

SOLAPUR UNIVERSITY, SOLAPUR
M. Sc. –II- GENETICS
SYLLABUS
(CHOICE BASED CREDIT SYSTEM)
(w.e.f. June-2016-17)

The syllabus of M.Sc. - Genetics course of two years duration has been prepared as per the Choice based credit system (C.B.C.S.). M. Sc. II syllabus is to be implemented from June 2016. The syllabus of M. Sc. Part I was implemented with effect from June 2015. The syllabus has been prepared taking into consideration the UGC guidelines, SET, NET examination syllabus, the syllabus of other universities and the specific inputs of the Expert Committee Members.

General Structure of the Course: The course will be of four semesters spread over two academic years. Each semester will have four theory papers of 70 marks each for University External Examination and 30 marks each for Internal Examination and two practical courses of 70 marks each for University External Examination and 30 marks each for Internal practical course. The distribution of marks is as mentioned below.

Theory Paper (Semester Exam),	16 X (70+30) marks	1600 marks
Practical's (Semester End Exam.),	8 X (70+30) marks	800 marks
Seminars for each Semester,	4 X (25 Marks)	100 marks

Total: 2500 marks

Semester I

Theory Paper No.	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
I	Concepts of Genetics	70	30	100	4
II	Biostatistics and Population genetics	70	30	100	4
III	Cytogenetics and Genome Organization	70	30	100	4
IV	Cellular and Molecular Biology	70	30	100	4
Practical Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
I	Concepts of Genetics, Biostatistics and Population genetics	70	30	100	4
II	Cytogenetics, Genome organization, Cellular and Molecular Biology	70	30	100	4
	Seminar – I	--	25	25	1
				625	25

Semester II

Theory Paper No.	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
V	Regulation of gene expression and developmental genetics	70	30	100	4
VI	Concepts of Biochemistry	70	30	100	4
VII	Advanced microbial genetics	70	30	100	4
VIII	Plant breeding and Tissue culture	70	30	100	4
Practical Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
III	Regulation of gene expression and developmental genetics and Concepts of Biochemistry	70	30	100	4
IV	Advanced microbial genetics, Plant breeding and Tissue culture	70	30	100	4
	Seminar – II	--	25	25	1
				625	25

Practical Course: (Semester End Examination) Practical Paper - I to IV for semester I and II. Practical Examination will be of 4 days (per day per subject) for each semester

SEMESTER III

Theory Paper No.	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
IX	Immunology & Immunotechnology	70	30	100	4
X	Cancer Genetics and Stem Cell Research	70	30	100	4
XI	Analytical Instruments and Techniques.	70	30	100	4
XII* OPEN ELECTIVE	A) Bioinformatics , Research Methodology and Scientific report writing OR B) Human Genetics	70	30	100	4
Practical Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
V	Immunology and Immunotechnology	35	15	50	2
VI	Cancer genetics and stem cell research	35	15	50	2
VII	Analytical Instruments and techniques	35	15	50	2
VIII* OPEN ELECTIVE	A) Bioinformatics and Research Methodology OR B) Human genetics	35	15	50	2
	Seminar – III	--	25	25	1
				625	25

*Theory Paper - XII is offered as an elective under CBCS to the students.

SEMESTER-IV

Theory Paper No.	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
XIII	Genetic Engineering	70	30	100	4
XIV	Molecular Medicine	70	30	100	4
XV	Agriculture Science and Seed Technology	70	30	100	4
XVI* OPEN ELECTIVE	A) Industrial Biotechnology and Intellectual Property Rights OR B) Animal Cell Culture	70	30	100	4
Practical Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
IX	Genetic Engineering, Molecular Medicine, Agriculture Science and Seed Technology.	70	30	100	4
X* OPEN ELECTIVE	A) Industrial Biotechnology and Intellectual Property Rights (IPR) OR B) Animal Cell Culture	35	15	50	2
XI**	Project Dissertation and Viva Voce	35	15	50	2
	Seminar - IV	--	25	25	1
				625	25

*Theory Paper –XVI is offered as an elective under CBCS to the students.

*Practical Paper – VIII & X are offered as elective under CBCS to the students

** Practical - XI – Project work has to be done by individual student. It may be in-house project including inter department/programme or projects in organizations outside the institution i.e. in Research Laboratories / Industry / other agencies

Practical Course (SEM-III): (Semester End Examination) Practical Papers – V to VIII for semester III Practical Examination will be of 4 days (per day per subject).

Practical Course (SEM-IV): (Semester End Examination) Practical Papers – IX will be of 2 days, Practical Paper -X will be of 1 day and Practical paper-XI will be of 1 day.

Summary:

Course	No. of Papers	Total marks	Examination Pattern		Total Credits
			UA	CA	
Core	14	1400	980	420	56
Elective	04 (any two)	200	140	60	08
Practical Course	08	800	560	240	32
Seminars	04	100	-	100	04
TOTAL		2500	1680	820	100

Nature of Examination: Each semester will have theory University external examination of four papers of 70 marks each (2 and 1/2 hrs. duration). The practical examination of Semesters I to IV will be conducted at the end of the each Semester. Duly certified copy of laboratory record must be produced at the time of examination.

