MAHENDRA ARTS & SCIENCE COLLEGE

(AUTONOMOUS)

(Affiliated to Periyar University)

[Accredited by NAAC with 'A^{++}' Grade & Recognized u/s 2(f) and 12(B) of the UGC act 1956]

KALIPPATTI – 637 501

MASTER OF SCIENCE

SYLLABUS FOR M.Sc. BIOTECHNOLOGY

OUTCOME-BASED EDUCATION WITH CHOICE-BASED CREDIT SYSTEM

FOR THE STUDENTS ADMITTED FROM

THE ACADEMIC YEAR 2023 – 2024 ONWARDS

MAHENDRA ARTS & SCIENCE COLLEGE

(Autonomous)

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DEPARTMENT OF BIOTECHNOLOGY

REGULATIONS FOR M.Sc. BIOTECHNOLOGY PROGRAMME
OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM
(Effective from the academic year 2023-2024)

I. PREAMBLE

Biotechnology has grown, extensively in the last couple of decades. This advanced 'interdisciplinary' life science branch has a tremendous networking potential with modern cutting-edge technology. This has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted to not only the current "Century of Knowledge" but also to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work.

The proposed credit-based curriculum and outcome-based education system will even add much more to the existing interdisciplinary nature of biotechnology and will also offer many courses to the other branches of life science. The generative power of biological data is effectively harnessed by biotechnology like no other field. The relevance and application of these studies on living organisms and their bioprocesses are extensively covered in this field with the help of technology. Education and research sectors require such an interdisciplinary trained workforce to develop future generations of science leaders.

II. GRADUATES ATTRIBUTES

- **In-depth knowledge and understanding of major concepts:** Understanding of theoretical principles and experimental findings in different sub-areas available in respective disciplines.
- **Creative and Critical thinking:** The capability of using creative and critical thinking in respective areas.

- **Analytical ability:** The ability to analyze issues and problems in all the disciplines.
- **Problem-solving skills:** The capability towards solving problems.
- **Entrepreneur skills:** The inclusion of leadership, business management, time management skills.
- **Communication skills:** The ability to transfer complicated/technical information in a precise manner.
- **Mutual and multidisciplinary competence:** The ability of teamwork in interdisciplinary fields.
- **Digital literacy:** The capability of utilizing modern digital tools to carry out the simulation process.
- **Moral and ethical awareness:** Ability to adopt moral ethics.
- **Social responsibility:** Creating socially responsible citizens.

III. PROGRAMME EDUCATIONAL OBJECTIVES

- ❖ To help the students to build an interdisciplinary approach.
- ❖ To expertise students in the field of biotechnology and industry needs and provide solutions for product/processes/technology development.
- ❖ To develop confidence among students to work as entrepreneurs and biotechnologists with strong ethics and practical skills.
- ❖ To pursue higher education and research in a reputed institute at the National and International levels.

IV. PROGRAMME OUTCOMES

- **PO1: Problem Solving Skill -** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
- **PO2: Decision Making Skill -** Foster analytical and critical thinking abilities for data-based decision-making.
- **PO3: Ethical Value -** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
- **PO4: Communication Skill -** Ability to develop communication, managerial and interpersonal skills.

- **PO5: Individual and Team Leadership Skill -** Capability to lead themselves and the team to achieve organizational goals.
- **PO6: Employability Skill -** Inculcate contemporary business practices to enhance employability skills in the competitive environment.
- **PO7: Entrepreneurial Skill -** Equip with skills and competencies to become an entrepreneur.
- **PO8: Contribution to Society -** Succeed in career endeavors and contribute significantly to society.
- **PO9: Multicultural Competence -** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
- **PO10: Moral and Ethical Awareness/Reasoning -** Ability to embrace moral/ethical values in conducting one's life.

V. PROGRAMME SPECIFIC OUTCOMES

- **PSO1: Placement -** To prepare the students who will demonstrate respectful engagement with others ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.
- **PSO2: Entrepreneur -** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
- **PSO3: Research and Development -** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.
- **PSO4: Contribution to Business World -** To produce employable, ethical and innovative professionals to sustain in the dynamic business world.
- **PSO5: Contribution to the Society -** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

VI. REGULATIONS

These regulations shall take effect from the academic year 2023-2024, i.e, for students who are to be admitted to the first year of the course during the academic year 2023-2024 and thereafter.

1. Eligibility for Admission

A candidate who has passed a Bachelor degree in Science with Biotechnology / Botany / Zoology / Biology / Microbiology / Microbial Gene technology / Bioinstrumentation / Bioinformatics / Biochemistry / Chemistry / Agriculture / Marine Biology / Home Science / Farm Science / Nutrition and Dietetics / Integrated Biology / Plant Science / Animal Science / Fisheries Science / Aquaculture / Mathematics with Physics, Chemistry as Ancillary / Medical Lab Technology / MBBS / BDS / B. Pharm / BSMS of this University or any of the above degree of any other University accepted by syndicates as equivalent thereto, subject to such conditions as may prescribed therefore shall be permitted to appear and qualify for the M. Sc., Biotechnology Degree Examination of this University after a course of study of two academic years.

2. Duration of the Programme

The candidates shall complete all the courses of the programme in 2 years from the date of admission. The programme of study shall consist of four semesters and a total period of two years with a minimum of 90 credits. The programme of study will comprise the course according to the syllabus.

3. Programme of Study

The Programme of study for the PG degree Programmes of all branches shall consist of the following:

(i) Core Courses

(ii) Elective Courses

(iii) Skill Enhancement Courses

(iv) Extra Disciplinary Course

(v) Project

(vi) Enhancement Compulsory Courses

(vii) Internship Course

(viii) Extension Activity

(ix) Value Added Course

4. Examinations

The Programme of study shall be based on semester pattern with Internal Assessment under Choice Based Credit System.

The examinations for all the papers consist of both Internal (Continuous Internal Assessment - CIA) and External (End Semester) theory examinations. The theory examinations shall be conducted for three hours duration at the end of each semester. The candidates failing in any subjects(s) will be permitted to appear for the same in the subsequent semester examinations.

V. STRUCTURE OF THE PROGRAMME:

SEMESTER - I

Course Category	Title of the Course	Course Code	Hrs/Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
Core Course - I	Biochemistry	M23PBT01	5	-	4	25	75	100
Core Course - II	Molecular Genetics	M23PBT02	5	-	4	25	75	100
Core Course - III	Molecular Cell Biology	M23PBT03	5	-	4	25	75	100
Core Practical - I	Practical – I Biochemistry, Molecular Genetics and Molecular Cell biology	M23PBTP01	-	5	4	40	60	100
Elective - I	Bioinstrumentation / Biostatistics	M23PBTE01	4	-	3	25	75	100
Elective - II	Food Technology / Environmental Biotechnology	M23PBTE02	4	-	3	25	75	100
Skill Enhancement Course – I	SEC - I -Horticulture	M23PBTS01	2	-	2	25	75	100
		Total	**25**	**5**	**24**	**190**	**510**	**700**

SEMESTER - II

Course Category	Title of the Course	Course Code	Hrs/Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
Core Course - IV	Microbiology	M23PBT04	5	-	4	25	75	100
Core Course - V	Plant and Animal Biotechnology	M23PBT05	5	-	4	25	75	100
Core Course - VI	Genetic Engineering	M23PBT06	5	-	4	25	75	100
Core Practical - II	Practical – II Microbiology, Genetic engineering, Plant and Animal Biotechnology	M23PBTP02	-	4	4	40	60	100
Elective - III	Enzymology	M23PBTE03	3	-	3	25	75	100
	Regulatory Affairs and Industrial Standards	M23PBTE04						
Skill Enhancement Course – II	SEC - II - Pharmaceutical Biotechnology	M23PBTS02	2		2	25	75	100
Extra Disciplinary Courses - I	EDC - I		4		4	25	75	100
Enhanced Compulsory Course (ECC)	Human Rights	M23PHR01	2		2	25	75	100
		Total	**26**	**4**	**27**	**215**	**585**	**800**

SEMESTER - III

Course Category	Title of the Course	Course Code	Hrs/Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
Core Course -VII	Bioinformatics	M23PBT07	6	-	4	25	75	100
Core Course - VIII	Immunology	M23PBT08	6	-	4	25	75	100
Core Course - IX	Bioprocess Technology	M23PBT09	6	-	4	25	75	100
Core Practical - III	Practical – III – Bioinformatics, Immunology and Bioprocess Technology	M23PBTP03		5	4	40	60	100
Elective - IV	Nanobiotechnology	M23PBTE05	5		3	25	75	100
	Molecular Developmental Biology	M23PBTE06						
Skill Enhancement Course – III	SEC - III - Diagnostic Biotechnology	M23PBTS03	2		2	25	75	100
Internship	Internship in Industries to Biotechnology or research laboratories	M23PBTIS01	-		2	40	60	100
		Total	**25**	**5**	**23**	**205**	**495**	**700**

