

**SOLAPUR UNIVERSITY, SOLAPUR**

**M.Sc. Part-I Biotechnology**

**Revised Syllabus (New CBCS Pattern Syllabus)**

**w. e. f. June 2016**

**SOLAPUR UNIVERSITY, SOLAPUR**  
**M. SC. BIOTECHNOLOGY**  
**REVISED SYLLABUS (NEW CBCS PATTERN)**  
**(w. e. f. June, 2016)**

**1) Title of the Course: M. Sc. BIOTECHNOLOGY**

**2) Introduction:** This course provides a broad overview of biotechnology and to produces expert hands that would have sufficient knowledge and expertise to solve the urgent problems of the region by using biotechnology. The course structure is technology-centric where students basically learn technology and are taught necessary basic subjects for that purpose.

**3) Objectives of the course:**

The objectives of M. Sc. Biotechnology course are

- To provide an intensive and in-depth learning to the students in field of biotechnology.
- Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing business world.
- To develop awareness & knowledge of different organization requirement and subject knowledge through varied subjects and training methodology in students.
- To train the students to take up wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.

**4) Advantages of the Course:**

- Biotechnology has tremendous job potential. The successful students will be able to establish trading, industrial and consultancy organizations in pharmaceuticals, paper, fermentation, food processing & preservation, agriculture, environment protection and also their own industry for micropropagation of commercially important plants in vitro, transgenic plants, vaccine production, clinical pathology, genetic counseling, human karyotyping etc.
- Multinational companies dealing with production of tissue cultured and genetically modified plants, food products, leather, dairy, beverages, pharmaceutical, chemical Industries, agribusiness, Environment protection.
- Medical & Scientific Research Organizations.
- Universities in India & abroad.

## 5) Eligibility of Course:

**Eligibility:** A Candidate possessing Bachelor Degree with Biotechnology / Biochemistry/Chemistry/ Microbiology/ Botany/ Zoology/ B. Pharm/ MBBS/ B. E./ B. Sc. Agri. Or life sciences as a principal subject (Biotech), and who have passed the entrance examination conducted by the Solapur University shall be held eligible for admission to M. Sc. Course in Biotechnology. Students from other University with B.Sc. General Degree and who have passed the entrance examination conducted by the University are also eligible.

- **Admission:** Merit list based on average of B.Sc. aggregate and entrance exam conducted by University. For other university student merit list only on basis of entrance examination conducted by University.

## 6) Duration:

- The duration for this program is of 2 years with semester pattern (04 Semesters)

## 7) Medium of Instruction: English

## 8) Structure of the Course:

- Structure of M.Sc. course in faculty of Science has total of 4 semesters for 2 years.
- M. Sc. I comprise of total two semesters and M. Sc. II comprises of total two semesters.
- Semester I includes four theory papers (3 Hard Core and 1 Soft Core) and practical course as per theory papers.
- Semester II & III includes four theory papers (2 Hard Core, 1 Soft Core and 1 Open Elective) and practical course as per theory papers.
- Semester IV includes four theory papers (3 Hard Core and 1 Soft Core) and a Major project substituting the practical course.
- Each theory paper comprising of 5 units which are distributed in total 60 lecture hours having weightage of 4 credits.
- Practical papers are to be conducted at the end of their respective semester.
- Final year Major project work should begin in III semester and the completed thesis should be submitted at the end of the IV semester.
- Student would have to present his/her project work during the project report submission which would be evaluated by the internal as well as the external examiners.
- As per the credit system, the assessment of Theory paper of 100 marks weightage will be as: 70 marks theory assessment by University examination (UA) and 30 marks internal assessment by the college (CA). For internal assessment of candidate, periodical tests/seminars/ viva/oral / quiz etc. may be suitably adopted.
- As per the credit system, the assessment of practical paper of 100 marks weightage will be as: 70 marks practical assessment by University examination (UA) and 30 marks internal assessment by the college (CA).
- In each semester students has to give compulsorily 16 tutorials (4 tutorials per theory paper) with weightage of 25 marks (1 credit).



**SOLAPUR UNIVERSITY, SOLAPUR**  
**Syllabus for M.Sc. Biotechnology Part - I**  
 (w. e. f. June, 2016)

**COURSE STRUCTURE**

**SEMESTER I**

<b>M. Sc. I- BIOTECHNOLOGY CBCS w. e. f. 2016-17 (REVISED) SEMESTER-I</b>									
<b>SEM -I</b>	<b>Code</b>	<b>Title of the Paper</b>	<b>Semester Exam.</b>			<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
		<b>Hard Core</b>	UA	IA	Total				
<b>Biotech</b>	HCT 1.1	Microbiology	70	30	100	4	----	----	4
	HCT 1.2	Concepts of Biochemistry	70	30	100	4	----	----	4
	HCT 1.3	Inheritance biology	70	30	100	4	----	----	4
<b>Soft Core (Any one)</b>									
	SCT 1.1	Biostatistics and Bioinformatics	70	30	100	4	---	----	4
	SCT 1.2	Clinical Bioinformatics	70	30	100	4	---	----	
		Tutorial			25		1		1
<b>Practicals</b>									
	HCP 1.1	<b>Practical Course HCP 1.1</b>	35	15	50	----	---	2	6
	HCP 1.2	<b>Practical Course HCP 1.2</b>	35	15	50	----	---	2	
	HCP 1.3	<b>Practical Course HCP 1.3</b>	35	15	50	----	---	2	
<b>Soft Core (Any one)</b>									
	SCP 1.1	<b>Practical Course SCP 1.1</b>	35	15	50	----	---	2	2
	SCP 1.2	<b>Practical Course SCP 1.2</b>	35	15	50	----	---	2	
<b>Total for First Semester</b>			<b>420</b>	<b>180</b>	<b>625</b>	----	---		<b>25</b>



