M. Sc. BIOTECHNOLOGY

SYLLABUS - 2014

SCHOOLS OF EXCELLENCE
with
CHOICE BASED CREDIT SYSTEM (CBCS)

SCHOOL OF BIOLOGICAL SCIENCES
St. JOSEPH'S COLLEGE (Autonomous)
Accredited at 'A' Grade (3rd Cycle) by NAAC
College with Potential for Excellence by UGC
TIRUCHIRAPPALLI - 620 002, INDIA

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS)

POST GRADUATE COURSES

St. Joseph's College (Autonomous), a pioneer in higher education in India, strives to work towards the academic excellence. In this regard, it has initiated the implementation of five "Schools of Excellence" from this academic year 2014 – 15, to standup to the challenges of the 21st century.

Each School integrates related disciplines under one roof. The school system allows the enhanced academic mobility and enriched employability of the students. At the same time this system preserves the identity, autonomy and uniqueness of every department and reinforces their efforts to be student centric in curriculum designing and skill imparting. These five schools will work concertedly to achieve and accomplish the following objectives.

- Optimal utilization of resources both human and material for the academic flexibility leading to excellence.
- Students experience or enjoy their choice of courses and credits for their horizontal mobility.
- The existing curricular structure as specified by TANSCHE and other higher educational institutions facilitate the Credit-Transfer Across the Disciplines (CTAD) - a uniqueness of the choice based credit system.
- Human excellence in specialized areas
- Thrust in internship and / or projects as a lead towards research and
- The **multi-discipline** nature of the newly evolved structure (School System) caters to the needs of stake-holders, especially the employers.

What is Credit system?

Weightage to a course is given in relation to the hours assigned for the course. Generally one hour per week has one credit. For viability and conformity to the guidelines credits are awarded irrespective of the teaching hours. The following Table shows the correlation between credits and hours.

However, there could be some flexibility because of practical, field visits, tutorials and nature of project work.

For PG courses a student must earn a minimum of 110 credits. The total number of courses offered by a department is given above. However within their working hours few departments / School can offer extra credit courses.

SUMMARY OF HOURS AND CREDITS PG COURSES - BIOTECHNOLOGY

Part	Semester	Specification	No. of Courses	Hours	Credits	Total Credits
1	I-IV	**Core Courses** Theory Courses Laboratory Courses	 11 6	 62 22	 51 16	
	II	**Internship** **Self Paced Learning**	- 1	- -	4 2	
	IV	**Comprehensive Examination**	1	-	2	**81**
	IV	**Project Dissertation & Viva Voce**	1	12	6	
2	III-IV	**Core Electives**	3	12	12	**12**
3	I-III	**IDC (WS)** **IDC (Common)** **IDC (BS)**	1 1 1	4 4 4	4 4 4	**12**
4	I-IV	**Additional Core Courses**	-	-	-	(3)
5	IV	SHEPHERD & Gender Studies	-	-	5	**5**
		TOTAL		**120**		**110**

IDC – Inter Departmental Courses
BS – Between School
WS – Within School

Total Hours : 120
Total Credits : 110

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Course Pattern

The Post Graduate degree course consists of five vital components. They are cores courses, core electives, additional core courses, IDC's and SHEPHERD. Additional Core courses are purely optional on the part of the student. SHEPHERD, the extension components are mandatory.

CORE COURSE

A core course is the course offered by the parent department related to the major subjects, components like theories, practicals, self paced learning, common core, comprehensive examinations, dissertations & viva voce, field visits, library record form part of the core courses.

CORE ELECTIVE

The core elective course is also offered by the parent department. The objective is to provide choice and flexibility within the School. There are three core electives. It is offered in different semester according to the choice of the school.

ADDITIONAL CORE COURSES (If any)

In order to facilitate the students gaining extra credit, the additional core courses are given. The students are encouraged to avail this option of enriching with the extra credits.

INTER DEPARTMENTAL COURSES (IDC)

IDC is an interdepartmental course offered by a department / School for the students belonging to other departments / school. The objective is to provide mobility and flexibility outside the parent department / School. This is introduced to make every course multi-disciplinary in nature. It is to be chosen from a list of courses offered by various departments.

There are three IDC's. Among three, one is the Soft-Skill course offered by the JASS in the II Semester for the students of all the Departments. The other one is offered "With-in the school" (WS) and the third one is offered "Between the school" (BS). The IDC's are of application oriented and inter disciplinary in nature.

Subject Code Fixation

The following code system (9 characters) is adopted for Post Graduate courses:

14	PXX	X	X	XX
↓	↓	↓	↓	↓
Year of Revision	PG Code of the Dept	Semester of the Part	Specification of Part	Running number in the part
14	**PBT**	**1**	**1**	**01**

For Example :

I M.Sc. Biotechnology, first semester, Advanced Molecular Biology
The code of the paper is 14PBT1101.
Thus, the subject code is fixed for other subjects.

Specification of the Part

1. Core Courses: (Theory, Practical, Self paced Learning, Common Core, Comprehensive Examination, Dissertation and Viva-voce)
2. Core Electives
3. Additional Core Courses (if any)
4. Inter Departmental Courses (WS, Soft Skill & BS)
5. SHEPHERD & Gender Studies

EXAMINATION

Continuous Internal Assessment (CIA):

PG - Distribution of CIA Marks	
Passing Minimum: 50 Marks	
Library Referencing	5
3 Components	35
Mid-Semester Test	30
End-Semester Test	30
CIA	**100**

MID-SEM & END – SEM TEST

Centralised – Conducted by the office of COE

1. Mid-Sem Test & End-Sem Test: (2 Hours each); will have Objective + Descriptive elements; with the existing question pattern PART-A; PART-B; and PART-C
2. CIA Component III for UG & PG will be of 15 marks and compulsorily objective multiple choice question type.
3. The CIA Component III must be conducted by the department / faculty concerned at a suitable computer centres.
4. The 10 marks of PART-A of Mid-Sem and End-Sem Tests will comprise only: OBJECTIVE MULTIPLE CHOICE QUESTIONS; TRUE / FALSE; and FILL-IN BLANKS.
5. The number of hours for the 5 marks allotted for Library Referencing/ work would be 30 hours per semester. The marks scored out of 5 will be given to all the courses (Courses) of the Semester.

SEMESTER EXAMINATION

Testing with Objective and Descriptive questions

Part-A: 30 Marks

Objective MCQs only

Answers are to be marked on OMR score-sheet. The OMR score-sheets will be supplied along with the Main Answer Book. 40 minutes after the start of the examination the OMR score-sheets will be collected.

Part-B + C = 70 Marks

Descriptive

Part-B: 5 x 5 = 25 marks; inbuilt choice;

Part-C: 3 x 15 = 45 marks; 3 out of 5 questions, open choice.

The Accounts Paper of Commerce will have

Part-A: Objective = 25

Part-B: 25 x 3 = 75 marks.

Duration of Examination must be rational; proportional to teaching hours 90 minute-examination / 50 Marks for courses of 2/3 hours/week (all Part IV UG Courses) 3-hours examination for courses of 4-6 hours/week.

EVALUATION

Percentage Marks, Grades & Grade Points

UG (Passing minimum 40 Marks)

Qualitative Assessment	Grade Points	Grade	Mark Range %)
Exemplary	10	S	90 & above
Outstanding	9	A+	85-89.99
Excellent	8	A	80-84.99
Very Good	7	B	70-79.99
Good	6	C	60-69.99
Pass (PG)	5	D	50-59.99
RA (PG)	0	RA	< 50

CGPA - Calculation

Grade Point Average for a semester is calculated as indicated here under:

$$\frac{\text{Sum total of weighted Grade Points}}{\text{Sum of Gredits}}$$

Weighted Grade Points is ***Grade point x Course Credits.*** The final CGPA will only include: Core, Core Electives & IDCs.

A Pass in SHEPHERD will continue to be mandatory although the marks will not count for the calculation of the CGPA.

POSTGRADUATE		
CLASS	Mark Range (%)	
	ARTS	SCIENCES
Distinction	75 & above, first attempt	80 & above, first attempt
First	60 - 74.99	60 - 79.99
Second	50 - 59.99	50 - 59.99

Declaration of Result:

Mr./Ms. _____ has successfully completed the Post Graduate in _____ programme. The candidate's Cumulative Grade Point Average (CGPA) is _____ and the class secured _____ by completing the minimum of 110 credits.

The candidate has also acquired _____ (if any) additional credits from courses offered by the parent department.