SEMESTER - IV

Course Category	Title of the Course	Course Code	Hrs/Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
Core Course - X	Research Methodology	M23PBT10	7	-	4	25	75	100
Elective - V	Stem Cell Biology	M23PBTE07	5	-	3	25	75	100
	Bioethics, Biosafety, Clinical Trails, IPR and Entrepreneurship	M23PBTE08						
Project	Project	M23PBTPR1	-	16	6	40	60	100
Skill Enhancement Course – IV	SEC - IV - Pharmacophore analysis	M23PBTS04	2	-	2	25	75	100
Extension activity		M23PEX01	-	-	1	-	-	-
Extra Credit for Swayam / MOOC Course*	-	-	-	-	-	-	-	-
		Total	**14**	**16**	**16**	**115**	**285**	**400**
		Grand Total	**90**	**30**	**90**	**725**	**1875**	**2600**

***** The students will gain extra credits for successful completion of online courses from SWAYAM / MOOC Course.

Summary of Credits, Hours and Mark Distribution

Course Category	Credits				Total Credits	Total Hours	No. of Courses	Max. Marks
	I	II	III	IV				
Core Course	12	12	12	4	40	55	10	1000
Core Practical	4	4	4	-	12	14	3	300
Elective	6	3	3	3	15	21	5	500
EDC	-	4	-	-	4	4	1	100
SEC	2	2	2	2	8	8	4	400
Project	-	-	-	6	6	16	1	100
Human Rights	-	2	-	-	2	2	1	100
Internship	-	-	2	-	2	-	1	100
Extension Activities	-	-	-	1	1	-	1	-
Extra Credit for Swayam / MOOC Course*	-	-	-	-	-	-	-	-
TOTAL	**24**	**27**	**23**	**16**	**90***	**120**	**27**	**2600**

***** The students will gain extra credits for successful completion of online courses from SWAYAM / MOOC Course.

ELECTIVE COURSES FOR M.Sc. BIOTECHNOLOGY STUDENT

Semester	TITLE	Course Title	Course Code
I	**Elective - I**	Bioinstrumentation	M23PBTE01
		Biostatistics	
	Elective - II	Food Technology	M23PBTE02
		Environmental Biotechnology	
II	**Elective - III**	Enzymology	M23PBTE03
		Regulatory Affairs and Industrial Standards	M23PBTE04
III	**Elective - IV**	Nano Biotechnology	M23PBTE05
		Molecular Developmental Biology	M23PBTE06
IV	**Elective - V**	Bioethics, Biosafety, Clinical trials, IPR & Entrepreneurship	M23PBTE07
		Stem Cell Biology	M23PBTE08

SKILL ENHANCEMENT COURSE

Semester	Course Title	Course Code
I	Horticulture	M23PBTS01
II	Pharmaceutical Biotechnology	M23PBTS02
III	Diagnostic Biotechnology	M23PBTS03
IV	Pharmacophore analysis	M23PBTS04

EXTRA DISCIPLINARY COURSES OFFERED FOR OTHER DEPARTMENT STUDENTS

Semester	Course Title	Course Code
II	Agrobiotechnology	M23PBTED1
	Health care and Environmental Biotechnology	M23PBTED2

VI. SCHEME OF EXAMINATION

1. Question Paper Pattern for Theory Examination

Time: Three Hours Maximum Marks: 75

Knowledge Level	Sections		Marks	Total Marks	Meaning of K's
K1	**Part – A** 10 Questions - Objectives type *1 Marks (No Choice)	Two Questions from each unit	**10**	**75**	**K1- Memory Level** **K2 - Understanding Level** **K3 - Application Level** **K4 - Analytical Level** **K5 - Evaluation Level**
K1, K2	**Part – B** 5 Questions *2 Marks (No Choice)	One Question from each unit	**10**		
K2, K3, K4	**Part – C** 5 Questions (either or type), *5 Marks	One Question from each unit	**25**		
K2, K3, K4, K5	**Part – D** 3 out of 5 Questions, *10 Marks	One Question from each unit	**30**		

2. Question Paper Pattern for Practical Examination

Time: Six Hours Maximum Marks: 60

Major Practical	**=**	**20 Marks**
Minor Practical	**=**	**10 Marks**
Spotters (5×4=20)	**=**	**20 Marks**
Viva - Voce	**=**	**05 Marks**
Record	**=**	**05 Marks**
Total	**=**	**60 Marks**

3. Distribution of Marks

The following is the distribution of marks for external and internal End Semester Examinations and continuous internal assessments and passing minimum marks for Theory / Practical / Project / Internship courses of PG programmes.

ESE	CIA Total	EA Total	Total Marks Allotted	Passing Minimum for EA	Passing Minimum (ESE)
Theory	25	75	100	38	50
Practical	40	60	100	30	50
Project	40	60	100	30	50
Internship	40	60	100	30	50

The following are the Distribution of marks for the Continuous Internal Assessment in Theory / Practical papers of M.Sc. Biotechnology programmes.

THEORY

EVALUATION OF INTERNAL ASSESSMENT

Test	: 10 Marks
Seminar	: 05 Marks
Assignment	: 05 Marks
Attendance	: 05 Marks
Total	: 25 Marks

PRACTICAL

EVALUATION OF INTERNAL ASSESSMENT

Test	:20 Marks
Attendance	: 10 Marks
Observation	: 10 Marks
Total	: 40 Marks

INTERNSHIP

EVALUATION OF INTERNAL ASSESSMENT

Training	:20 Marks
Attendance	: 10 Marks
Report	: 10 Marks
Total	: 40 Marks

PROJECT

EVALUATION OF INTERNAL ASSESSMENT

Review 1	: 10 Marks
Review 2	: 10 Marks
Review 3	: 10 Marks
Pre-Viva	: 10 Marks
Total	: 40 Marks

4. Passing Minimum

The Candidates shall be declared to have passed the examination if he/she secure not less than 50 marks in total (CIA mark + Theory Exam mark) with a minimum of 38 marks (out of 75 marks) in the End Semester Theory Examinations.

The Candidates shall be declared to have passed the examination if he/she secures not less than 50 marks in total (CIA mark + Practical Exam mark) with

a minimum of 30 marks (out of 60 marks) in the End Semester Practical Examinations.

5. Submission of Record Note Books for Practical Examinations

Candidates appearing for practical examinations should submit a bonafide record note books prescribed for practical examinations. The candidates who fail to submit the record book shall not be permitted to appear for the practical examinations

6. Internship/Project:

Internship

Internship training (Minimum two weeks period) is mandatory for all the M.Sc. Biotechnology programmes during the first-year vacation period.

The Internship training should be valued for 60 marks by an External examiner; however, the Viva-Voce examination should be conducted by the both the external examiner appointed by the College and internal examiner / guide/ teacher concerned.

1. The Internship training Report may consist of a minimum of 30 pages.
2. The candidate has to submit the Internship training Report 20 days before the commencement of the III Semester Examinations.

Project

The following guidelines are to be followed for the Project with Viva-voce:

The project should be valued for 60 marks by an external examiner however, the Viva-Voce examination should be conducted by both the external and internal examiners appointed by the College.

1. The Project Report may consist of a minimum of 50 pages.
2. The candidate has to submit the Project Report 10 days before the Commencement of the IV Semester Examinations.
3. A candidate who fails in the Project / Dissertation or is absent may resubmit the report, on the same topic, with necessary modification / correction / improvements in the subsequent Even Semester Examinations for evaluation and shall undergo viva-voce Examination.

VII. Note

a) SWAYAM / MOOC – Free Online Course

SWAYAM / MOOC is an instrument for self-actualization providing opportunities for a life-long learning. Here the student can choose from hundreds of courses, virtually every course taught at the college level, offered by the best teachers in India and elsewhere.

The students can choose an online SWAYAM / MOOC course during their period of study which will earn an extra credit and it will be transferred to the academic records of the students.

SEMESTER - I

Core Course - I	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT01	**BIOCHEMISTRY**	**Contact Hours Per Week: 5**

Objectives

- To understand the structure and functions of important biological macromolecules.
- To study the structure, properties and metabolism of different biomolecules.
- To understand the principles of biochemical pathways which regulate the cellular mechanisms.
- To acquire the knowledge on the role of biomolecules on general dogma of all living cell.

Course outcomes

At the end of the course, the student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Provide basic knowledge about lipid metabolism and related significance.	K1
CO2	Understand the basics of pH and related principles and carbohydrate metabolism.	K2
CO3	Update the knowledge on Amino acids and Protein.	K3
CO4	Enlighten the students on Bio-energetics and Biological oxidation pathways.	K4
CO5	Assess and appraise the role of Nucleic acids.	K5

Unit I **15 Hrs**

pH, pKa acid, base Buffers – Henderson - Haselbach equation, biological buffer system - Phosphate buffer system, protein buffer system and bicarbonate buffer system, Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, glycolysis, citric acid cycle, cori cycle, glyoxalate pathway.

Unit II **15 Hrs**

Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, Phospholipids and Cholesterol. Bile acids and salt formation. Oxidation of fatty acids-mitochondrial and peroxisomal ß-oxidation, alpha and beta-oxidation, oxidation of unsaturated and odd chain fatty acids.

Unit III **15 Hrs**

Bioenergetics – Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP ads universal unit of free energy in Biological systems. Biological oxidation: Electron transport chain, oxidative phosphorylation. Photosynthesis.

