Kristu Jayanti College

AUTONOMOUS Bangalore

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DEPARTMENT OF LIFE SCIENCES

Master of Science
(Biotechnology)
Curriculum – 2015-2017

http://www.kristujayanti.edu.in

PROCEEDINGS OF THE MEETING OF THE BOARD OF STUDIES (BoS) FOR THE FACULTY OF SCIENCE - LIFE SCIENCES (PG)

The meeting of the B.O.S. (P.G) in Biotechnology, Genetics, Biochemistry & Microbiology was convened on 24th January, 2015 in the panel room P.G block, Kristu Jayanti College, Bangalore.

MEMBERS PRESENT **SIGNATURE**

1. Dr. Calistus Jude A.L
   Dean – Faculty of Sciences, KJC

2. Dr. S.K.Sarangi
   Professor, Department of Biotechnology, BUB

3. Dr. Jaya Prakash
   Professor & Director, Centre for Applied Genetics, BUB

4. Dr. M.S. Shaila
   Department of Microbiology and Cell Biology, IISC

5. Dr. Nitesh Dave
   Senior Scientist, Biocon India Pvt., Ltd, Bangalore

6. Dr. Elcey C.D
   Professor & Head, Department of Life Sciences, KJC

7. Dr. Deepa MA
   Associate Professor, Department of Life Sciences, KJC

8. Dr. Vijayanand S
   Assistant Professor, Department of Life Sciences, KJC

9. Mr. Thomas Abraham
   Assistant professor, Department of Life Sciences, KJC

10. Dr. Shalini Prabhu
    Assistant professor, Department of Life Sciences, KJC

11. Mr. John Caleb T.D
    Assistant professor, Department of Life Sciences, KJC

12. Ms. Apoorva Udhayashankar
    Assistant professor, Department of Life Sciences, KJC

The Dean - Faculty of Sciences Dr. Calistus Jude A.L welcomed the members of the board and initiated discussions on the following:

1. Curriculum overview

The head of the department presented an overview of the academic programme of the department which included programme matrix, assessment methodology, credit system for major core, practical, project and additional impetus. The BoS approved the same with some necessary corrections.

2. Syllabus

The draft Autonomous syllabi for PG programmes in Biotechnology and Microbiology was presented, which was scrutinized thoroughly course wise by the subject experts. The BOS suggested necessary corrections and approved I Semester syllabus.

3. Panel of Examiners:

Panel of Examiners (both external and internal) for M.Sc. Biotechnology and Microbiology was finalized and approved for the academic year 2015-2016.

CURRICULUM OVERVIEW

1. **Aim of the Programme**

   This program provides in depth and advanced knowledge in biotechnology and prepares the students for diverse careers in the field. The program facilitates the students to undertake studies with focus in their field of interest and creates a desire for research.

2. **Eligibility**

   - B.Sc. Degree with 50% marks (45% in the case of SC / ST students) in all subjects.
   - Students should have studied Chemistry / Biochemistry compulsorily as an optional subject along with Biotechnology / Microbiology / Botany / Zoology / Genetics / Life Science / Applied Botany / Applied Zoology / Environmental Science / Home Science / Sericulture / Biological Science/ Agricultural Sciences / Horticultural Sciences / Fisheries / Dairy Sciences / Forestry / BE and B.Tech in Biotechnology / four year BS program.

3. **Credits**

Part	Category	Hours per week	Credits			Total credits	Semester
			Credit	No. of courses	Semester		
I	Major Core (Theory)	4	3	8	2	24	I, II
	Practical	8	5	4	2	20	

	Major Core (Theory)	4	3	6	2	18	III, IV
	Major Core (Practical)	8	5	2	2	10	
	Elective	4	3	1	1	03	
	Elective Practical	4	5	1	1	05	
II	Project	-	-	-	1	10	IV
III	**Additional Impetus**						
	Add on Courses (AOC)*	-	1	-	2	02	II, III
	Social Outreach Programme (SOP)*	-	1	-	1	01	II
	Aptitude Enrichment Programme (AEP)*	-	1	-	1	01	II
	Skill Enrichment Programme (SEP)*	-	1	-	1	01	III
	Award Seminars*	-	1	-	2	02	I – IV
	Internship	-	1	-	1	01	III
	External/Seminars/ Conferences/Workshops *	-	1	-	1	01	IV
	Industrial Visit (IV)*	-	1	-	1	01	IV
	Grand Total	-	-	-	-	**100**	

*** Grades/Credits will be reflected in the final marks card**

Sem	Paper Code	Title of the Paper	Hrs	Credits	CIA	ESE	Total
I	MBT151201	Cell Biology	52	3	30	70	100
	MBT151202	Molecular Genetics	52	3	30	70	100
	MBT151203	Biochemistry	52	3	30	70	100
	MBT151204	General Microbiology	52	3	30	70	100
	MBT1512L1	Cell Biology and Molecular Genetics Practical	104	5	15	35	50
	MBT1512L2	Biochemistry and General Microbiology Practical	104	5	15	35	50
		Award Seminar	30	-	-	-	-
		Aptitude Enrichment Program (AEP)	30	-	-	-	-
II	MBT152201	Biochemical Techniques and Enzymology	52	3	30	70	100
	MBT152202	Molecular Biology	52	3	30	70	100
	MBT152203	Immunology and Immunotechnology	52	3	30	70	100
	MBT152204	Bioinformatics and Biostatistics	52	3	30	70	100
	MBT1522L1	Biochemical Techniques, Enzymology, Immunology and Immunotechnology Practical	104	5	15	35	50
	MBT1522L2	Molecular Biology, Bioinformatics and Biostatistics Practical	104	5	15	35	50
		Add on Course (AOC)	25	1	-	-	-
		Social Outreach Program (SOP)	-	1	-	-	-
		Aptitude Enrichment Program (AEP)	30	1	-	-	-
		Award Seminar	30	1	-	-	-
III	MBT153201	Genetic Engineering	52	3	30	70	100

	MBT153202	Medical Biotechnology	52	3	30	70	100
	MBT153203	Intellectual Property Rights, Bioethics and Entrepreneurship	52	3	30	70	100
	MBT153A01 MBT153B01	Elective 1: Animal Cell Culture and Biotechnology Elective 2: Plant and Agricultural Biotechnology	52	3	30	70	100
	MBT1532L1	Genetic Engineering and Medical Biotechnology Practical	104	5	15	35	50
	MBT153AL1 MBT153BL1	Elective 1: Animal Cell Culture and Biotechnology Practical Elective 2: Plant and Agricultural Biotechnology Practical	104	5	15	35	50
		Add on Course (AOC)	25	1	-	-	-
		Skill Enrichment Program (SEP)	30	1	-	-	-
		Internship	60	1	-	-	-
		Award Seminar	30	-	-	-	-
IV	MBT154201	Bioprocess Engineering and Biosafety	52	3	30	70	100
	MBT154202	Genomics and Proteomics	52	3	30	70	100
	MBT154203	Environmental Biotechnology	52	3	30	70	100
	MBT1542L1	Bioprocess Engineering, Biosafety and Environmental Biotechnology Practical	104	5	15	35	50
	MBT1542P1	Project Work	156	5	50	80D+ 20Vv	150
		Project		5			
		External Seminars/Conferences/ Workshops	-	1	-	-	-
		Industrial Visit	-	1	-	-	-
		Award Seminar	30	1	-	-	-
		Grand Total	-	**100**	-	-	**2000**

4. **Electives**

Two elective papers are offered during the III semester and the student can opt one. The electives will be assigned based on the students' preference.

5. **Project**

- The students have to undertake a project on any of the subjects related to Life Sciences.
- The students should perform the project individually or in groups of 3 members (max), in which case the work done and contribution by members of the group will be assessed on an individual basis.
- Projects may be in-house or can be carried out in other research institutes. Co-guide from other institutions/university/industry is permitted.
- Periodic assessment of the project work will be carried out by a panel of faculty members.
- Two copies of the dissertation should be submitted to the Controller of Examinations.
- Evaluation of the project work to be done by an External and Internal Examiner appointed by the Controller of Examinations. The total marks for evaluation of project will be 150 marks (Dissertation: 80 marks; *Viva-voce* 20 marks; Continuous Internal Assessment: 50 marks).

6. **Passing Criteria**

- No minimum pass mark for CIA
- ESE (End Semester Examination) alone 40% (Theory – 24 marks out of 60; Practical – 12 marks out of 30; Project – 40 marks out of 100)
- (ESE + CIA) aggregate 40% (Theory – 40 marks out of 100; Practical – 20 out of 50; Project – 75 out of 150)
- A student has to earn a minimum of 90 credits for successful completion of the programme

7. **Assessment Methodology**

The End Semester Examination (ESE) will be conducted for 60 marks (Theory), 30 marks (Practicals) and the Continuous Internal Assessment (CIA) will be for 40 marks (Theory) and 20 marks (Practicals). Project evaluation is for 100 marks and CIA will be for 50 marks.

CIA will be awarded as follows:

Assessment Parameters	**I Semester**	**II Semester**	**III Semester** C/E*	**IV Semester**
Theory				
Mid Term Exam	20	20	20	20
Attendance	05	05	05	05
Assignment	05	05	05	05
Class Seminar	05	05	05	05
General Performance	05	05	05	05
Practical				
Practical Record	05	05	05	05
Attendance	05	05	05	05
Term Exam for Practical Subjects (TEPS)	05	05	05	05
General Performance	05	05	05	05
Project				
Review (2)	-	-	-	20
Execution of Project work	-	-	-	30

Note: General performance marks will be awarded based on discipline, regularity and involvement of the student in subject related activities.
* C= Core subjects; E= Elective subjects

8. **Attendance**
   - A student should have 85 percentage of attendance in each course
   - Any student who is not complying to this requirement will not be allowed to appear for the End Semester Examination (ESE)
   - In case a student does not appear for the examination due to shortage of attendance, the student has to repeat that semester to make up for the attendance and the student will have to pay the fees for that semester as applicable.