_____

M. Sc. Biotechnology

Course Pattern - 2014 Set

Sem	Code	Course	Hrs	Crs
I	14PBT1101	Advanced Molecular Biology	6	5
	14PBT1102	Biochemistry	6	5
	14PBT1103	Genomics and Proteomics	6	5
	14PBT1104	Lab Course 1 (Molecular Biology & Genomics)	4	3
	14PBT1105	Lab Course 2 (Biochemistry & Proteomics)	4	3
	14PBT1106	Cell Biology (Self-paced Learning)	---	2
	14PBT1201 A	Developmental Biology	4	4
	14PBT1201 B	Stem Cell Technology		
	14PBT1301	Industrial Training (2 weeks, Optional)		(3)
		Total for Semester I	***30***	***27+(3)***
II	14PBT2107	Recombinant DNA Technology	5	4
	14PBT2108	Microbiology	5	4
	14PBT2109	Basic Bioinformatics	4	3
	14PBT2110	Lab Course 3 (Recombinant DNA technology and Bioinformatics)	4	3
	14PBT2111	Lab Course 4 (Microbiology and Diagnostics)	4	3
	14PBT2202 A	Cell signaling	4	4
	14PBT2202 B	Molecular Diagnostics and Therapeutics		
	14PSS2401	IDC: Soft Skills	4	4
	14PBT2112	Internship (8 weeks)	--	4
		Total for Semester II	***30***	***29***
III	14PBT3113	Research Methodology for Biosciences	6	5
	14PBT3114	Fermentation Technology	6	5
	14PBT3115	Lab Course 5 (Fermentation Technology)	3	2
	14PBT3116	Lab Course 6 (Immunology and Biostatistics)	3	2
	14PBT3203 A	Immunology	4	4
	14PBT3203 B	Drug Discovery and Development		
	14PBT3402	IDC (WS): Bioprocess Technology	4	4
	14PBT3403	IDC (BS): Food Technology	4	4
		Total for Semester III	***30***	***26***
IV	14PBT4117	Environmental Biotechnology	6	5
	14PBT4118	Plant & Animal Biotechnology	6	5
	14PBT4119	Regulation of Gene Expression	6	5
	14PBT4120	Comprehensive Examination	--	2
	14PBT4121	Project Dissertation and *Viva Voce*	12	6
		Total for Semester IV	***30***	***23***
	14PCW4501	SHEPHERD and Gender Studies		05
		Total for all Semesters	***120***	***110(3)***

Sem. I **Hours/Week: 6**

14PBT1101 **Credits: 5**

ADVANCED MOLECULAR BIOLOGY

Objectives

i) To understand the basic structure and functioning of the genetic materials - DNA.

ii) To understand the changes in the genetic material and the consequences.

Unit I

Introduction: Terms and definitions - DNA is the Genetic Material: Griffith's Experiment, Avery et al., Experiments and Hershey & Chase Experiment. RNA is the Genetic Material: Conrat & Singer Experiment with TMV - Central Dogma, Viral genome - types of RNA and their role. Organization of Chromosome: Structural organization of Prokaryotic and Eukaryotic cells. Components, types & Structure of nucleic acids, C value paradox. Types and basic structure of chromosomes. Chromosomal Proteins - Histones and Protamines - Nucleosomes - levels in the organization of Metaphase Chromosome. Organization of prokaryotic DNA. Special types of Chromosome: Polytene and Lamp brush chromosomes. Duplication & segregation of Chromosomes.

Unit II

Transposons: Discovery, IS elements, Transposons in Bacteria (Tn elements), Maize (Ac/Ds and Sp/Dsp elements), Drosophila (P elements) and Yeast (Ty elements). Transposition, Genetic and evolutionary significance of transposons. Extra chromosomal DNA: Maternal Inheritance, Structure, gene contents and functions of Chloroplast and Mitochondrial DNA - Interaction between cpDNA and nDNA, theory of prokaryotic endosymbionts. Plasmids: Definition, Types, Structure, Properties, gene content. Use in rDNA technology

Unit III

DNA replication: Models - Meselson & Stahl Experimental proof for Semi-conservative replication - Rules, requirements, problems and Molecular mechanism of the replication of linear and circular (Rolling circle Model) DNA. DNA polymerases - structure and function. Replication of RNA - RNA and DNA mediated. Recombinations: Homologous and non-homologous recombination- Site specific recombinations & transposition of DNA.

Unit IV

Transcription: RNA types (tRNA, mRNA, rRNA, Ribozyme, snoRNA, hnRNA, RNAi, RNA-P and micro RNA), structure and functions. Transcription Mechanism in Prokaryotes and Eukaryotes - initiation, elongation and termination, Post transcriptional modifications. Antibiotic inhibitors of transcription. Translation: Genetic code and features. Wobbling hypothesis. Machinery, initiation, elongation and termination of translation in bacteria and eukaryotes. Translational proof reading, translational inhibitors, Post translational modifications, chaperones and protein targeting- translocation, Heat shock proteins, glycosylation; SNAPs and SNAREs. Bacterial signal sequences. Mitochondrial, chloroplast and nuclear protein transport. Endocytosis - viral entry. Ubiquitin TAG protein destruction.

Unit V

Changes and consequences: Changes in the Chromosome number: Euploidy and aneuploidy and related genetic disorders. Changes in the chromosome structure: addition, deletion, inversion and translocation and related genetic disorders. Mutation: Definition, chemical basis and types. Mutagens: Physical and chemical. Mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. DNA repair mechanism: Thymine dimer, Light activation, Excision, Recombinational, SOS and Mismatch repair.

Books

1. David Freifelder. 2008. Molecular Biology. (Ed: 2). Narosa Publications. New Delhi.
2. Gardner, Simmons and Snustad. 2004, Principles of Genetics. (Ed: 8). John Wiley & Sons, Inc. New York.
3. Jeoffrey M. Cooper and Rober E. Hausman. 2000. The Cell: A Molecular Approach (Ed: 4). ASM Press, Washington D.C.
4. Watson J.D. 2006. Molecular Biology of the gene (Ed. 5) Pearson Education Inc. London.

Reference

1. Ajoy Paul. 2007. Textbook of Cell and Molecular Biology. Books and Allied [P] Ltd. Kolkata
2. De Robertis and De Robertis. 1990. Cell and Molecular Biology. Saunders College, Philadelphia.
3. Gerald Karp. 2008. Cell and Molecular Biology. (Ed: 5). John Wiley and Sons, New York.

4. Krebs, J.E. 2009. Lewin's Genes X. (Ed: 10). Jones and Barlett Publishers, Sudbury, Massachusetts.
5. Tom Strachan and Andrew P Lead. 2004. Human Molecular Genetics (Ed: 3). Garland Science / Taylor & Francis Group, USA.
6. Twyman. 2003. Advanced Molecular Biology. Bios Scientific Publishers LTD. Oxford, UK.

Sem. I **Hours/Week: 6**
14PBT1102 **Credits: 5**

BIOCHEMISTRY

Objectives

i. To study the structure, properties and metabolism of different biomolecules.
ii. To know the interrelationships between different metabolisms.

Unit I

The molecular logic of life: The chemical unity of diverse living organisms, composition of living mater. Water - Physio-chemical properties of water. Biomolecular reactions. Macromolecules and their monomeric subunits, Bioenergetics - laws of thermodynamics, Gibb's Free energy, Activation energy, exergonic and endergonic reactions, Biological energy transductions. Enzymes - nomenclature, classification, principle, regulation and mechanisms of enzyme catalysis, enzyme kinetics- MM equation, LB plot, Inhibition. Introduction to Metabolisms - Anabolism and Catabolism, Experimental approaches to study metabolism.

Unit II

Carbohydrates - Classification, Structure and Isomerism. Monosaccharides, Oligosaccharides, Polysaccharides- Structure and Properties. Metabolism of Carbohydrates- Glycolysis, Citric acid cycle, HMP shunt, Glucuronic acid pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Glyoxylate cycle, Regulations of Glycolysis and Gluconeogenesis. Metabolism of Amino sugars, Sialic acids, Mucopolysaccharides and Glycoproteins.

Unit III

Aminoacids - structures, classification, properties. Biosynthesis of Aspartate, Pyruvate and Aromatic aminoacids families. Amphibolic activity of amino acids. Protein - classification, types, characteristics and structures, functions. Methods for determining protein conformations. Symmetry and functional

properties, Protein folding, Denaturation & Renaturation, Ramachandran plot, Solid state synthesis of peptides, Sequence determination. Degradation of Proteins and Aminoacids, Urea cycle and its significance.

Unit IV

Lipids - classification, sources and biological functions. Biosynthesis of fatty acids and its regulation, Hydroxy fattyacids, Acylglycerols. Membrane lipids- Phospholipids, Sphingolipids & Eicosanoids. Cholesterol biosynthesis and its regulation. Fatty acid degradation. Lipoproteins- types and functions. Methods of inter organ transport of fatty acids. Formation of ketone bodies.

Unit V

Nucleic acids - bases, nucleosides & nucleotides, Structure of RNAs and DNA, Forces stabilizing nucleic acid structures. Fractionation, sequencing and chemical synthesis of oligonucleotides. Denaturation and Hybridization. Synthesis of Purines and Pyrimidines, Synthesis of Deoxy ribonucleotides. Biosynthesis of nucleotide coenzymes, nucleotide degradation. Intermediary metabolism.

Text Book

1. David L. Nelson and Michael M. Cox. 2008. Principles of Biochemistry (Leningher) (Ed: 5), W.H Freeman, New York.

References

1) Robert K. Murray, David A. Bender, Kathleen M. Botham, Peter J. Kenelly, Victor W. Rodwell and P. Anthony Weil. 2012. Harper's Illustrated Biochemistry.(Ed: 29), McGraw-Hill Medical, New York.
2) Stryer, L., 1988. Biochemistry. Ed: 2, W.H. Freeman & Co., New York.
3) White, A. 1973. Principles of Biochemistry (Ed: 5), McGraw-Hill Book Co., New York.

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Sem. I **Hours/Week: 6**
14PBT1103 **Credits: 5**

GENOMICS AND PROTEOMICS

Objectives

i) To understand thoroughly the concepts and importance of genes and genomes.
ii) To understand the principles and significance behind the nature and organization of genes and genomes.
iii) To study the basic techniques and concepts in genomics and proteomics.
iv) To understand the applied fields of genomics and proteomics.