Unit IV **15 Hrs**

Amino acids and proteins: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolisms and carbon skeleton of amino acids, urea cycle.

Unit V **15 Hrs**

Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. *De novo* and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidine bases.

TEXT BOOK

S. No.	Name of the Book	Authors	Publishers	Year
1	Fundamentals of Biochemistry	Jain J.L	S. Chand and company	2004
2	Biochemistry	Philip W. Kuchel; Gregory B. Ralston	TATA Mcgraw Hill	2008
3	Biochemistry	Veerakumari L	MJP Publishers	2019
4	Biochemistry	Sathyanarayana. U and U. Chakrapani	Books and Allied Private Limited	2011

REFERENCE BOOKS

S. No.	Name of the Book	Authors	Publishers	Year
1	Outline of Biochemistry	Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews	McGraw-Hill, 3rd Edition,	2011
2	Biochemistry	Jeremy M. Berg, John L. Tymoczko, Lubert Stryer	W. H. Freeman, 7th Edition	2010
3	Principles of Biochemistry	Albert Lehninger, David L. Nelson Voet Donald, Judith G. Voet and Charlotte W. Pratt	John Wiley and Sons, Inc., New Jersey	2008
4	Principles of Biochemistry	Michael M. Cox	W. H. Freeman publishers, 5th Edition	2008

Mapping with Programme-Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	M	M
CO2	M	S	S	S	M
CO3	S	S	M	S	S
CO4	M	M	S	M	S
CO5	S	S	M	S	M

S- Strong; **M**-Medium

SEMESTER - I

Core Course - II	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT02	**MOLECULAR GENETICS**	**Contact Hours Per Week: 5**

Objectives

- To understand the basic knowledge of genetics encompassing prokaryotic/phage genetics, and higher eukaryotic domains and over all concepts of Mendelian genetics.
- To understand the Genetics concepts, molecules, DNA and their regulation.
- To understand the relationship between phenotype and genotype in human genetic traits.
- To gain knowledge of basics of human genetics and disease gene mapping.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Acquire good knowledge about the molecular mechanisms of gene expression and understand the theories behind the organization and functions of genetic material in the living world.	K1
CO2	Identify and distinguish genetic regulatory mechanisms at different levels explain the processes behind mutations and other genetic changes and study various chromosomal abnormalities.	K2
CO3	Make the students understand the different ranges of DNA damage and the range of tools for their detection.	K4
CO4	Learn the concepts of the transposons and their applications.	K3
CO5	Detects the Allele frequencies and genotype frequencies in populations and describes the concepts behind the theory of evolution	K5

Unit I **15 Hrs**

Genes and chromosomes, Genetic code, Identification of DNA as the genetic material. The complexity of the eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes). DNA markers - VNTR, STR, microsatellite, SNP and their detection techniques.

Unit II **15 Hrs**

Replication of DNA - regulation in prokaryotes and eukaryotes. Mutation: Spontaneous and virus-induced mutation, Radiation-induced mutation. Ionizing radiation, UV radiation. Chromosomal Abnormalities and associated genetic diseases, Techniques in the study of chromosomes and their applications.

Unit III **15 Hrs**

DNA Damage and Repair - Oxidative damages, Depurinations, Depyrimidinations, methylguanines, Cytosine deamination, single and double-strand breaks, Mechanisms of DNA damage - transition, transversion, frameshift, nonsense mutations, Repair Mechanisms - Photo reactivation, excision repair, mismatch repair, post replication repair, SOS repair. Complex transposons and their mechanisms.

Unit IV **15 Hrs**

Allele frequencies and genotype frequencies, Random mating population, Hardy - Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked) inbreeding, genetics and evolution, random genetic drift.

Unit V **15 Hrs**

Extrachromosomal heredity: Biology of Plasmids - discovery, types and structure, Ti – Replication and partitioning, Incompatibility and copy number control, natural and artificial plasmid transfer and their applications - Human Genome Project, Genomics and modern methodologies in understanding genome.

TEXT BOOKS

S. No	Name of the Book	Authors	Publishers	Year
1.	Microbial Genetics	Stanley R Maloy	Jones and Bartlett Series in Biology	1994
2.	Concepts of Genetics	Michael R Cummings; William S.Klug	Pearson Education	2019
3.	Genetics	Sambamurty A.V.S.S	Narosa Publishing House	1999
4.	Genetics	TATA Mcgraw Hill	Sarin C	1995
5.	Genetic Engineering,	Rastogi Smita and Neelam Pathak	Oxford University Press, New Delhi	2010

REFERENCE BOOKS

S. No	Name of the Book	Authors	Publishers	Year
1	Principles of Genetics	Gardner, Simmons and Snustad	Wiley, 8th Edition	2002
2	The Cell - A Molecular Approach.	Geoffrey M. Cooper, Robert E. Hausman	Sinauer Associates Inc, 3rd Edition	2003
3	Genetics - Analysis and Principles	Robert Brooker	McGraw Hill	2011
4	Genetics: From Genes to Genomes	Leland Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver	McGraw Hill, 4th Edition	2010

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	S
CO2	S	S	M	S	S
CO3	M	S	M	S	M
CO4	M	M	S	M	S
CO5	M	S	S	M	M

S- Strong; **M**-Medium

SEMESTER – I

Core Course – III	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT03	**MOLECULAR CELL BIOLOGY**	**Contact Hours Per Week: 5**

Objectives

- To understand the Cell biology concepts, molecules functions and their regulations.
- To study the DNA replication, protein biosynthesis and translational regulation.
- To develop a comprehensive understanding of the complete cellular and molecular function of cell organelles in cell-to-cell interaction, gene regulation, and cellular signaling.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism.	K1
CO2	Understand the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.	K2
CO3	Demonstrate knowledge and understanding of the principles and basic mechanisms of the nuclear envelope and its functions.	K5
CO4	Understand the metabolic pathways and the process of transmission of extracellular signals	K4
CO5	Demonstrate the operation of various microscopes and microtomy in the laboratory	K5

Unit I **15 Hrs**

Introduction to cell Biology - Basic properties of cells-Cellular Dimension - Size of cells and their composition - Organelles of the eukaryotic cell and its functions; Bio membranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell-Cell adhesion - Cell junctions (Tight junctions, gap junctions, desmosomes, adherence).

Unit II **15 Hrs**

Structure of Nucleic acids, Genome organization in Eukaryotes, DNA Replication, Transcription, Translation and post-translational Modification. Synthesis, sorting and trafficking of proteins: site of synthesis of organelle and membrane proteins – transport of secretary and membrane proteins across ER – post-translational modification in RER – transport to mitochondria, nucleus, chloroplast and peroxisome.

Unit III **15 Hrs**

Nucleus: Nuclear envelope – Nuclear pore complexes-nuclear matrix – organization of chromatin – supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome (Solenoid and Zigzag model)-Global structure of chromosome – (Lamp brush and polytene chromosomes).

Unit IV **15 Hrs**

Molecular basis of eukaryotic cell cycle, Regulation and cell cycle checkpoints; Programmed cell death (Apoptosis); Cell-Cell signaling-signaling molecules, types of signaling, signal transduction pathways (GPCR-cAMP, IP3, RTK, MAP Kinase, JAK-STAT, Wnt Pathway).

Unit V **15 Hrs**

Cancer Biology: Multistage cancer development Mitogens, carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes-Rb, p53, Apoptosis and significance of apoptosis.

TEXT BOOKS

S. No.	Name of the Book	Authors	Publishers	Year
1.	Molecular Cell Biology	Harvey Lodish	W.H.Freeman & Co Ltd	2016
2.	Molecular Cell Biology	Lodish H; Berk A; Zipursky S L; Matsudaira P	W.H.Freeman & Co Ltd	2003
3.	A Text Book of Cell Biology	Sambamurthy A.V.S.S	Konark publishers	2005
4.	Cell Biology	Rastogy S.C	Newage International	2006
5.	Cell biology organelles structure and function	David E. Sadva	CBS publishers and distributors New Delhi	2009
6.	Text Book Of Cell and Molecular Biology	Paul A	Niyogi Books, 2nd Edition	2001

REFERENCE BOOKS

S. No.	Name of the Book	Authors	Publishers	Year
1	Cell and Molecular Biology, Sixth edition	Karp, G	John Wiley & Sons, New York	2009
2	Molecular Biology of the Cell, Fifth edition	Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff	Garland Science	2007
3	Molecular Cell Biology	Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Kaiser, A., Krieger, Scott and Darnell, J.	W.H. Freeman and Company	2007
4	The Cell-A Molecular Approach, Fourth edition	Geoffrey. M. Cooper, Robert. E. Hausman	Sinauer Associates	2007
5	Basic Histology Text and Atlas	Luiz Carlos Uchoa, Janqueira, Jose, Carneiro	McGraw-Hill Professional	2005

Mapping with Programme-Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	S	M
CO2	S	M	M	M	S
CO3	M	M	S	M	S
CO4	S	S	M	S	M
CO5	S	M	S	M	S

S- Strong; **M**-Medium

SEMESTER – I

Core Practical - I	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBTP01	PRACTICAL - I - BIOCHEMISTRY, MOLECULAR GENETICS AND MOLECULAR CELL BIOLOGY	Contact Hours Per Week: 5

Objectives

- To establish skills in biochemistry, and isolation and characterization of biomolecules.
- To perform the isolation, purification and quantification of nucleic acids.
- To introduce students to various practical aspects of Molecular genetics.