9. **Additional Impetus**

Sl. No.	Activities	Semester (Credits)			
		I	II	III	IV
i.	Orientation and Bridge Programme	-	-	-	--
ii.	Add on Courses (AOC)	-	1	1	-
iii.	Social Outreach Programme (SOP)	-	1	-	-
iv.	Aptitude Enrichment Programme (AEP)	-	1	-	-
	Skill Enrichment Programme (SEP)	-	-	1	-
v.	Award Seminars	-	1	-	1
vi.	Internship	-	-	1	-
vii.	External Seminars/Conferences/ Workshops	-	-	-	1
viii.	Industrial Visit (IV)	-	-	-	1
ix.	Life Skill Education (LSE)	-	-	-	-
x.	Co-curricular activities	-	-	-	-

i. Orientation and Bridge Programme

The orientation programme familiarizes students joining the programme on the department culture. Students are inducted into the main programme through bridge programmes on Fundamentals of Botany, Zoology, Biotechnology, Microbiology and Biochemistry.

ii. Add on Courses (AOC)

The following Add on Courses (AOC) are offered by the Department. AOC on Research Methodology is mandatory and will be offered in the II Semester. In the III Semester, three AOCs are offered and the student can choose any one. The students will be earning one credit per course (total 2 credits during the M.Sc. program), Evaluation of the AOC will be done at the end of the each Semester through an examination. Following are the list of AOCs offered by the Department.

- **Research Methodology**
- **Plant and Animal Histology**
- **Fundamentals in Quality Control**
- **Clinical Research**

iii. Social Outreach Programme (SOP)

A Social Outreach Programme (SOP) is conducted make students realize their social responsibility. The student are expected to participate and contribute in a way to express their concern towards the society. The student participating in SOP will be awarded with one credit during the II Semester.

iv. Aptitude Enrichment Program (AEP) and Skill Enrichment Program (SEP)

This programme will comprise of activities that help students to mould their soft skills and prepare them to face entry level competitions in their career and prepare for competitive exams. The activities organized under AEP are Current Affairs, Latest discoveries in Science, Problem solving activities and Aptitude Test. The student will be earning one credit during the II Semester. The activities organized under SEP are Quiz, Debate, Group Discussion, Preparation for CSIR/NET/other Competitive Exams & Mock Interviews, teaching by student peers. The student will be earning one credit during the III Semester.

v. Award Seminars

During I – IV semesters, students will be presenting seminars on various general topics related to Life Sciences, which will be evaluated by a jury comprising of three faculty members and three students. The student will be earning one credit each during the II and IV Semester. In addition, best seminars will be awarded with a prize and a certificate.

vi. Internship

The students are expected to be an intern in any University / Institute / Industry Hospital/ Diagnostic laboratories / R & D laboratories for a minimum of 15 days during first year of their M.Sc. program. The students should submit the report of the Internship during III semester for evaluation. The student will be awarded one credit for their Internship during III Semester.

vii. External Seminars/Conferences/Workshops

The students presenting papers/posters in seminars / conferences or selected for attending workshops (either with summer/winter fellowships or through screening) or attended any of the above during the course of their study, will be awarded one credit during IV semester.

viii. Industrial Visit

The students should undertake industrial visit during the course of their study organized by the Department. The student will be awarded one credit during IV semester for their participation in the industrial visit.

ix. Life Skill Education (LSE)

Life Skills Education is designed to facilitate the practice and reinforcement of psychological skills in a culturally and developmentally appropriate way: it contributes to the promotion of personal and social development. The student should undergo a training program in LSE during the course of their study, which will familiarize the students in theoretical foundation in Life Skills Education, enable him/her to apply Life Skills in various spheres and empowers youth with the ability to contribute as youth worker specialized in the respective areas.

x. Co-curricular Activities

Co-curricular activities will enhance the team building, competitive spirit and leadership quality in students. Hence, students are encouraged to participate in various intra and inter-collegiate Bio-fests or organize Bio-fests, seminars, conferences etc.

10. **Programme Matrix**

I Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MBT151201	Cell Biology	52	3	30	70	100
MBT151202	Molecular Genetics	52	3	30	70	100
MBT151203	Biochemistry	52	3	30	70	100
MBT151204	General Microbiology	52	3	30	70	100
MBT1512L1	Cell Biology and Molecular Genetics Practical	104	5	15	35	50
MBT1512L2	Biochemistry and General Microbiology Practical	104	5	15	35	50
	Award Seminar	30	-	-	-	-

	Aptitude Enrichment Program (AEP)	30	-	-	-	-
	Total	**-**	**22**	**-**	**-**	**500**

II Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MBT152201	Biochemical Techniques and Enzymology	52	3	30	70	100
MBT152202	Molecular Biology	52	3	30	70	100
MBT152203	Immunology and Immunotechnology	52	3	30	70	100
MBT152204	Bioinformatics and Biostatistics	52	3	30	70	100
MBT1522L1	Biochemical Techniques, Enzymology, Immunology and Immunotechnology Practical	104	5	15	35	50
MBT1522L2	Molecular Biology, Bioinformatics and Biostatistics Practical	104	5	15	35	50
	Add on Course (AOC)	25	1	-	-	-
	Social Outreach Program (SOP)		1	-	-	-
	Award Seminars	30	1	-	-	-
	Aptitude Enrichment Program (AEP)	30	1	-	-	-
	Total	**-**	**26**	**-**	**-**	**500**

III Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MBT153201	Genetic Engineering	52	3	30	70	100
MBT153202	Medical Biotechnology	52	3	30	70	100
MBT153203	Intellectual Property Rights, Bioethics and Entrepreneurship	52	3	30	70	100
MBT153A01 MBT153B01	Elective 1: Animal Cell Culture and Biotechnology Elective 2: Plant and Agricultural Biotechnology	52	3	30	70	100
MBT1532L1	Genetic engineering and Medical Biotechnology Practical	104	5	15	35	50
MBT153AL1 MBT153BL1	Elective 1: Animal Cell Culture and Biotechnology Practical Elective 2: Plant and Agricultural Biotechnology Practical	104	5	15	35	50
	Add on Course (AOC)	25	1	-	-	-
	Skill Enrichment Program (SEP)	30	1	-	-	-
	Internship	60	1	-	-	-
	Award Seminar	30	-			
	Total	**-**	**25**	**-**	**-**	**500**

IV Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MBT154201	Bioprocess Engineering and Biosafety	52	3	30	70	100
MBT154202	Genomics and Proteomics	52	3	30	70	100
MBT154203	Environmental Biotechnology	52	3	30	70	100
MBT1542L1	Bioprocess Engineering, Biosafety and Environmental Biotechnology Practical	104	5	15	35	50
MBT1542P1	Project Practical	156	5	50	80D+ 20Vv	150
	Project		5			
	External Seminars/Conferences/Workshops		1	-	-	-
	Industrial visit	-	1	-	-	-
	Award Seminar	30	1	-	-	-
	Total	-	**27**	**-**	**-**	**500**

SEMESTER I

MBT151201 CELL BIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand cell structure, types and functions
- Provide an insight into membrane transport and cell communication
- In-depth knowledge on concepts of cell mechanisms

UNIT 1: Specialized Cells **12 hrs**

Ultra structure of prokaryotic and eukaryotic cells; Structure and function of specialized cells – muscle, nerve and endocrine cells; Molecular basis of muscle contraction; Conduction and transmission of nerve impulse; Structure and function of endocrine tissues – Pituitary, Thyroid, Adrenal & Gonads; Components of blood plasma and their functions – RBC, WBC and types, platelets; Extracellular matrix components – Proteoglycans, Glycosaminoglycans - types and functions, Collagens - types and functions, Elastin, Fibronectin, Basal lamina - structure and function.

UNIT 2: Cell Wall and Plasma Membrane **06 hrs**

Structure, organization and function of cell wall in plants; Plasma membrane – structural organization, lipid bi-layer, membrane carbohydrates, membrane proteins, compartmentalization of higher cells and its functional significance.

UNIT 3: Cytoskeleton and its Importance **04 hrs**

Structure of Cilia and Flagella in eukaryotes and prokaryotes; Cytoskeletal proteins, actin binding proteins; Cell motility.

UNIT 4: Membrane Transport **06 hrs**

Transport of nutrients, ions and macromolecules across membranes – passive diffusion, osmosis, active transport, permease, channels, ABC transporters; Na and K, $Ca2^{++}$ ATPase pumps, co-transport, symport, antiport; Endocytosis and exocytosis; Membrane vesicular traffic.

UNIT 5: Cell Interactions and Signal Transduction **12 hrs**

Junction between cells – desmosomes, plasmodesmata; synapse, gap and tight junctions; Cell to cell adhesion; Chemical signaling in unicellular organisms and between cells in higher organisms; Cell surface and intracellular receptors and their role in signal mediation; Importance of second messengers in signal transduction (cAMP, cGMP, calcium ions, phosphatidyl inositol, phytohormones).

UNIT 6: Cell Mechanisms **12 hrs**

Cell cycle events - cyclins, cyclin dependant kinases, inhibitors,; Cellular mechanisms of development in animals – gametogenesis, blastulation, gastrulation, neurulation and somite formation; Mechanisms involved in cell determination and differentiation; Cell senescence, apoptosis and necrosis.