University Practical Examination of M. Sc. II The practical examination will be of 4 days for each semester. There will be 70 marks University external practical examination while 30 marks internal examination. The distribution of marks for each Practical paper -V, VI, VII and VIII will be of 70 marks. Project work and its report of 35 marks will be included in P-VIII (B) whereas distribution of marks for P VIII (B) will be below:

The report shall be examined by the Examiners (appointed by the University) who will assign marks out of 35 for project work as follows:

- 1) Selection of the project topic - 05 marks
- 2) Literature review - 05 marks
- 3) Experimental Design - 05 marks
- 4) Result and Discussion - 05 marks
- 5) Conclusion and findings - 05 marks
- 6) Report Writing - 05 marks
- 7) Oral presentation and Viva - 05 marks

Total: 35 marks

** The valuation to be done by both external and internal examiners at the time of P V-VIII practical examination. Valuation of Seminars is to be done by Departmental Faculty involved in Genetics.

Nature of Theory question paper for each theory paper.

	SOLAPUR UNIVERSITY, SOLAPUR Nature of Question Paper for Semester Pattern (New CBCS) M.Sc. Genetics	
Time:- 3 hrs		Total Marks-70
Note: 1) Section - I Compulsory 2) Answer any four questions from Section - II		
Section - I		
Q. 1 A) Multiple choice questions		(07)
i) -----		
a) b) c) d)		
ii)		
iii)		
iv)		
v)		
vi)		
vii)		
B) Define the following terms		(07)
i)		
ii)		
iii)		
iv)		
v)		
vi)		
vii)		
Section - II		
Q. 2) Long answer type question		(14)
Q. 3) Long answer type question		(14)
Q. 4) Long answer type question		(14)
Q. 5) Answer any TWO of the following		(14)
i) Short answer type question		
ii) Short answer type question		
iii) Short answer type question		
Q. 6) Write Short notes on any TWO of the following		(14)
i) Short note		
ii) Short note		
iii) Short note		

N.B. In Q.5 and 6 the sub-questions (i, ii, and iii) in a given question should be from different topics of the syllabus.

At least 25 % questions should be problem oriented, where-ever possible, in view to train students for the SET/NET/GATE and other competitive examinations. These questions should test the understanding of candidate rather than the memory. The question paper should cover all the Units included in the syllabus of the respective paper and the weightage of the questions should correspond to the number of lectures allotted to the respective Units / Topics.

Paper-IX
Immunology and Immunotechnology

45L = 4 Credits

UNIT 1 Immunity: (09L)

Innate Immunity: Anatomical barriers, Chemical Barrier, Inflammation, Phagocytosis. Acquired immunity. Primary and secondary immune response. Cells and Organs of Immune System. B Cell generation, activation and differentiation; T Cell maturation, activation and differentiation-Cell mediated Immunity, Humoral immunity.

UNIT 2 Mediators: (09L)

Major Histocompatibility Complex: Introduction, Organization, MHC molecules and gene organization; Cytokines: Introduction, Properties and their functions, Complement system: Introduction and its function, Alternate and Classical pathway, Lectin pathway.

UNIT 3 Antigen and Antibody: (09L)

Antigen: Introduction, types of antigens, Factors affecting antigenicity. Endogenous and Exogenous, Antigen, Processing and presentation, Antibody: Introduction, basic structure, structure and biological function of antibody classes, Organization of Immunoglobulin gene, Genetics of antibody diversity; Monoclonal antibodies: Introduction, Steps in production, and Application.

UNIT 4 Immune disorders and vaccine: (09L)

Hypersensitivity, Autoimmunity: Organ specific and Systemic; Transplantation: Graft Rejection, Types of transplants, Immunosuppressive therapy; Cancer and Immune System. Vaccine: Traditional and new trend vaccines with their advantages and disadvantages.

UNIT 5 Immunotechnique and immune diseases: (09L)

Immuno-assay methods: Principle of antigen-antibody interactions, Immunoprecipitation, Agglutination, Complement fixation, Immunodiffusion, Immunoelectrophoresis, Immunofluorescence, RIA, ELISA, Flow cytometry. AIDS and Other Immunodeficiency diseases

Recommended Text Books:

- Basic and Clinical Immunology; Stites et al., [Ed.] (1982) Lange.
- Roitt's Essential Immunology; Ivan, M. Roitt & Peter J Delves (2001) Blackwell Science
- Immune System; M.C. Connel et al., [Eds.] (1981) Blackwell Science.
- Immunology at a Glance; J.H.L. Playfare [ed.] (1987), Blackwell Science.
- Immunology; Jan Klein [Ed.] (1990), Blackwell Science.
- Introduction to Immunology; Kim Bell [Ed.] (1990) 3 Ed. McMillan.
- NMS for Immunology; Hyde and Patnide [Eds.] (1990) John Wiley.
- Microbiology; Prescott, Harley and Klein, (2003) McGraw-Hill.
- Kuby-Immunology; Goldsby et al., (2000), WH Freeman &Co

Paper-X
Cancer genetics and Stem cell research

45L = 4 Credits

UNIT 1 Introduction to Cancer Biology: (9L)

Cancer cell vs. Normal cell; Hallmarks of cancer cell; Cell cycle - Regulation of Cell cycle and Tumor suppressor genes (pRb tumor suppressor; P53 tumor suppressor); Oncogenes and Proto-Oncogenes; Factors activating proto-oncogene to oncogene (Tumor Virus; Physical and Chemical Carcinogene); Introduction to Epigenetics, Epigenetics in cancer

UNIT 2 Cancer Progressions: (9L)

Apoptosis mechanism, Apoptotic Pathways; Metastasis (Clinical significances of invasion, Metastatic cascade, Basement membrane disruption); Theory of invasion (Proteinases and tumour cell invasion; Angiogenesis and its sequence of events in detail

