

**SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR**



**SYLLABUS EFFECTIVE FROM: 2018-19
Under Choice Based Credit Scheme**

**M.Sc. GENETICS
SEMESTER-III**

Paper Code: PS03CGEN21		Total Credits: 4
Title of Paper: Genetics of Mammalian Development		
Unit	Description in detail	Weightage
1	<p>Overview of embryogenesis in mammals:</p> <p>Structures of spermatozoa and ovum Fertilization, Cleavage and blastulation, Gastrulation.</p> <p>Organogenesis and Stem cells</p> <p>Sex determination in mammals Types and functions of stem cells</p> <p>Development of human brain Epidermis and the origin of cutaneous structures.</p>	25 %
2	<p>Teratogenesis and Aging:</p> <p>Teratogenic agents, Classification of teratomas, Tumerogenesis</p> <p>Overview of tumor suppressor genes, protooncogenes and oncogenes Causes and genetic regulation of aging, Promoting longevity.</p>	25 %
3	<p>Gene expression during Development:</p> <p>Differential gene expression during development, RNA localization techniques</p> <p>Determination of functions of genes, Overview of transcriptional factors and human development.</p>	25 %
4	<p>Medical implications of Developmental biology:</p> <p>Genetic errors of human development, Identification of defective genes Nature of human syndromes, Gene expression and human diseases Infertility.</p>	25 %

Basic Text & Reference Books:

- Scott F Gilbert, Developmental Biology, 8th edition, Sinauer Associates Inc., USA. ISBN 0-87893-250-X
- Shastry and Shukal, Developmental Biology, Rastogi Publications, ISBN 81-7133-734-1
- Klug W. S. & Cummings M. R. Concepts of Genetics. Seventh edition. Pearson Education. ISBN 81-317-0811-X
- WWW.devbio.com
- Fundamentals of Genetics by B D Singh.
- P. K. Gupta, Genetics. Rastogi Publications, Meerut, India, ISBN: 81-7133-842-9.
- Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. Eighth edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.
- Elements of Breeding and breeds of cattle and Buffalo- P Kanakraj, Jaypee Brothers Medical, ISBN:978-8180618420

Paper Code: PS03CGEN22		Total Credits: 4
Title of Paper: Human Molecular Genetics		
Unit	Description in detail	Weightage
1	<p>Genetic mapping: Genetic and physical map, Genetic markers, Synteny of genes, Assembly of clone contigs, Positional cloning and chromosome walking.</p> <p>Identifying human diseases genes: Principles and strategies, Position-independent and positional cloning. Candidate gene approaches.</p> <p>Studying whole genome: Pulse field gel electrophoresis, Cloning and sequencing of DNA.</p>	25 %
2	<p>Monogenic and polygenic disorders</p> <p>An overview of the genetic basis of syndromes and disorders: Genetic susceptibility to common diseases, Monogenic and Polygenic diseases with well known molecular pathology</p> <p>Monogenic diseases (Huntington's disease, Neurofibromatosis, Cystic fibrosis, Hemophilia A and B, Trinucleotide repeat expansion mutations).</p> <p>Polygenic diseases (Diabetes mellitus, Obesity and Cancer).</p>	25 %
3	<p>Biochemical Genetics</p> <p>Inborn errors of metabolism (Molecular and biochemical pathways in Phenyl ketonuria, Alkaptonuria, Maple syrup urine disease, Albinism, Mucopolysaccharidosis, Lipidosis and Glycogen storage disorders).</p> <p>Human mitochondrial syndromes.</p>	25 %
4	<p>Over view of Human genome projects and its practical implications</p> <p>DNA testing: Screening for unknown mutations, Detection of known mutations.</p> <p>Pharmacogenetics: Definition, drug metabolism, genetic variation revealed solely by the effect of drugs, Hereditary disorders with altered drug response, pharmacogenomics, ecogenetics.</p> <p>Social and ethical issues in medical genetics</p>	25 %