References:

Bray, R. (1998). *Essential Cell Biology,* Garland Publishing, New York
Bruce Alberts, J. L. (1994). *Molecular Biology of the Cell,* Garland Publishing, New York.
Celis, J. E. (1998). *Cell Biology,* Academic Press, New York.
Cooper, G.M. (2009). *The Cell - a molecular approach.* ASM Press, Washington.
Darnell, J., Lodish H and Baltimore D.(1990). *Molecular cell biology*, Scientific American Books Inc., New York.
De Robertis, E. D. P., (2010). *Cell and Molecular Biology,* Lippincott Williams & Wilkins, UK.
George, P. (2013). *Principles of Cell Biology.* Jones & Bartlett.
Hawes, C. (2004). *Plant Cell Biology,* Oxford, UK.
Karp G. (1996). *Cell and Molecular Biology – concepts and experiments*, John Wiley and Sons Inc., New York.
Lodish, B. S. (2003). *Molecular Cell Biology,* Freeman and Co., UK.
Sadava, D. E. (2004). *Cell Biology.* Panima Publishers, New Delhi.
Stansfield, W. C. (1996). *Molecular Cell Biology.* T. H. M. Publishers, Atlanta.
Starr, T. (2004). *Cell Biology and Genetics.* Thomson Brooks, UK.
Wayne M. Becker, L. J. (2009). *The World of the Cell.* Pearson Education Inc., San Franscisco.

MBT151202 MOLECULAR GENETICS

3 Credits **Total: 52 Hours**

Objectives:

- Understand the organization of genetic material
- Knowledge on concepts of Genetics at molecular level

UNIT 1: Physical Basis of Heredity 14 hrs

Chromosome organization - Eukaryotic chromosomes – loops, domains and scaffolds; Difference between interphase chromatin and mitotic chromosomes; Telomeres, Heterochromatin and Euchromatin; Human chromosomal aberrations; Karyotype analysis – normal and abnormal karyotype; Nucleosomes – Organization of the histone octamer. Experimental evidence for the organization of DNA in the nucleosome;; Modes of epigenetic inheritance-involvement of histones; Organization of viral genomes into their protein coats; Organization of bacterial chromosomes into supercoiled loops; Extra-chromosomal inheritance.

UNIT 2: Sex Determination and Dosage Compensation 05 hrs

Sex determination in mammals and *Drosophila*; Secondary sex determination in humans; Dosage compensation in mammals and *Drosophila*.

UNIT 3: Genetic Recombination 14 hrs

Mechanism of recombination – Holliday, White House, Messelson and Radding models; Enzymes involved in homologous and site-specific recombination; Breakage and reunion of DNA at specific sites; Synapsis of homologous duplexes; Role of Rec A in recombination; Genetic recombination in Bacteria - Transformation, natural transformation systems, mechanism, gene mapping by transformation; Conjugation –

discovery, interrupted mating and temporal mapping, Hfr; Transduction – Generalized and specialized transduction; Gene mapping by specialized transduction, abortive transduction; Identification and selection of mutants

UNIT 4: Transposons **07 hrs**

Bacterial and yeast transposons; Replicative and non-replicative transpositions; Common intermediates for transpositions – role of transposase and resolvase; Controlling elements in Bacteria; Ac Ds system in maize; P elements in *Drosophila*; Transposons in humans; Retrotransposons.

UNIT 5: Mutation **08 hrs**

Molecular basis of spontaneous and induced mutations; Adaptive mutations in bacteria; Detection of mutations – Ames test; Use of ionizing radiations, base analogues and alkylating agents for mutagenesis; Molecular mechanism of radiation and chemical mutagenesis; Chloroplast mutations in *Chlamydomonas*, Variegation in *Mirabilis*; Mitochondrial mutations in yeast and *Neurospora*; Mitochondrial mutations and human disorders.

UNIT 6: Genetic Polymorphism **04 hrs**

Gene pools, allele frequencies, migration, selection, genetic drift, inbreeding, dominance and heterosis; Protein polymorphism and DNA sequence polymorphism –role in speciation; Genetic divergence;

References:

Dale, J.W. (1994). *Molecular Genetics of Bacteria*, John Wiley and Sons, New York.

Lewin, B, (2002). *Genes VIII*, Pearson Prentice Hall, USA.

Miller J.H, (1992). *Short course in Bacterial Genetics*, CSHL Press, John Wiley and Sons, New York.

Stanley, R, Maloy, John E, Cronan, J.R.,David Freifelder, (1994). *Microbial Genetics*, Jones and Barlett Pub, Boston.

Streips and Yasbin, (2001). *Modern Microbial Genetics*. John Wiley and Sons, New York.

Lodish, H.D., Baltimore, A., Berk, B.L, Zipursky, P., Mastsydairs and Darnell, J, (2004). *Molecular Cell Biology*, Scientific American Books Inc, New York.

John Ringo, (2004). *Fundamental Genetics*. Cambridge university press, United Kingdom.

Klug, W.S. and Cummings, (2003). *Concepts of Genetics*, 7th Edn. Pearson Prentice Hall, USA.

Gardner, E.J., Simmons, M.J., and Snustad, P., (1991). *Principles of Genetics*, John Wiley and Sons, New York.

MBT151203 BIOCHEMISTRY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the principles of energetics and oxidation of biomolecules
- Knowledge on the structure and metabolism of biomolecules

UNIT 1: Carbohydrates 12 hrs

Classification, structure & properties of mono, oligo and polysaccharides, chirality, optical activity, Stereoisomers, cyclic structure of monosaccharides, structure of glucose, relative configuration; Derived sugars, sugar acids, amino sugars, disaccharides, structure of maltose, lactose, sucrose, trehalose and raffinose; Polysaccharides - homo & hetero, glycosaminoglycans and glycoproteins; Metabolism – glycogenolysis, glycogenesis, glycolysis, gluconeogenesis, citric acid cycle, glyoxalate cycle, pentose phosphate pathway; Disorders of carbohydrate metabolism.

UNIT 2: Bioenergetics and Oxidation 10 hrs

Introduction, laws of thermodynamics, free energy, enthalpy, entropy, equilibrium constant, high energy compounds, ATP, oxidation-reduction reactions, electromotive force, half reactions, redox potentials, standard free energy change, standard redox potential of biologically important half reactions; Oxidative phosphorylation, iron sulfur centers, multiple enzyme complexes, inhibitors, ATP synthesis, brown fat, regulation of oxidative phosphorylation.

UNIT 3: Amino Acids and Proteins 10 hrs

Classification, structure & properties of amino acids, peptide bond, classification of proteins, structural organizations, conformational analysis, Ramachandran plot; Metabolism - transamination, deamination, decarboxylation; Glutamic acid pathway, urea cycle, uric acid formation; Disorders of amino acid metabolism.

UNIT 4: Lipids 10 hrs

Classification, structure, properties and functions of phospholipids, sphingolipids, glycolipids, steroids-cholesterol, bile salts, steroid hormones; Metabolism – beta oxidation, alpha & omega fatty acids; Biosynthesis of fatty acids, cholesterol & eicosanoids (prostaglandins, leucotrienes & thrombaxane); Disorders of lipid metabolism.

UNIT 5: Nucleic Acids 10 hrs

Structure and properties – Nitrogen bases, nucleoside, nucleotide, polynucleotides; Biosynthesis of purine & pyrimidine; Degradation.

References:

Conn E.E. and Stumpt P.K., (1976). *Outlines of Biochemistry*. John Wiley and Sons, New York.

Deb A.C., (1989). *Fundamentals of Biochemistry* (3rd Ed.), Prentice Hall International, London.

Garrett and Grisham, (1995). *Biochemistry* (3rd Ed.), Saunders College Publishers, Florida, USA.

Jain J.L., (2005). *Fundamentals of Biochemistry* (6th Ed.), S Chand Publication, New Delhi.
Lehninger, A.L., (1982). *Principles of Biochemistry* (4th Ed.), CBS Publishers, New Delhi.
Mathews, C.K. and Holde K.E.V., (1996). *Biochemistry,* The Benjamin/Cummings Pub. Co., California.
Mathews, Freeland and Misfield, (1996). *Biochemistry* (4th Ed.),Wiley & sons Publication, New York.
Nelson D L and Cox M M, (2004). *Lehninger's Principles of Biochemistry.* CBS publishers and distributors, New Delhi.
Ranganatha Rao, (2002). *Text Book of Biochemistry* (3rd Ed.), Prentice Hall Publishers, New Delhi.
Stryer L, (1995). *Biochemistry* (4th Ed), W H Freeman and Co, New York.
Vasudevan D.M., and Sreekumari S, (2005). *Biochemistry* (4th Ed.), Jaypee publishers, New Delhi.
Voet and Voet, (2002). *Biochemistry* (2nd Ed.), John Wiley & Sons, New York.
Zubey G L., Parson W W and Vance D E, (1994). *Principles of Biochemistry*, W.C. Brown Pub, Oxford, England.

MBT151204 GENERAL MICROBIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Familiarize classification of microbial flora
- Knowledge on structure and characteristics of various groups of microorganism
- Understand techniques for isolation of organisms from various sources

UNIT 1: Microbial Classification 10 hrs

Three domain system of classification; International Code for Bacterial Nomenclature; Dichotomous keys, Type cultures; Criteria for bacterial classification – Conventional methods - morphological, staining techniques, biochemical methods, serological techniques; Molecular methods – G : C ratio, nucleic acid hybridization, nucleic acid sequencing, DNA finger printing, amino acid sequencing; Numerical taxonomy; Chemotaxonomy; Phylogenetic relationships - cladogram, dendrogram, universal phylogenetic trees.