UNIT 3 Diagnostic and Treatment: (9L)

Methods of diagnosis - Chemotherapy, Radiation Therapy, Immunotherapy- use of immunotoxins in cancer therapy, retroviral drugs, Anti- angiogenic Drug; Drugs based on Epigenetics (Acetylation of Histones and Methylation of DNA)

UNIT 4 Stem Cell and Technology: (9L)

Basics, Properties and Classification. Types of Stem cells – Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells, Stem cells from adult organs. Characteristics, Isolation, Culture and Characterization protocols, Extra Cellular Matrices, Morphogenesis and Tissue Engineering, Principles of Tissue Culture

UNIT 5 Regenerative Medicine: (9L)

Tissue Engineering and Transplantation Technique, Immunoisolation Techniques , Modes of Cell and Tissue Delivery, Regeneration of Bone and Cartilage, Islet Cell transplantation and Bioartificial Pancreas Bioprinting of Organs and Tissues, Stem Cells in Gastrointestinal , Liver, Pancreas, Kidney, Heart, Spinal Cord and Lung Regeneration, Stem Cells in Eye Diseases and Disorders.

Recommended Text Books:

- The Biology of Cancer, Robert Weinberg, Garland Science; 2 edition;2010
- King R.J.B., Cancer Biology, Addison Wesley Longmann Ltd, U.K., 1996.
- Rudson.R.W., Cancer Biology, Oxford University Press, Oxford, 1995.
- Bishob J. A. 1982, Retrovirus ,Cancer genes, Advances in Cancer Research.
- Vogel F. Chemical mutagenesis Spinger and Verlag.
- Sanberg A. A. 1980, The Chromosome in Human Cancer And Leukemia
- Stich H. F. Carcinogens and Mutagens in EnvironmentCRC press.
- R. Lanza, J. Gearhart et al (Eds), Essential of StemCell Biology. (2009), Elsevier Academic press.
- R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009)
- J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering & Regenerative Medicine 2008, Artech House, INC Publications.
- Robert Lanza et al. Principles of Tissue Engineering, 3rd Edition. Academic Press;
- 3 edition (August 21, 2007)

- Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual. Wiley-Blackwell; 1 edition (January 4, 2011)
- Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells(v. 1).Academic Press (September 28,2004)

Paper-XI
Analytical Instruments and Techniques

45L = 4 Credits

UNIT 1 Microscopy: (9L)

Introduction; Optical principles of Microscopy; Image formation by compound light microscope & electron microscope; Types of Microscopes - Inverted, Phase-contrast, Bright field, Dark field, Fluorescence microscope; Advanced Microscopy- Scanning electron Microscopy, Transmission electron Microscopy, Confocal Microscopy.

UNIT 2 Spectroscopy: (9L)

Introduction; Instrumentation & Applications of Colorimetry, UV Spectroscopy, VIS. Spectroscopy, Atomic Absorption Spectroscopy, X- ray spectroscopy, IR Spectroscopy & Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Mass Spectroscopy.

UNIT 3 Radioactivity: (9L)

Nature of Radioactivity; Isotope, Production of isotopes, Synthesis of labeled compounds; Labeling procedures. Detection & Measurement of Radioactivity - A) Methods Based on Gas Ionization- Ionization Chamber, Proportional Counters, GM Counters B) Methods Based on Excitation- Solid Scintillation counting, Liquid Scintillation counting. C) Photographic method. Autoradiography; Applications of Radioisotopes in Biological Sciences; Safety measures.

UNIT 4 Electrophoresis: (9L)

Basic principle of electrophoresis; Factors affecting electrophoretic mobility; Support Media. Types of electrophoresis; Theory & Applications of Paper, Starch gel, Agarose, Cellulose Acetate, High Voltage, Pulse field gel electrophoresis, Native PAGE, SDS-PAGE, Isoelectric focussing, Electrophoresis on cellular gels, Capillary Electrophoresis; Blotting Techniques: Southern, Northern, Western Blotting, Dot Blot.

UNIT 5 Chromatography: (9L)

Introduction and types of chromatography – Plane, Paper, TLC, Column Chromatography. Principle, procedure and applications of Adsorption, Affinity, Gel Permeation, Ion Exchange, Gas Liquid chromatography, Fast Protein Liquid Chromatography(FPLC), High Performance Liquid Chromatography (HPLC), Gas Chromatography- Mass Spectrometry(GCMS), Liquid Chromatography- Mass Spectrometry(LCMS)

Recommended Text Books:

- Analytical Biochemistry; D.J.Holme and H. Pick, 3rd Ed.(1998) Longman.
- Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work (1969) Vol. I & II, North Holland.
- Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, (1993), Blackwell Science.
- Methods of Enzymatic Analysis; Berg Meyer (1974) Vol. 1-X,
- Practical Biochemistry ; Principles and Techniques; K.Wilson and J. Walker (1995) 4th Edn. Cambridge University Press.
- Principles of Instrumental Analysis, (1980) 2nd Edn. Holt- Saunders.
- Principles and Techniques of Practical Biochemistry; Williams and Wilson (1981) 3rd Edn. Edward Arnold.

- Protein Purification Applications, S.L.V. Harris and Angal (1990) IRL Press.
- Protein Purification, Robert, K. Scopes (1988) 2 nd Edn. Springer-Verlag.
- Protein Purification Methods, S.L.V. Harris and Angal (1989) IRL Press.
- Techniques in Molecular Biology, Walker and Gastra (1983) Croom Helm.