Course outcomes

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Illustrate basic biochemistry procedures	K4
CO2	Study the methods of estimation of biomolecules	K4
CO3	Isolate and analyse DNA, RNA and protein	K4
CO4	Critically analyze the isolated biomolecules	K4
CO5	Evaluate the quality and purity of DNA, RNA and Protein	K4

(A) Biochemistry - Practical

1. SDS-PAGE for separation of low molecular weight proteins
2. Estimation of Proteins by Lowry's method
3. Estimation of RNA by orcinol method
4. Estimation of DNA by diphenylamine method
5. Estimation of Carbohydrate by Anthrone method
6. Separation of amino acids by Paper Chromatography
7. Separation of amino acids by Thin layer chromatography

Demo Experiments

8. Western blotting
9. PCR

(B) Molecular Genetics - Practical

1. Isolation of DNA from bacteria
2. Isolation of DNA from plants
3. Plasmid DNA isolation
4. Agarose gel electrophoresis of DNA
5. Isolation of RNA
6. Radiation induced genetic damage assessment
7. Chemical induced genetic damage assessment

(C) Molecular Cell Biology - Practical

1. Histochemical staining to localize proteins
2. Histochemical staining to localize carbohydrates
3. Histochemical staining to localize lipids.
4. Giant chromosome studies in Chironomus larvae
5. Meiotic study in flower bud sand cockroach or grasshopper
6. Preparation of tissue culture medium and membrane filtration
7. Preparation of single cell suspension from spleen
8. Cell counting and cell viability

SEMESTER - I

Elective - I	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE01	**ELECTIVE - I - BIOINSTRUMENTATION**	**Contact Hours Per Week: 4**

Objectives

- To understand the instrumentation principles and concepts in biological applications.
- To emphasize the working skill in basic and advanced analytical instruments
- To enhance the ability of understating and working methods of various instruments.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Introduction and various types of microscopic techniques.	K1
CO2	Understand the application and detection of bioinstrumentation.	K2
CO3	Impart an understanding of centrifugation instruments and techniques.	K3
CO4	Analytical methods of spectroscopic analysis.	K4
CO5	Separation of Biomolecules.	K5

Unit I **12 Hrs**

Microscopic techniques: principles and applications: Compound, Light, Stereo, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, FRET and Flow Cytometry.

Unit II **12 Hrs**

Centrifugation: Principle and Applications of various types of centrifugation, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques, Principle and Application, Gel

Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC and HPLC.

Unit III **12 Hrs**

Electrophoretic Techniques: Principle and Application of Agarose Gel Electrophoresis, 2D-gel Electrophoresis, PAGE - NATIVE and SDS PAGE, Iso-electric Focusing, Immuno-Electrophoresis, ELISA, RIA, Southern, Northern and Western Blotting. Electro blotting, PCR and RT-PCR, Microarray (DNA, Proteins).

Unit IV **12 Hrs**

Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, ESR, Atomic Absorption Spectroscopy, X-spectroscopy, Laser Spectroscopy and Raman Spectroscopy

Unit V **12 Hrs**

Radio-isotopic Techniques: Introduction to Radioisotopes, Uses and their Biological Applications, Radioactive Decay – Types and Measurement, Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, RIA, Radiation Dosimetry, Health effects of Radiations.

TEXT BOOKS

S. No.	Name of the Book	Authors	Publishers	Year
1.	Biophysics	Vasanth Pattabhi	Narosa Publishing House	2002
2.	Biophysics	Vasantha Pattabhi; Gautham.N	Narosa Publishing House	2010
3.	Principles of Biochemistry	David L. Nelson; michael M. Cox	WH Freeman and Company	2017
4.	Bioinstrumentation	L. Veerakumari	MJP Publisher Kindle edition	2006
5.	Handbook of Advanced Chromatography /Mass Spectrometry Techniques	Holcapek, M., Byrdwell, Wm. C.	Elsevier	2017

REFERENCE BOOKS

S. No	Name of the Book	Authors	Publishers	Year
1.	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson, John Walker,	Cambridge University Press, 7th Edition	2010
2.	Principles of Biochemistry	David L. Nelson, Michael M. Cox. Menninger	W. H. Freeman, New York, 5th edition	2008
3.	The chemical reactions of living cells	Metzler D.E	Academic Press. 2nd edition	2001
4.	Biochemistry	Stryer L	W.H. Freeman and Company, New York - 4th edition	1999
5.	Biotechnology - A Laboratory Course	Jefrey. M., Backer	Academic Press, New York	1996

Mapping with Programme-Specific Outcomes

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	S	S	M	S	M
CO3	M	M	M	S	S
CO4	S	M	S	M	S
CO5	M	S	M	S	S

S- Strong; **M**-Medium

SEMESTER – I

Elective - I	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE01	**ELECTIVE - I - BIOSTATISTICS**	**Contact Hours Per Week: 4**

Objectives

- To understand the statistical concepts, in biology and the core concepts of computation principles for data analysis.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Provide basic knowledge about methods of analysis of variance	K1
CO2	Understand the major methods of collection and presentation of data	K2
CO3	Enlighten the students about the methods of setting hypotheses and calculation of errors.	K3
CO4	Update the knowledge on tests of significance for large and small samples.	K4
CO5	Assess and appraise the role of novel microbes in the environment and integrate them in specific innovative approaches.	K5

Unit I **12 Hrs**

Statistics – Scope – collection, classification, tabulation of statistical Data – Diagrammatic representation – graphs – graph drawing – graph paper – plotted curve – Sampling method and standard errors – random sampling – use of random numbers – the expectation of sample estimates – means – confidence

limits – standard errors – variance. Measures of central tendency – measures of dispersion – skewness, kurtosis, moments.

Unit II **12 Hrs**

Correlation and regression – correlation table – coefficient of correlation – Z transformation – regression – relation between regression and correlation. Probability – Markov chains applications – Probability distributions – Binomial (Gaussian distribution) and negative binomial, compound and multinomial distributions – Poisson distribution.

Unit III **12 Hrs**

Normal distribution – graphic representation – frequency curve and its characteristics –measures of central value, dispersion, coefficient of variation and methods of computation – Basis of Statistical Inference – Sampling Distribution – Standard error – Testing of hypothesis – Null Hypothesis –Type I and Type II errors.

Unit IV **12 Hrs**

Tests of significance for large and small samples based on Normal, t, z distributions with regard to mean, variance, proportions and correlation coefficient – chi-square test of goodness of fit – contingency tables – c2 test for independence of two attributes – Fisher and Behrens 'd' test – 2×2 table – testing heterogeneity – r X c table – chi-square test in genetic experiments – partition X 2 – Emerson's method.

Unit V **12 Hrs**

Tests of significance – t tests – F tests – Analysis of variance – one-way classification – Two-way classification, CRD, RBD, LSD. Spreadsheets – Data entry –mathematical functions – statistical function – Graphics display – printing spreadsheets – use as a database word processes – databases – statistical analysis packages graphics/presentation packages.

TEXT BOOKS

S. No.	Name of the Book	Authors	Publishers	Year
1.	Fundamentals of Biostatistics	Veer Bala Rastogi	Ane books Pvt Ltd, Chennai	2011
2.	An Introduction to Biostatistics	Sundar Rao P. S.S., Jesudian G. and Richard J.	Prestographik, Vellore, India, 2nd Edition	1987

REFERENCE BOOKS

S. No.	Name of the Book	Authors	Publishers	Year
1.	Fundamentals of Biostatistics	Rosner, B	Duxbury Press	2005
2.	Statistical Methods in Bioinformatics	Warren, J; Gregory, E; Grant, R	Springer, 1st Edition	2004
3.	Statistical methods in the Biological and Health Sciences	Milton, J.S.	Mc Graw Hill, 2nd Edition	1992

Mapping with Programme-Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	M	S	S	M	S
CO3	S	S	M	S	S
CO4	S	M	S	M	M
CO5	M	M	S	M	S

S- Strong; **M**-Medium

SEMESTER - I

Elective - II	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE02	**ELECTIVE - II - FOOD TECHNOLOGY**	**Contact Hours Per Week: 4**

Objectives

- To provide scientific knowledge of food preservatives, food additives and the functions of enzymes in industrial applications.
- To understand the principles and concepts of technology to overcome the problems in food handling and processing.
- To acquire the information about role of microbes in food processing.

Course outcomes

At the end of the course, the student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Explain the basic food preservative techniques.	K1
CO2	Classify and summarize the detailed methodologies of food preservative techniques.	K2
CO3	Examine the packing system of food and additives	K3
CO4	Assess extraction and downstream processing of food	K4
CO5	Compile the uses of food and design the packages for Industrial and public	K5

Unit I **12 Hrs**

Introduction, scope and importance of food biotechnology. Microorganisms associated with food - bacteria, fungi & yeast. Enzymes in food preparation. Food contaminations. Food preservation & Food spoilage- types. Canning of foods.