**SOLAPUR UNIVERSITY, SOLAPUR**  
**Syllabus for M.Sc. Biotechnology Part - I**  
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**COURSE STRUCTURE**  
**SEMESTER-II**

<b>M. Sc. I- BIOTECHNOLOGY CBCS w. e. f. 2016-17 (REVISED) SEMESTER-II</b>									
SEM-II	Code	Title of the Paper	Semester Exam.			L	T	P	Credits
<b>Biotech</b>		<b>Hard Core</b>	UA	IA	Total				
	HCT 2.1	Cell Biology	70	30	100	4	---	---	4
	HCT 2.2	Enzyme Technology	70	30	100	4	---	---	4
<b>Soft Core (Any one)</b>									
	SCT 2.1	Molecular Cell Processing	70	30	100	4	---	---	4
	SCT 2.2	Molecular Medicine	70	30	100	4	---	---	
<b>Open Elective(Anyone)</b>									
	OET 2.1	Immunology and Immuno techniques	70	30	100	4	---	---	4
	OET 2.2	Agriculture Science and Seed Technology	70	30	100	4	---	---	
		Tutorial			25	---	1	---	1
<b>Practicals</b>									
	HCP 2.1	<b>Practical Course HCP 2.1</b>	35	15	50	---	---	2	4
	HCP 2.2	<b>Practical Course HCP 2.2</b>	35	15	50	---	---	2	
<b>Soft Core(Any one)</b>									
	SCP 2.1	<b>Practical Course SCP 2.1</b>	35	15	50	---	---	2	2
	SCP 2.2	<b>Practical Course SCP 2.2</b>	35	15	50	---	---	2	
<b>Open Elective(Anyone)</b>									
	OEP 2.1	<b>Practical Course OEP 2.1</b>	35	15	50	---	---	2	2
	OEP 2.2	<b>Practical Course OEP 2.2</b>	35	15	50	---	---	2	
<b>Total for Second Semester</b>			<b>420</b>	<b>180</b>	<b>625</b>	<b>---</b>	<b>---</b>	<b>---</b>	<b>25</b>

\*\* L = Lecture T = Tutorials P = Practical

\*\* IA=Internal Assessment

\*\* UA= University Assessment

\*\* 4 Credits of Theory = 4 Hours of teaching per week

\*\* 2 Credits of Practical = 4 hours per week

\*\* HCT = Hard core theory

\*\* SCT = Soft core theory

\*\* HCP = Hard core practical

\*\* SCP = Soft core practical

\*\* OET = Open elective theory

\*\* OEP = Open elective practical

\*\* MP = Major project

## M. SC. BIOTECHNOLOGY (SEMESTER –I)

### HCT 1.1: MICROBIOLOGY

4 Credit - (60 L)

#### UNIT- I: Microbial Taxonomy

[12]

History of Bergey's Manual, Prokaryotic Domains, Taxonomic ranks, Traditional and Modern methods of prokaryote Identification, General outline of Numerical and Polyphasic Taxonomy, Bacterial Nomenclature, Type Strain, Major Bacterial Culture collection units, Introduction to PHYLIP software.

#### UNIT-II: Microbial Diversity

[12]

General characters of oxygenic and anoxygenic Photosynthetic microbes, Magnetotactic bacteria, Methanogenic archaeobacteria. Gram positive and gram negative pathogenic bacteria, Extremophiles: General characters (origin, habitat, molecular adaptations) and examples of Extremophiles: Acidophiles, Alkalophiles, Thermophiles, Psychrophiles, Barophiles, Halophiles, Barophiles (Piezophiles), Xerophiles, Radiophiles, Metallophiles, Endoliths, and Osmophiles. Applications of Extremophiles.

#### UNIT-III: Microbial Techniques

[12]

Simple and differential, fluorescent, negative; Structural staining: capsule, spore, cell wall and reserve food material. Fungal staining. Sterilization: Physical and chemical methods. Cultivation of microorganisms: culture media and types of culture media. Isolation of microorganism: serial dilutions, streak plate, pour plate & spread plate. Characterization & identification of colonies, Preservation of cultures.

#### UNIT-IV: Mycology

[12]

Etymology, History, Characteristics, Classification, Morphology-Microscopic structure and macroscopic structure. Diversity, Growth and physiology, Reproduction, Mycotoxins, Symbiosis-with plant, cyanobacteria and algae, insects; Pathogenesis and Industrial Applications.

#### UNIT-V: Virology

[12]

Classification of viruses, Isolation, Cultivation and Enumeration of Bacteriophages, Cultivation of Animal viruses by using- Egg inoculation, Animal cell culture and Live animals. Electron microscopy (SEM & TEM), Reproduction of Viruses: Lytic cycle (T phage, phage  $\theta$ -X 174), Lysogenic cycle ( $\lambda$ , and Mu1 phages), Replication of viruses: ssRNA + stranded (Polio), ssRNA - stranded (Influenza), dsRNA (HIV), ssDNA (Parvo), dsDNA (Hepatitis B); Plant viruses- reproduction of TMV.

