expressivity; organelles genetics; Autosomal and sex inheritance-dominant and recessive traits.

**UNIT-2 (BIOMOLECULES):**

Carbohydrates; Classification of carbohydrates; Structure of monosaccharides, disaccharides and Polysaccharides; Amino acids functions and classification; Biological functions of proteins; Structural organization of proteins (Primary, Secondary, tertiary and quaternary structure); Ramachandran plot; Lipids - Structure, classification and properties of lipids, fatty acids, waxes, phospholipids; Nucleic acids - Purine and Pyrimidine Bases, Nucleosides, Nucleotides, phosphodiester bond and its stability; Structure of DNA - Watson and Crick model; types of DNA and RNA; Denaturation and Renaturation of DNA, melting curves.

**UNIT-3 (CELL BIOLOGY AND CYTOGENETICS):**

Structure and function of cellular organelles (Endoplasmic reticulum, Golgi complex, lysosomes, vacuoles, peroxisomes, mitochondria, chloroplast, secretory pathway; Cytoskeleton and extracellular matrix); Cell cycle - Phases of cell cycle, restriction points, cell cycle determining genes, $G_0$ Phase (Quiescence phase, Points of no return); totipotency of stem cells; Cell death - Apoptosis, necrosis and autophagy; Chromatin organization -

Euchromatin and Heterochromatin, Structure and organization of nucleosome; Chromatin Modifications; Dosage compensation; Detection and analysis of chromosomal alterations - Karyotyping and its significance, Banding techniques (G, Q, T, R, etc), Chromosome break points Mapping (Deletion mapping, translocation mapping, Inversion mapping).

**UNIT 4 (MUTATIONS):**

Cytological techniques - analysis of mitotic chromosomes; human karyotyping; Cytogenetic variations - Structural chromosomal abnormalities, Numerical chromosomal abnormalities; Polyploidy - sterile polyploids, fertile polyploids, tissue-specific polyploidy; polyteny; Aneuploidy; Chromosome rearrangement mutation (inversion, translocations); Origin and frequency of spontaneous mutations; Induced mutations - physical and chemical mutagens, molecular basis of spontaneous and induced mutations; Transposable element in bacteria, human and plants; Genetic basis of syndromes and disorders; Monogenic disorders- Cystic fibrosis, Huntington's disease, Hemophilia, Neurofibromatosis, sickle cell disease and thalassemias; Chromosome disorders- cri-du-chat syndrome, Down syndrome; Inborn errors of metabolism- Albinism, Alkaptonuria, cystinuria and pentosuria; Multifactorial disorders – Diabetes mellitus, coronary artery disease, mitochondrial syndromes and congenital malformation.

**UNIT-5 (CHROMOSOMES AND LINKAGE ANALYSIS):**

Eukaryotic and prokaryotic chromosome organization; Histone proteins, non-histone chromosomal proteins, nucleosome, linkers, chromatin fibers, centromeres, telomeres and alternative chromatin structures; Chromatin structure: nucleosome morphology and higher level organization; Functional states of chromatin and alterations in chromatin organization; Linkage - complete and incomplete linkage, strength of linkage, factors affecting strength of linkage, Inheritance of linked genes; gene mapping in *Drosophila* using two point and three point test crosses; Tetrad analysis and gene mapping in *Neurospora;* Interference and the coefficient of coincidence; Linkage analysis in humans (pedigree analysis). Population based Linkage analysis; Whole genome linkage analysis; Linkage disequilibrium analysis; Sex determination; Sex linked genes; sex limited traits; sex influenced traits.

**Unit 6 (BIOSTATISTICS AND POPULATION GENETICS):**

Basic statistics - Samples and populations, experimental design, Data analysis, Graphs; Hypothesis testing - Null and alternate hypothesis, test of significance, Type I and Type II

errors, confidence intervals and confidence levels; test statistics - Chi-square test (test for goodness of fit), Z test (for proportions and means), t- test (students t test, paired t test); ANOVA - One way and Two-way Anova (F- test); Correlation and regression (Simple regression, multiple regression, logistic regression); Population structure, Gene pool, Estimation of gene and genotype frequencies for biallelic, multiple allelic and X- linked loci; Linkage disequilibrium; Effects of Inbreeding and assortative mating; Hardy-Weinberg Law - Assumption, prediction, deviation and extensions; Factors affecting HWE - Mutation, Selection, Migration, Genetic drift, Effective population size; Heritability and description of continuous variation of wheat kernel color and human skin color; Quantitative characteristics - variability, relation between genotype and phenotype, types of quantitative characteristics, phenotypic inheritance, determining gene number for a polygenic characteristic, QTL data analysis; Heritability- phenotypic variance, types of heritability, calculating heritability, limitations of heritability; Locating genes that affect quantitative characteristics.