OPEN ELECTIVE

Paper-XII

A) Bioinformatics and Research Methodology

45L = 4 Credits

UNIT 1 Introduction to bioinformatics:

(9L)

Introduction to genomics and proteomics; NCBI; SRS. BIOLOGICAL DATABASES [Introductory only]: Nucleic acid sequence databases:- EMBL, DDBJ, GenBank; Primary Protein sequence databases:- PIR, MIPS, Swiss – PROT, TrEMBL, NRL–3D; Composite Protein sequence databases: - NRDB, OWL, MIPSx, SWISS-PROT + TrEMBL; Secondary Protein databases:- PROSITE, PRINTS, BLOCKS, PROFILES, Pfam, IDENTIFY; Structure classification databases: - SCOP, CATH, PDBsum.; Structural Databases: - PDB, NDB, MMDB.

UNIT 2 Sequence analysis methods:

(9L)

Methods, Algorithms, tools and applications of Pairwise sequence analysis and multiple sequence analysis. Phylogenetic analysis: Elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, phylogenetic analysis tools- Phylip, ClustalW.

UNIT 3 Homology modeling:

(9L)

Homology modeling, prediction of protein structure from sequences, Secondary structure, three-dimensional structure prediction, Validation of 3-D structure (Ramchandran plot).

Molecular Modeling: Introduction, molecular mechanics, force field, potential energy functions, energy minimization, single point calculations, full-geometry optimization, conformational search, docking, molecular dynamics simulations, molecular modeling packages.

UNIT 4 Research Methodology:

(9L)

Definition, Importance and Meaning of Research, Objectives of research, Characteristics of Research, Types of Research. Steps in Research; Identification, Selection and Formulation of Research Problem, Research Design, Formulation of Hypothesis, Review of Literature.

Research Report: Components of Research report; Use of tables and figures in research report; Formatting and typing of research report, Plagiarism

UNIT 5 Thesis and Manuscript writing:

(9L)

Abstract, Introduction, Materials and Methods, Results and Discussion, Summary and conclusion, References (IMRAD). Preparation of Manuscript; Author instructions, modes of paper communication, criteria for publication. Computer and internet application in Research. Presentation of a scientific Paper, Preparation of Oral Presentation and Poster Presentation for conferences. Use of Audio-Visual aids in Presentation.

Recommended Text Books:

1. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
2. An introduction to Computational Biochemistry. (C. Stain Tsai, A JohnWiley and Sons, Inc., publications).
3. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
4. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
5. NCBI Web site: <http://www.ncbi.nlm.nih.gov>
6. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.
7. Research Methodology by Gurumani.

OPEN ELECTIVE

Paper-XII

B) Human genetics

45L = 4 Credits

Unit 1 History of Human Genetics and Inheritance: (9 L)

History of Human Genetics. Pedigrees- gathering family history, pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees. Monogenic traits: Autosomal inheritance (dominant, recessive), Sex linked inheritance, Mitochondrial inheritance, genomic imprinting and uniparental disomy, spontaneous mutations, mosaicism and chimerism, male lethality, X-inactivation.

Unit 2 Gene detection and Molecular pathology: (9 L)

Identifying human disease genes: Principles and strategies; Position-independent and positional cloning, Candidate gene approaches; Confirming a candidate gene- mutation screening, testing in animal models. Molecular pathology: Nomenclature of mutations and their databases; Loss-of-function and gain-of-function mutations in diseases.

Unit 3 Genetic syndromes: (9 L)

An overview of the genetic basis of syndromes and disorders. Monogenic diseases with well known molecular pathology (Cystic fibrosis). Inborn error of metabolism and their genetic base (Phenylketonuria,). Neurogenetic disorders: Major regions of human brain and nerve conduction, Syndromes due to triplet nucleotide expansion, Alzheimer's disease. Genetic disorder of Haemopoietic systems (Thalassemia). Complex polygenic syndrome (Diabetes mellitus).

Unit 4 Reproductive disorder: (8 L)

Reproductive disorders: Disorders of gonads, genital tracts and genitalia – Pseudohermaphroditism, True hermaphroditism, Gonadal dysgenesis, Anomalies of genital ducts. Infertility - Genetic basis of male infertility, Genetic basis of female infertility, Recurrent pregnancy loss.

Unit 5 Genetic counseling, Screening of diseases and Ethical issues: (10 L)

Components of genetic counseling: Physical examination (General and dysmorphology examination, Documentation), Legal and ethical considerations; Patterns of inheritance, risk assessment and counseling in common Mendelian and multifactor syndromes; Genetic testing: biochemical & molecular tests: in children, Indications for prenatal diagnosis, Indications for chromosomal testing, Noninvasive methods (Ultrasound, Embryoscopy, MRI, etc.); Invasive methods; Prenatal screening for Down's syndrome (maternal serum) & Neural tube defect; Pre-implantation genetic diagnosis; Ethical issues in pre-natal screening & diagnosis.