UNIT I

Genetics - Segregation of single gene, two or more genes, Genetic linkage and Chromosome Mapping - coupling & repulsion of syntenic alleles - Linkage & Crossing over - Map distance and frequency of recombination - Genetic mapping with three point crosses - Mapping by Tetrad analysis (Neurospora) - Genetic mapping in Human pedigrees: Maximum likelihood and Lod scores. Molecular Evolution - Population Genetics - allele and genotype frequencies, DNA typing, Inbreeding Genetics and Evolution - Mutation and Migration - Natural selection - Random Genetic drift.

UNIT II

Gene fine structure: Unique and repetitive sequences in eukaryotes - DNA renaturation kinetics, Molecular structure of Centromere and Telomere, Human Karyotype. concept of the gene, units of genetic structure and genetic function, Gene - cistron relationship in prokaryote and eukaryote, Basics of Gene Regulation - Transcriptional regulation in prokaryotes: Inducible and repressible systems of positive and negative regulation - Operon system.

Unit III

Comparative genomics - Bacteria, Organelles and Eukaryotes Genome Mapping-Types and uses. Human physical map. Sequencing strategies and automation: (Maxam and Gilbert, Sanger's method,) advanced methods (Automated DNA sequencing, Pyrosequencing, MPSS, BAC end sequencing) Human Genome Project.

UNIT IV

Functional genomics (Functional studies at genetic level): Genetic interaction mapping, Transcriptome profiling: (Microarray, ChIP, SAGE) RNAi -Studying gene function through protein-protein interaction. (Phage display, yeast

two hybrid,) Loss of function techniques (mutagenesis and RNAi).- Functional annotation of genes.

Unit V

Proteomics: Protein sequencing, Protein expression analysis by 2-DE, 2D-MALDI- TOF MS, LC-MS/MS, Quantitative proteomics. Tandem Mass spectrometry, peptide mass fingerprinting. Mining the proteome, Protein expression profiling, Protein tags; protein arrays and antibody arrays.

Text Books

1. Daniel L. Hartl and Elizabeth W. Jones. 2009. Genetics (Ed: 7) Jones and Barlett Publishers Inc,Subury.
2. Primrose S.B. and Twyman R.M. 2004. Principles of Genomics and Proteomics (Ed: 3). Blackwell Science Ltd. Oxford, UK.
3. Westermeier R and Naven T. 2002. Proteomics in Practice: A Laboratory Manual of Proteome Analysis, John Wiley & Sons Ltd, England.

References

1. Brown T.A. 2007. Genomes 3. Garland Science Publishing.
2. Cullis C. A. 2004. Plant Genomics and Proteomics. John Wiley & Sons, Inc., Hoboken, New Jersey.
3. Dale J. W and M.V. Schantz. 2002. From Gene to Genomes: Concepts and Applications of DNA Technology, John Wiley& Sons, Ltd., England.
4. Grandi G. 2004. Genomics, Proteomics and Vaccines, John Wiley & Sons Ltd., England.
5. Liebler D.C. 2002. Introduction to Proteomics: Tools for the new biology, Humana press, Totowa, New Jersey.

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Sem. I **Hours/Week: 4**
14PBT1104 **Credits: 3**

Lab Course - I

MOLECULAR BIOLOGY & GENOMICS

1. Calculations in Molecular biology - (a) Calculating DNA in mM and conversion to picomoles (b) Oligonucleotide Quantitation (c) Calculating Molecular weight of a vector (d) Calculations in Oligonucleotide synthesis (e) Calculating T_m and concentration of primers.
2. Curing of plasmid using agents such as Ethidium bromide and Acridine orange.
3. Transformation of drug resistance.
4. Isolation of extracellular DNA from biofilm matrix.
5. Induced mutation by: (a) Chemical mutagen. (b) Ultraviolet light.
6. Total RNA isolation.
7. Spectroscopic analysis of DNA/RNA and calculate dsDNA, ssDNA and RNA concentration.
8. Determination of size of Nucleic acids in Agarose gel electrophoresis.
9. Chromosome banding - G - Banding.
10. *In vitro* Transcription.
11. SNP and INDEL identification.
12. Genome annotation.

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Sem. I **Hours/Week: 4**
14PBT1105 **Credits: 3**

Lab Course - II

BIOCHEMISTRY & PROTEOMICS

BIOCHEMISTRY

1. Preparation of Standard solutions (Molar & Normal) and various buffers.
2. Preparation of Titration curve & determination of pKa values for and aminoacids (Glycine).
3. Differential estimations of carbohydrates - reducing vs non-reducing.
4. Estimation of Vitamin C (Titration)
5. Chromatography: Column Chromatography - Separation of Photosynthetic Pigments and recording their absorption spectra in the visible range.
6. Separation of amino acids / sugars by Ascending Paper Chromatography.
7. Separation of lipids/ sugars/amino acids by Thin Layer Chromatography.
8. Enzyme Kinetics
   (a) Phosphatase assay (Rat liver)
   (b) Protease assay (Bacterial / fungal cell)
   - Substrate curve, Determination of Vmax and Km values
   - pH of the reaction medium and the Enzyme velocity.
   - Temperature of the reaction medium and the Enzyme velocity.
   - Enzyme concentration in the reaction medium and the Enzyme velocity.

PROTEOMICS

9. Isolation of Proteins from Bacteria, Preparation of cell-free extract: Rat liver by homogenization.
10. Estimation of Proteins by Bradford method.
11. Separation of proteins and Molecular weight determination by Polyacrylamide Gel Electrophoresis.
    - Coomassie Brilliant Blue and
    - Silver staining
12. Native gel Electrophoretic Staining of Proteins - Isozyme analysis (Catalase, a - Amylase / Acid phosphatase, Alkaline Phosphatase).

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Sem. I **Hours/Week: -**
14PBT1106 **Credits: 2**

Self Paced Learning

CELL BIOLOGY

Objectives

i. To understand fundamental concepts of cellular function.
ii. To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

Unit I

Introduction to cell types and shapes. Overview of chemical nature of the cell. Carbon as backbone of biologically important molecules. Macromolecules and their role in form and function of living systems.

Unit II

Plasma membrane: Structure, Location of Intrinsic and extrinsic proteins and channels; Receptors- Structure and role in signal transduction; membrane potential and synaptic transmission; glycocalyx; cell junction, cell adhesion molecules.

Unit III

Endomembrane system: (Endoplasmic reticulum, Golgi complex, Lysosomes; Glyoxysomes, peroxisomes: Structure and function), protein trafficking. Mitochondria and chloroplast- Structure, Genetic system, Functions; protein import.

Unit IV

Nucleus: Ultrastructure, Nuclear pore complex, nuclear cytoplasmic interactions, Nucleolus, Nuclear lamina and its role in cell division. Lamin dissociation.

Unit V

Cell Cycle: Phases, Check points of cell cycle, mechanism of regulation (Cyclin and cyclin dependent kinases) Regulation of CDK cyclin activity. Cytoskeleton: types, Chemistry, organization, associated proteins and their role.

References

1. Alberts, B., D. Bray, J. Lewis, M. Raff, K. Roberts and J.D.Watson. 1995. Molecular Biology of the Cell. (Ed: 3), Garland Publications. New York and London.

2. Lodish, H., D. Baltimore, A. Berk, L. Zipursky, M.Matsudaira and J. Darnell. 1995. Molecular Cell Biology. (Ed: 3), Scientific American & W. H. Freeman. New York.
3. De Robertis, EDP and De Robertis EME. 1988. Cell and Molecular Biology. Molt Saunders Inc.

Sem. I **Hours/Week: 4**
14PBT1201A **Credits: 4**

DEVELOPMENTAL BIOLOGY

Objectives

i. To study the cellular basis of development.
ii. To elucidate the early developmental process of humans.

Unit I

Basic concepts: General concept of cellular development: Potency, commitment, specification, induction, competence, determination & differentiation; morphogenetic gradients; cell fate & cell lineages; genomic equivalence and cytoplasmic determinants; imprinting. General principles of cell-cell communication in development: cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, paracrine factors.

Unit II

Fertilization, development and sex determination in humans: Gametogenesis - Sperm & Egg formation; ultrastructure of sperm and ovum, egg types, egg membrane. Fertilization, cleavage, Morula, Implantation, blastulation, gastrulation, formation of germ layers, axis formation - anterior and posterior. Sex determination - chromosomes and environment.

Unit III

Organogenesis - I: Organogenesis: Central nervous system and the epidermis - Formation of neural tube, Differentiation of the neural tube, tissue architecture of the central nervous system, origin of cutaneous structures. Neural crest cells and axonal specificity - Specification, Trunk Neural Crest, Pattern generation in the nervous system. Organogenesis - II: Plant meristem organization and differentiation - Organization of shoot apical meristem (SAM); Organization of root apical meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self incompatibility and its genetic control; Embryo and endosperm development; heterosis and apomixes.

Unit IV

Organogenesis - III: Paraxial and intermediate mesoderm - somites formation, osteogenesis, urogenital system. Lateral plate mesoderm and endoderm - heart formation, digestive tube and its derivatives.

Unit V

Implications of developmental biology: Medical implications of developmental biology - genetic disorders in human development, environmental assaults on human development, Future therapies and Developmental biology, Environmental regulation of animal development - Environment as a part of normal development, Polyphenisms and plasticity, Learning system.