#### REFERENCE BOOKS:

- 1) Bergey's Manual of Systemic Bacteriology.
- 2) Brock Biology of Microorganisms – M.F Madigan
- 3) General Microbiology – Stanier et al.
- 4) Microbiology – Pelczar JR.
- 5) Microbial Genetics - Freifelder
- 6) General Virology - Luria
- 7) Introduction to Plant Virology – Bos I
- 8) Animal Virology – Fenner, F and White, D.O.

## HCT 1.2 CONCEPTS OF BIOCHEMISTRY

4 Credit (60 L)

### UNIT-I: Biomolecules

[12]

Composition, structure and role of carbohydrates, lipids, proteins, nucleic acids and vitamins. Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds). Stability of protein and nucleic acid structures. Cyclic AMP-its structure and role.

### UNIT-II: Energy Concepts

[08]

Bioenergetics, thermodynamic principles of biology, concept of free energy, energy conservation and release, biological energy transducers, energy rich bonds, coupled reaction, redox potential, Phosphorylation potential.

### UNIT-III: Metabolism of Biomolecules

[14]

Reactions, energetic, regulations of glycolysis, gluconeogenesis, glycogen metabolism, pentose phosphate pathway, TCA cycle, fatty acid biosynthesis,  $\beta$ -oxidation, nucleic acid metabolism and general reactions of amino acid metabolism. Disorders of Metabolism- Introduction, Nutritional disorder-Protein Energy Malnutrition (PEM) (Kwashiorkar and Marasmus), Obesity Metabolic disorders-Diabetes. Inborn errors of metabolism- Protein-PKU, Alkaptonuria and Maple syrup & Gauchers. Carbohydrates- glycogen storage disorders, Cori's disease and Pomes disease. Lipids- Atherosclerosis. Nucleic acids- Gout, Lesch-Nyhan syndrome, Sickle cell anaemia.

### UNIT-IV: Oxidative phosphorylation and Photosynthesis

[12]

Oxidative phosphorylation - Locations, components and their arrangement, mechanism of working, theories and evidences for it, stoichiometry, inhibitors and uncouplers. Photosynthesis – Location, light harvesting in green plants, photosystem I & II, Z scheme of noncyclic photophosphorylation, Cyclic photophosphorylation, dark reactions – C3 and C4 pathway, rubisco enzyme, synthesis of sucrose and starch.

### UNIT-V: Hormones

[14]

General classification of hormones, Cell membrane and intracellular receptors for hormones, Secondary messengers. Synthesis, structure, secretion, transport, metabolism and mechanism of action of pancreatic, thyroid, parathyroid, hypothalamus, pituitary, adrenal and prostaglandins. Hormonal control of spermatogenesis, menstrual cycle, pregnancy and lactation. Plant growth hormones - auxins, gibberellins, abscisic acid, cytokinins, and ethylene. Phenoromones.

### REFERENCE BOOKS:

1. Biochemistry by Lubert Stryer, 4th Edition
2. Biochemistry by Mathew VanHolde
3. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
4. Hormones by Norman Litwack
5. Basic and Clinical Endocrinology- Greenspan and Baster
6. Biochemistry and Physiology of Plant Hormones- Thomas Moore
7. Annual Review of Biochemistry 1977
8. Thermodynamics for Biological Systems -Baine

9. Textbook of medical physiology by Arthur C. Guyton 11<sup>th</sup> Edition
10. Plant Physiology by Taiz & Zeiger, 3<sup>rd</sup> Edition
11. Life: The Science of Biology, by David Sadava, 9<sup>th</sup> Edition
12. Biochemical Methods.1<sup>st</sup> , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India
13. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, Inc. USA
14. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
15. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. India



## **HCT 1.3: INHERITANCE BIOLOGY**

**4 Credit (60 L)**

### **UNIT-I: Mendelian Genetics**

**[12]**

Concept of Gene: Allele and its types, Mendelian laws- Law of Dominance, Co-Dominance, Incomplete Dominance, Segregation, Independent assortment. Test cross, Back cross, Allelic interactions, gene interactions, Linkage and crossing over.

### **UNIT- II: Cytogenetics**

**[14]**

Chromosomes-Morphology, Heterochromatin & Euchromatin, Lampbrush chromosome, Polytene chromosome, Role of chromosome in heredity. Numerical changes- Aneuploidy, Euploidy. Chromosomal aberrations: Deletion, duplication, inversion, translocation. Structure of sex chromosomes, Sex linked inheritance, extra chromosomal inheritance- chloroplast, mitochondria, and plasmid.

### **UNIT- III: Microbial Genetics**

**[10]**

Methods of genetic transfers –Transformation, competency Conjugation-nature of donor strain and compatibility, Hfr, F, map of F plasmid. Transduction- generalized and specialized.

### **UNIT- IV: Population genetics**

**[12]**

Neo-Darwinism, Genetic polymorphism, Hardy-Weinberg genetic equilibrium, causes of changes in allele frequency, gene frequency, factors affecting gene frequency. Significance of population genetics.

### **UNIT- V: Evolutionary genetics**

**[12]**

Theory of evolution, genetic basis of evolution. Genome mapping (Physical maps), C-value paradox, Functional genomics, Repetitive DNA-Microsatellite, Minisatellite, LINES, SINES, Alu family.