Recommended Books

1. Human Molecular Genetics, Fourth Edition 4th Edition by Tom Strachan (Author), Andrew Read (Author), 2015
2. Genetics and Genomics in Medicine 1st Edition by Tom Strachan (Author), Judith Goodship (Author), Patrick Chinnery (Author), 2014
3. Human Genetics and Genomics, 4th Edition, by Bruce r. Korf and Mira B.Irons, Wiley

Blackwell publication (2013,2014,15)

4. Human Genetics 4th edition, Author : Gangane, Publisher : Elsevier India
5. Essentials of Medical Genetics, Connor & Smith, Blackwell
6. Human Genetic Disease Analysis Davies IRL

PRACTICALS

SEMESTER- III (Practical)

Practical Paper-V: Immunology and Immunotechnology

1. Ouchterlony Immuno-diffusion.
2. Radial immuno-diffusion.
3. Blood typing
4. Rocket Electrophoresis
5. ELISA
6. WIDAL test
7. VDRL test
9. Differential staining of Blood.
10. RBC and WBC counting

Practical Paper-VI: Cancer genetics and Stem cell research

1. *In vitro* assay of drugs, predictive test for anticancer drugs.
2. Immuno histochemical staining (oncogene expression).
3. Study of malignant and benign tumor (Diagrammatic)
4. Study of Metastasis (Diagrammatic)
5. Study of Angiogenesis (Diagrammatic)
6. Study of cancer cell behavior in culture medium.
7. Study of cancer diagnosis methods (Chemotherapy, Radiation therapy and Immunotherapy).
8. Case study of treatment of any disease using Gene therapy
9. Case study of treatment of any disease using Stem Cell Therapy
10. Study of different types of stem cells.

Practical Paper-VII: Analytical Instruments and techniques

1. Detail study of various parts of following microscopes
 - Compound Microscope
 - Inverted Microscope
2. Electrophoresis of Nucleic acid (DNA and RNA) and serum proteins.
3. SDS-PAGE for protein mol. wt. determination
4. Ion exchange chromatography
5. Separation of proteins by 2D gel electrophoresis.
6. UV spectra of protein/ Protein estimation using UV Spectroscopy
7. UV spectra of nucleic acid/ Nucleic acid estimation using UV Spectroscopy
8. Colorimetric estimation of inorganic phosphate.
9. Ascending Paper chromatography 1. Leaf Pigment 2. Amino Acids
10. TLC of Amino Acids.

OPEN ELECTIVE

Practical Paper-VIII: A) Bioinformatics and Research methodology

1. Retrieval of amino acid/Gene sequence from NCBI/SRS from EBI and studying file format.
2. Studying of pair-wise alignment of given sequences by BLAST/FASTA.
3. Studying multiple alignment of given sequence by Clustal X/W (Offline tool)
4. Retrieval of 3D structure of proteins from PDB and visualization by RasMol/Chimera.
5. Identification of Gene structure in genomic DNA by GENSCAN.
6. Prediction of secondary structure, folding classes of proteins and 3D Structure prediction and validation of it.
7. Study of Plagiarism for given articles.
8. Practicals on Research methodology : Preparation of Research papers, Poster and oral Presentation for conferences.
9. Preparation of Manuscript for publication.
10. Preparation of Scientific report and review article.

OPEN ELECTIVE

Practical Paper-VIII: B) Human genetics

1. Karyotyping Study of normal and abnormal cells
2. Pedigree analysis for autosomal recessive and dominant disease.
3. Pedigree analysis Sex-linked inheritance
4. Pedigree analysis Mitochondrial inheritance
5. Study of Genetic disorder (Thalassemia, Atherosclerosis, Diabetes mellitus) by using ICT.
6. Study of Reproductive disorders Pseudohermaphroditism by using ICT.
7. Study of male and female infertility.
8. Study of Noninvasive methods (Ultrasound, Embryoscopy, MRI)
9. Study of Prenatal screening for Down's syndrome (maternal serum)
10. Study of Prenatal screening Neural tube defect; Pre-implantation genetic diagnosis

❖ SEMINAR-III

(25 Marks, Credit-1)

SEMESTER- IV

Paper XIII: Genetic Engineering

45L = 4 credit

UNIT 1 Enzymes, Vectors & Probes in Cloning: (9L)

Restriction Enzymes - Exonucleases, Endonucleases; Restriction Endonucleases – Classification & Properties; DNA Manipulating Enzymes - Nucleases, DNA Polymerases, RNA Polymerases, Reverse Transcriptase; Nucleic Acid modifying enzymes - Ligases, Alkaline Phosphatases, Terminal Transferases, Kinases; Gene Cloning Vectors - Properties & Structure of Plasmids, Cosmids, Phagemids, Shuttle Vector, BAC, YAC, Bacteriophages (λ and M13), Yeast vector. Molecular Probes - Preparation of genomic DNA probes, C-DNA probes.

UNIT 2 Introduction & Commonly used techniques in Genetic Engineering: (9L)

Introduction; Commonly used techniques: Chromosome walking, Molecular markers: Restricted Fragment Length Polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP), PCR and its types (Inverse, Real time, Reverse transcriptase).

UNIT 3 Recombinant DNA Technology: (9L)

Construction of r-DNA Molecules - Isolation of Vector and donor DNA and its purification; Assembly of gene of interest and vector DNA; Introduction to genomic library; Construction of Genomic library; C-DNA library construction; Screening of Recombinant Cell - Direct Screening, Indirect Screening, Colony hybridization, Immuno-Screening; Fusion protein.

UNIT 4 Cloning and Transformation methods: (9L)

Methods of direct transformation - PEG mediated microinjection, particle bombardment, electroporation, CaCl₂; Methods of indirect transformation - *Agrobacterium tumefaciens* and *A. rhizogenes*; DNA sequencing: Maxam's and Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing.