Book

1. Gilbert S.F. 2010. Developmental Biology, (Ed: 9) Sinauer Associates Inc. Pub., Sunderland, Massachusetts.

Reference

1. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P. 2002. Molecular Biology of the Cell, (Ed: 3). Garland Science, New York.
2. Lodish, H., Berk A., Zipursky L., Matsudaira P., Baltimore D. and Darnell J. 2000. Molecular Cell Biology. (Ed: 4). W.H. Freeman, New York.

Sem. I **Hours/Week: 4**
14PBT1201B **Credits: 4**

Core Elective-1

STEM CELL TECHNOLOGY

Objectives

i. To understand the stem cell biology and biotech revolution; and
ii. To realize the molecular mechanisms, applications, and social implications associated with this technology.

Unit I

Basic concepts of Stem cells - definition; unique properties - proliferation and differentiation; Potency definitions: totipotent, pluripotent, multipotent and unipotent; basics of early human embryology; History and key stem cell research events. Stem-cell plasticity, Regulators of pluripotency and differentiation of stem cell. The isolation, expansion, genetic manipulation, genomic reprogramming, and cloning of stem cells. The problem of differentiation of stem cells. Stem Cells and imprinted genes.

Unit II

Differentiation & Types of Stem cells: Isolation, culture, identification and assays. Types: unlimited and limited; Embryonic and adult stem cells - bone marrow, cord blood, neural, endothelial, hematopoietic, corneal, epithelial, pancreatic, hepatic, glandular, cardiac and gastrointestinal, leukemia and cancer stem cells.

Unit III

Stem cells and cloning; Induced Pluripotent stem cells (iPS), germ line stem cells; Recruiting Donors and Banking hES Cells; IPRs and hES Cells. Fate mapping of stem cells in experimental systems.

Unit IV

Genetically engineered stem cells and experimental therapies. Stem cell based therapies: stem cells and repair of heart and nervous system; regeneration strategies. Skin replacement, brain cell transplantation and stem cells in aging.

Unit V

Controversies and Guidelines for hES cell research - Scientific background of hES research; societal implications: women, low-income, Different religious views, Current Ethical Guidelines in India, Ethical views of other countries and how this affects advancement of science Policy. Current Regulation of Human Embryonic Stem Cell Research. Future of SC research.

Books

1. Hossein Baharvand. 2009. Trends in stem cell biology and Technology. Humana Press, NY
2. Robert Paul Lanza. 2006. Essentials of Stem Cell biology. Elsevier Academic Press.
3. Stewart Sell. 2003. (Ed) Stem Cells Handbook, Humana Press, NY (Unit - I)
4. Verma IM and Gage FH. 2002. (Ed) Regenerative Medicine, Natl Acad Sci & Engg, USA
5. The Natl Academies, USA 2007 Understanding Stem Cells (Unit - II)
6. The Natl Academies, USA 2002 Stem Cells and the Future of Regenerative Medicine (Unit - IV & V).

Online Resources

- Stem Cells and the Future of Regenerative Medicine (2001) National Academies Press, USA. http://www.nap.edu/catalog/10195.html

- Scientific and Medical Aspects of Human Reproductive Cloning (2002) National Academies Press, USA. http://www.nap.edu/catalog/10285.html
- Cord Blood: Establishing a National Hematopoietic Stem Cell Bank Program (2005).
- http://www.nap.edu/catalog/11269.html
- Guidelines for Human Embryonic Stem Cell Research (2005).
- http://www.nap.edu/catalog/11278.html
- http://stemcells.nih.gov/info/scireport/2006report.htm

Sem. I **Hours/Week: -**
14PBT1301 **Credits: 3**

Additional Core - Optional (2 weeks)

INDUSTRIAL TRAINING

Sem. II **Hours/Week: 5**
14PBT2107 **Credits: 4**

RECOMBINANT DNA TECHNOLOGY

Objectives

i. To study the various underlying principles of genetic engineering that forms the basis of rDNA technology.
ii. To study the methodologies, and in brief the applications and related issues of rDNA technology.

Unit I

Introduction to Recombinant DNA technology - isolation (mechanical, cDNA, shotgun) & Purification of Nucleic acid, PCR; Enzymes in molecular biology (restriction endonuclease, Ligases, Reverse transcriptase, Nucleases, Polymerase, Alkaline phosphatase, Terminal transferase, and T4 polynucleotide kinase). Joining DNA molecules: E. coli DNA ligase, T4 DNA ligase, linkers, adaptors, and homopolymers.

Unit II

Expression cassette: Promoters (Constitutive, Inducible, Tissue specific), Terminators, Reporters, Markers (Antibiotic resistant, Herbicide resistant, Antimetabolite); Vectors in gene cloning - Plasmids (pBR322, pUC), Bacteriophages (phage l, M13), Cosmids, Phagemids, Yeast plasmid vector, Viral vectors (Adenovirus, Adeno-associated virus, Baculo virus, Herpes virus, Retrovirus, Cauliflower mosaic virus, Tobacco mosaic virus, Potato virus X), Transposons (Ac-Ds, P) Artificial chromosome (BAC, YAC, HAC), Shuttle vector, Expression vector.

Unit III

Gene transfer methods - Transformation - Physical method (electroporation, micro-injection, particle bombardment, liposome mediated transfer); Chemical method (PEG mediated, DEAE Dextran mediated, CaPO4 mediated gene transfer); Biological method (Agrobacterium mediated gene transfer). Expression systems - Prokaryotes (Bacteria) and Eukaryotes (Yeast, Mammalian and Insect cell lines).

Unit IV

Screening & Selection methods - Insertional inactivation, Blue-White selection, Colony - in situ hybridization, In vitro selection, In vitro translation, Radioactive antibody test, Immunological techniques, DNA labelling, dot blot hybridization, Molecular beacons. Gene Silencing, RNA interference,

antisense therapy, Gene Knockout. Blotting techniques - Southern, Northern, Western and South-Western.

Unit V

Molecular Techniques - RFLP, RAPD, AFLP, DNA Finger printing, DNA Foot printing, Microarray (DNA & Non-DNA). Libraries - Genomic library; C-DNA library & its types; BAC library; YAC library; Methyl filtration libraries; COT fractionation based libraries. Bioethics & Biosafety in genetic engineering; IPR & Patenting.

Books

1. Glick R. and J.J. Pasternak. 2002. Molecular Biotechnology (Ed:3). ASM Press, Washington.
2. Old RW. and SB Primrose. 1989. Principles of gene manipulation. Blackwell scientific publications, London.

Reference

1. Brown T. A. 1988. Gene cloning -An introduction. VNR (UK) co. Ltd, England.
2. David M. Glove. 1984. Gene cloning - The mechanisms of DNA manipulations. Chapman and hall, New York.
3. Ernst L. Winnacker. 2002. From genes to clones - Introduction to gene technology. VCR Pub., Weinheim.
4. James D. Watson. 1992. Recombinant DNA (Ed:2) WH freeman and co., New York.
5. Maniatis T. and J. Sambrook. 2003. Molecular cloning- A laboratory manual. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

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Sem. II **Hours/Week: 5**
14PBT2108 **Credits: 4**

MICROBIOLOGY

Objectives

i. To understand the applications of different microbes.
ii. To study the applications of microbiology in various industries.

Unit I

General Microbiology: introduction and scope of microbiology. Brief study of structure and organization of major groups of microorganisms - archaebacteria, cyanobacteria, eubacteria, fungi, algae, protozoa and viruses. Culture of microorganisms - batch, continuous and pure cultures. Control of microorganisms - physical, chemical and chemotherapeutic agents. Preservation of microorganisms.

Unit II

Environmental Microbiology: microbiology of soil - soil microflora - role of soil microbes in biogeochemical cycles (C,N,S) - Marine and fresh water microbiology. Contamination of domestic and marine waters. Water purification and sewage treatment. Role of microbes in waste water treatments. Microbiology of air.

Unit III

Industrial Microbiology: selection of industrially useful microbes. Fermentors and fermentation technology. Industrial production of alcohol, vinegar, lactic acid, antibiotics, enzymes and amino acids. Microbiology of food - sources of contamination - food spoilage - food preservation methods.

Unit IV

Clinical Microbiology: epidemic, endemic, pandemic and sporadic diseases. Pathogenicity, virulence and infection. Epidemiology of infectious diseases. Bacterial diseases of human (typhoid, cholera, syphilis, gonorrhoea and pertussis). Fungal diseases of human (superficial, cutaneous, subcutaneous and systemic mycoses). Viral diseases of human (AIDS, Hepatitis, Polio, Rabies and Measles). Mycoplasmal, Chlamydial, Rickettsial and protozoan diseases of human. Mycotoxins.

Unit V

Applied Microbiology: role of microbes in the manufacture of antibiotics and vaccines. Microorganisms as biofertilizers. Microbes as foods - SCP production. Role of microbes in bio-gas production, petroleum industry and mining. Microbial degradation of lignin, cellulose and pesticides. Microbial immobilization. Microbes in biological warfare.

Books

1. Chan E.C.S. and Noel R.K. 2010. Microbiology (Pelczar). An Application Based Approach. Tata McGraw Hill Education Private Limited, New Delhi.
2. Willey J., Sherwood L. and Woolverton C. 2008. Microbiology (Prescott). Ed: 4. McGraw-Hill Higher Education Private Limited, New Delhi.