UNIT 2: Acellular Entities 10 hrs

Viruses – general characters, structure, criteria for classification of viruses, viruses that affect human, animals and plants; Isolation, culture and identification of viruses (growing in bacteria, living animals, embryonated eggs, cell culture); Viral multiplication (lytic and lysogenic life cycle); Viroids and prions – general properties and diseases.

UNIT 3: Prokaryotic Microorganisms 10 hrs

General properties, structure and reproduction; Domain Bacteria – Proteobacteria (Alpha, Beta, Gamma, Delta, and Epsilon); Cyanobacteria, Chlorobium, Fermicutes, Actinobacteria, Chlamydiae, Spirochaetes, Bacteriodetes, Fusobacteria; Domain Archaea – Crenarchaeota, Euryarchaeota.

UNIT 4: Eukaryotic Microorganisms 08 hrs

General characteristics, structure and reproduction – Fungi (*Saccharomyces*), Algae (*Chlorella*, *Spirulina*), Protozoa (*Plasmodium*), Slime mould (*Physarum*).

UNIT 5: Microbial Growth and Control 08 hrs

Physical parameters (temperature, pH, osmotic pressure), chemical parameters (Carbon, Nitrogen, Phosphorous, Sulphur, Trace elements, Oxygen); Growth factors, culture media; Phase of growth, growth measurement; Microbial growth control – physical methods (heat, Pasteurization, filtration, radiation, desiccation, low temperature, high pressure, osmotic pressure) and chemical methods (Phenols, Halogen, Alcohols, Quaternary ammonium compounds).

UNIT 6: Isolation and Culture of Microorganisms 06 hrs

Isolation and culture of microorganisms from water, soil, air, rhizosphere, phylloplane and Mycorrhiza.

References:

Alexander, M, (1977). *Introduction to soil microbiology*, John Wiley and sons Inc. New York

Atlas, R.M, (1988). Microbiology, *Fundamentals and applications*, (2^{nd} Ed.), Mac Millan Publishing Co., New York.

Brock, T.D. and Madigan, M.T, (1992). *Biology of Microorganisms*, 6^{th} Ed., Prentice Hall, New York.

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Holt, J.S., Kreig, N.R., Sneath, P.H.A. & Williams S.T, (1994). *Bergey's Manual of Systematic Bacteriology*, 9^{th} Edn. William and Wilkins, Blatimore.

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Sullia, S.B. and Shantharam, S, (1998). *General Microbiology*, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Willey, M.J., Sherwood, M.L. and Woolverton, J.C., (2008). *Prescott, Harley and Klein's Microbiology*, McGraw Hill Higher Education, New York.

MBT1512L1 CELL BIOLOGY AND MOLECULAR GENETICS PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Hands-on experience to study cell division
- Learn techniques to isolate cells and organelles
- Develop skill to understand practical concepts related to genetics

1. Study of mitosis using onion root tips
2. Study of meiosis using grasshopper testis
3. Study of karyotypes in humans (normal and abnormal)
4. Study of polytene chromosomes
5. Study of Barr bodies
6. Study of conjugation, transduction and transformation in *E.coli*
7. Study of induced mutation in *E.coli* by U V light
8. Demonstration of multiple allelism (blood group in humans)
9. Mounting of imaginal discs of *Drosophila*
10. Study of *Drosophila* mutant types
11. Isolation of nucleus and determination of its purity
12. Isolation of mitochondria and determination of its purity
13. Isolation of chloroplast by sucrose density gradient and determination of its purity
14. Determination of muscle ATPase activity
15. Determination of acetylcholine esterase activity in rat brain

MBT1512L2 BIOCHEMISTRY AND GENERAL MICROBIOLOGY

5 Credits **Total: 104 Hours**

Objectives:

- Learn techniques for quantitative analysis of biomolecules
- Develop skills to separate biomolecules by analytical techniques
- Perform staining techniques and biochemical tests for microorganisms
- Learn to isolate and identify microorganisms from samples

1. Determination of PI of amino acid by titration method
2. Estimation of glucose by HJ method
3. Estimation of total sugars by Anthrone method
4. Estimation of amino acid by Ninhydrin method
5. Estimation of protein by Lowry's method
6. Estimation of inorganic phosphorous by Fiske Subarrow method
7. Determination of Iodine number
8. Determination of acetyl number

9. Estimation of lactate / citrate from bacterial cultures
10. Colony characteristics and counting of colony (serial dilution method)
11. Bacterial growth assessment by turbidometry
12. Staining techniques (a) Simple staining (b) Gram staining (c) Endospore staining (d) Capsule staining (e) AFB staining (f) negative staining
13. Biochemical tests: (a) Indole test (b) Methyl red test (c) Vogues Proskeur test (d) Citrate utilization test (e) Triple sugar iron agar test (f) starch hydrolysis test (g) gelatin hydrolysis test (h) catalase test (i) catalase test (j) oxidase test
14. Soil microbiology- Isolation of (a) microflora from Rhizophere (b) microflora from phylloplane (c) Actinomycetes from soil (d) *Rhizobium* from root nodules (e) Micorrhizal spores by sieve method
15. Air microbiology: Isolation of air microflora - exposure plate method
16. Water microbiology: Coliform test for quality of water by MPN method

SEMESTER II

MBT152201 BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the function of enzymes and its importance
- Knowledge on the principles of instrumentation

UNIT 1: Physical Techniques 08 hrs

Principles and applications of Rayleigh scattering, viscometry; Distillation, liquid-liquid extraction, absorption, adsorption, crystallization, x-ray crystallography; Centrifugation: differential, gradient, ultracentrifugation.

UNIT 2: Chromatographic and Electrophoretic Techniques 12 hrs

Chromatography – Principles and applications of adsorption, partition, gel filtration, ion exchange, thin layer and affinity chromatographic techniques; Gas Liquid Chromatography, High Performance Liquid Chromatography; Electrophoresis – Principles and applications of moving boundary electrophoresis, zone electrophoresis, gel electrophoresis – PAGE, iso electric focusing, 2D gel electrophoresis, pulse field electrophoresis.

UNIT 3: Spectrophotometric Techniques 08 hrs

Beer-Lambert's law – principle; Instrumentation and application of Colorimetry, Spectrophotometry, Fluorimetry and Flame photometry; Spectroscopy – atomic absorption and plasma emission spectroscopy; NMR and Mass Spectroscopy.

UNIT 4: Enzymes 08 hrs

Introduction to enzymes, nomenclature and classification of enzymes, properties of enzymes, factors affecting enzyme activities, active site, allosteric site; Enzyme specificity and enzyme substrate reactions; Strategies of purification of enzymes, molecular weight determination and characterization of enzymes.

UNIT 5: Enzyme Kinetics and Catalysis 10 hrs

Chemical kinetics, rate of reaction; Derivation of Michaelis-Menton equation, Km value and its significance, Lineweaver-burk plot; Mechanism of enzyme action, lock and key model, induced fit model; Enzyme inhibition – reversible and irreversible, competitive, uncompetitive, non-competitive; Regulation of enzyme activity – covalent modulation, allosteric regulation.

UNIT 6: Co-enzymes 06 hrs

Structure and mechanism of action of important co-enzymes – NAD, FAD, FMN, TPP, Pyridoxal phosphate, Lipoic acid, COASH and Vitamin B_{12}.

References:

Asenjo, J. and Dekker, M., (1990). *Separation processes in biotechnology*, Marcel Dekker, New York.

Belter, P. A. and Cussier, E., (1988). *Bioseparations*, Wiley publications, New York.

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MBT152202 MOLECULAR BIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Learn structure and properties of nucleic acids
- Understand concepts in Molecular Biology
- Familiarize with gene regulatory mechanisms

UNIT 1: Structure and Properties of DNA and RNA 10 hrs

Introduction, Central dogma of molecular biology, Biochemical evidences for DNA as genetic material; Structure of DNA (Watson & Crick model) and types (A, B, Z DNA); Properties of DNA – UV absorption, denaturation, renaturation; Thermodynamics of melting of the double helix, kinetics of unwinding of double helix, interaction of small ions; DNA damage – deamination, oxidation, alkylation, UV radiation; DNA Repair – photo-reactivation, excision repair, post-replication repair, mis-match repair and SOS repair; Structure and functions of rRNA, tRNA and mRNA.

UNIT 2: DNA Replication 08 hrs

General properties of replication – semi-conservative, bidirectional, discontinuous, Chemistry and enzymology of replication -DNA helicases, SSB proteins, Topoisomerases, Primases, DNA polymerases, DNA ligases, Telomerases; Mechanism of replication in Prokaryotes and Eukaryotes; Models of replication in prokaryotes – asymmetric replication, looped, rolling circle, concatamer formation; DNA replication in viruses (M13 bacteriophage); Inhibitors of replication; Fidelity of replication.

UNIT 3: Transcription 08 hrs

Enzymes and factors in transcription - RNA polymerases, transcription factors; Mechanism of transcription - initiation, elongation and termination in prokaryotes and eukaryotes; RNA processing - capping, splicing, spliciosome assembly, poly-adenylation; RNA editing; mRNA transport; Inhibitors of transcription.