UNIT 5 Applications of Genetic Engineering: (9L)

rDNA Technology in Human Health - Production of recombinant hormones: insulin, HGH, Hepatitis-B recombinant vaccine production; Synthesis of Human Interferon; GE in Plants - Insect-resistant plants, Herbicide-resistant plants, Development of salt stress tolerant plants, plant as edible vaccines, Modification of food plants taste (Sweetness); GE in Animals - Transgenic sheep and mice (mice as model for Alzheimer); GE in Microbes - Diagnosis of Malaria, *Trypanosoma cruzi* and sickle-cell anemia.

Recommended Text Books

- An Introduction to Genetic Engineering, 2nd Edition, Desmond S.T. Nicholl, Cambridge University Press (2006)
- Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Edition, B.R. Glick and J.J. Pasternak, ASM Press (2007)
- Principles of Gene Manipulation and Genomics, 7th Edition, S.B. Primrose and R.M. Twyman, Blackwell Publishing (2006)
- Molecular Biotechnology, 2nd Edition, S.B. Primrose, Panima Publishing (2001)
- Introduction to Biotechnology, Low Price Edition, W.J. Thieman and M.A. Palladino, Peason Education (2007)

- Genetic Engineering : Principles And Practice, Sandhya Mitra, Macmillan India (1996)
- Genetic Engineering: Principles and Methods, Setlow J.K., Kluwer Academic, Publishers. (2000)
- Genetic Engineering, Yount L., Gale Group (2002)
- Molecular Cloning: A Laboratory Manual (Volume - I, II & III) Sambrook J., D.W. Russell, Cold Spring Harbor Laboratory Press (2001)
- Gene Cloning and DNA Analysis: An Introduction, 4th edition, Brown T. A., Blackwell Science Inc (2001)
- Recombinant DNA: Genes and Genomes - A Short Course, 3rd Edition, James D.

**Paper XIV:
Molecular Medicine**

45L = 4 credit

UNIT 1 Human Molecular Genetics: (9L)

Human genome project; Sequence Architecture of human genome; Blood and Blood group Antigens; MHC Antigen – HLA; Identification and isolation of disease genes – Positional cloning, Functional cloning, Microarray technology; Pre-natal diagnosis - Chorionic villus sampling, Amniocentesis; Forensic testing - DNA fingerprinting, DNA footprinting, Paternity testing.

UNIT 2 Genetic Diseases in Human: (9L)

Cystic fibrosis, Duchenne muscular dystrophy, Haemoglobinopathies, Agammaglobulinemia, Marfan syndrome, Huntington's disease, Phenylketonuria, Down syndrome, Parkinson's Disease, Alzheimer's Disease.

UNIT 3 Stem Cell as Regenerative medicine: (9L)

Introduction; Stem cell sources; unique properties of stem cells; Classification - Embryonic stem cells, Adult stem cells; Similarities and differences between adult and embryonic stem cells; Applications of Embryonic stem cells and ethical issues associated with it; Adult stem cell Differentiation, plasticity, types of adult stem cells; Stem cell specific transcription factors - Induced pluripotent stem cells (iPSC); Therapeutic applications as regenerative medicine.

UNIT 4 Gene Therapies: (9L)

Introduction; Types of Gene therapy: Somatic and Germ line gene therapy, *In-vivo* and *Ex-vivo* gene therapy; Virus based vehicle for gene therapy, Non Viral Methods of Gene transfer.

UNIT 5 Pharmacogenetics : (9L)

Steps involved in Drug Discovery/Design - Insilco method, Structure based method, Nature and Sources of drugs; Route of drug administration; Absorption and Bioavailability of drugs in system; Excretion of drugs from system; Pharmacogenetics study of drug.

Recommended Text Books

- Peter Sudbery, Ian Sudbery, 2009, Human Molecular Genetics, 3rd edition, Pearson education limited.
- Leaf Huang, Mien-Chie Hung, Ernst Wagner, 1999, Non viral vectors for gene therapy, Academic press.
- Max Levitan, Ashley Montagu, 1977, text book of Human Genetics, 2nd Ed. Oxford University press, N.Y.
- Tom Strachan & Andrew P. Read. 2004, Human Molecular Genetics, 2nd Ed. John Wiley & Sons. (Asia) PTE Ltd.
- Ricki Lewis. Human Genetics- Concepts and Applications, 3rd Ed. WCB, McGraw-Hill.
- Amita Sarkar. 2001, Human Genetics, Dominant Publishers, VOL No-1&2 New Delhi.
- Nagy A, Gertenstein M, Vintersten K, Behringer R (2003). Manipulating the Mouse Embryo, New York: Cold Spring Harbor Press.
- Gilbert SF. (2000) Developmental biology, 6th edition Sunderland, MA: Sinauer Associates, Inc.

Paper XV:
Agriculture Science and Seed Technology

45L = 4 credit

UNIT 1 Plant Physiology: (9L)

Plant physiology and its significance in agriculture; Physical properties and chemical constitution of protoplasm; plant cell water relation - imbibition, surface tension, diffusion, osmosis; Absorption and translocation of water and nutrients; Transpiration; Guttation; Mineral deficiencies and their symptoms; Photo respiration; Plant Growth hormones – Auxins, Gibberellins, Abscisic acid, Cytokinins, Pheromones; Growth inhibitors and their use in agriculture; Tropism in plants photoperiodism and vernalization; Seed dormancy and germination, Fruit ripening process and its control.