References

1. Martin Alexander. 1969. Introduction to soil microbiology. Wiley, New York.
2. Adams and Moss. 1996. Food microbiology. Ed: 3. RSC Publishing, Cambridge, UK.
3. Greenwood. 2012. Medical Microbiology. Ed: 18.Churchil livingstone. Elsevier publication.

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Sem. II **Hours/Week: 4**
14PBT2109 **Credits: 3**

BASIC BIOINFORMATICS

Objectives

i. To understand the importance of various databases.
ii. To understand various dimension of bioinformatics.

Unit I

History of Bioinformatics; Role of Bioinformatics in biological sciences; Scope of Bioinformatics; Types of biological databases; Data mining and its techniques; Data warehousing.

Unit II

Nucleic acid databases - Genbank, NCBI, EMBL, DDBJ; Primary protein databases - PIR, SWISSPROT, TrEMBL; Secondary protein databases - PROSITE, PROFILES, PRINTS, Pfam; Structural classification databases - SCOP, CATH; Literature databases - PubMed, Medline; Bibliographic databases - OMIM, PubMed.

Unit III

Sequence Annotation - Principles and tools; Sequence retrieval system - Entrez, SRS; Sequence submission tool - BANKIT, SEQUIN, WEBIN, SAKURA. Molecular phylogeny - Concepts of tree - rooted and unrooted trees; Molecular Clocks, Clustering and Phenetic method, Cladistic method; Steps in constructing phylogenetic analysis; Bootstrapping strategies. Molecular viewers - Rasmol, Chime and Spdb viewer

Unit IV

Sequence alignment - concepts in alignment, Local & Global; Pairwise & Multiple; Tools for sequence alignment - BLAST, FASTA, Clustal W;

Substitution matrices; Scoring matrices - PAM & BLOSUM; Dot plot; EST Clustering and analyses, Computational methods of gene prediction.

Unit V

Genomics & Proteomics: Comparative, Structural & Functional genomics; Proteomics -Expression, Structural & Functional proteomics; Applications of Metabolomics & Transcriptomics; Concept of system biology.

Books

1. Arthur M Lesk. 2005. Introduction to Bioinformatics (Ed:2). Oxford university press, NY
2. Attwood, T.K. and Parrysmith, D.J. 2001. Introduction to Bioinformatics. Pearson Education New Delhi.

Reference

1. Andreas D. Baxevanis and B. F. Francis Ouellette. 2005. Bioinformatics - A Practical guide to the analysis of Genes and Proteins (Ed:3). John Wiley & Sons, Inc., Publications, US.
2. David W Mount. 2004. Bioinformatics: sequence and Genome analysis(Ed:2). Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
3. Rastogi, S.C., Menderatta, M. and Rastogi, P. 2004. Bioinformatics - concepts, skills and applications. CBS Publishers & Distributors, New Delhi.

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Sem. II **Hours/Week: 4**
14PBT2110 **Credits: 3**

Lab Course-III

RECOMBINANT DNA TECHNOLOGY AND BIOINFORMATICS

Recombinant DNA Technology

- Agarose gel electrophoresis
- Isolation of genomic and plasmid DNA from bacteria
- Isolation of total RNA from plant tissue
- Isolation of genomic DNA from Plant tissue
- Restriction digestion and ligation of DNA
- GFP cloning
- Gel elution of DNA
- DNA fingerprinting

Bioinformatics

- Biological databases-file formats.
- Data retrieval using ENTREZ
- Sequence analysis: Pairwise alignment (BLAST)
- Sequence analysis: Multiple alignment (Clustal W)
- Motif and domain analysis
- Phylogenetic analysis
- Six frame translation
- Primer designing
- Gene finding
- Molecular visualization using Rasmol

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Sem. II **Hours/Week: 4**
14PBT2111 **Credits: 3**

Lab Course-IV

MICROBIOLOGY AND DIAGNOSTICS

MICROBIOLOGY

- Study of Autoclaving of media.
- Preparation of basal media - Solid, Liquid: Serial dilution, plating with a known microbial strain; isolation of single colonies.
- Study of a compound microscope.
- Identification of bacteria by gram staining
- Subculturing of a strain using a synthetic liquid media.
- Study of bacterial growth of E.coli by a Spectrophotometer.
- Assay of an antibiotic by zone-inhibition method using antibiotic impregnated discs.
- Estimation of antimicrobial activity using standard guidelines (NCCLS/ CLSA)
- Study of biochemical identification of microorganisms.
- Bacterial biofilm formation by microtitre plate assay.

DIAGNOSTICS

- Molecular diagnosis of E. coli using PCR
- VDRL test
- ELISA for the detection of pathogens
- Detection of pathogens by direct and indirect agglutination.

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Sem. II **Hours/Week: 4**
14PBT2202A **Credits: 4**

Core Elective-2

CELL SIGNALLING

Objectives

i. To understand the mechanism of cell communication.
ii. To understand how cells are programmed and the mechanism of cancer and apoptosis.

Unit I

Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

Unit II

Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

Unit III

Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extra cellular matrix, integrins, neurotransmission and its regulation.

Unit IV

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Unit V

Programmed cell death: Apoptosis - genes involved, Functions: Cell termination - Homeostasis - lymphocyte interaction. Process of Apoptosis: mitochondrial regulation - direct signal transduction - excretion and removal of dead cells. Theories of aging and senescence - gene regulation. Cellular senescence and whole organism aging.

Text Book

1. Michel Friedman and Brett Friedman. 2004. Cell communication: Understanding how information is stored and used in cells. Ingram International Inc.

Reference

1. Geoffery M Cooper and Robert E Hausman. 2009. The Cell and Molecular Approach. (Ed: 5). ASM Press and Sinauer Associates Inc.
2. Gomperts, Basten D, Ijbrand M Kramer and Peter ER Tatham. 2009. Signal transduction. (Ed:2). Academic Press.
3. Ernst JM Helmreich. 2001. The Biochemistry of cell signaling. Oxford Univ Press.
4. Krauss G. 2003. Biochemistry of signaling transduction and regulation. (Ed:3). JohnWiley and Sons.

Sem. II **Hours/Week: 4**
14PBT2202B **Credits: 4**

Core Elective-2

MOLECULAR DIAGNOSTICS AND THERAPEUTICS

Objectives

i. To explore the molecular mechanisms of diseases
ii. To study the various diagnostic tools available for these diseases.

Unit-I

Molecular mechanisms of diseases: Detection of genetic defects, Detection of infectious agents, tumor diagnosis markers and grading. Molecular genetics of B-cell neoplasia. Liver specific expression of cloned human genes, technology of carrier erythrocytes: a tool for diagnosis and therapy. Diagnosis of single gene disorders - Spinal muscular atrophy, DMD and BMD, Fragile X syndrome.

Unit-II

Use of probes for diagnostics: Restriction Fragment Length Polymorphism (RFLP) - DNA probes detection of mutations and deletions in gene. Eg: thalassemia, haemophilia, sickle cell anemia, retinoblastoma. DNA finger printing. Genetic disease probes. Chromosomal DNA probes for prenatal diagnosis of X-linked Retinitis pigmentosa, prenatal sex determination.

Unit-III

Hereditary persistence of fetal hemoglobin: model for abnormal development regulation. Apolipoprotein genes, DNA polymorphism and hyperlipidemia, cDNA of human protein C for diagnosis of protein C deficiency. Prenatal diagnosis and carrier detection of phenylketonuria by gene. Prenatal

diagnosis - Fluorescent in situ hybridization (FISH) DNA probes - fluorescent labeling, chromosome painting and spectral karyotyping, peptide mapping.

Unit-IV

Approaches in hybridoma technology: Hybridoma variants affecting isotype, antigen binding and idiotype: isolation of class and subclass switch variants by selection. The MHC locus, HLA polymorphisms, HLA nomenclature, molecular analysis of the MHC, serological analysis DNA-based typing, combining typing results, HLA test discrepancies, coordination of HLA test methods, additional recognition factors, Minor histocompatibility antigens, nonconventional MHC antigens, killer cell immunoglobulin-like receptors, MHC & its disease association.

Unit-V

Polymerase chain reaction - Its applications in diagnosis of infectious diseases - eg: HIV, hepatitis B and tuberculosis. Identification of gene mutations and deletions - eg: p53 mutations. Use in solving paternity disputes and crime detection. Molecular Oncology-Classification of Neoplasms, Molecular Basis of Cancer, Analytical Targets of Molecular Testing- Gene and Chromosomal Mutations in Solid Tumors, Microsatellite Instability, Loss of Heterozygosity. Enzyme linked immunosorbent assay (ELISA) - Diagnosis of infectious diseases and cancer antigens, HIV detection.

Book

1. Gath, D. 1994. PCR-based diagnostics in infectious diseases. Blackwell Scientific.
2. Grom well, L. 1994. Biomedical instrumentation & measurements, Addition Weisly.
3. Koporowski, H. 1985. Biotechnology in Diagnostics, Elsevier publishers. Vol-21.

Reference

1. Fazal Ahmed. 1984. Advances in Gene technology: human genetic disorders, ICSU
2. Stanely, A et al., 1994. Vaccines. W. B. Saunders & Co. Lela Buckingham, Maribeth L. Flaws, 2007, Molecular Diagnostics - Fundamentals, Methods, & Clinical Applications, F.A. Davis & Company, Philadelphia.