Basic Text & Reference Books:

- Human molecular Genetics, Strachan T. & Read A.P., 3rd edition, published by Garland Science, 2004. 978-0815341840.
- Genetics in medicine by Thompson and Thompson, 7th edition, published by Elsevier Science ISBN: 978-81-312-1819-9.
- Lecture Notes on Molecular Medicine, Bradley J., Johnson D.& Rubenstein D., 2nd edition, published by Blackwell Science, 2001. ISBN: 0632058390.
- Principle of gene manipulation by Primrose, S. B. & Twyman R. M. & Old, R. W. 6th ed. Blackwell Science, USA. ISBN: 0-632-05954-0.
- Principles of Genetics by Gardener, Eldon John., Simmons, Michael J., Snustad, D. Peter., 8th Edition, John Wiley & Sons Publications, New York. ISBN: 9971-51-346-3.
- Principles of Genetics-Sinnot, Dunn & Dobzhansky, Tata-McGraw Hill India, New Delhi. ISBN: 978-0070994133
- Genetics 3rd Ed. By M. W. Strickberger, Prentice-Hall of India (P) Ltd, New Delhi, ISBN: 81-203-0949-9.
- Essentials of Human Genetics by S.M. Bhatnagar et al, 4th Edition, (1999), Orient Longman. ISBN: 81-250-1426-8
- Topic related review articles.

Paper Code: PS03CGEN23		Total Credits: 4
Title of Paper: Genetics in Crop Improvement		
Unit	Description in detail	Weightage
1	<p>Introduction to Crop Improvement:</p> <p>Methods for crop breeding</p> <p>Self pollinated crops - pure line theory and pure line method, pedigree method, Bulk population method and Back cross method of crop breeding.</p> <p>Cross pollinated Crops- Theory of selection and response to selection, Mating systems and their consequence Male sterility and its types, Applications of male sterility in crop improvement.</p> <p>Heterosis breeding and Hybrid varieties. Polyploidy and mutation breeding as methods of crop improvement.</p>	25 %
2	<p>Tissue culture for Crop Improvement:</p> <p>Production and uses of haploids - Anther culture, Pollen culture, Chromosome elimination (Bulbosm method), Ovule culture, Detection of haploids, Methods for diploidization of haploids, Uses of haploids and dihaploids in crop improvement.</p> <p>Somatic hybrids – Isolation of protoplast, culture and purification of protoplasts, Viability and plating density of protoplast, Protoplast fusion and somatic hybridization.</p>	25 %
3	<p>Somaclonal variation for Crop Improvement and Transgenic in Crop Improvement - I</p> <p>Definition, Schemes for obtaining somaclonal Variation, Factors influencing somaclonal variation, genetic basis of somaclonal variation, Applications and disadvantages of somaclonal variation.</p> <p>Resistance to biotic stresses- Insect resistance, Virus resistance, Bacterial and fungal disease resistance.</p>	25 %
4	<p>Transgenic in Crop Improvement - II and Molecular markers for Crop Improvement</p> <p>Resistance to abiotic stresses-, Salt resistance, Drought resistance Herbicide resistance Transgenic for quality improvement, Commercial transgenic crops.</p> <p>Non – PCR based approaches- RFLP (Procedure, Construction of RFLP maps, Uses of RFLP) PCR based approaches- Random Amplified Polymorphic DNA (RAPD), DNA Amplification Fingerprinting (DAF), Arbitrarily Primed Polymerase Chain Reaction (AP-PCR), Amplified Fragment Length Polymorphism (AFLP), Simple Sequences Repeat (SSR), Marker Assisted Selection (MAS) and DNA Barcoding.</p>	25 %

Basic Text & Reference Books:

- Principles of plant breeding by Robert W. Allard, Johan Wiley and Sons. ISBN-047023094.
- Plant breeding by Briggs and Knowles, Reinhold Publishing Crop , Newyork.ISBN-0-582-45586-3
- Plant tissue culture: Theory and Practice by S. S. Bhojwani and M. K. Razdan, Springer Publication.ISBN:-0-444-81623-2
- Plant tissue culture manual by K. Lindsey, Springer Publication. ISBN:81-8128-582-4
- Introduction to plant tissue culture by M.K. Razdan, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN: 81-204-1571-X
- Experiment in plant tissue culture by John H. Dodds and Lorin W. Robert, Cambridge University Press. ISBN: 0521299659
- Plant propagation by tissue culture by George and Sherington, Exegetics Publisher. ISBN:978-0950932507
- Micropropagation by plant tissue culture by Reinert and Bajaj, Springer Publication, Netherland. ISBN: 978-1-4020-5004-6
- Introduction to plant biotechnology by H. S. Chawla, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN:81-204-1549-3
- Fundamentals of genetics by B. D. Singh, Kalyani Publication, New Delhi. ISBN: 81-272-3292-0
- Element of biotechnology by P. K. Gupta, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN: 81-7133-481-4
- Genetics by P. K. Gupta, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN: 81-7133-842-9
- Practical applications of plant molecular biology by R.J. Henry, Chapman and Hall.ISBN:978-041273201
- Plant propagation by tissue culture (Vol.1&2) by Edwin George, Springer Publication, Netherland.ISBN: 1402050046
- Plant Breeding: Theory and Practice by V.L. Chopra, intercept Ltd. ISBN: 8120403886
- General Plant Breeding by A. R. Dabholkar, Concept Publishing Company. ISBN: 8180692426
- Plant Genotyping: The DNA Fingerprinting of plants by R. J. Henry, CABI Publishing. ISBN: 0857995152
- DNA fingerprinting in plants: Principle, method and application by Kurt Weising, Kirsten Wolf,Hilde Nybom, CRC Press. ISBN: 0849314887.
- Practical manual of plant tissue culture by H. S. Chawla, Oxford and IBH Publishing Co. Pvt Ltd,New Delhi. ISBN: 81-204-1613-9.

PS03CGEN24 : Practical-I (Practical Based on PS03CGEN21 & PS03CGEN22)

PS03CGEN25 : Practical-II (Practical Based on PS03CGEN23 & PS03EGEN2X)

Paper Code: PS03EGEN21	Total Credits: 4
Title of Paper: Advanced Immunology	

Unit	Description in detail	Weightage
1	<p>Experimental systems and methods for diagnostics and therapy: Antibody generation (polyclonal, monoclonal, modification of monoclonal antibodies), Methods to Determine the Affinity (<i>Equilibrium dialysis, surface Plasmon resonance</i>), Microscopic visualization of cells and sub cellular structures (<i>Immunocytochemistry, Immunohistochemistry, Immunoelectron microscopy</i>), Immunofluorescence-Based Imaging Techniques of Antigen-Antibody Interactions (<i>Flow cytometry, Magnetic activated cell sorting, cell cycle analysis, assays of cell death</i>).</p> <p>Antibody Engineering: Chimeric and hybrid monoclonal antibodies, Construction of monoclonal antibodies from Ig-gene libraries.</p> <p>Vaccines: Active and passive immunization, conjugate or multivalent vaccines, DNA vaccines, vaccines under development – malaria and cancer.</p>	25 %
2	<p>T cell Development: Early Thymocyte Development, Positive and Negative Selection, Lineage Commitment, Exit from the Thymus and Final Maturation, Other Mechanisms That Maintain Self-Tolerance, Apoptosis.</p> <p>B cell Development: The Site of Hematopoiesis, B-Cell Development in the Bone Marrow, The Development of B-1 and Marginal-Zone B Cells, Comparison of B- and T-Cell Development.</p> <p>T-Cell Activation, Differentiation and Memory: T-Cell Activation and the Two Signal Hypothesis, T-Cell Differentiation, T-Cell Memory.</p> <p>B-Cell Activation, Differentiation and Memory generation: T-Dependent B-Cell Responses, T-Independent B Cell Responses, Negative Regulation of B Cells.</p>	25 %
3	<p>Allergy, Hypersensitivity and Chronic inflammation:</p> <p>Allergy: Type I Hypersensitivity Reaction, Antibody-Mediated (Type II) Hypersensitivity Reactions, Immune Complex-Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity (DTH), Chronic Inflammation.</p> <p>Transplantation immunology: Immunological principles of graft rejection, Role of T cells in graft rejection, Role of Blood Group and MHC Antigens in Graft Tolerance, Predictable clinical course of graft rejection, General and target specific immunosuppressive therapy, Circumstances favoring.</p>	25 %
4	<p>Immunodeficiency disorders: Primary and secondary immunodeficiencies.</p> <p>Cancer and immune system: Terminology and Common types of cancer, Malignant transformation of cells, Tumor antigens. The Immune Response to Cancer, Cancer immunotherapy.</p> <p>Tolerance and autoimmunity: Establishment and maintenance of tolerance (<i>antigen sequestration, central tolerance, peripheral tolerance</i>), Autoimmunity (<i>Organ specific autoimmune disease, systemic autoimmune disease, intrinsic and extrinsic factors that can favor susceptibility to autoimmune disease, proposed</i></p>	25 %