UNIT 2 Soil Science and Agricultural Chemistry: (9L)

Soil as a medium of plant growth and its composition; Soil Types in India; Mineral and organic constituents of soil and their role in crop production; Chemical, physical and microbiological properties of soil; Essential plant nutrients, Principles of soil fertility and its evaluation for judicious use of fertilizers.

UNIT 3 Responses of crops to nutrient deficiency and pathogens: (9L)

Phosphorous and Iron deficiencies, Heavy metal stress, Physiological and molecular biology of heavy metal tolerance; Physiological and molecular responses of plants to water stress, salinity stress, temperature stress (heat and cold), Photo oxidative stress; Plant responses to pathogen and herbivores – biochemical and molecular basis of host plant resistance; Bio composting; Organic manure and Bio fertilizers; Water soluble fertilizers; Bio pesticides: microbes and plants, Biominearlization.

UNIT 4 Seed Technology: (9L)

Seed technology and its importance; production processing and testing of seeds of crop plants; seed storage, seed certification; role of National Seeds Corporation (NSC) in production; New seed policy and seed control order, Terminator Technology.

UNIT 5 Animal Husbandry: (9L)

Importance of livestock in agriculture; relationship between plant and animal husbandry; mixed farming; animal breeding; breeds of indigenous and exotic cattle, buffaloes, goats, sheep, and poultries and their potential for milk, egg, meat and wool production.

Recommended Text Books

- Edited by Garry C Whitelam and Karen J Halliday, Light and Plant Development, Oxford Ames, Iowa: Blackwell Pub., 2007.
- Esau's Plant Anatomy; Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development, 3rd Edition, John Wiley & Sons, 2006.
- Thomas L Rost, Michael G Barbour, Terence M Murphy and C Ralph, Stocking Plant Biology (with InfoTrac), 2005.
- U. Chakraborty, Bishwanath Chakraborty, 2005. Stress biology, Vidhyasekaran, P. 2007. Narosa Publishing House
- Handbook of molecular technologies in crop disease management, Haworth Food & Agricultural Products Press, New York.462 p

- Taiz and Zeiger, Plant Physiology, 3rd Edition, Panima Publishing Corporation, New Delhi, 2003
- Gatehouse, A. M .R., Hilder, V. A. and Boulter, D., Plant Genetic manipulation for crop protection In: Biotechnology in Agriculture Series (Eds.) Vol. 7 CAB International, Wallingford, UK. 266p. 1992
- Panda N. and G.S.Khush, Host plant resistance to insects. CAB International, Walling Ford. 431p, 1995
- Slater, A., Scott, N. and Fowler, M., Plant biotechnology –The genetic manipulations of plants. Oxford University press. 346p, 2003.
- Vidhyasekaran, P., Fungal pathogenesis in plants and crops: Molecular biology and host defense mechanisms, Marcel Dekkar Inc., New York. 624p, 1997
- Vidhyasekaran, P., Bacterial Disease Resistance in Plants: Molecular Biology and Biotechnological Applications, Haworth Food & Agricultural Products Press, New York.452p, 2005.

OPEN ELECTIVE

Paper XVI

A) Industrial Biotechnology and Intellectual Property Rights (IPR)

45L = 4 credit

UNIT 1 Bioprocessing in Industry and Upstream processing : (9L)

Introduction; Basic design of fermenter and various parts of fermenter; Types of fermenter; Batch, Fed Batch, Continuous fermentation method; Media Formulation , Types of fermentation media, Sterilization of medium, Methods of preservation and improvement of Industrially Important organisms; Upstream Process -fermenter, feed, liquid waste; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH;

UNIT 2 Downstream Processing: (9L)

Downstream process - Filtration, Centrifugation, Cell disruption (Physical and Chemical), Liquid –Liquid Extraction, Supercritical fluid extraction; Purification by chromatography and ultra filtration; Drying, Crystallization; Steps Involved in Industrial production of Penicillin, Vitamin B12, Ethanol, Citric acid.

UNIT 3 Industrial Impacts on Environment: (9L)

Treatment and disposal of effluents – Physical treatment, Chemical treatment, Biological treatment; Disposal site. Sources and Pollutants of Air pollution; Control measures of air pollution; Sources and Pollutants of Water pollution; Concept of DO, COD, BOD. Dissolved oxygen concentration as an indicator of water quality; Chemical Toxicants from Industry;

UNIT 4 Bioremediation & Energy: (09L)

Bioremediation of soil and water; Biodegradation of toxic wastes from industry; Bioaugmentation; Bioleaching; Phytoremediation. Energy crisis , Conventional sources, Non conventional sources.

UNIT 5 Intellectual Property Rights (IPR): (9L)

Introduction; Protection of intellectual property; World organizations; Forms of protection – Copyright, Trademark, Trade secrets and Patent; Patent application; Patenting of biological material; Patenting procedure in India; Geographical indications. Union for the Protection of New Varieties of Plants (UPOV), Advantages and disadvantages of Plant breeders right (PBR).

Recommended Text Books

- Gautam, N. C., Food Biotechnology in Comprehensive Biotechnology, Vol. 6.,
- Gutierrez – Lopez, G. F. et. al., Food Science and Food Biotechnology.
- Maheshwari, D. K. et. al., Biotechnological applications of microorganisms,
- Stanbury, P. F. et. al., Principles of Fermentation Technology, 2nd Edition,
- Waites, M. J. et. al., Industrial Biotechnology: An Introduction, N Gurumani, “Research Methodology for Biological Sciences, MJP Publishers, Chennai.
- H. S. Chawala, “Introduction to Plant Biotechnology”, 3rd Edition, Oxford & IBH publishing Co. Pvt. Ltd, New Delhi.