**UNIT 7 (MOLECULAR GENETICS):**

Evidence for DNA and RNA is the genetic material; Chargaff's ratios; Chemical, physical and spectroscopic properties of nucleic acids; Denaturation and renaturation kinetics of nucleic acids; DNA topology-linking, writhing, twisting number, positive and negative supercoiling, topoisomerases; Molecular mechanisms of DNA replication in prokaryotes and eukaryotes; DNA damage and repair; Homologous recombination, site-specific recombination and transposition; Transcription - RNA polymerases and Mechanism; Maturation and processing of different RNA transcripts-capping, methylation, polyadenylation, splicing, RNA editing and modification of nucleosides in tRNAs; Translation - Genetic code and its elucidation, structure and composition of prokaryotic and eukaryotic ribosome's; protein synthesis in prokaryotic and eukaryotes; post- translational modification of proteins, regulation of translation, Regulation of gene expression - positive and negative gene regulation in *E. coli* (lac, trp operons).

**UNIT 8 (Animal and PLANT BREEDING)**

Collection, evaluation and conservation of germplasms; Committee for Control and Supervision of Experiments on Animals (CPCSEA) - General CPCSEA guidelines; Development of genetically controlled laboratory animals – Rules for nomenclature, inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains, Composition, quality control and preservation of livestock products, methods of processing

and storage livestock products; International Trade/WTO/IPR issues related to livestock products; Reproductive systems in plants; Sexual reproduction - self and cross fertilization - Autogamy, Allogamy; Asexual reproduction and Apomixis; Genetic basis of breeding - Mating systems of plants; Wide hybridization - Inter-specific crosses and inter-generic hybridization; Breeding Methods in self - pollinating and cross pollinating crops, Hybrid Breeding - Development and evaluation of inbred lines, A, B and R lines, male sterility systems; Mutation breeding, Cultivar release and certification, Plant breeders rights. Heterosis - Occurrence and causes of heterosis and role of heterosis in increasing production.

**UNIT 9 (GENE MAPPING AND GENE FUNCTION IDENTIFICATION)**

Approaches for gene identification; Construction of genetic linkage maps - Types of mapping populations ($F_2$ populations, BC population, RIL populations); Molecular markers (RFLP, SSR, STS, SNP, RAPD, CAPS, SCAR, AFLP); Positional cloning; Construction of Physical maps – FISH, cytogenetic DNA FIBRE FISH, Restriction mapping, Radiation hybrid mapping, Clone contig mapping; Mapping for single gene disorders, Mapping for complex genetic disorders; TILLING (Targeted Induced Local Lesion IN Genome); ECO-TILLING; DE-TILLING, T-DNA insertional mutagenesis; Transposon mutagenesis (*Ac/Ds*); RNAi; CRISPR (CRISPR/Cas9); TALEN; Zinc Finger Nuclease gene editing; SAGE; DNA micro array; qRT-PCR; Mapping in prokaryotes by Transformation, Transduction, and Conjugation; Genetics of viruses - Baltimore classification Phage mutants, recombination in phages, fine-structure mapping of T4 rII locus.

**UNIT 10 (GENETIC ENGINEERING AND GENOME DATABANKS)**

Tools for genetic engineering; Restriction nucleases (exo- and endonuclease); Polynucleotide phosphorylase; DNase; Phosphatases; Methylases; Ligases; Polynucleotide kinase; RNase; Oligonucleotides; Vectors - plasmid and phage vectors, cosmids, phagemids, BAC and YAC; Types and applications PCR; Probes; Cloning; Construction and screening of cDNA and genomic DNA libraries; Maxam and Gilbert sequencing; Sanger's dideoxy sequencing; Site-directed mutagenesis; Gene therapy- Ex vivo and In vivo gene therapy; Applications of genetic engineering; Sequence data banks – GenBank, EMBL, DDBJ nucleotide sequence data bank, AIDS virus sequence data bank; Protein sequence data bank- NBFR-PIR, SWISSPROT, Signal peptide data bank; NCBI-BLAST; Structural data banks; The Cambridge Structural Database (CSD): Sequence alignment- pair wise sequence alignment, multiple sequence alignment and their importance.

**UNIT 11 (RESEARCH METHODOLOGY):**

Applications of basic and applied research; Essential steps in research - literature survey, defining the research problem, formulation and validation of hypothesis, designing experimental approach and execution of experiments, data compilation, analysis, presentation of research findings in graphs and tables, preparation of technical report; Design experimental approach - variables in the experiments, materials and methods, application of methods; Progress of research – evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communications; Scientific writing - Research report, thesis and dissertation, manuscript/research article, review monographs; Preparation of manuscript/dissertation for research proposals; literature citation, bibliography, impact factor of journals; Plagiarism - Software's used in plagiarism, ethics in manuscript writing; conflicts of interest; copyright issues; patents; Themes and role of different scientific funding agencies of India and abroad.

**UNIT 12: (ANALYTICAL BIO-TECHNIQUES)**

pH and Buffers; Centrifugation - Basic principles, types and applications of centrifugation; Chromatography - Paper Chromatography, TLC, Column Chromatography, GLC, HPLC, Affinity Chromatography; Electrophoresis; Northern blotting, Southern blotting, Western blotting; Radioactivity - GM counter, liquid scintillation counter, γ-counter; Isotope dilution techniques and Radioactive disposal. Principle, types and applications of Microscopy; Spectroscopy- Beer Lamberts law, UV, fluorimetry, flame photometry, spectroscopy.