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Sem. II **Hours/Week: 4**
14PSS2401 **Credits: 4**

IDC-1
SOFT SKILLS

Objectives

* Introducing learners to the relevant soft skills at the territory level in order to make them gain competitive advantage both professionally and personally.

Module 1: Basics of communication and Effective communication

Basics of communication: Definition of communication, Process of Communication, Barriers of Communication, Non-verbal Communication. Effective communication: Johari Window, The Art of Listening, Kinesthetic, Production of Speech, Organization of Speech, Modes of delivery, Conversation Techniques, Dialogue, Good manners and Etiquettes.

Module II. Resume writing and Interview skills

Resume Writing: What is Resume? Types of Resume? Chronological, Functional and Mixed Resume, Steps in preparation of Resume. Interview Skills: Common interview questions, Attitude, Body Language, The mock interviews, Phone interviews, Behavioral interviews.

Module III: Group discussion and team building

Group Discussion: Group Discussion Basics, GD Topics for Practice, Points for GD Topics, Case-Based and Article based Group Discussions, Points for Case Studies, and Notes on Current Issues for GDS. Team Building: Team Vs Group - synergy, Stages of Team Formation, the Dabbawala. Leadership - Styles, Work ethics. Personal Effectiveness: Personal Effectiveness: Self Discovery, Self Esteem, and Goal setting. Conflict and Stress Management.

Module IV: Numerical Ability

Average, Percentage, Profit and Loss, Simple Interest, Compound Interest, Time and Work, Pipes and Cisterns, Time and Distance, Problems on Trains, Boats and Streams Calendar, Rations and Proportions.

Module V: Test of reasoning

Verbal Reasoning: Series Completion, Analogy, Data Sufficiency, Assertion and Reasoning, Logical Deduction. Non-Verbal Reasoning: Series, Classification

References

1. Aggarwal, R.S. 2010 Quantitative Aptitude, S.Chand & Sons
2. Aggarwal, R.S. 2010. A Modern Approach to Verbal and Non Verbal Reasoning. S.Chand
3. Covey, Stephen. 2004. 7 Habits of Highly effective people, Free Press.
4. Egan, Gerard. 1994. The Skilled Helper (5th Ed). Pacific Grove, Brooks / Cole.
5. Khera, Shiv 2003. You Can Win. Macmillan Books , Revised Edition
6. Murphy, Raymond. 1998. Essential English Grammar. 2nd ed., Cambridge Univ. Press.
7. Prasad, L. M. 2000. Organizational Behaviour, S.Chand
8. Sankaran, K., & Kumar, M. 2010 Group Discussion and Public Speaking. M.I. Pub, Agra, Adams Media.
9. Schuller, Robert. (2010). Positive Attitudes. Jaico Books.
10. Trishna's (2006). How to do well in GDs & Interviews, Trishna Knowledge Systems.
11. Yate, Martin. (2005). Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting.

Sem. III **Hours/Week: 6**
14PBT3113 **Credits: 5**

RESEARCH METHODOLOGY FOR BIOSCIENCES

Objectives

i. To understand the working principles, construction and applications of the instruments often used in the studies related to various disciplines of Biological Sciences.
ii. To understand the statistical concepts and applying them in data collection, analysis and interpretation.
iii. To understand the importance and the concept of Research and learn the art of paper writing and publication.

Unit - I

Electrochemical techniques - principles, electrochemical cells and reaction - pH and buffers. Measurement of pH - glass electrode and titration curves. Ion selective and gas sensing electrodes, oxygen electrode, and their applications. Microscopy - Compound, Fluorescence, Phase contrast, SEM, TEM, AFM, CSLM. Chromatographic techniques -general principle; adsorption and partition chromatography. Techniques and application of paper, column, thin layer, normal phase and reverse phase - ion-exchange chromatography, exclusion chromatography, affinity chromatography, GLC and HPLC, HPTLC.

Unit - II

Centrifuges: Principles, differential and analytical centrifugation, density gradient centrifugation; Analysis of subcellular fractions, ultracentrifuge and its application. Electrophoresis: Principles, electrophoretic mobility, factors influencing electrophoretic mobility - paper, disc, slab gel electrophoresis. Isoelectric focussing, 2D PAGE, blotting techniques, capillary electrophoresis.

Unit - III

Spectroscopy - Properties of EMR, absorption spectrum., Absorption vs Emision spectrophotometry, AAS & flame photometer, UV/VIS spectroscopy, IR, ESR, NMR, MS, GC-MS, spectrofluorimetry ,CD spectroscopy, X-ray diffraction. Tracer technique: Nature of Radioactivity, Patterns of decay, half life and its application, Detection and measurement of radioactivity: Geiger Muller Counter- principle, construction, applications, advantages and disadvantages. Scintillation counter - Principle, types, construction

and applications. Use of isotopes in biological studies. Laser: principle and application, population inversion, stimulated emission CO2 laser, Nd-YAG laser, biological application.

Unit - IV

Biostatistics - Basics and uses of Measures of Central values (Mean, Median, Mode), Measures of Dispersion (Standard Deviation and coefficient of variation) in data analysis and presentation. Basic theoretical knowledge of Correlation and Probability - Sample Testing: Large samples (Z), small sample test: t, Chi-square, ANOVA (one-way & two-way). Experimental Design: Principles: Randomization, Replication, Local control, Size and shape of the plot. CRD and RBD.

Research: Selection of research problems - hypothesis - definition and characteristics. Experimental approaches - biological, physical and chemical methods. Sources of information: Journals, e-journals, books, biological abstracts, Preparation of index cards, Review writing, Article writing - structure of article (title, introduction, methods, specimens and techniques of statistics, results, discussion, acknowledgements, references, abstracts), Selection of journals for publication. Proposal writing for funding.

UNITV

Bioinformatics: Introduction to Bioinformatics, Bioinformatics and its applications, Information networks - EMB net and NCBI. Databases; Primary Nucleic acid databases - EMBL; Gene Bank and DDBJ. Structure of Gene bank entries. Protein sequences databases; primary databases PIR, MIPS, SWISS - PROT, TrEMBL, NRL-3D. Structure of SWISS - PROT entries. Secondary Databases; PRO SITE, PROFILES, PRINTS, Pfam, BLOCKS and IDENTITY. Composite protein Databases.

Book

1. Cantor and Schimmel. 2004. Biophysical chemistry: Part I, part II and Part III.W.H Freeman San Francisco .
2. Wayne W. Daniel. 2006. Biostatistics . Ed: 7. John wiley & sons, inc.
3. Wilson K. and J. Walker. 2000. Practical Biochemistry: Principles and Techniques. Ed: 5. Oxford University Press, UK.

Reference

1. Braun, R.P. 1987. Introduction to Instrumental Analysis. McGraw Hill.
2. Gurumani. N. 2006. Research methodology for biological sciences.MJP publications

3. Upadhyay A. and Upadhyay K. 2009. Biophysical Chemistry - Principles and Techniques (Ed: 4). Himalaya Publishing House, Chennai.
4. West, E.S. et al., Textbook of Biochemistry. Macmillon, New York.
5. West, E.S., Todd, W.R., Mascon, H.S. and Bruggen, T.V. 1974. Textbook of Biochemistry. Oxford and IBH.

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Sem. III **Hours/Week: 6**
14PBT3114 **Credits: 5**

FERMENTATION TECHNOLOGY

Objectives

i. To study the avenues of exploiting microbes.
ii. To study the downstream processes for product recovery in fermentation.

Unit I

Introduction to fermentation technology: Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation, introduction to fermentation processes, media formulation and optimization. Basic concepts: batch, continuous and fed batch culture, selection methods for industrially important microorganisms. Strain improvement, preservation, and properties of industrial strains.

Unit II

Fermentor - Design & Types: Gaden's Fermentation classification, design and operation of fermentors, Basic concepts for selection of a bioreactor, impellers, baffles and sparger, sterilization. Types of reactor- submerged reactor - mechanically stirred draught- tube reactor- continuous flow stir type reactor - airlift reactor- jet loop reactor, surface reactor, packed bed reactor, Fluidized bed reactor.

Unit III

Bioprocess control and monitoring variables - O2 requirement and uptake, factors affecting Kla. Flow measurement and control, control system - manual and automatic. PID control. Application and the role of computers in bioprocess.

Unit IV

Down-stream processing: Introduction, recovery of microbial cells, precipitation, filtration-theory of filtration, batch and continuous filters. Centrifugation. Cell disruption - physical and chemical methods. Extraction

- liquid-liquid extraction and aqueous two phase extraction. Chromatography, membrane processes, drying and crystallization.

Unit V

Production strategies for industrial products: (lactic acid and ethanol), therapeutics (insulin and interferon), antibiotics (cephalosporin), microbial enzymes (chitinase, glucose oxidase, lipase), exopolysaccharides (pullulan). Use of immobilized cells. Use of fungi in industry including food industry: biosensors and fuel cells, Use of fungi in agriculture and environmental applications: Biofertilizers, bioremediation and biological control. Animal cell culture technology to produce recombinant vaccines

Books

1. Stanbury P.F. and Whitakar A. 1984. Principles of Fermentation Technology, Pergamon Press.
2. El-Mansi E.M.T., Bryle C.I.A., Dahhou B., Sanchez S., Demain A.L. and Allman A.R. 2007. Fermentation Microbiology & Biotechnology. CRC / Taylor & Francis.