Unit II **12 Hrs**

Food borne diseases and prevention – infection, in-toxification – Salmonellosis, poliomyelitis. Food colors (natural and artificial food colourants), Food flavouring agents.

Unit III **12 Hrs**

Food engineering operations: Characteristics of food raw materials, preparative operations in the food industry, cleaning of food raw materials, sorting of foods, grading of foods.

Unit IV **12 Hrs**

Food quality: Sensory evaluation of food quality, quality factors for consumer safety, and food safety standards. FSSA, HACCP and FDA. Processing plant - Cleaning and sanitation methods.

Unit V **12 Hrs**

General principle, plant design – design, construction, functionality of building, design & fabrication of equipment. Plant layout Pest proofing / fumigation methods. Water supply to food processing unit.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Fats in Food Technology	Kanes K Rajah	Wiley-Blackwell	2014
2.	Food Processing and Preservation	Subbulakshmi G; Shobha A Udipi	New Age International Publishers	2016
3.	Food Biotechnology	Dietrich Knorr	Dietrich Knorr	1987
4.	Food Microbiology	William C. Frazier, Dennis C. Westhoff	McGraw Hill Publications	2017
5.	Fundamentals of Food Engineering	D.G. Rao	PHI Learning Pvt. Ltd.	2010

REFERENCE BOOKS

S. No.	Title of the book	Author	Publishers	Year
1	Food Biotechnology	Yiu Hui and G. Khachatourians	Wiley-Inter Science	1995
2	Fundamentals of Food Microbiology	Bibek, Laramie and Bhunia	CRC Press	2004
3	Food Processing and Preservation	B. Siva	PHI Learning Pvt. Ltd.	2011

Mapping with Programme-Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	S	M
CO2	S	S	M	M	M
CO3	S	S	M	M	S
CO4	S	M	S	S	S
CO5	M	S	M	M	M

S- Strong; **M**-Medium.

SEMESTER – I

Elective - II	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE02	**ELECTIVE - II - ENVIRONMENTAL BIOTECHNOLOGY**	**Contact Hours Per Week: 4**

Objectives

- To provide knowledge about the functions of the ecosystem and the reduction of pollution by biotechnological applications.
- To impart appropriate information and adequate knowledge about environmental impact assessment and environmental acts; to acquaint students in the area of disasters management.
- To understand the energy sources, environmental pollution and remediation using biotechnology and its control.

Course outcomes

At the end of the course, the student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Explain various waste management methods.	K1
CO2	Understand the potential methods of biodegrading organic pollutants.	K2
CO3	Examine the techniques involved in the remediation of polluted environments.	K3
CO4	Assess types of pollution and its control.	K4
CO5	Compile biotechnological approaches to degrade xenobiotic compounds.	K5

Unit I **12 Hrs**

Environment: Basic concepts and issues; Environmental management and Conservation, Environmental Laws and agencies involved in conservation. Environmental Pollution: Types of pollution & its control strategies - Air pollution, Soil pollution, Water pollution, Oil pollution &radioactive pollution.

Unit II **12 Hrs**

Biofilm Kinetics: Completely mixed biofilm reactor-soluble microbial products and inert biomass-special-case biofilm solution. Reactor types: - batch reactor - continuous-flow stirred-tank reactor- Plug-flow reactor. Engineering design of reactors- Reactors in series.

Unit III **12 Hrs**

Wastewater management, source of wastewater, Waste water treatment-physical, chemical and biological treatment. Microbiology of Wastewater; Aerobic and anaerobic process, BOD and COD.

Unit IV **12 Hrs**

Toxicity: Types and Test for Evaluating Toxicity. Biosensors, Biomonitoring of toxic materials. Biomagnification, Biomining and Biofuels.

Unit V **12 Hrs**

Bioremediation; *In-situ and Ex-situ* Bioremediation of contaminated soils and wasteland; Microbiology of degradation of Xenobiotics in the environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Environmental Biotechnology	Arvind Kumar	Daya Publishing House	2005
2.	Environmental Biotechnology: Principles and Applications	Moo-Young M; Anderson W.A; Chakrabarty A.M	Springer	1996
3.	Environmental Biotechnology	Agrawal K.C	Nidhi Publishers-India	2008
4.	Introduction to Environmental Biotechnology	Chatterji A.K	Prentice Hall India Learning Private Limited	2011

5.	Environmental Biotechnology,	M. H. Fulekar,	Science Publishers Department of Life Sciences, University of Mumbai, India	2010
6.	Industrial and Environmental Biotechnology.	Ahmed N, Qureshi, F.M. and Khan, O.Y..	Horizon Press	2001

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1	Environmental Biotechnology: Principles and Applications	M. Moo-Young, W.A. Anderson, A.M. Chakrabarty,	Springer	2010
2	Environmental Biotechnology: Principles and applications	Bruce E. Rittmann and Perry L. McCarty.	McGraw Hill, Newyork	2001

Mapping with Programme-Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	S
CO3	S	M	S	M	S
CO4	S	M	M	S	M
CO5	S	S	M	M	M

S- Strong; **M**-Medium

SEMESTER - I

SEC - I	M.Sc. Biotechnology	Credits: 2
Course Code: M23PBTS01	**SEC - I - HORTICULTURE**	**Contact Hours Per Week: 2**

Objectives

- To emphasize on development of entrepreneurial potential and skills amongst the students in horticulture.
- To understand about the floriculture and cultivation process.

Course Outcomes

At the end of the course, the student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the classification, importance and nutritional requirements of horticulture crops	K1
CO2	Knowledge about plant propagation methods, and plant regulators uses.	K2
CO3	Impart knowledge of garden design, types and maintenance.	K4
CO4	Make knowledgeable and learn about floriculture and cultivation of commercial flowers and fruits.	K3
CO5	Understand basic concepts about greenhouse, indoor gardening and its maintenance.	K5

UNIT I **6 Hrs**

Horticulture: - Importance and scope of Horticulture, Classification of horticultural crops – fruits, vegetable crops, climate, soil, water, nutrition needs of horticultural crops,

UNIT II **6 Hrs**

Plant propagation methods, cutting, layering, grafting, budding, and stock-selection relationship. Use of plant regulators in horticulture.

UNIT III **6 Hrs**

Garden designs, types of gardens – formal, informal and kitchen garden, units of garden, hedge, border, topiary arches and lawn maintenance.

UNIT IV **6 Hrs**

Floriculture, cultivation of commercial flowers – rose and jasmines. Cultivation of important fruit trees – Mangoes and Banana.

UNIT V **6 Hrs**

Greenhouse, Indoor gardening – Bonsai – flower arrangements – nursery management and maintenance.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1	Floriculture – fundamental and practices.	Lex Lauries and Victor H. Rice	McGraw Hill Publishers	1985
2	Plant Propagation	Sandhu, M.K	Wiley Eastern Ltd., New Delhi	1989
3	Introduction to Horticulture	Kumar, N.	Rajalakshmi Publications	1997

REFERENCE BOOK

S. No.	Title of the Book	Author	Publishers	Year
1	Gardening in India,	Bose, T.K. and Mukherjee, D.	Oxford and IBH Publishing Co	1992

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	M	M	S	S	S
CO4	S	M	S	M	M
CO5	M	S	M	M	M

S- Strong; **M**-Medium.

SEMESTER - II

Core Course - IV	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT04	**MICROBIOLOGY**	**Contact Hours Per Week: 5**

Objectives

- To provide a comprehensive knowledge of taxonomy and microbial diversity, growth and the significance of microorganisms in health and environment.
- To understand and predict the intermediate metabolism of any microbe used in industrial production processes.
- To acquire knowledge of microbial metabolism.

Course outcomes

At the end of the course, the student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.	K1
CO2	Provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques	K2
CO3	Enlighten the students on host-microbe interaction and the Epidemiology of microbial disease	K3
CO4	Update the knowledge on epidemic and pandemic diseases.	K4
CO5	Assess and appraise the role of novel microbes in the environment and integrate them in specific innovative approaches.	K5

Unit I **15 Hrs**

History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Biovars, Serovars and Prions, Microbial growth: Growth curve, factors affecting growth, Microbial metabolism - Methanogenesis, acetogenesis and auxotrophs.

Unit II **15 Hrs**

Microbial culture, identification, and control: Nutritional requirements for growth - Growth media and types, Pure culture techniques: Serial dilution and plating methods, Staining methods - Principles and types of staining (simple and differential), Identification of bacteria – Biochemical – IMViC, 16S rRNA sequencing. Microscopy: principles and applications of Bright field, florescent and Scanning electron microscopes, Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods

Unit III **15 Hrs**

Host-microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases.

Unit IV **15 Hrs**

Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Leprosy, Cholera, Typhoid, COVID-19, Yellow Fever, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chikungunya, Malaria, filariasis, Candidiasis, superficial mycosis.