OPEN ELECTIVE

Paper XVI

B) Animal cell culture

45L = 4 credit

UNIT 1 Introduction: (9L)

History. Laboratory design, Characteristics of animal cell in culture, substrate for cell growth, Equipments required for animal cell culture – Laminar air flow, CO₂ incubator, Centrifuge, Inverted microscope etc. Sterilization of apparatus.

UNIT 2 Cell culture Media: (9L)

Culture media: – Natural media, synthetic media – serum containing media, serum free media, balanced salt solution, and complete media. Physicochemical properties of media, Sterilization of media. Maintenance of sterility and use of antibiotics, Mycoplasma and viral contaminants.

UNIT 3 Culture techniques: (9L)

Primary cell culture: Cell Separation – Mechanical, Enzymatic. Criteria for subculture, Types of organs culture, **Cell synchronization**- Cell separation by physical means and chemical blockade
Growth studies: Cell proliferation, cell cycle, mitosis in growing cells.

UNIT 4 Establishment of cell lines: (9L)

Cell lines selection and routine maintenance of cell lines, Cell counting and monitoring, Indirect methods of cell determination – Protein, DNA, LDH, and Glucose determination. Cell line identification: Tests of identification – Karyotyping, Isozymes, Labeled antibodies and DNA fingerprinting. Analysis of the cell cycle – Tritiated thymidine pulse method, Flow cytometry

UNIT 5 Applications of animal cell culture: (9L)

Production of animal cell in bioreactors: purpose, production strategy, purification, Efficiency & productivity of a culture system, Cost of the process.

Applications: Monoclonal antibodies. Viral vaccines – production of viruses & cell lines for vaccine production, Glycoprotein from mammalian cells – Interferons, Plasminogen activators, Blood clotting factors and Erythropoietin. Cells as a product – Artificial skin, Organs, Drugs screening & toxicity tests. Gene Therapy

Introduction to transgenic animals- Method of production, Examples of transgenic animals and their commercial applications, ethical issues of transgenic animals.

Recommended Text Books

1. Kuchler, R.J., Biochemical Methods in cell culture and Virology, Dowden, Hutchinson and Ross, Inc. Strausberg, USA, 1977.
2. Morgan, S.I. Animal cell culture, 1993, Bio Scientific Publishers Ltd, Oxford.
3. Freshney, R.I. Culture of Animal cells: A Manual of Basic Technique, 1994, John Wiley and Sons Inc. Publication, USA.
4. Butler, M. Mammalian, cell Biotechnology: A Practical Approach (1991), IRL Press, Oxford.
5. Jenni P. Mather and David Barnes, eds; Animal cell culture Methods, Methods in cell Biology, vol.57, Academic Press.
6. Cell Culture: Methods in enzymology, Vol-58, Academic Press 1979 or recent.

Practicals

SEMESTER- IV

Practical Paper-IX: Genetic engineering and Molecular medicine and Agriculture Science & Seed technology

1. Isolation of Mitochondrial/ Chloroplast DNA
2. Isolation of genomic DNA from Yeast / Plant cell / Animal Cell and verify using electrophoresis
3. Isolation and quantification of total RNA from Yeast / Plant cell / Animal Cell and verify using electrophoresis
4. Molecular weight determination of digested DNA.
5. Construction of restriction map of plasmid DNA.
6. Ligation theory and ligation of DNA.
7. Southern blotting technique.
8. DNA amplification by PCR
9. Reporter gene assay (b- Gal)
10. Study of Sickled RBCs.
11. Demonstration of Study of Flow cytometer
12. Isolation and quantification of hemoglobin from blood
13. Separation of serum from plasma
14. Estimation of alkaline & acid phosphatase activity in blood plasmas
15. Laboratory techniques to measure water and nutrient uptake in plants.
16. Production of artificial seed.
17. Seed inoculation with rhizobia
18. Testing of nodulation ability by rhizobia

OPEN ELECTIVE

Practical Paper-X: (A) Industrial Biotechnology and Intellectual Property Rights (IPR)

1. Estimation of BOD from water sample.
2. Estimation of COD from water sample.
3. Effect of industrial effluents on seed germination and plant growth.
4. Crude protein purification using Filtration, Centrifugation and Dialysis.
5. Study of fermenter and its various parts
6. Citric acid fermentation.
7. Alcohol fermentation.
8. Determination of growth curve of a microorganism - Compute specific growth rate
9. Writing of patent application
10. Case studies of patent conflicts.

OPEN ELECTIVE

Practical Paper-X: (B) Animal Cell culture

1. Instrumentation of ATC
2. Aseptic Transfer technique in animal Cell Culture
3. Preparation of Balanced Salt Solution
4. Preparation of pH standards for animal cell culture.
5. Trypsinization methods in animal cell culture -
A. Warm Trypsinization B. Cold Trypsinization
6. Chick Embryo Culture
7. Lymphocyte Culture.
8. Effect of medicine on angiogenesis
9. Shell-less egg culture
10. Separations and culture of phagocytic cell

PRACTICAL PAPER XI: PROJECT DISSERTATION AND VIVA VOCE: Students have to begin their projects in 3rd Semester and submit the report in 4th Semester. (50 Marks, Credits-2)

SEMINAR-IV

(25 Marks, Credits-1)