### **REFERENCE BOOKS:**

1. Principles of Genetics 8<sup>th</sup> edition, Eldon J. Gardner, Michael J. Simmons, and D. Peter Snustad, Wiley India Edition (Indian edition).
2. Molecular Genetics: An introductory Narrative (2<sup>nd</sup> Edition) Gunther S. Stent and Richard Calendar, CBS Publishers and Distributors (Indian Edition) –Reprint 2004.
3. Principles of Genetics, 7<sup>th</sup> Edition, Robert H Tamarin, Tata McGraw Hill Edition (Indian Edition) –Reprint 2004
4. Genetics 5<sup>th</sup> edition –Strickberger, Pearsons publisher –Low Price Edition (Indian Edition).
5. Modern Microbial Genetics –Editors Uldis N Streips and Ronald E. Yasbin Wiley –Liss publications, 1991.

## SCT 1.1: BIOSTATISTICS AND BIOINFORMATICS

4 Credit (60 L)

### UNIT-I: Basic terms, measures of central tendency and dispersion [14]

Population, Sample, sampling methods, variable, parameter, classification of data, Frequency Distribution, tabulation, graphic and diagrammatic representation. Mean, median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis Probability and distributions: Definition of probability (frequency approach), independent events. conditional probability, Examples of Bernoulli, Binomial, Poisson and Normal distributions. Coefficient of distribution, Use of these distributions to describe in biological models.

### UNIT-II: Bivariate data [12]

Scatter plot, correlation coefficient ( $r$ ), properties (without proof), Interpretation of  $r$ , linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination. Hypothesis testing: Hypothesis, critical region, and error probabilities. Z-test, 't'-test, Chi-square test for independence. P-value of the statistic. Confidence limits, Introduction to analysis of variance.

### UNIT-III: Introduction to bioinformatics [12]

Introduction to genomics and proteomics; NCBI; SRS. Biological Databases: 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-IV: Sequence analysis methods [10]

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-V: Homology modeling [12]

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.

### REFERENCE BOOKS:

1. Biostatistics: A foundation for Analysis in the Health Sciences 7/E /Wayne W. Daniel, Wiley Series in Probability and Statistics.
2. Introductory Statistics. Fifth Edition. (2004) Prem S. Mann John Wiley and Sons (ASIA) Pte Ltd.
3. Basic Statistics-Aprimer for Biomedical Sciences-(Olive Jean Dunn).
4. Biostatistics-An introductory text – (Auram Gold Stein).
5. Statistics : An Introductory Analysis (Taro Yamane) Harper and Row Publisher 1964,67,73
6. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).

7. An introduction to Computational Biochemistry. (C. Stain Tsai, A JohnWiley and Sons, Inc., publications).
8. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
9. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
10. NCBI Web site: <http://www.ncbi.nlm.nih.gov>

## **SCT 1.2: CLINICAL BIOINFORMATICS**

**4 Credit (60 L)**

### **UNIT-I: Next Generation Sequencing; Introduction** **(12)**

Process, Application, NGS Platforms & Techniques, **NGS Tools:** Data & Data Formats, introduction to R scripting and QC tools PrinSeq, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOT, NGS Methods: Reference Based Genome Assembly, De Novo Genome Assembly, Transcriptomics, Epigenomics, Genome Mapping, Microarray Data Analysis, RNA Sequence Analysis and NGS Data Annotation.

### **UNIT-II: Medical Bioinformatics** **[12]**

Basic understanding, causes and available treatment strategies for bacterial and viral and parasitic diseases, Neurodegenerative disorders, Disease of circulatory system and respiratory system, Cancer, Genetic diseases. Introduction to pathology informatics, study of pathogen genomes (bacteria, fungi and viruses), databases, computational study of host–pathogen interactions (Animals and Plants).

### **UNIT-III: Clinical Data Analysis** **[12]**

Introduction to Medical coding, International Classification of Disease-10, Pharmacovigilance, Tools for Clinical trial data analysis and management.

### **UNIT-IV: System and Functional Biology** **[12]**

Pharmacogenomic: Introduction, History, Application and Challenges. System Biology, System structures, system dynamics Metabolomics: Introduction to Metabolome, Metabolites, Metabonomics, Analytical technologies, applications.

### **UNIT-V: Genome sequencing projects and applications** **[12]**

Human Genome Project Introduction, Applications, Challenges of HGP, Introduction to various genome sequencing projects and their implications in human health and diseases, Comparative genome analysis Genome data visualization using Ensemble and Mapviewer.

### **REFERENCE BOOKS:**

1. Eija Korpelainen, Jarno Tuimala, Panu Somervuo, Mikael Huss, Garry Wong 2014: RNA-seq Data Analysis: A Practical Approach by Chapman & Hall/CRC Mathematical and Computational Biology
2. Robert Gentleman: 2008 R Programming for Bioinformatics by Chapman and Hall/CRC
3. Shui Qing Ye 2015: Big Data Analysis for Bioinformatics and Biomedical Discoveries by Chapman and Hall/CRC
4. Bentley DR, Balasubramanian S, Swerdlow HP, et al. Accurate whole human genome sequencing using reversible terminator chemistry. Nature. 2008; 456:53-59

## **PRACTICALS**

### **PRACTICAL COURSE HCP 1.1: MICROBIOLOGY**

**2 Credit**

1. Study of aseptic techniques-Disinfection, cotton plug making, cleaning and sterilization of used and new glassware's.
2. Preparation of culture media for growth of various microorganisms.
3. Isolation of bacteria from different sources (Soil, water and air) by spread, pour and streak plate method.
4. Study of colony characters of bacteria.
5. Microscopic Examination- Motility, Simple, Gram's stain, Acid-fast stain and Lactophenol cotton blue staining (Fungi).
6. Structural staining: capsule, endospore, cell wall, flagella and reserve food material.
7. Growth curve of *E. coli*.
8. Study of morphological and biochemical characters *E. coli* and *Bacillus sp.*.
9. Study of ClustalW tool for phylogenetic relationship among related species.
10. Isolation and characterization (morphological and biochemical) of Acidophilic/Alkalophilic/ Thermophilic/ Halophilic bacteria.
11. Antimicrobial susceptibility test by disc diffusion method.
12. Isolation and cultivation of Bacteriophages (Plaque assay).
13. Embryonated Chick egg technique.