UNIT 4: Translation 08 hrs

Basic features of genetic code; amino acid activation, mechanism of initiation, elongation and termination; inhibitors of protein synthesis; post-translational modification of proteins

UNIT 5: Regulation of Gene Expression **14 hrs**

Transcriptional control, enzyme induction and repression, constitutive synthesis of enzymes in prokaryotes and eukaryotes; The operon concept, catabolic repression, instability of bacterial RNA, inducers and co-repressors; Negative gene regulation – *E.coli lac* operon; Positive regulation – *E.coli* ara operon; Regulation by attenuation – his and trp operons, anti-termination – N protein and nut sites, DNA binding protein, enhancer sequences, identification of protein binding site on DNA; Control of gene expression at transcription and translation level – regulation of phage, virus, prokaryotic and eukaryotic gene expression (*cis* control elements, promoters, enhancers, trans acting factors), role of chromatin regulating gene expression;

Gene silencing – transcriptional and post-transcriptional, RNAi pathway (siRNA and mi RNA). Molecular mechanism of antisense molecules - inhibition of splicing, poly-adenylation and translation, disruption of RNA structure and capping; Biochemistry of ribozyme, hammerhead, hairpin and other ribozymes; Strategies for designing ribozymes, application of antisense and ribozyme technologies.

UNIT 6: Protein Targeting **04 hrs**

Synthesis of secretory and membrane proteins; Import into nucleus, mitochondria, chloroplast and peroxisomes.

References:

Adams R.L.P., (1992). *DNA Replication*, IPL Oxford, England.

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Sinden, R.R., (2006). *DNA structure and function*, Academic press, New York.

Tropp, E, B., (2012). *Molecular Biology – Genes to proteins*, (4th Ed.), Jones and Bartlett India Pvt. Ltd., New Delhi.

MBT152203 IMMUNOLOGY AND IMMUNOTECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Familiarize with components of the immune system
- Knowledge on immune responses
- Understand concepts of hypersensitivity and immunization

UNIT 1: Immune System and Immunity 10 hrs

History of immunology; Structure, composition and functions of cells and organs of the immune system; T-cells, B-cells; Antigen processing and presentation, antigen processing cells - macrophages, eosinophils, neutrophils, mast cells and killer T-cells; Microbial infections and immune responses – innate immunity, acquired immunity; Clonal nature of immune response.

UNIT 2: Antigens and Antibodies 10 hrs

Antigens – structure and properties; Types – iso and alloantigens, haptens, adjuvants, epitopes, chimeric peptides; Antigen specificity; Immunoglobulins – structure, heterogeneity, types and subtypes, physico-chemical and biological properties; Complement system – structure, components, properties and functions; Complement pathways and biological consequences of complement activation; Generation of immunological diversity; Effector mechanisms.

UNIT 3: Antigen-Antibody Reactions 10 hrs

In vitro methods – agglutination, precipitation, complement fixation, immuno-fluorescence, immuno-electrophoresis, immuno-blotting, ELISA, radio-immuno assay; *In vivo* methods – skin tests and immune complex tissue demonstrations; Applications of immunological reactions in diagnosis of microbial infections; Autoimmunity - mechanisms, altered antigens; Autoimmune diseases - Systemic Lupus Erythematosus, Graves disease, Rheumatoid Arthritis, Myasthenia Gravis, Multiple Sclerosis; Immunodeficiency – phagocytic, humoral, cell mediated immunity (CMI), combined HLA association.

UNIT 4: Major Histocompatibility Complex and Tumor Immunology 10 hrs

Structure and functions of MHC and HLA systems; Gene regulation and Ir- genes; HLA and tissue transplantations in humans; Tissue reaction and rejection of transplant - Graft versus host reaction, Host versus graft reaction; Immuno hematology – blood groups, blood transfusion and Rh incompatibilities. Tumor immunology – tumor markers; Immune response to tumors; Immuno-diagnosis of tumors, detection of tumor markers; tumor antigens – tumor specific (Cancer antigens) and tumor associated antigens -AFP, CEA; Immunosurveillance; Genetic control of Immune response.

UNIT 5: Hypersensitivity Reactions 08 hrs

Definition of allergy, Types of hypersentitivity reactions and symptoms - antibody-mediated Type I – Anaphylaxis; Type II – Antibody dependent cell cytotoxicity; Type III – Immune complex mediated reactions; Type IV – Cell mediated hypersensitivity reactions; Immunological methods of diagnosis; Lymphokines and cytokines – their assay methods; Interleukins and Interferons; Immunological tolerance and modulation.

UNIT 6: Immunization **04 hrs**

Polyclonal and monoclonal antibodies; Hybridoma technology; Catalytic monoclonal antibodies; Vaccines – conventional, peptide vaccines, DNA vaccines, toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies; Immuno stimulatory complexes; Common immunization programmes – BCG, small pox, DPT, polio, measles, Hepatitis – B.

References:

Abul K. Abbas, Andrew K. Lightman, Jordan S. Pober, (2005). *Cellular and molecular immunology*, Elsevier Publications, Boston.

Chakravarthy, A.K. (2006). *Immunology and Immunotechnology,* Oxford University Press, New Delhi.

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MBT152204 BIOINFORMATICS & BIOSTATISTICS

3 Credits **Total: 52 Hours**

Objectives:

- Aquaint with essentials of computer programmes and languages
- Understand the concepts of Bioinformatics
- Understand biostatistics and its applications

UNIT 1: Computer Fundamentals **08 hrs**

Computer architecture, softwares, network, internet technologies; C programming and PERL – introduction, algorithm and flowchart; C-programming – structure of C program, header file, global declaration, main function, variable declaration, control statement – conditional, looping and unconditional control statement- sub functions; PERL – basics, pattern matching and regular expression, BLAST output, PERL to Bioinformatics, Application of Bio PERL.

UNIT 2: Biological Databases and Sequence Analysis 08 hrs

Introduction to database generation; Data mining and applications. Accessing bibliographic databases – pubmed, sequence retrieval; Nucleic acid sequence databank – NCBI, EMBL; Protein sequence data bank – NBRF, PIR, SWISSPORT; Structural databases (PDB); Metabolic pathway databank – Kyoto Encyclopedia of Genes and Genomes (KEGG), Microbial Genomic Databases (MBGD), Cell Line Databases (ATCC), Virus Databank (UICTV), Sequence alignment – global and local alignment, scoring matrices; Restriction mapping – WEB CUTTER & NEB CUTTER, similarity searching (FASTA and BLAST); Pair wise comparison of sequences, multiple sequence alignment; Identification of gene in genome and phylogenetic analysis with reference to nucleic acids and protein sequences, identification of ORF, identification of motifs.

UNIT 3: Protein Structure and Molecular Interactions 08 hrs

Chemical bonding and non-bonding interactions, stability of electrovalent bonds; Covalent bond – partial ionic characteristics of co-valent bond and Vander-Waals forces. Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling – principles of homology and comparative modeling; Threading, structure evaluation and validation and *ab* initio modeling; Applications – rational drug designing and molecular docking - Autodock.

UNIT 4: Introduction to Biostatistics 10 hrs

Basic concepts, classification, data types, frequency distribution, variables, attributes, population, sample, use of random number table for drawing a random sample, need for statistical technique for biological applications, replicable data, tabulation of data, construction of graph and graphical representation of data; Different models and data presentation; Features of statistical software and SPSS.

UNIT 5: Properties of Data 08 hrs

Organization of data, central tendency, dispersion, skewness and curtosis and their various measures, percentile, simple linear correlation and regression analysis; Analysis of Variance.

UNIT 6: Probability 10 hrs

Definition, types of events - sample space, addition and multiplication; rules of probability; Conditional probability (simple problems); Probability distributions-binomial, Poisson and normal distribution (simple problems); Statistical interference – estimation, standard error, confidence intervals for mean and proportion; Testing of hypothesis – basic concepts, types of errors; Tests based on normal student t and chi square distributions, interpretation of *p* value.

References:

Anna Tromontano, (2002). *Introduction to Bioinformatics*, CRC Press, Florida, USA.

Higgins, (2005). *Bioinformatics: Sequence structure and data banks: A practical approach*, Blackwell Publishers, UK.

Higgin D, Taylor, W and Higgins D, (2000). *Bioinformatics: Sequence structure and databanks: A practical approach*, Oxford University Press, New York.

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MBT1522L1 BIOCHEMICAL TECHNIQUES, ENZYMOLOGY, IMMUNOLOGY AND IMMUNOTECHNOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Learn to perform assays relating to enzymatic activity
- Practical analysis of the factors affecting enzyme activity
- Acquire skills on various immunological techniques

1. Assay of amylase activity from saliva
2. Assay of urease from horse gram
3. Assay of acid phosphatase from sweet potato
4. Determination of Km & Vmax
5. Effect of pH & temperature on enzyme activity
6. Determination of specific activity of an enzyme
7. Molecular weight determination of a protein by gel electrophoresis
8. Immobilization of enzyme (Urease, amylase)
9. Separation of amino acids by TLC
10. Separation of amino acids by paper chromatography
11. Partial purification of IgG by column chromatography
12. Serum separation and serological reactions a) agglutination b)precipitation
13. Enzyme linked immunosorbant assay
14. Isolation of lymphocytes from peripheral blood
15. Ouchterlony double diffusion
16. Single radial immune-diffusion
17. Rocket immune-electrophoresis

MBT1522L2 MOLECULAR BIOLOGY, BIOINFORMATICS AND BIOSTATISTICS PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Acquire skills to isolate, analyse and quantify nucleic acids
- Familiarize with various tools in bioinformatics

1. Isolation of genomic DNA from plants, microbes, animals
2. Agarose gel electrophoresis of isolated DNA
3. Estimation of DNA by Diphenyl amine method
4. Isolation and estimation of RNA by Orcinol method
5. Isolation of plasmid DNA and agarose gel electrophoresis
6. Use of bioinformatics tools for searching bibliographic databases
7. Sequence retrieval from nucleic acid and protein databases
8. Sequence searches and analysis (FASTA and BLAST)
9. Pair wise comparison of sequences, multiple alignments of sequences
10. Restriction mapping
11. Identification of genes in genomes and primer design
12. Evolutionary studies/phylogenetic analysis
13. Protein databank retrieval and visualization - RASMOL
14. Ramachandran plot- secondary structure prediction of proteins
15. Demonstration of Protein modeling - Autodock
16. Calculation of SD, variance and plotting the graph by using MS excel

SEMESTER III

MBT153201 GENETIC ENGINEERING

3 Credits **Total: 52 Hours**

Objectives:

- Knowledge on various tools and enzymes used in Genetic engineering
- Familiarize with applications of the technology

UNIT 1: Molecular tools 04 Hrs

Introduction, definition and scope; Restriction endonucleases – types, nomenclature, recognition sequences, cleavage pattern; DNA ligases – properties and functions of T4 DNA Ligase and NAD dependant DNA ligase of *E.coli*, ligation techniques.