Unit V **15 Hrs**

Agricultural and Environmental Microbiology: Biological nitrogen fixation, free-living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers-types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremphiles-Thermophiles Acidophiles, Halophiles and alkalophiles.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Microbiology	Sharma P.D	Rastogi Publishers	2016
2.	Microbiology	Michael J. Pelczar	McGraw Hill Education	2001
3.	General Microbiology	Hans G. Schlegal	Cambridge University Press	1993
4.	A Textbook of Microbiology	Maheshwari D K, Dubey R C	S Chand Publishing India, 4th Edition	2013
5.	Textbook of Microbiology	Ananthanarayan and Paniker's	The Orient Blackswan, 10th Edition	2017

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1	Prescott's Microbiology	Joanne Willey, Linda Sherwood, Christopher J. Woolverton	McGraw-Hill Education, 10th edition	2017
2	Microbiological Applications: A Laboratory manual in General Microbiology	Benson HJ.	McGraw Hill, 7th Edition	1999
3	Environmental Microbiology, Second Edition.	O'Flaherty, Vincent & Collins, Gavin &Mahony, Thérèse.	Managing epidemics-Key facts about major deadly diseases, World Health Organization (WHO)	2018

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	M	M
CO2	S	S	M	S	S
CO3	S	M	S	M	M
CO4	S	S	S	M	S
CO5	S	M	S	S	M

S- Strong; **M**-Medium

SEMESTER - II

Core Course - V	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT05	PLANT AND ANIMAL BIOTECHNOLOGY	Contact Hours Per Week: 5

Objectives

- To impart knowledge of plant cell and animal cell characters, cell culture and their applications in biotechnological aspects.
- To understand the fundamental aspects of plant tissue culture and molecular biology of plants.
- To get knowledge on transgenic animals, pest and animal management.

Course Outcomes

At the end of the course, the student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation and their application in industries.	K1
CO2	Importance of secondary metabolites and production in plants.	K2
CO3	Develop concepts, principles and processes in animal biotechnology.	K3
CO4	Concept and different types in Animal Cell Culture and animal cell lines.	K4
CO5	The use of molecular biology techniques to genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical and industrial applications.	K5

Unit I **15 Hrs**

Introduction of plant tissue culture, composition of media, Micropropagation, organogenesis, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed production. Secondary metabolites in plants - Glycosides and Flavonoids; Anthocyanins and Coumarins - Lignans, Terpenes, Volatile oils and Saponins; Carotenoids and Alkaloids: biogenesis, therapeutic applications.

Unit II **15 Hrs**

Plant Transformation Direct transformation by electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards the development of enriched food products, plant growth regulators; Molecular Marker aided breeding: RFLP maps, Linkage analysis, RAPD markers, STS Mirco satellite, SCAR, SSCP, QTL, Map based cloning and Molecular marker assisted selection.

Unit III **15 Hrs**

Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Prophylaxis - Vaccines, Oral vaccines DNA Vaccines in animal disease. Cell culture: primary and established culture; organ culture; tissue culture.

Unit IV **15 Hrs**

Disaggregation of tissue and primary culture; cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, cryopreservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning, somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays

Unit V **15 Hrs**

Application of animal cell culture for in vitro testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Culture Scale up and mass production of biologically important compounds. Harvesting of products, purification and assays. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases; Stem Cells- Properties, Types, Therapy, Prospects and Ethics in stem cell research.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Plant Biotechnology	Sudhir M	Dominant	2013
2.	Plant Biotechnology	Hammond J; Mcgarvey P; Yusibov V	Springer	2000
3.	Animal Biotechnology	Ranga M M	Agro-Bios	1999
4.	Animal Cell Culture	John R W Mastere Ed. Ed.	Oxford University Press	2000
5.	Culture of Animal Cells: A Manual of Basic Techniques	Ian Freshney R	Wiley-Blackwell publishers.	2010
6.	Plant tissue culture.	Razdan. M. K.	Oxford and IBH publishing Company Pvt. Ltd, New Delhi	2011
7.	Introduction to plant biotechnology	Chawla. H. S.	Oxford and IBH publishing company pvt. Ltd, New delhi.	2010
8.	Textbook of Biotechnology	W.H.Freeman. K. Dass	Wiley Dreamtech, India (P) Ltd. 2nd Edition	2005
9.	Applied Biotechnology & Plant Genetics	M.Sudhir	Dominant publishers and distributors.	2000

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Plant Biotechnology: The Genetic manipulation of plants, Second Edition,	Slater	Oxford University Press, USA	2008
2.	Recombinant DNA and Biotechnology: A guide for teachers	H.Kreuzer & A.Massey.	ASM press, Washington, 2nd Edition	2001

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	S	M
CO2	M	M	S	M	M
CO3	M	M	S	M	S
CO4	S	M	S	S	M
CO5	S	M	M	M	S

S- Strong; **M**-Medium

SEMESTER – II

Core Course - VI	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT06	**GENETIC ENGINEERING**	**Contact Hours Per Week: 5**

Objectives

- To deliver the ideas of genetic tools and their applications in biotechnological applications on the development of transgenic plants, animals and microbes.
- To provide methodologies of rDNA technology.
- To understand the applications of rDNA technology.

Course Outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.	K1
CO2	Get detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.	K2
CO3	Acquire theoretical knowledge in the techniques, tools, and application and safety measures of genetic engineering.	K3
CO4	Describes the genome mapping and sequencing and methods for gene therapy.	K4
CO5	Elucidate different techniques involved in genetic engineering	K5

Unit I **15 Hrs**

Gene cloning. Genetic engineering tools. Nucleic acid manipulating enzymes. Promoters, Selective markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation and Selection of Recombinants. Construction of gene libraries

Unit II **15 Hrs**

E. coli vectors - pBR322 and its derivatives; Cloning vectors for gram-negative bacteria - ColE1, p15A, R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram-positive bacteria (*Bacillus subtilis*)

Unit III **15 Hrs**

Cloning in yeast *Saccharomyces cerevisiae*. Life cycle and types of vectors; Eukaryotic vectors. SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro.

Unit IV **15 Hrs**

Nucleic acid hybridization techniques; Molecular probes (Types of probes and their construction); probe labelling. Nick translation, End labelling and Random primer labelling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sangers Di-deoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing), Second generation sequencing methods.

Unit V **15 Hrs**

Site-directed mutagenesis; DNA microarray; chromosome walking and jumping. Molecular techniques in prenatal diagnosis gene therapy, Transgenic animals (knockout mice) and plants (Flavrsavr tomato), Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods; Modern Concepts in Genetic Analysis.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Gene cloning and DNA analysis: An introduction	T.A. Brown,	Wiley-Blackwell, 6th edition	2010
2.	Molecular Biology and Genetic Engineering	Narayanan L M; Selva Raj A M; Mani A; Arumugham N	Saras Publication	2014
3.	Methods in Biotechnology	Hans-Peter Schmauder	Taylor Francis	1998
4.	Gene Biotechnology	Shailendra Singh	Cambridge	2005

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Principles of Gene Manipulation and genomics	Primrose and Richard Twyman Sandy B.	Wiley-Blackwell, 7th edition	2006
2.	Survey of molecular cloning vectors and their uses	Raymond Rodriguez and David T. Denhart Vectors, A	Butterworth-Heinemann	2003

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	M	M	M	S	S
CO3	M	S	S	S	S
CO4	S	M	M	S	M
CO5	M	M	M	S	S

S- Strong; **M**-Medium

SEMESTER - II

Core Practical - II	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBTP02	**PRACTICAL-II - MICROBIOLOGY, GENETIC ENGINEERING, PLANT AND ANIMAL BIOTECHNOLOGY**	**Contact Hours Per Week: 4**

Objectives

- To establish a study skill on the subject and will improve the student's ability to have hands-on experience on the above core subjects.
- To get training in basic genetic engineering techniques which are essential for them to enrich their technical skills.
- To understand about the establishment and maintenance of cultures.
- To provide hands on training on plant and animal tissue culture technology.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Isolate and identify microbes from various sources.	K4
CO2	Characterize microbes.	K4
CO3	Examine Plant and Animal cells and their functions	K4
CO4	Assess extracted DNA, RNA and protein for rDNA technology	K4
CO5	Study cloning tools	K4

(A) Microbiology - Practical

1. Isolation of microbes from soil, water and air
2. Isolation of microbes from plant surface.
3. Isolation of pure culture of *E. coli*.
4. Isolation of pure culture of *Aspergillus niger* and Streptomyces
5. Gram staining and morphological characterization of microbes.
6. Negative staining of bacteria
7. Determination of growth curve of bacteria – *E. coli*
8. IMViC test of enteric bacteria

Demonstration

7. 16srRNA sequencing

Genetic Engineering - Practical

1. Preparation of plasmid DNA by alkaline lysis method.
2. Elution of DNA from agarose gel.
3. Restriction enzyme digestion.
4. Ligation.
5. Competent cell preparation
6. Transformation and selection of recombinants.
7. Insertional inactivation/Blue-white screening
8. Amplification of DNA - PCR

Demonstration:

9. RAPD
10. RFLP

(B) Plant and Animal Biotechnology - Practical

1. Plant tissue culture media preparation
2. Plant tissue culture sterilization techniques.
3. Generation of Callus from leaf, root, bud and shoot apex
4. Maintenance of callus culture.
5. Suspension culture of Cell, Anther, Pollen and Embryo
6. Isolation of plant protoplast and viability test.
7. Mass culture of Chlorella /Spirulina
8. Introduction to Animal Cell culture: Procedure for handling cells and medium.
9. Preparation of sera for animal cell culture
10. Preparation of single cell suspension from chicken liver (Primary cell culture).
11. Trypsinization of established cell culture.
12. Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue, Erythrosin (b) Giemsa staining.