### **PRACTICAL COURSE HCP 1.2: CONCEPTS OF BIOCHEMISTRY**

**2 Credits**

1. Qualitative and Quantitative analysis of carbohydrates.
2. Qualitative and Quantitative analysis of proteins.
3. Qualitative and Quantitative analysis of amino acids.
4. Quantitative analysis of nucleic acids
5. Estimation of Vitamin C and Riboflavin.
6. Lipid isolation detection and estimations
7. Fractionation of egg proteins
8. Disruption of plant/animal/microbial cells by Physical/chemical/biological methods of extraction of intracellular proteins.
9. Assay of Extracted proteins
10. Study of Kranz anatomy
11. Production and estimation of indol acetic acid.
12. Isolation of chloroplast and spectrophotometric assay of Hill's oxidation.

### **PRACTICAL COURSE HCP 1.3: INHERITANCE BIOLOGY**

**2 Credit**

1. Demonstration of Mendelian principles using *Drosophila* / plant system.
2. Numerical exercises related to Mendelian principles, gene interactions, linkage and gene mapping.
3. Studies on induction and detection of sex linked recessive lethals (*Drosophila*).
4. Studies on mutagenic treatment to seeds, pollen grains and its mitotic and meiotic analysis.
5. Study of mutation analysis in bacteria (antibiotic resistance).
6. Study of Karyotype.
7. Strain improvement using physical and biological agent.
8. Study of transformation, conjugation and transduction.
9. Study of construction of restriction map of plasmid DNA.

### **PRACTICAL COURSE SCP 1.1: BIOSTATISTICS AND BIOINFORMATICS**

**2 Credits**

1. Measures of Central Tendency and Dispersion on Excel
2. Statistical Analysis using EXCEL (Diagrammatic and graphical presentation)
3. Introduction to PubMed & PMC and retrieval of literature.
4. Retrieval of an amino acid sequence, nucleotide sequence and performing BLAST and FASTA.
5. Multiple sequence alignment by CLUSTAL X/ CLUSTAL W (offline tool).
6. Predication of secondary structure of proteins.
7. Homology modeling for prediction of 3D structure & its visualization.
8. Structure analysis: secondary, tertiary and quaternary structure, bond angle, bond length, different interactions by RasMol.
9. Phylogenetic studies & construction of phylogenetic tree.
10. Introduction to chimera.
11. Primer designing by primer3 server.

### **PRACTICAL COURSE SCP 1.2: CLINICAL BIOINFORMATICS**

**2 Credits**

1. Practical's based on R language.
2. Study online Next Generation sequencing resources and databases.
3. Study of PrinSek, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOT tools.
4. Study of Microarray Data Analysis tools and databases.
5. Introduction of International Classification of Disease-10 codes.
6. Study of Human genome project database and genome analysis tools

## M. SC. BIOTECHNOLOGY (SEMESTER –II)

### HCT 2.1: CELL BIOLOGY

4 Credit (60 L)

#### **UNIT- I: Cell theory and Cell Dynamics** [12]

Cell Theory, Cell Structure and organization of prokaryotic and eukaryotic (plant and animal) cells. Cell motility, Cell dynamics, Extracellular matrix. Cell-cell interactions and cell-matrix interaction. Cell lineages and the context of Developmental biology. Cell differentiation, hormones and growth factors.

#### **UNIT-II: Cytoskeleton and Cell Organelles** [12]

Cytoplasmic Membrane: Chemical Composition of Membrane, Structure and function of Membrane. Models of cell membrane. Structure and functions of microtubules, microfilaments and intermediary filaments. Working of actin, kinesin, dynein and ATPase as motor protein. Actin and myosin in heart. Structural and functional capitalization of Cell organelles – mitochondria, chloroplast, endoplasmic reticulum, ribosomes, golgi apparatus, lysosomes, peroxisomes and nucleus.

#### **UNIT-III: Cell cycle and Cell adhesion** [10]

Cell Cycle: Cell Cycle Phases-mitosis and meiosis, Role of cyclins and Cdks, Cell cycle check points. Cell Adhesion- Extracellular matrix. Cell-cell interactions and cell-matrix interaction. Desmosomes, Hemidesmosomes, Integrins, Selectins, Cadherins, Tight Junction, Gap Junction. Cell senescence and programmed cell death. Biology of oncogenes and anti-oncogenes.

#### **UNIT-IV: Cell signaling** [14]

Extracellular Messengers & their receptors, G -protein- Coupled receptors their second messengers and signal transduction pathway- Regulation of Glucose levels, Protein Tyrosine Kinases-RTK-Dimerization, Protein Kinase activation, RTKs activates downstream signaling pathway, signaling by the insulin receptors (RTKs) , Calcium as an intracellular messenger: IP3 and Voltage-Gated Ca<sup>2+</sup> Channels, Calcium binding Protein(calmodulin) & its role in signaling Intrinsic pathway of Apoptosis; Light induced signal transduction (Plant transduction). General Pathways of Ras- MAP Kinase pathway, Hedgehog pathway,WNT signalling pathway, Notch Pathway, Nf-κB Pathway.