UNIT 2: Vectors 12 Hrs

General characters, desirable characters – size, on site selection/marker gene, restriction sites and unique multiple cloning sites; Cloning and expression vectors – Plasmids, PBR 322, pUC vectors, Ti plasmids, M13 derived pUC vectors; Phage vectors – Lambda based vectors, M13 cosmids, Phagemids; ARS, Mini-chromosome; Yeast artificial chromosomal vectors (YAC); shuttle vectors; Promoters – Lac Z, T7 and Tac transcriptional terminators; vectors for plants – Gemini viruses, Caulimo viruses; vectors for animals – SV 40, Bovine papilloma virus (BPV); Retroviral vectors; expression vectors.

UNIT 3: Cloning and Expression 12 Hrs

Preparation of competent cells of bacteria, yeast, mammalian and plant cells; Methods of DNA transfer – exogenously supplied chemical methods, calcium phosphate precipitation method, liposome mediated method and electroporation, *Agrobacterium* T-DNA mediated method, gene gun method; Determination of Transformation /Transfection efficiency; Plating, screening and selection; preparation of nutrient media with selection, marker antibiotics and additives for visual screening of recombinant clones; selection of clones, amplification, preservation and purification of vector DNA, digestion and end modification.

UNIT 4: Gene Libraries 06 Hrs

Types of gene libraries; cDNA library – preparation, isolation and purification of mRNA; importance of poly-A tailing, Synthesis of cDNA (PCR), construction of cDNA library; Genomic DNA Library – isolation and purification of total genomic DNA, partial digestion with suitable enzyme, size fractionation and end modification.

UNIT 5: Labeling 06 Hrs

DNA, RNA and Protein labeling; Use of radioactive isotopes; Non-radioactive labeling, relative advantages and disadvantages; *in vivo* labeling; Nick translation; random primer labeling; autoradiography, autofluorography.

UNIT 6: Molecular Techniques 12 Hrs

DNA sequencing – Chemical, enzymatic method; DNA Microarray; Gel electrophoresis – Agarose, PAGE, PFGE; Blotting techniques – Southern, northern and western; PCR, RFLP, AFLP, RAPD.

References:

Alikhan and Irfan (2004), *Molecular Biology and Genetic Engineering Biotechnology*, Ukaaz publishers, hyderabad.

Anthony JF Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart. (2000), *An introduction to genetic analysis*, W H Freeman and company, New york.

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Winnaker and Ernst L., (2003) *From Genes to Clones*, Panima Publishers, New Delhi.

MBT153202 MEDICAL BIOTECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Knowledge on important diseases, genetic disorders and methods of diagnosis
- Understand concepts of drug discovery and delivery

UNIT 1: Human Diseases 12 Hrs

Etiology, pathology, symptoms and treatment of the genetically inherited diseases – PKU, Alkaptonuria, Galactosemia, Von'Gierke disease, Lesch Nyhan syndrome, Gout, Sickle Cell Anemia, Beta Thalassemia and Diabetes; Evaluation of organ functions – liver, kidney, cardiac and gastric function tests; Mode of infection, symptoms, epidemiology and control measures of disease caused by – Viruses (HIV, Hepatitis- B,

Rabies, HSV-1); Bacteria (Typhoid, Syphilis, TB); Fungi (Aspergillosis, Histoplasmosis, Cryptococcosis); Protozoa (Malaria, Amoebiasis)

UNIT 2: Cancer Biology 08 hrs

Tumors, types and causes; Molecular mechanisms ivolved in tumour formation; Genes associated with cancer; Methods of tumor detection – tumor markers; Treatment of cancer – chemotherapy, radiotherapy, immunotherapy (Cancer vaccines and monoclonal antibodies).

UNIT 3: Nanobiotechnology 06 hrs

Introduction, types and synthesis of nanomaterial, protein-based nano structures, DNA-based nano structures; Applications of nanomaterial – nanobiosensors, drug and gene delivery, disease diagnostics, cancer therapy.

UNIT 4: Pharmacodynamics and Pharmacokinetics 06 hrs

Pharmacodynamics – Drug receptors and administration, relationship between drug concentration and response; Pharmacokinetics – ADME, Concepts in toxicology, acute, subacute and chronic toxicity studies, Calculation of LD_{50} and ED_{50}, biological half-life, physicochemical principles, drug accumulation; Molecular mechanisms of drug action.

UNIT 5: Drug Discovery 08 hrs

Introduction, conventional drug design approaches, irrational *vs* rational, Lipinski's rule of five, Drug development process (Preclinical, clinical and toxicological studies); Novel Drug Development approaches – QSAR (quantitative structure activity relationship), High throughput screening.

UNIT 6: Molecular Therapeutics 12 hrs

Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases for gene therapy, Organelle mediated transfer of drug molecule to the desired site, Molecular mechanisms associated with drugs reaching peak serum concentrations, Liposome-mediated gene delivery, cellular therapy, use of stem cells, recombinant therapy; Erythropoietin in the treatment of Leukemia, Insulin analogues and its role in diabetes, Streptokinase and urokinase in thrombosis, role of recombinant interferons, immunostimulants and immunosuppressors in organ transplants.

References:

Bartram G. Katzung, (2004). *Basic and Clinical Pharmacology*, (9th Ed.), Mc Graw Hill publications, USA.

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MBT153203 INTELLECTUAL PROPERTY RIGHTS, BIOETHICS AND ENTREPRENEURSHIP

3 Credits **Total: 52 Hours**

Objectives:

- Understand the fundamentals of Intellectural property rights
- Knowledge on ethical implications, issues related to life sciences
- Familiarize on entrepreneurship and its strategies

UNIT 1: Intellectual Property Rights 12 hrs

IPRs – implications for India, WTO, WIPO, GATT, TRIPS; Patenting and the procedures involved in the applications for patents and granting of patent; Compulsory licenses, patent search, Patent Cooperation Treaty, examples of patents in biotechnology, provisional and complete specification, claims, patentable and non-patentable materials, product planning and development, special applications of patent laws in patenting of living organisms, plant breeders rights, legal implications, traditional knowledge, commercial exploitation, protection.

UNIT 2: Ethical Issues in Plant Genetic Resources 08 hrs

Bioethics in Biodiversity, ethics of resource management, impact of patenting on biodiversity rich developing countries, current status of GM crops in India and other countries, ethical issues associated with GM crops & foods, labeling of GM plants and products.

UNIT 3: Ethical Implications 08 hrs

Ethical implications of Human Genome Project – International ethical and legal issues connected to HGP; Human fetal sex determination – implications in India; Genetic study on ethnic races.

UNIT 4: Ethical Issues in Animal Research 10 hrs

Ethical issues involved in stem cell research, use of cell cultures as alternative for animal models in research, testing of drugs on human volunteers, use of animals for research and testing, ethical and social issues involving human cloning, organ transplantation and xeno transplantation; cGMP, cGLP, guidelines – ICH, KOSHER, MHRA, TGA, OECD and USFDA.

UNIT 5: Entrepreneurship 06 hrs

Introduction, concept and theory; Entrepreneurial traits and motivation; Nature and importance of Entrepreneurship in India; Barriers in Entrepreneurship, agreements, valuation and business concerns; Government regulations for products.

UNIT 6: Entrepreneurship Strategies **08 hrs**

Potential entrepreneurship activities in biotechnology, product development, marketing, research and training units; Industrial licensing, venture capital, Biotech Parks; Biotechnology industries in India and the potential job opportunities.

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MBT153A01 ELECTIVE 1: ANIMAL CELL CULTURE AND BIOTECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the design and set up of animal cell culture facility
- Knowledge on the principles, basics and analysis of animal cell culture
- Familiarize techniques of manipulating cell cultures

UNIT 1: Animal Tissue Culture Laboratory **06 hrs**

Design, layout and maintenance of animal tissue culture laboratory; Essential equipment– working principle and uses of biosafety cabinet, CO_2 incubator, inverted microscope; Beneficial equipment.

UNIT 2: Animal Cell Culture Media **08 hrs**

Natural media; Synthetic media – composition and preparation; Functions of different constituents of culture medium; Sterilization of media – filtration; Balanced salt solution; Serum and protein-free defined media – advantages, disadvantages and applications; Supplements; Growth factors promoting proliferation of animal cells – EGF, PDGF, IGF, NGF, Gap-43.

UNIT 3: Animal Cell Culture Technique **14 hrs**

Biology of cultured cells – culture environment, cell adhesion, proliferation, differentiation and cellular interactions; Primary culture methods – explants, single and double coverslip methods; Enzymatic, chemical and mechanical disaggregation of tissue; Subculture, propagation and maintenance of cell lines; Cell lines – types, characteristics and applications; Scale-up of suspension and monolayer cultures; Design and engineering of tissues – tissue modeling; Embryonic stem (ES) cell engineering – ES cell culture to produce differentiated cells; Introduction to human embryonic stem cell research.