Reference

1. Bailey J. and D.F. Ollis. 1986. Biochemical Engineering Fundamentals, McGraw-Hill, NY.
2. Cinar A. Parulekar S.J. and Undey C. 2003. Batch Fermentation - Modelling, Monitoring and Control. Taylor and Francis Inc. USA.

Sem. III **Hours/Week: 3**
14PBT3115 **Credits: 2**

Lab Course-V

FERMENTATION TECHNOLOGY

1. Bioassay and Chemical estimation of penicillin
2. Preparation of bioinoculants and cell count determination on time scale
3. Preparation of enzyme immobilized columns for biotransformation - e.g. yeast cells immobilized in calcium alginate beads
4. Parameter testing for immobilized enzyme columns:
   a. Comparative enzyme activity of free cells and immobilized cells
   b. Effect of gel concentration on enzyme activity
   c. Effect of cell concentration on enzyme activity
5. Laboratory scale production of microbial emulsifiers

6. Biosorption of Congo Red dye using dead biomass of Aspergillus niger.
7. Preparation and maintenance of plant callus culture, Extraction and estimation of bioactive (antimicrobial) principles from plants; and activity fractionation.
8. Fermentation Kinetics.
9. Microbial Production of amino acids.
10. Screening and isolation of Antibiotic producing organisms from soil.
11. Production of cellulase by solid state fermentation.

Sem. III **Hours/Week: 3**
14PBT3116 **Credits: 2**

Lab Course-VI

IMMUNOLOGY AND BIOSTATISTICS

IMMUNOLOGY

1. Blood typing,
2. RBC Total and differential count.
3. WBC Total and differential count.
4. Blood smear identification of leukocytes by Giemsa stain.
5. Separation of Peripheral blood mononuclear cells.
6. Isolation of peritoneal macrophage.
7. Generation and purification of chicken egg yolk antibodies
8. Isolation of DNA from leukocytes
9. WIDAL Test
10. Immuno electrophoresis-Rocket immuno electrophoresis.
11. Single radial Immuno diffusion.
12. Ouchterlony double immuno diffusion.

BIOSTATISTICS

1. Random sampling by Random Number Table (Tipett's) Method (Cluster Bean N = 500; n = 50).
2. Data Collection on discrete and continuous variables.
3. Data classification: Discrete frequency distribution, Continuous frequency distribution and Cumulative frequency distribution.
4. Statistical Illustrations - Manual and Computer aided using Microsoft Excel.
5. Measure of Central values (Mean, Median and Mode) for the data collected in the earlier exercises.

6. Determining the correlation coefficient between pod length & pod weight and testing the relationship.
7. Training on the SPSS (Statistical Package for Social Sciences) for
8. Measure of central values: Minimum, Maximum, Mean, Median and Mode
9. Measure of Dispersion: Standard Deviation and coefficient of variation
10. Coefficient of correlation and regression
11. Testing the significance
12. Single Mean T test
13. Two mean T test
14. Paired T test
15. One way ANOVA
16. Two way ANOVA
17. DMRT in one way and two way ANOVA
18. Interpretation of the results obtained from SPSS.

Sem. III **Hours/Week: 4**
14PBT3203A **Credits: 4**

Core Elective-3

IMMUNOLOGY

Objectives

i. To elucidate the immune response of humans to foreign substances.
ii. To study the modern techniques that help determine human protection.

Unit I

Basics of immunology: Immunity - Types of Immunity, Innate and Acquired Immunity. Cells of the Immune System - B & T Lymphocytes; T-cell sub-sets; Antigen Presenting Cells. Organs of the immune System : Primary lymphoid organs (Bone marrow and Thymus); Secondary lymphoid organs (lymph nodes, spleen and mucosal-associated lymphoid tissue). Antigens - Immunogenecity versus Antigenicity, Factors that influence immunogenecity, Epitopes - Properties of B-cell epitopes and T-cell epitopes, Haptens and the study of Antigenicity.

Unit II

Immunoglobulin: Structure and Functions domains, classes, Organization and expression of Immunoglobulin Light and Heavy chain genes Principles of cell signaling; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors.

Unit III

Major Histocompatibility Complex (MHC): General organization and inheritance of MHC; MHC Haplotypes. The structure of MHC class-I and class-II molecules; organization of MHC class I and class II genes, peptide binding of MHC molecules. Complement system-alternate and classical pathways. HLA typing. Polyclonal and Monoclonal antibody. Transplantation - Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy.

Unit IV

Antigen-antibody interactions: Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, Immunofluorescence, Flow cytometry and Immunoelectron Microscopy; Surface plasmon resonance, Biosensor assays for assessing ligand - receptor interaction, CMI techniques - lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.

Unit V

Clinical Immunology: Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency - Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Books

1. Kindt T.J., Goldsby R.A., Osbone B.A. and Kuby J., 2007. Kuby Immunology (Ed: 6), W.H. Freeman & Co., New York.
2. Roit M. Ivan. 1998. Essential Immunology (Ed: 7). Blackwell Scientific Publisher, England.

Reference

1. Donald M. Weir and John Steward. 1993. Immunology (Ed: 7). ELBS, London.
2. Murphy K., Travers P. and Walport M. 2007. Janeway's Immunology the immune system in health and disease. (Ed: 7). Garland Science Publisher, New York.

Sem. III **Hours/Week: 4**
14PBT3203B **Credits: 4**

Core Elective-3

DRUG DISCOVERY AND DEVELOPMENT

Objectives

i. To make a detailed study of drugs, particularly their actions on living systems
ii. To know their chemotherapeutic values

Unit I

Drugs - definition, source and nature, types of classification and nomenclature, dose response curve and LD50. Role of drugs, Drug - protein interactions, routes of drug administration.

Unit II

Drug targets - Enzymes, receptors, carrier proteins. Structural proteins, nucleic acids, lipids and carbohydrates. Forces in drug - receptor interaction, Receptor theories.

Unit III

Drug absorption, distribution, metabolism, excretion and dosing. Pharmacokinetic oriented drug design - Drug solubility and drug stability.

Unit IV

Biological testing and bioassays - testing drugs in vitro and in vivo. Drug discovery. Lead compounds - natural sources and synthetic sources.

Unit V

Drug development. Target - oriented drug design, computer aided drug design, Quantitative structure, activity relationship - binding interaction, Functional groups and Pharmacophore. High thoroughput screening and Molecular docking.

Books

1. Barar F S K.2004. Essentials of Pharmacotherapeutics, S. Chand & Co. Ltd. New Delhi.
2. Patrick G. 2002. Medicinal Chemistry-Instant notes series, Viva Books,
3. Arunabha Ray and Kavita Gulati. 2000. Current Trends in Pharmacology. I. K. International Pvt. Ltd.

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Sem. III **Hours/Week: 4**
14PBT3402 **Credits: 4**

IDC-2(WS):

BIOPROCESS TECHNOLOGY

Objectives

i. To study the avenues of exploiting microbes in bioconversion technology.
ii. To study the downstream processing for product recovery in fermentation.

Unit I

Principles of fermentation process, Bioprocess vs Chemical process, Media formulation - Growth factors, Buffers, O2, Antifoams and Media Optimization. Cell growth and quantitation - density, cell mass, growth pattern, yield factors and environmental conditions. Batch, Continuous and Fed batch culture.

Unit II

Bioreactor design, parts and functions, sterilization, impellers, baffles and sparger. Types of reactor - submerged reactor, mechanically stirred draught-tube reactor, continuous flow stir type reactor, airlift reactor, jet loop reactor, surface reactor and packed bed reactor.

Unit III

Bioprocess control and monitoring variables: O2 requirement and uptake-factors affecting Kla-aeration, agitation, pressure and pH, medium rheology. Computers in bioprocess. Flow measurement and control, control system - manual and PID control.

Unit IV

Bioconversion and biocatalysts: Immobilization of cells and enzymes - methods and advantages. Selection of industrially important microorganisms. Strain improvement preservation and properties of industrial strains. Production strategies for insulin, lactic acid and vinegar. Scale-up and scale-down - problems and solutions.

Unit V

Downstream processing: recovery of microbial cells and products - Precipitation. Filtration and Centrifugation. Cell disruption - physical and chemical methods. Extraction - liquid-liquid extraction and aqueous-two phase extraction. Chromatography. Membrane processes, drying and crystallization.

Books

1. Stanbury, P F and Whitaker, A, 1995, Principles of Fermentation Technology, Pergamon.
2. Schuler ML and Fikret Kargi, 2002, Bioprocess Engg: Basic Concepts, Prentice Hall, NJ.
3. Wulf Crueger and Anneliese Cruger, 2004, Biotechnology: A Textbook of Industrial Microbiology, 2nd Edn., Panima Publishing Co.
4. El-Mansi, EMT., Bryle, CFA., Demain, A., Allman, A.R. 2012. (Ed: 3). Fermentation Microbiology and Biotechnology, CRC Press.
5. Bailley, J E and Ollis, F. 1986, Biochemical Engg Fundamentals, McGraw Hill, New York.
6. Coulson, J M and Richardson, S F, 1984, Chemical Engg, Pergamon Press.
7. Mooyoung (ed.), 1985, Comprehensive Biotechnology, Vol. I, II, III & IV, Pergamon Press.

Sem. III **Hours/Week: 4**
14PBT3403 **Credits: 4**

IDC-3 (BS): FOOD TECHNOLOGY

Objectives

i) To understand the chemical nature and associated microbes of food.
ii) To understand the principles of food processing, preservation and manufacture.