#### **UNIT-V: Embryonic development** [12]

Structure of gametes, cellular and biochemical processes during early fertilization, strategies for monospermy and conservation of species specificity, cascade of events (acrosome reaction and egg activation cleavage blastulation, gastrulation) embryonic development in frog, morphogenetic movements origin of embryonic endoblasts (ecto, meso and endoderm)regeneration in animals with reference to hydra, planaria and salamander limb.

#### **REFERENCE BOOKS:**

1. Molecular Cell Biology, Lodish et al.Scientific American Books (1995)
2. The World of the Cell Becker, W.M. et al.Benjamin Cummings (2004)
3. Cell and Molecular Biology, Karp G,John Wiley and Sons. (1999).
4. Molecular Biology of Cell, Alberts B et al.Garland Publishers, (2001)
5. Lehninger Principle of Biochemistry, Nelson DL and Cox MM, Worth Publishers, (2000)
6. Principles of cell and Molecular Biology, Kleinsmith LJ & Kish VM,Harper Collins College Publishers (1995).

## **HCT 2.2: ENZYME TECHNOLOGY**

**4 Credit (60 L)**

### **UNIT-I: Enzymes**

**[14]**

Historical aspect, Nomenclature and Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme Catalysis: Factors affecting catalytic efficiency - proximity and orientation effects, distortion or strain, acid - base and nucleophilic catalysis. Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes, Ribozymes, Abzymes. Multienzyme complex: Properties, pyruvate dehydrogenase system (*E. coli* and mammalian), Tryptophan synthetase, multienzyme complex from *E. coli*, fatty acid synthetase.

### **UNIT-II: Enzyme Kinetics**

**[12]**

Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of  $V_{max}$  and  $K_m$ . Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. Enzyme inhibition - types of inhibitors - competitive, non-competitive and uncompetitive, their mode of action and experimental determination. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay.

### **UNIT-III: Structure Function Relations**

**[10]**

Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase and Na - K ATPase. Clinical aspects of enzymology: LDH isozymes, SGOT, SGPT, creatine kinase, alpha amylase, phosphatase.

### **UNIT-IV: Allosteric Interactions**

**[10]**

Allosteric sites, Modulators, Protein ligand binding including measurements, analysis of binding isotherms, cooperativity, Hill and Scatchard plots and kinetics of allosteric enzymes. ENZYME REGULATION: Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.

### **UNIT-V: Engineering Techniques**

**[14]**

Metabolic engineering, enzyme engineering. Immobilized Enzymes: Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and  $K_m$ ). Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. Immobilized multienzyme systems. Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors

#### **REFERENCE BOOKS:**

- 1) Fundamentals of Enzymology- Price and Stevens
- 2) Enzymes -Dixon and Webb
- 3) Isoenzymes By D. W. Moss
- 4) Immobilized Biocatalysts- W. Hartneir
- 5) Selected papers Allosteric Regulation -M. Tokushige
- 6) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Trevor Palmer, (2004)
- 7) Principles and Applications in Engineering Series: Biotechnology for Biomedical Engineers - Martin L. Yarmush, CRC Press, Boca Raton London New York Washington, D.C.
- 8) Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988



## **SCT 2.1: MOLECULAR CELL PROCESSING**

**4 Credit (60 L)**

### **UNIT-I: Genome organization**

**[14]**

Organization of prokaryotic and eukaryotic genome; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive DNA and unique sequences; Satellite DNA; DNA melting and buoyant density. Structure and conformation of nucleic acids [(A, B & Z), Triplex DNA, t-RNA, micro-RNA. DNA as a genetic material (Avery MacLeod and McCarty; Hershey and Chase experiments). Prokaryotic and eukaryotic gene structure.

### **UNIT-II: DNA Replication**

**[12]**

Unit of Replication (Replicon: Bacterial, Eukaryotic and Extra chromosomal). Enzymes involved in replication (DNA Polymerases of *E. coli* and eukaryotes) Replication origin and Replication fork, Fidelity of Replication. Replication initiation, elongation and termination in prokaryotes and eukaryotes. DNA proof reading, DNA methylation.

### **UNIT-III: Transcription**

**[14]**

Prokaryotic transcription: RNA Polymerases, Sigma factor and specificity binding to DNA, Promoters and their consensus sequences, Transcription initiation, Elongation and Termination (Rho dependent, Rho independent), RNA Editing, splicing. Eukaryotes transcription: RNA Polymerases (I, II & III) & subunits, Promoter elements for three polymerases, Activators, Enhancers, Repressors. Initiation, Elongation and Termination of transcription. Post transcription modification-RNA editing, splicing, polyadenylation. Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons, Reverse transcription.

### **UNIT-IV: Translation**

**[10]**

Prokaryotic and eukaryotic ribosomes, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post translational modification of proteins.

### **UNIT-V: DNA Repair and Recombination**

**[10]**

Photoreactivation, Nucleotide and base Excision, Mismatch, SOS, Recombination repair, Eukaryotic repair Mechanisms Recombination: Recombination between heteroduplex, Holiday intermediate, Proteins involved in Recombination, Role of recA, recBCD pathway in *E.coli*, single strand assimilation in Bacteria.