UNIT 4: Animal Cell Culture Analytics **06 hrs**

Methods of characterization of cell lines – Morphology, genetic tests, immunological tests, biochemical tests; Analysis of cell viability and cytotoxicity – Dye exclusion and inclusion tests, plating efficiency, recovery index, metabolic assays (MTT and XTT assays); Apoptosis and measurement of cell death.

UNIT 5: Transgenic Animals and Reproductive Technology **12 Hrs**

Methods of obtaining transgenic animals; Importance of transgenic animals – increased productivity and improved desired characters of domestic animals; Production of proteins for pharmaceutical use; Genetic improvement of disease resistance in poultry and livestock; Animal models for tackling human diseases - gene knock-out mice models; Transgenic silkworms; Reproductive cycles in cattle and human; Hormonal control of reproduction in mammals; Embryo transfer technology and *in vitro* fertilization in human and cattle.

UNIT 6: Animal Cell Culture Products **06 hrs**

Pharmaceutical products – tissue plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins and interferons; Vaccine production using animal cell lines.

References:

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MBT153B01 ELECTIVE 2: PLANT AND AGRICULTURAL BIOTECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand basic methodologies of plant tissue culture
- Provide an insight on molecular mechanism of disease development and biotechnological control
- Familiarize on using biotechnological tools in creating transgenics and its application in crop improvement

UNIT 1: Plant Cell and Tissue Culture 10 hrs

Introduction, plant tissue culture media – composition, types and preparation; Plant growth regulators in tissue culture, selection and preparation of explant; Micropropagation – direct regeneration, indirect regeneration – callus culture and organogenesis, somatic embryogenesis; Protoplast isolation and culture, somatic hybridization; Haploid production – androgenic haploids (anther, pollen culture) and gynogenic haploids (ovary, ovule culture); Somaclonal variation and its significance; Cell suspension culture; Cell culture methods for secondary metabolite production; Cryopreservation, gene banks for germplasm conservation.

UNIT 2: Gene Transfer in Plants 10 hrs

Promoters – 35S, Ubiquitin; Marker genes – reporter genes (OS, CAT, GUS, Lux, Luc, GFP), selectable markers (antibiotic resistance marker, antimetabolite resistance marker, herbicide resistant marker); Gene transfer methods – Vector or *Agrobacterium* mediated gene transfer – Ti and Ri plasmids, virulence genes, *Agrobacterium* vectors – cointegrate vectors and binary vectors; Plasmid vectors – pBLUESCRIPT IIKs, pBin 19, pGreen vectors; Virus mediated gene transfer – Caulimo viruses, Gemini viruses, RNA viruses; Vectorless or Direct gene transfer – Physical methods - particle bombardment, electroporation, microinjection; Chemical methods – PEG mediated, Calcium phosphate coprecipitation, polycation DMSO.

UNIT 3: Metabolic Engineering of Plants 06 hrs

In vitro production of secondary metabolites – pigments, flavonoids, alkaloids, mechanism and manipulation of shikimate pathway; Transgenics as bioreactors – biodegradable plastics, industrial enzymes, therapeutic proteins, edible vaccines.

UNIT 4: Applications of technology in Agriculture 10 hrs

Biofertilizer – types, production and quality control. Cultivation and mass production of bioinoculants- *Azotobacter, Rhizobium, Azospirillum*, Cyanobacteria, phosphate solubilising microorganisms, *Azolla;* Carrier-based inoculants – production and applications; Biopesticides – types and applications – *Pseudomonas fluorescens, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viride.*Vermicomposting. Terminator Gene technology.

UNIT 5: Crop Improvement using Transgenic Technology 10 hrs

Role of biotechnology in crop improvement – increasing photosynthetic productivity, solute uptake, nitrogen fixation; Molecular mechanism of disease development (elicitors, phytoelexins, R and r genes) - Disease resistance – viral resistance by coat protein mediated protection and RNA mediated protection, bacterial resistance by lysozyme gene, fungal resistance by chitinase and 1,3-betaglucanase genes, Herbicide resistance in commercially important plants; Insect resistance by Bt genes (cry genes) and protease inhibitor genes; Male sterile plants, methods of inducing male sterility, its importance in breeding, barstar and barnase system, hybrid vigour.

UNIT 6: Post Harvest Technology 06 hrs

RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalacturonase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelon); Post harvest protection of cereals, pulses and millets using biotechnology; Bt crops – cotton, corn; GM crops – golden rice, sweet potato.

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MBT1532L1 GENETIC ENGINEERING AND MEDICAL BIOTECHNOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Hands on experience on amplification, cloning and blotting techniques
- Acquire practical knowledge on diagnostic techniques

1. Isolation of nucleic acids from plant, animal and bacteria
2. Restriction enzyme digestion of DNA and calculation of molecular weight of the digested DNA
3. DNA amplification by PCR method
4. Preparation of competent cells in *E. coli*
5. Cloning and sub-cloning using plasmid and *E. coli* expression vectors
6. Transformation through $CaCl_2$, PEG methods
7. Selection of cloned microorganisms by X-Gal method.
8. Western and Southern Blotting
9. Blood urea analysis by diacetyl monoxyme method
10. Analysis of acid and alkaline phosphatase from serum samples
11. Estimation of serum cholesterol
12. Assay of SGOT enzyme activity
13. Assay of SGPT enzyme activity
14. Estimation of creatinine from serum
15. Detection of MIC of an antibiotic by NCCLS method
16. Study of *Salmonella typhi* using Widal test
17. Diagnosis of venereal diseases by using VDRL test
18. Study of malarial parasite from human blood sample
19. Diagnosis of HIV by using dot ELISA
20. Study of antibiotic sensitivity test using paper disc method
21. Study of cancer cell - visit to cancer research centres / hospitals

MBT153AL1 ELECTIVE 1: ANIMAL CELL CULTURE AND BIOTECHNOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Knowledge on essential animal cell culture experiments
- Acquire skills to analyse samples using animal cell culture

1. Packing and sterilization of glass and plastic wares for cell culture
2. Risks and biohazards in a tissue culture laboratory and safety measures
3. Preparation of media for cell culture
4. Mechanical disaggregation of animal tissue
5. Enzymatic disaggregation of animal tissue
6. Primary culture techniques – single and double coverslip methods; flask culture
7. Primary culture of chick embryo fibroblast cells
8. Isolation and culture of lymphocytes
9. Cryopreservation and thawing cell cultures
10. Quantification of cells by dye exclusion method
11. Suspension culture of blood cells
12. Study of toxic effect of chemicals on cultured mammalian cells
13. MTT assay
14. Visit to animal breeding centre

MBT153BL1 ELECTIVE 2: PLANT AND AGRICULTURAL BIOTECHNOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Hands on experience on plant tissue culture experiments and handling bioinoculants
- Perform various experiments on application of biotechnological tools in crop improvement

1. Plant culture media – types, preparation
2. Organ culture: shoot tip, nodal and leaf culture
3. Callus culture: initiation and regeneration; squash preparation of callus tissue
4. Anther culture for the production of haploids
5. Isolation and culture of protoplast
6. Preparation and regeneration of artificial seeds
7. Isolation of plant genomic DNA (pea shoot tip – CTAB, Cauliflower – SDS)
8. *Agrobacterium* mediated transformation, selection of transformants
9. Suspension culture and production, separation and estimation of secondary metabolites β-carotene from carrot
10. Isolation, mass production of bioinoculants, biofertilizer production and assay
11. Assay of antifungal, antibiotics and fungicides against plant pathogens
12. Study of rhizosphere microorganisms and VAM (root and soil samples)
13. Study and culture of biocontrol agents (*Trichoderma viridae, Trichoderma harzianum, Bacillus thuringiensis*)
14. Biopesticidal activities of plant extracts and Bt toxins on lepidopteron larvae
15. Vermicomposting

SEMESTER IV

MBT154201 BIOPROCESS ENGINEERING AND BIOSAFETY

3 Credits **Total: 52 Hours**

Objectives:

- Understand essential modules in Bioprocess engineering and large scale production process
- Knowledge on concepts in Biosafety

UNIT 1: Bioreactors 10 hrs

Scope and importance of bioprocess engineering; Bioreactor – introduction, design and working mechanism; Specialized bioreactors, design and their functions – Airlift bioreactors, Tubular bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors and Photobioreactors.

UNIT 2: Fermentation Media and Process 08 hrs

Natural and synthetic media; Strategies for media formulation, sources of carbon, nitrogen, vitamins and minerals; Role of buffers, precursors, inhibitors, inducers and antifoam agents; Types of fermentation process – submerged fermentation, surface or solid state fermentation, batch, fed batch and continuous fermentation; Bioprocess control, monitoring of variables – temperature, agitation, pH and pressure; Strain selection and improvement of industrially important microorganisms.

UNIT 3: Downstream Processing 10 hrs

Cell disruption, precipitation methods, solid– liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (lyophilization and spray dry technology), crystallization, solvent recovery, effluent treatment, quality control of fermented products.

UNIT 4: Immobilization and Biotransformation 04 hrs

Immobilization techniques – adsorption, cross-linking, ionic bonding, entrapment, encapsulation; Advantages and industrial applications of immobilized enzymes and cells; Biotransformation of antibiotics and steroids and its application.

UNIT 5: Production of Industrially Important Products 14 hrs

Alcohol, glycerol, acetone, butanol; Organic acids – Citric and Gluconic acid; Amino acids – Lysine; Antibiotics – Penicillin, Tetracycline; SCP; Vitamins – Riboflavin; Enzymes – Amylase; Hydrocarbons – biodegradable plastic – polyhydroxyalkanoates; butyrate, propionate; Recombinant proteins – Insulin, Hepatitis-B vaccine; Fermented foods – sausages, olives, bread, idly and acidophilus milk.