SEMESTER – II

Elective - III	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE03	**ELECTIVE - III - ENZYMOLOGY**	**Contact Hours Per Week: 3**

Objectives

- To provide the knowledge of enzyme structure, kinetics, downstream processing and the industrial application of enzymes.
- To obtain basic knowledge about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the basics of enzyme nomenclature and properties	K1
CO2	Classify and Cognize the native and immobilized enzyme	K2
CO3	Examine the equations of steady-state kinetics	K3
CO4	Assess extraction and downstream processing of enzymes	K4
CO5	Compile the uses of enzymes and design enzymes for Industrial and Clinical application	K5

Unit I **9 Hrs**

Introduction to enzymes, Classification, nomenclature and general properties of enzymes. Extraction Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis and liquid-liquid extraction methods

Unit II **9 Hrs**

Kinetics of catalysed reaction: Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Inhibition of enzyme activity.

Unit III **9 Hrs**

Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis.

Unit IV **9 Hrs**

Theories on mechanism of catalysis-Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex.

Unit V **9 Hrs**

Coenzyme action. Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications. Clinical and industrial applications of enzymes, Enzyme Engineering.

TEXT BOOKS

S. No	Name of the Book	Authors	Publishers	Year
1.	Fundamentals of Enzymology	Nicholas C.Price and Lewis Stevens	Oxford University Press, New Delhi	2010
2.	Enzyme Technology	Ashok Paendey; Colin Webb, Carlos Ricardo Soccol, Christian Larroche	Asiatech Publishers	2005
3.	Harper's Biochemistry	Robert K Murray	McGraw Hill Education	2012

REFERENCE BOOKS

S. No.	Name of the Book	Authors	Publishers	Year
1.	Principles of Biochemistry	Lehninger, Nelson and Cox	WH Freeman and Company, New York, USA, 4th edition	2005
2.	Principles of Biochemistry with human focus	Garrett and Grisham	Harcourt College Publishers, Orlando, Florida, USA	2002
3.	Biochemistry	Harper.S, Murray	Appleton and Lange Publishers, 25th edition	2000

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	M	M	M
CO2	M	S	S	S	S
CO3	S	M	S	M	S
CO4	S	M	M	M	S
CO5	M	M	S	S	S

S- Strong; **M**-Medium.

SEMESTER - II

Elective - III	M.Sc. Biotechnology	Credits: 3
Course Code: M23UBTE04	**ELECTIVE - III - REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS**	**Contact Hours Per Week: 3**

Objectives

- To provide knowledge on the scientific, technical and regulatory requirements for industries.
- To impart sufficient information and scientific knowledge about food packaging process and food microbiology.

Course Outcomes

At the end of the Course, the Student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Elucidate the basic requirements of establishing laboratory for testing samples as per the regulatory body's requirements	K1
CO2	Describe the Scientific, and technical knowledge about various food preservation techniques	K2
CO3	Describe the basic concepts of packing of food materials, various parameters observed during packaging	K3
CO4	Describe the testing of food materials and identifying of microbial food contaminants	K4
CO5	Explain the basic of the food safety management system, good manufacturing practice and good hygienic practices	K5

Unit I **9 Hrs**

Planning, Organization and setting of Food testing laboratory and laboratory safety

Understand the requirements for setting up a laboratory for the legal defensibility of analytical data. The ideal structure design, environment, layout for microbiological testing and Air handling etc., Introduction about

accreditation, Different accreditation bodies (NABL, APLAC, ILAC), Requirements for ISO/IEC 17025:2017, documentation, pre-requisites for accreditation, management requirements, technical requirements, measurement of traceability, Laboratory safety: Personnel and laboratory hygiene, emergency planning, general hazards in a food laboratory, safety equipment, storage of chemicals, acids, handling and biological spills and waste disposal.

Unit II **9 Hrs**

Principles of Food Preservation Technology

Heat: Principles of Heat transfer, Blanching, Pasteurization, Heat sterilization, thermal extrusion, and cooking. Water Removal: Forms of Water in Foods, Sorption of water in foods, Water activity, drying and evaporation technology. Temperature reduction: Chilling, Freezing, Radiation: Ionizing Radiation, Microwave, Use of chemicals: Class-I & Class-II preservatives, smoke other chemical additives, New non-thermal methods: High hydrostatic pressure, modified atmosphere, high intensity pulsed electric fields, intense pulsed light, oscillating magnetic fields, hurdle technology, ultrasonic and ohmic heating etc.

Unit III **9 Hrs**

Principles of Food Packaging Technology

Effect of environment on food stability: light, oxygen, water, temperature, sensitivity to mechanical damage and attack by biological agents, Different packaging materials used for food packaging and their properties including barrier properties, strength properties, optical properties, Selection of packaging material and design for various food commodities, water and processed foods, Evaluation of quality and safety of packaging materials- different testing procedures, Function of packaging: Protective packaging and active packaging smart and intelligent packaging.

Unit IV **9 Hrs**

Food Microbiology and testing

Introduction of Food microbiology: Bacterial groups (lactic acid, acetic acid, butyric acid etc.,), thermophilic, proteolytic, saccharomyticetc, coliforms, faecal coliforms, enteric pathogens and emerging microbes, Sources of microorganisms in food chain (raw materials, water, air, equipment etc) and microbiological quality of foods, Microbial growth in foods: intrinsic (pH,

Moisture content, oxidation-reduction potential, nutrient content, antimicrobial constituents and extrinsic parameters (temperature of storage, relative humidity of environment, presence and concentration of gases in the environment, Thermal destruction of microorganisms, Microbial food spoilage and food borne diseases, food pathogens.

Unit V **12 Hrs**

HACCP and Food safety management systems:

ISO 22000: Importance of implementing a HACCP system and how it can be applied to various products. Prerequisite programs, HACCP principles, and some limitations of HACCP food safety objective (FSO). Food safety audits: Management review, audit certification and importance. Good manufacturing practices (GMP), Good hygienic practices (GHP), Food safety plan, and food safety management risk analysis. Traceability food products recall and sanitation.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Food Biotechnology	Dietrich Knorr	Marcel Dekker	1987
2.	Food Biotechnology	Tripathy S.N	Dominant Publishers & Distributors	2004
3.	Biochemistry	Veerakumari L	MJP Publishers	2019
4.	Gene cloning and DNA analysis: An introduction	T.A. Brown	Wiley-Blackwell, 6th Edition	2010

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1	Principles of Gene Manipulation and genomics	Primrose and Richard Twyman Sandy B.	Wiley-Blackwell, 7th Edition	2006
2	Survey of molecular cloning vectors and their uses	Raymond Rodriguez and David T. Denhart Vectors, A	Butterworth-Heinemann	2003

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	M
CO3	S	M	S	S	S
CO4	S	M	M	M	S
CO5	M	S	M	S	S

S- Strong; **M**-Medium.

SEMESTER - II

SEC - II	M.Sc. Biotechnology	Credits: 2
Course Code: M23PBTS02	**SEC – II - PHARMACEUTICAL BIOTECHNOLOGY**	**Contact Hours Per Week: 2**

Objectives

- To provide an overview about identifying drug targets and strategies to develop drugs.
- To learn about basic and essential qualities of a candidate drug and testing methods.
- To understand the prerequisites of obtaining drug approval, important aspects of commercialization.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the basic components of the pharmaceutical and biotechnology industry and the methods and applications of biosensor	K1
CO2	Describe the Scientific, technical and economic aspects of vaccine & rDNA technology	K2
CO3	Describe the basic concepts of protein Engineering, therapeutic proteins and enzyme immobilization techniques	K3
CO4	Describe the concepts of hybridoma technology, microbial biotransformation and microbial bio-transformed products	K4
CO5	Explain the basic components of somatic gene therapy, Xeno-transplantation and fermenter and bio-safety methods	K5

Unit I **12 Hrs**

Introduction to concepts and technologies in pharmaceutical biotechnology and industrial applications, Biosensors - Working and applications of biosensors in pharmaceutical Industries; Pharmacology: Scope, applications and Importance.

Unit II **12 Hrs**

Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Storage conditions and stability of vaccines, Interferon, hepatitis - B and Hormones – Insulin, Brief introduction to Protein Engineering, Therapeutic proteins, Methods of enzyme immobilization and applications.

Unit III **12 Hrs**

Hybridoma technology - Production, Purification and Applications, Formulation of biotech products - Rituximab, Study of the production of – penicillins, citric acid, Vitamin B12, Glutamic acid and Griseofulvin Somatic gene therapy, Xenotransplantation in pharmaceutical biotechnology, Biosafety in the pharmaceutical industry.

Unit IV **12 Hrs**

Pharmacological activity of Plant drugs in modern pharmacology. Biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, vinca alkaloids, synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and bio-transformation. Criteria for pharmacological evaluation of drugs.