Unit I

Food chemistry: constituent of food - contribution to texture, flavour and organoleptic properties of food; food additives - intentional and non-intentional and their functions; enzymes in food processing.

Unit II

Food Microbiology: sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases - infections and intoxications, food spoilage - causes.

Unit III

Food processing: raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations - mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

Unit IV

Food preservation: use of high temperatures - sterilization, pasteurization, blanching, canning - concept, procedure & application; Low temperature storage - freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods.

Unit V

Manufacture of food products: bread and baked goods, dairy products - milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

Books

1. Crosby,N.T. 1981. Food packaging Materials Applied Science Publishers, London.
2. David, S. Robinson. 1997. Food Chemistry and nutritive value. Longman group, UK.
3. Frazier, W.C. and Westhoff, D.C. 1988. Food Microbiology, 4th ed. McGram-Hill, New York.
4. Pyke, M. 1981. Food Science and Technology, 4th ed., John Murray, London.
5. Sivasankar, B. 2002. Food processing and preservation, Prentice Hall, New Delhi.

References

1. Brenner, J.G., Butters, J.R., Cowell, N.D. and Lilly, A.E.V. 1979. Food engineering operations, 2nd ed., Applied Sciences Pub. Ltd., London.
2. Desrosier, N.W. 1996. The Technology of Food Preservation, CBS Publishers and Distributors, New Delhi.
3. Fennema, O.R. 1976. Principles of food science: Part I, Food chemistry, Marcel Dekker, New York.
4. Lindsay, W. 1988. Biotechnology, Challenges for the flavor and food Industries, Elsevier Applied Science.
5. Shakuntala, N. and Shadaksharaswamy, M. 1997. Foods; Facts and principles, (Ed: 2), New Age International Publishers, New Delhi.

Sem. IV **Hours/Week: 6**
14PBT4117 **Credits: 5**

ENVIRONMENTAL BIOTECHNOLOGY

Objectives

i. To connect two different facets of Environmental Biotechnology, principles of environmental microbiology and environmental engineering.
ii. To teach students the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society.

Unit I

Environmental Pollution: Classification of pollutants, Air pollution and their properties, Gaseous pollutants, water pollutants and their properties. Noise pollution, Soil pollution, thermal pollution, marine pollution, solid water pollution. Bioremediation & Phytoremediation: Biofeasibility, applications of Bioremediation and Bioreduction.

Unit II

Bioabsorption and bioleaching of heavy metals: cadmium, lead, mercury, metal binding targets and organisms, bioabsorption, metal microbial interaction, biomethylation of elements (methylation of mercury and arsenic), commercial biosorbants, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

Unit III

Waste water Treatment: biological treatment system (oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), biological waste treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme for dairy, distillery, tannery, sugar, fertilizers, refinery, chemical and antibiotic wastes.

Unit IV

Solid waste pollution and its management: Current practice of solid waste management, Treatment process for solid waste, Thermal conversion, Pyrolysis. composting systems, vermicomposting, sewage treatment.

Unit V

Xenobiotics in environment: biodegradation of hydrocarbons, substituted hydrocarbons, surfactant, pesticides, lignin, tannin, synthetic dyes,

biotransformation: oxidation reactions: Cytochrome P450 monooxygenase system, Alcohol and aldehyde dehydrogenases, Peroxidases. Reduction reactions: Cytochrome P450 and flavin dependent reactions. Hydrolysis reactions: Carboxyl esterases. Conjugation reactions: Gluthione S transferases.

Books

1. Nazaroff, W.W. and Alvarez-Cohen, L. 2001, Environmental Engineering Science, John Wiley, USA
2. Rittmann, B.E. and McCarty, P.L. 2001, Environmental Biotechnology: Principles and Applications, McGraw-Hill.

Reference

1. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G. 1985, Environmental Engineering, McGraw-Hill International.
2. Grady, Jr., C.P.L. and Lim, H.C. 1980, Biological Wastewater Treatment: Theory and Applications, Marcel Dekker, Inc.

Sem. IV **Hours/Week: 6**
14PBT4118 **Credits: 5**

PLANT AND ANIMAL BIOTECHNOLOGY

Objectives

i) To study the basic principles and techniques involved in plant and animal cell culture.
ii) To understand the concepts of transformation and achievements of biotechnology in Plant and Animal systems.

Unit I

Establishment of plant tissue culture: culture media (types of media), explants and its preparation, Types of culture (callus, suspension, Meristem, Embryo, Protoplast, Root cultures), regeneration of plants (organogenesis and Somatic embryogenesis), Haploid plant production (androgenesis and gynogenesis). Isolation and fusion of Protoplast, Artificial seeds, Hardening of plants, Cryopreservation and Germplasm storage. Applications of plant tissue culture in Agriculture and Forestry.

Unit II

Introduction of genetic engineering of plants - Vector (Viral vectors and Ti & Ri plasmids) and Gene transfer methods (electroporation, particle

bombardment, microinjection). Chloroplast transformation. Transgenic plants - biotic stress resistance (pest, viral, bacterial & fungal), abiotic stress tolerance (herbicide, salt, drought). Crop improvement (flavr savr tomato, golden rice, amino acid enrichment, preventing discolouration, improving flower pigmentation, male sterility).

Unit III

Transgenic plant as bioreactors - plantibodies, therapeutic proteins and edible vaccines. Introduction to animal tissue culture - culture media. Primary cell culture. development and maintenance of cell lines. Infinite and finite cell lines, suspension culture, embryo culture, organ and histotypic cultures.

Unit IV

Lab based and large-scale culture. Cell synchronization. Cryobiology. Applications of animal cell culture. Stem cells - isolation, culture, manipulation and applications. Gene therapy-method, gene delivery systems and applications. Production and applications of monoclonal antibodies.

Unit V

Methods of animal cloning (Somatic nuclear transfer, chromatin transfer, embryo splitting) and its pros& cons. Methods of production of transgenic animals (transfection, retroviral vector, microinjection, embryonic stem cells, YAC, gene trageting) and its applications (human disease models, gene knockout mice, transgenic cattle, sheep, fish, chickens). Transgenic animals as bioreactors - therapeutic proteins, vaccines, recombinant insulin.

Book

1. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - the genetic manipulation of plants. Oxford University press, USA.
2. Ranga M.M. 2010. Animal Biotechnology, Agrobios, India.

Reference(s)

1. Butler M. 1987. Animal cell technology- Principles and procedures. Open University press, New York
2. Darling D.C. and S.J Morgan. 1994. Animal cell cultures and media. BIOS scientific Publishers Ltd, London.
3. Ed. Martin Clynes. 1998. Animal Cell Culture Techniques. Springer, Heidelberg.
4. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.

Sem. IV **Hours/Week: 6**
14PBT4119 **Credits: 5**

REGULATION OF GENE EXPRESSION

Objectives

i) To understand the mechanisms of gene regulation in various groups of organism so us to plan the genetic engineering experiments.
ii) To understand the regulation of gene during the various stage of development of an organism.

Unit I

Central Dogma - Need for gene regulation. Gene regulation in Prokaryotes: Gene Expression by regulatory proteins, Regulation by activators and repressors, Allostery: Post RNA polymerase binding & Action at distance and, Anti-termination and beyond.

Unit II

Regulation of transcription initiation: Bacteria: Lac gene -Activator and repressor together control, Combined control of CAP on other genes. S factor, NtrC & MerR Transcriptional activators. AraC and control of araBAD operon. Gene regulation after Transcription initiation: Premature transcription termination, Regulation in Phage l. Ribosomal Proteins as repressors.

Unit III

Transcriptional - Level Control: Role of Transcription factors - Structure of transcription factors - DNA sites involved in regulation - Transcriptional Activation: Role of Enhancers, Promotors, and coactivators - transcriptional repressors. Processing level control - Translational level control: Cytoplasmic localization of mRNA, Control of mRNA translation, control of mRNA stability - Post translational control, Determining Protein stability.

Unit IV

Gene regulation in Eukayotes: transcriptional Regulation in Yeast & Mammals. Eukaryotic Activators - Signal Integration & Combinatorial control. Transcriptional repressors. Signal transduction and the control of transcriptional regulators. Gene silencing by modification of Histones and DNA - regulation after transcription initiation - RNAs in gene regulation. Regulation of gene expression in Plant cells by light. Regulation of synthesis of Vitellogenin. Human Gene Expression.

Unit V

Gene regulation during development. Expression of specific sets of genes during development - Establishing differential gene expression. Regulation of gene during Drosophila embryogenesis.

Book

1. Freifelder D. 2008. Molecular Biology (Ed. 2). Narosa Publishing House. New Delhi (pp. 453-550).
2. Gardner E.J., Simmons M.J. and Snustad P. 2004. Principles of Genetics (Ed. 8). John Wiley & Sons, Inc. NY.
3. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine, M. and Losick R. 2013. Molecular Biology of the Gene (Ed: 7), Benjamin Cummings.

Reference

1. Karp G. 2008. Cell & Molecular Biology - Concepts and Experiments. John Wiley & Sons Inc. USA.
2. Strachan T. and Read A. 2011. Human Molecular Genetics (Ed. 4) Garland Science. USA.

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Sem. IV **Hours/Week: 12**
14PBT4121 **Credits: 6**

PROJECT DISSERTATION

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VIVA VOCE

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