UNIT 6: Biosafety 06 hrs

The Cartagena protocol on biosafety; Biosafety management – key to the environmentally responsible use of biotechnology; Ethical implications of biotechnological products and techniques; Social and ethical implications of biological weapons; Biosafety regulations and national and international guidelines with regard to rDNA technology, transgenic science, GM crops; Experimental protocol approvals, levels of containment; Guidelines for research in transgenic plants; Good manufacturing

practice and Good lab practices (GMP and GLP); Use of genetically modified organisms and their release to environment.

References:

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MBT154202 GENOMICS AND PROTEOMICS

3 Credits **Total: 52 Hours**

Objectives:

- Understand the concepts and applications of genomics and proteomics
- Familiarize with the data bases used in genomics and proteomics

UNIT 1: Introduction 05 hrs

Concept of structural genomics, functional genomics, transcriptomics, RNAmics proteomics, and metabolomics, polymorphisms, discovery of new genes and their function.

UNIT 2: Genomics 12 hrs

Genome sequencing – fluorescence method, automated sequencing, shot-gun approach; Clone contig method, Genome sequencing projects - organization of *E.coli* genome, *Arabidopsis* genome, Rice genome, Human genome, Chloroplast & Mitochondrial genomes; Genome sequence data bases, Expressed Sequenced Tags (ESTs), Gene variation and Single Nucleotide Polymorphisms (SNPs), disease association, diagnostic genes and drug targets, genotyping – DNA chips, diagnostic assays, Genome sequence analysis; Principle, salient features and drawbacks of methods of gene prediction / gene modeling – GRAIL, GENEMARK, GLIMMER; Promoter prediction methods.

UNIT 3: Genome Analysis and Genome Structure 12 hrs

C-values of genomes, repetitive and coding sequences, genetic and physical maps, methods of physical mapping, mapping of microbial, plant and animal genomes; Usefulness of genome mapping to breeding; Molecular breeding – molecular markers, DNA as a molecular markers; Hybridization based markers - Restriction Fragment Length Polymorphism (RFLP), Random Amplification of Polymorphic DNA (RAPD) and Amplified Fragment Length Polymorphisms (AFLP); Multiple arbitrary amplicon profiling using short oligonucleotide primers, SCAR, micro satellites and other markers, length polymorphisms in simple sequences repeats (SSR and ISSR); Approaches to mapping, Fluorescence *In Situ* Hybridization (FISH), telomerase as molecular markers, T-DNA tagging, transposon tagging.

UNIT IV: Functional and Comparative Genomics 05 hrs

Transcriptomes – transcripts of a tissue, use of northern blot, subtractive and additive library, RNase protection assay, RT-PCR, Analysis of steady state gene expression by EST tags and cDNA library, Microarray techniques, Sequence Analysis of Gene Expression (SAGE); Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling and comparative genomics of closely related bacteria.

UNIT V: Proteomics 10 hrs

Expression analysis and characterization of proteins, separation of proteins – 2D PAGE (2DGE), multiplexed analysis, multidimensional liquid chromatography, high throughput screening by mass spectrometry, MALDI-TOF, peptide fingerprinting, protein micro array-antibody arrays, antigen arrays, general protein arrays, biochips; Analysis of protein structures-Sequence analysis by Tandem mass spectrometry, structure prediction, X-ray, NMR, CD and Bio-informatic approaches; Protein–protein interactions - genetic, comparative genomic, biochemical approaches; Large scale analysis of protein interactions – yeast two hybrid interaction screens, post-translational modification analysis, proteomics databases and analysis.

UNIT VI: Metabolomics 08 hrs

Concepts, levels of metabolite analysis, metabolomics in humans, sample selection and handling, overview of different methods used for analysis of metabolites; metabolic regulation network at genome level, basic concepts of metabolic engineering.

References:

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MBT153203 ENVIRONMENTAL BIOTECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the fundamentals of Environmental chemistry
- Knowledge on ecotoxicology of pollutants from various sources
- Familiarize with global environmental problems

UNIT 1: Environmental Chemistry and Chemical Pollutants 08 hrs

Fundaments of environmental chemistry – stoichiometry, chemical potential, chemical equilibria, solubility products, solubility of gases in water, carbonate system, inorganic and organic pollutants, carcinogenic compounds and their effects; Surfactants – cationic, anionic and non-ionic detergents, modified detergents; Synthetic Polymers – microbial decomposition, polymer decay, Lead and its compounds – properties, behaviour, human exposure, absorption, influence; Pesticides – types, degradation, analysis, pollution due to – DDT, Endosulphan; chemistry of corrosive and metallic compounds; Industrial pollutants.

UNIT 2: Chemistry of Pollutants and Aerobiology 12 hrs

Heavy metals, asbestos and food additives, chemistry of pollutants from pulp and paper mill, sugar and starch industries, textile, cement and pharmaceutical industries; Droplet nuclei, aerosol, assessment of quality – Anderson, Rotorod, Burkard sampler, solid and liquid impingement method and filters; Brief account of transmission of air borne microbes– viruses, bacteria, fungi and actinomycetes; Microbiology of indoor and out door environments, disease caused by air borne microbes and allergens – infection, their detection and enumeration; Biohazards caused by endotoxins.

UNIT 3: Biomining and Water Treatment 10 hrs

Biomining – bioleaching of ores to retrieve scarce metals, Biofuels – production from Algae, Jatropa, Pongamia and Castor; Production of oils and fuels from wood waste; Biotechnology for solving slime problem in the pulp and paper industry; Biogas production, methanol production from organic wastes, sugar industry by-products; Bio-deterioration of paper, leather, wood textiles, mode of deterioration; Waste water characteristics, waste water treatment – physical, chemical and biological processes; Aerobic processes – Activated sludge, oxidation ditches, trickling filters, oxidation ponds; Anaerobic processes – anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors; Treatment of industrial effluents - dairy, distillery, tannery, textile, paper and sugar industries; CETP, Reverse osmosis and ultrafiltration.

UNIT 4: Bioremediation and Extremophiles 06 hrs

Concept and principles, Bioremediation using microbes, *In situ* and *Ex situ* bioremediation; Biosorption and bioaccumulation of heavy metals, phytoremediation; Bioremediation of xenobiotic compounds and their sources, biomagnifications; Extremophiles – acidophilic, alkalophilic, thermophilic, barophilic, osmophilic and radiodurant microbes; Mechanisms and adaptation, halophilic membrane variation – electron transport, application of thermophiles, extremophiles and extremozymes.

UNIT 5: Energy, Biosensors and GIS 10 hrs

Renewable and non-renewable sources, water, soil and air; Global patterns of energy consumption; Biosensors – components, types, transducer principles, specific biosensors – glucose, ammonia, BOD, methane and mutagen sensors; Bioindicators, Biomonitoring; Remote sensing – history, definition, types of maps and map reading, components; Electromagnetic Remote (EMR) sensing process – Electromagnetic Spectrum and its characteristics; Geographic information system (GIS) – definition, categories, components, fundamental operations, functional elements – data; Visual image interpretation – basics, key elements; Digital image interpretation – basics (preprocessing, registration, enhancements, classification); Interpretation of satellite imagery.

UNIT 6: Environmental Problems and Management 06 hrs

Global warming, ozone depletion, UVB, green house effect and acid rain, their impact and management; Biodiversity and its conservation, status of biodiversity, hotspots, red data book, role of biotechnology in conservation of biodiversity, GMOs and environment; Natural disaster, earth quake, cyclone, floods, storms, Tsunami, draught, volcanoes, epidemics; Prediction indicators of disaster planning and control of natural disasters; National and state level planning for hazard mitigation; Disaster management, Disaster Management Plan (DMP), social and economic impact of natural disaster.

References:

Allsopp D and K.J. Seal (1999). *Introduction to Biodeterioration*. Edward Arnold Publication, London.

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Larry Anderson and David A. Tilman., (1980). *Fuels from waste*, Academic Press, USA.

Rajendran P. and Gunasekharan, (2007). *Microbial bioremediation*, Formatex Research Center, Spain.

5 Credits **Total: 104 Hours**

Objectives:

- Develop practical and analytical skills in bioprocess technology
- Acquire skill to test various organic and inorganic chemical of polluted water
- Understand the global impact of various environmental activities

1. Study of fermentor.
2. Production and isolation of antibiotics (Pencillin and Streptomycin)
3. Production and analysis of single cell protein (*Spirulina* and Yeast)
4. Production of yoghurt and estimation of lactic acid at different time intervals
5. Production of wine – estimation of percentage of alcohol, total acidity & volatile acidity in wine.
6. Production and assay of α-amylase from *Aspergillus niger*
7. Purification and assay of α amylase by simple precipitation using sodium sulphate, poly amines and organic solvents and immobilization
8. Detection of coliforms for the determination of the purity of potable water
9. Determination of total dissolved solids of water
10. Determination of BOD & COD of water sample
11. Estimation of chromium in industrial effluent by colorimetry
12. Estimation of calcium in water sample by titration method
13. Sludge analysis (a) organic matter, (b) nitrogen, (c) phosphorous (d) potassium
14. Isolation of bacteriophages from sewage
15. Determination of phosphate and nitrate from sewage samples
16. Study of microflora of industrial wastes and effluents
17. Isolation of bacteria degrading xenobiotics by selective enrichment technique
18. Isolation of iron and manganese reducing bacteria
19. Selective enrichment of auxotrophic and antibiotic (*tet*, *Rif*) mutants