Basic Text & Reference Books:

1. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology* (7th Edn). New York: WH Freeman.
2. Murphy, K., & Weaver, C. (2016). *Janeway's immunobiology* (9th Edn) Garland Science.
3. Male, D., Brostoff, J., Roth, D., & Roitt, I. (2012). *Immunology* (8th Edn) *With STUDENT CONSULT Online Access*. Elsevier Health Sciences.
4. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). *Cellular and molecular immunology* (6th Edn) Elsevier Health Sciences.
5. Relevant review articles / research papers / handouts of latest development in the subject.

Paper Code: PS03EGEN22	Total Credits: 4
Title of Paper: Bioinformatics	

Unit	Description in detail	Weightage
1	<p>Introduction to Bioinformatics: Overview, Internet and bioinformatics, Applications.</p> <p>Introduction and Bioinformatics Resources:</p> <p>Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases:</p> <p>Nucleic acid sequence databases: GenBank, EMBL, DDBJ</p> <p>Protein sequence databases: SWISS-PROT, TrEMBL, PIR, PDB, SCOP, CATH</p> <p>Genome Databases at NCBI, EBI, TIGR, SANGER</p> <p>Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources)</p> <p>Sequence analysis:</p> <p>Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrfpir etc.</p> <p>Basic concepts of sequence similarity, identity and homology, Definitions of homologues, orthologues, paralogues, xenologus.</p> <p>Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.</p> <p>Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA.</p> <p>Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wunsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA.</p> <p>Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.</p>	25 %
2	<p>Gene prediction:</p> <p>Gene structure in Prokaryotes and Eukaryotes, Gene prediction methods: Neural Networks, Pattern Discrimination methods, Signal sites Predictions, Evaluation of Gene Prediction methods.</p> <p>Computational RNA Structure analysis:</p> <p>Secondary and tertiary structure of RNA. Various algorithms of RNA folding and their analysis. Energy minimization in RNA folding. RNA sequence alignment based on secondary structure and its applications in functional genomics and phylogeny.</p> <p>Transcriptomics:</p>	25 %