### **REFERENCE BOOKS:**

1. Benjamin Lewin -Gene VI, Gene VII, Gene IX, Gene X Oxford University press
- 2 David Friefieder -Essentials of Molecular Biology, Jones &Barlett publications 3
- J. Kendrew Encyclopedia of MolecularBiology Blackwell Scientific publications.
- 4 Weaver Molecular Biology
- 5 J.D.Watson, N.H.Hopkins ,J.W Roberts,et alMolecular Biology of the Gene,Benjamin Cummings publ.co.inc.,California
- 6 J.Darnell. *et. al.*, molecular biology of the cell (2nd edition) Garland Publishing Inc.
- 7 Meyers R.A (ed)., Molecular biology and biotechnology.VCH publishers NY Inc.

8 Alberts B *et. al.*, Molecular biology of the cell. Garland Publishing Inc. 9 Watson J.D., Recombinant DNA.  
10 Malacinski; Essentials of Molecular Biology.  
11 Stansfield; Molecular and cell biology.  
12 Walker Molecular biology and Biotechnology.  
13 Brown T.A Essential of Molecular biology Vol 1 and 2 each. 14 Dale Molecular Genetics of Bacteria

## SCT 2.2: MOLECULAR MEDICINE

4 Credits (60 L)

### UNIT-I: Human Molecular Genetics

[14]

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-II: Genetic Diseases in Human

[10]

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

### UNIT-III: Stem Cell as Regenerative medicine

[14]

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-IV: Gene Therapies

[10]

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-V: Pharmacogenetics

[12]

Steps involved in Drug Discovery/Design- *In silico* 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.

### REFERENCE BOOKS:

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

## OET 2.1: IMMUNOLOGY AND IMMUNE TECHNIQUES

4 Credit (60 L)

### UNIT-I: Immunity

[14]

Innate immunity- 1st and 2nd line of Defense (Phenomenon of Phagocytosis, Necrosis, Apoptosis) Role of Primary and Secondary Lymphoid organ, Role of Immune cells (Macrophages, Dendritic Cells, Follicular Dendritic Cells, B cells, T cells), 3<sup>rd</sup> Line of Defense Humoral immunity- Components of Humoral immunity Clonal selection theory, Primary and Secondary immune response, Mechanism of antibody production against TI and TD antigens, Structures of Antibodies, Gene expression and Ig Diversity. Cell-Mediated immunity- Components of CMI, lysis of Self-altered cells, Lytic pathways of CMI.

### UNIT-II: Antigen, MHC, Complement and Cytokines

[12]

Antigen - Types, Factors affecting antigenicity, Epitopes, Haptens, Adjuvants, Mitogens, MHC- Genetic organization and inheritance, Antigen processing and presentation (Cytosolic and Endocytic pathway), Presentation of non-peptide antigens, Complements- Complement activation pathways, Regulation of complement pathways , Cytokines- Introduction, Properties, General Functions, Cytokines secreted by TH1 and TH2 cells and its regulation, Cytokines based Therapy.

### UNIT-III: Medical Microbiology

[10]

General information, structure/morphological and cultural characters, Life cycle, pathogenicity, Laboratory Diagnosis and prophylaxis of Bacterial Diseases (*C. diphtheria*, *C. tetani*, *M. tuberculosis*, *S. typhi*), Viral Diseases (Hepatitis A & B, Influenza, HIV), Fungi (*Candida albicans*), Protozoan (*Plasmodium malaria*).

### UNIT-IV: Clinical Immunology

[12]

Hypersensitivity: Gell and Coomb's Classification and general mechanism of hypersensitivity) Autoimmunity: general mechanism, (organ specific, non-organ specific). Transplantation immunology- Immunologic Basics of Graft rejection, Immuntolerance to allograft, Immunosuppressive Therapy, Tumor immunology- Tumor antigens, Immune response to tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy.

### UNIT-V: Antigen-Antibody Interactions and Vaccines

[12]

Antigen-antibody interactions: Principles, applications, strength, cross-reactivity, features of interactions, precipitation, immunodiffusion, Immunolectrophoresis, agglutination, complement fixation test, immunofluorescence test, Radioimmunoassay, ELISA, Flow cytometry with fluorescence. Genetically Engineered Vaccines- Subunit vaccines (Herpes simplex, SARS, *S. aureus*), Peptide vaccines (Foot and Mouth disease, Malaria), DNA vaccines (Dental caries), Attenuated vaccines (Cholera, Salmonella, Leishmania), Vector vaccines.

### REFERENCE BOOKS:

1. Immunology - Kuby
2. Essential Immunology- Roitt
3. Cellular and Molecular Immunology- Abbas
4. Immunology and Serology- Philip Carpenter
5. Textbook of Immunology- Barrette J.T.
6. Basic and Clinical Immunology- Fundenberg H.

7. Biology of Immune response- Abramoff and Lavice
8. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul
9. Immunology an Introduction- Tizard
10. Molecular Biotechnology-Principles and applicatons of rDNA- 4<sup>th</sup> Edition, Bernard R. Glich et al.
11. Textbook of Microbiology- Ananthanarayan and Paniker
12. Microbiology 5<sup>th</sup> Edition- Prescott
13. Microbiology – Pelczar JR.
14. Microbial Genetics - Freifelder
15. Brock Biology of Microorganisms – MF Madigan
16. General Microbiology – Stanier et al.
17. General Virology - Luria
18. Animal Virology – Fenner, F and White, D.O.
19. Virology – Dulbecco R. and Ginsberg H.S.
20. Medical Microbiology- Fritz H. Kayse

## OET 2.2: AGRICULTURE SCIENCE AND SEED TECHNOLOGY

4 Credits (60 L)

### UNIT-I: Plant Physiology

[14]

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. Crops grown in India and their types.

### UNIT-II: Soil Science and Agricultural Chemistry

[12]

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-III Responses of crops to nutrient deficiency and pathogens

[14]

Phosphorous and Iron deficiencies, Heavy metal stress and non optimal pH-acid and calcareous soil; 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, Bioremediation. Steps involved in Mushroom Cultivation.

### UNIT-IV: Seed Technology

[10]

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-V: Animal Husbandry

[10]

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 pultries and their potential for milk, egg, meat and wool production.

### REFERENCE BOOKS:

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

6. Taiz and Zeiger, Plant Physiology, 3rd Edition, Panima Publishing Corporation, New Delhi, 2003
7. 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
8. Panda N. and G.S.Khush, Host plant resistance to insects. CAB International, Walling Ford. 431p, 1995
9. Slater, A., Scott, N. and Fowler, M., Plant biotechnology –The genetic manipulations of plants. Oxford University press. 346p, 2003.
10. Vidhyasekaran, P., Fungal pathogenesis in plants and crops: Molecular biology and host defense mechanisms, Marcel Dekkar Inc., New York. 624p, 1997
11. Vidhyasekaran, P., Bacterial Disease Resistance in Plants: Molecular Biology and Biotechnological Applications, Haworth Food & Agricultural Products Press, New York.452p, 2005.

## **PRACTICAL**

### **PRACTICAL COURSE HCP 2.1: CELL BIOLOGY**

**2 Credit**

1. To isolate and study Animal cell (human), Plant cell, Bacteria, and Fungi under a microscope and prepare a comparative table.
2. To study all the phases of Mitosis and Meiosis in a cell.
3. To study Permeable and Semi-permeable membrane of cell using the concept of Osmosis.
4. To investigate the effect of Heat/Enzymes/Chemicals on the permeability of plant cell membranes.
5. Isolation and Observe chloroplast under microscope.
6. Isolation and Observe mitochondria under microscope.
7. Preparation of salivary gland chromosome.
8. To observe red blood cells and white blood cells.
9. Visit to nearest Hospital to study flow cytometer (FACS).
10. Study of Micrometry and Measurement of given biological sample.
11. Study of Plant and Animal Organs Histology.
12. Developmental stages of chick embryo.

### **PRACTICAL COURSE HCP 2.2: ENZYME TECHNOLOGY**

**2 Credits**

1. Isolation and quantification of activity of – amylase / invertase / alkaline phosphatase (salivary / plant source)
2. Determination of specific activity of enzyme.
3. Determination of activity of enzyme in presence of activator and inhibitor.
4. Determination of  $K_m$  and  $V_{max}$  of Invertase.
5. Determination of optimum parameter of enzyme – pH and temperature.
6. Induction and estimation of beta- galactosidase.
7. Immobilization of enzyme/Cell



### **PRACTICAL COURSE SCP 2.1: MOLECULAR CELL PROCESSING**

**2 Credits**

1. Effect of protein synthesis inhibitors on the induction of beta galactosidase.
2. To study the photoreactivation in bacteria
3. Isolation of bacterial genomic DNA.
4. Isolation plasmid DNA.
5. Isolation of DNA from Plant/yeast.
6. Isolation of RNA from Plant cell / yeast.
7. Silver nitrate staining of DNA.
8. Isolation of organelle DNA (Chloroplast / mitochondria)

### **PRACTICAL COURSE SCP 2.2: MOLECULAR MEDICINE**

**2 Credits**

1. Isolation of Genomic DNA from different sources (dried blood & hair).
2. Study of Sickled RBCs.
3. Demonstration of Study of Flow cytometer
4. Isolation and quantification of hemoglobin from blood
5. Separation of serum from plasma
6. Estimation of alkaline & acid phosphatase activity in blood plasmas
7. Study of Genetic Diseases.
8. Isolation and cultivation of lymphocytes

## **PRACTICAL COURSE OEP 2.1: IMMUNOLOGY AND IMMUNE TECHNIQUES**

**2 Credits**

1. Study of Immunodiffusion. (Ouchterlony Technique.)
2. Study of Immunoelectrophoresis. ( CIEP, Rocket Immunoelectrophoresis )
3. Preparation of *Salmonella typhi* antigens.
4. Study of slide agglutination test by colony emulsion method for the diagnosis of *Salmonella typhi*.
5. Diagnosis of *Salmonella typhi* by Widal test (Qualitative and Quantitative test)
6. Isolation of *Candida* species and study its morphological characters (Budding, Mycelia, Spores).
7. To study the Dot-blot ELISA.
8. Demonstration of ELISA for HIV diagnosis.

## **PRACTICAL COURSE OEP 2.2: AGRICULTURE SCIENCE AND SEED TECHNOLOGY**

**2 Credits**

1. Effect of industrial effluents on seed germination and plant growth.
2. Crude protein purification using Filtration, Centrifugation and Dialysis.
3. Study of fermentor and its various parts
4. Isolation of Mitochondrial/ Chloroplast DNA
5. Isolation of genomic DNA from Plant cell and verify using electrophoresis
6. Isolation and quantification of total RNA Plant cell and verify using electrophoresis
7. Laboratory techniques to measure water and nutrient uptake in plants