	Complete transcript cataloguing and gene discovery sequencing based approach, Microarray based technologies and computation based technologies.	
3	<p>Genomics:</p> <p>Concepts and tools for genomics and comparative Genomics</p> <p>Ancient conserved regions</p> <p>Horizontal gene transfer</p> <p>Functional classification of genes</p> <p>Gene order (synteny) is conserved on chromosomes of related organisms.</p> <p>Prediction of gene function based on a composite analysis. Functional genomics.</p> <p>Putting together all of the information into a genome database.</p> <p>Phylogenetic analysis:</p> <p>Definition and description of phylogenetic trees and various types of trees, Molecular basis of evolution, Method of construction of Phylogenetic trees: Distance based method (UPGMA, NJ), Character Based Method (Maximum Parsimony and Maximum Likelihood method).</p>	25 %
4	<p>Proteomics and Protein Computational Biology:</p> <p>Tools for proteomics: Acquisition of protein structure information, databases and applications.</p> <p>Structural classification of proteins, Protein structure analysis structure alignment and comparison,</p> <p>Secondary structure and evaluation: algorithms of Chou Fasman, GOR methods.</p> <p>Tertiary Structure: basic principles and protocols, Methods to study 3D structure. prediction of specialized structures.</p> <p>Active site prediction, Protein folding, Protein modeling and drug design.</p> <p>Protein structure comparison and classification:</p> <p>Classes, folds, motif, domain; the concepts in 3D structure comparison, purpose of structure comparison, algorithms such as FSSP, VAST and DALI. Principles of protein folding and methods to study protein folding.</p>	25 %

Basic Text & Reference Books:

Bioinformatics: A Beginners Guide, Clavarie and Notredame
 Bioinformatics: David Mount
 Bioinformatics: Rastogi
 Introduction to Bioinformatics: Arthur M. Lesk
 Bioinformatics: Principles and applications, Ghosh and Mallick
 Bioinformatics: Genes, Proteins and Computer, C A Orengo
 Protein Structure Prediction: Methods and Protocols, Webster, David
 (Southern Cross Molecular Ltd., Bath, UK)

Paper Code: PS03EGEN23	Total Credits: 4
Title of Paper: Omics and Computational Biology	

Unit	Description in detail	Weightage
1	<p>Genomics and methods in genomics</p> <p>Introduction to the proteome and the genome, codon bias, gene expression, Genome size-C value paradox, DNA sequencing: Maxam- Gilbert, Sanger, Pyrosequencing, automated DNA sequencing. Other features of nucleic acid sequencing. Analysis and Annotation-ORF.</p> <p>Exon-intron boundaries, DNA Microarray technology: The generation of cDNA expression libraries, their robotic arraying, Complex hybridization on DNA chips.</p> <p>Transcriptomics: Comparative transcriptomics, Differential gene expression; Genotyping/SNP detection; Detection technology; Computational analysis of microarray data.</p>	25 %
2	<p>Proteomics and methods in proteomics</p> <p>Relationship between protein structure and function, Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting; Common ionization methods for peptide/protein analysis; Introduction to Mass spectrometers; MALDI-TOF and LCMS analyses.</p> <p>Protein-protein interactions: Solid phase ELISA, pull-down assay (using GST-tagged protein), far western analysis, surface plasmon resonance technique, Yeast two hybrid system, Phage display; Protein interaction maps.</p> <p>Protein arrays-definition, applications- diagnostics, expression profiling. Uses of automated technologies to generate protein arrays and chips.</p>	25 %
3	<p>Introduction to computational biology basics and biological databases</p> <p>Computers in biology, Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage.</p> <p>Pairwise and multiple sequence alignments: Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.</p>	25 %
4	<p>Genome analysis</p> <p>Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project.</p> <p>Structure visualization: Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.</p>	25 %

Basic Text & Reference Books:

- Discovering Genomics, Proteomics and Bioinformatics, A.M, Campbell, C,S,H, Press, (2003).
- Essential of Genomics and Bioinformatics C,W, Sensen, Wiley (2003).
- Hand book of Comparative Genomics: Principle and Methodology by Cecilia Saccone, GrazianoPesole, Wiley-LISS publication (2003).
- Proteomics: From protein sequencing to function by S.R. Pennington and M.J. Dunn, Private Ltd (2001).
- Introduction to Proteomics by Daniel C, Liebler, Humana Press.
- Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
- Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
- Campbell, M & Heyer, L. J. (2006), Discovering Genomics, Proteomics and Bioinformatics, Pearson Education.