Unit V **12 Hrs**

Clinical Pharmacology, Drug therapy, therapeutic situation, benefits and risk of use of drugs, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug action, factors affecting drug action; Adverse Drug reactions and drug poisoning-classification. ADR- causes, principle, clinical manifestations and treatment.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Pharmaceutical Biotechnology	Purohit S S; Kakrani H.N; Saluja A.K	Agrobios (India)	2021
2.	Pharmaceutical Microbiology	Purohit C.S; Saluja	Student Store	2008
3.	Pharmaceuticals biochemistry	Harbanslal,	CBS Publishers and distributors Pvt. Ltd, Chennai.	2011

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Pharmaceutical Biotechnology	Carlos A. Guzmán and Giora Z. Feuerstein	Springer	2009
2.	Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals	Daniel Figeys (Ed.).	Wiley, John & Sons, Incorporated	2005
3.	Pharmaceutical Biotechnology Drug Discovery and Clinical Applications	Kayser, O and Muller R.H..	WILEY-VCH	2004
4.	Applied Biopharmaceutics & Pharmacokinetics	Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong, and Yu Andrew B. C	McGraw-Hill Companies	2004
6.	Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology)	John F. Corpenter (editor), Mark C. Manning	Plenum, US.	2002
7.	Bioinformatics – from Genomes to Drugs	Thomas Lengauer (Ed.)	Wiley-VCH	2002

Mapping with Programme-Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	S	S	S	S
CO3	M	M	S	S	M
CO4	S	M	S	M	M
CO5	M	S	M	S	S

S- Strong; **M**-Medium.

SEMESTER - II

ECC	M.Sc. Biotechnology	Credits: 2
Course Code: M23PHR01	**HUMAN RIGHTS**	**Contact Hours Per Week: 2**

Objectives

- To present the different aspects of humans and also to make the students understand the duties to be carried out in the days to come.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	Statement	Knowledge Level
CO1	Remember the need and types of Human rights	K1
CO2	Understand the Classification of Human Rights	K2
CO3	Apply the Rights of Women and Children	K3
CO4	Learn the Rights of Labour	K4
CO5	Analyze the National and State level Human Rights Commission	K5

UNIT I **6 Hrs**

Human Rights: Meaning – Definitions – Origin and Growth of Human Rights in the World – Need and types of Human Rights – UNHRC (United nations Human Rights) – Human Rights in India.

UNIT II **6 Hrs**

Right to Liberty – Right to Life – Right to Equality – Right to dignity – Right against Exploitation – Educational Rights – Cultural Rights – Economic Rights – political Rights – Social Rights.

UNIT III Rights of Women and Children: **6 Hrs**

Rights of Women – Female feticide and Infanticide and selective abortion – Physical assault and sexual harassment – Domestic Violence – Violence at workplace – Remedial Measures. Rights of Children – Protection rights, survival

rights – Participation rights – Development rights – Role of UN on the convention on rights of children.

UNIT IV Multi-Dimensional Aspects of Human Rights: 6 Hrs

Labour rights – Bodend Labour – Child Labour – Contract Labour – Migrant Labour – Domestic Women Labour – Gender Equity – Rights of Ethnic refugees – Problems and remedies – Role of trade union in protecting the unorganized labourers.

UNIT V Grievance and Redressal Mechanism: 6 Hrs

Redressal Mechanism at national level – Structure and functions of National and State level human Rights Commission – constitutional remedies and directive principles of state policy.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Teaching of Human Rights	Barat Sergio and Swaronjali Ghosh	Dominant Publishers and distributors, New Delhi	2009
2.	Human Rights Achievements and Challenges	Roy A.N	Vista International Publishing House, Delhi	2005
3.	Human Rights in India	Asish Kumar das and Prasant KumarMonaty	Sarup and Sons, New Delhi	2007
4.	Human Rights Social justice and political change	Bani Bargohain	Kanishka publishers and distributors, New Delhi	2007
5.	Human Rights and Development Issues	Velan G,	Ambala Cantt	2008
6.	Human rights Theory and Practice	Meena P K	Murali Lal and Sons, New Delhi	2008
7.	Human Rights Development and Environmental Law	Bhavani Prasad Panda	Academic Excellence, Delhi.	2007

8.	Human Rights – Twenty first Century Challenges	Vishvanathan V N	Kalpaz Publications, New Delhi.	2008
9.	Protecting Human Rights	Ansari M.R	Max Ford Books, New Delhi.	2006

Mapping with Programme-Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	S	S	S	S
CO3	M	M	S	S	M
CO4	S	M	S	M	M
CO5	M	S	M	S	S

S- Strong; **M**-Medium.

SEMESTER - III

Core Course - VII	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT07	**BIOINFORMATICS**	**Contact Hours Per Week: 6**

Objectives

- To understand the creation and development of databases, software, computational, statistical techniques and also solving problems generated from the management and analysis of biological data.
- To understand the network behaviour of the biological system and in particular their dynamic aspects, which requires the utilization of mathematical modelling tightly linked to the experiment

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.	K1
CO2	Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics.	K2
CO3	Explain about the methods to characterize and manage the different types of Biological data.	K3
CO4	Classify different types of Biological Databases.	K4
CO5	Introduction to the basics of sequence alignment and analysis	K5

UNIT I **18 Hrs**

Database concepts, Introduction to internet and its application, Introduction to bioinformatics, Protein and nucleotide databases, Information retrieval from biological databases, Sequence alignment and database searching-similarity searches using BLAST and FASTA. Big data analysis - DNA/RNA/protein sequence or structure data, gene expression data, protein-protein interaction (PPI) data, pathway data and gene ontology (GO) data.

UNIT II **18 Hrs**

Sequence alignment basics, match, mismatch, similarity, scoring an alignment, gap penalty, protein vs DNA alignments, Dot-matrix alignment, pairwise alignment. Global and local alignment algorithms, multiple sequence alignment-progressive alignment and Iterative alignment algorithms, consensus sequence, patterns and profiles, Database searching: Pairwise alignment based rigorous algorithm (Smith and Waterman).

UNIT III **18 Hrs**

Bioinformatics for genome sequencing, EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation, Protein structure-X-ray crystallography, The protein databank and the PDBSum-SCOP, CATH, DALI and HSSP ;Visualization of molecular structures - RasMol and Pymol; Protein secondary structure prediction.

UNIT IV **18 Hrs**

Molecular visualization tools. Rasmol, Chime and Spdb viewer. Structure analysis tools. VAST and DALI, Structural biology - Homology modeling, Bioinformatics for micro array designing and transcriptional profiling, Bioinformatics for metabolic reconstruction, Bioinformatics for phylogenetic analysis.

UNIT V **18 Hrs**

Medical application of Bioinformatics. Disease genes, Drug Discovery. History. Steps in drug discovery. Target Identification. Target Validation. QSAR. Lead Identification. Preclinical pharmacology and toxicology. ADME. Drug designing. Rational drug design. Computer aided drug design. Ligand based approach. Target based approach.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Bioinformatics: Sequence and Databanks	Des Higgins Ed. Ed.; Willie Taylor	Oxford University Press	2000
2.	Bioinformatics A Primer	Narayanan P	Newage International	2006
3.	Introduction to Bioinformatics	Arthur M. Lesk	Oxford University Press	2019
4.	Genomic and Proteomic Techniques	DassanayakeS. Ranil, Y.I.N. Silva Gunawardene	Narosa Publishing House Pvt. Ltd, New Delhi	2011
5.	Computational Biology	Thiagarajan B, Rajalakshmi. P.A.,	MJP publishers, Chennai.	2009
6.	Bioinformatics Databases, Tools and Algorithms	Bosu Orpita, Simminder Kaur Thukral	Oxford University press, New Delhi	2007

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Bioinformatics methods and applications	Rastogi .S.C, Mendiratta .N, Rastogi .P	Prentice-Hall of India private limited, New Delhi	2004
2.	Bioinformatics	Lohar s. Prakash	MJP Publishers, Chennai.	2009
3.	Bioinformatics methods and protocols	Stephen Misener and Stephen A. Krawetz	Humana press Inc, New Jersey	2000
4.	Biological sequence analysis	Durbin .R, S. Eddy, A. Krogh and G. Mitchison	Cambridge university press, Cambridge.	1998

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	M
CO3	S	M	S	S	S
CO4	S	M	M	M	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium

SEMESTER - III

Core Course - VIII	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT08	**IMMUNOLOGY**	**Contact Hours Per Week: 6**

Objectives

- To impart the principles and applications of immunology and immunotechnology.
- To understand the basic elements of immunology.
- To increase knowledge about the basics of the immune system and immune responses.
- To acquire basic knowledge on immunosuppression and modulation.

Course outcomes

At the end of the Course, the Student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Illustrate various mechanisms that regulate immune responses and maintain tolerance	K1
CO2	Describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses	K2
CO3	Learn the concepts of cellular and molecular processes that represents the human immune system.	K3
CO4	Elucidate the role of immunological regulation and tolerance at a cellular and molecular level	K4
CO5	Compile concepts on immunological principles and diagnosis	K5

UNIT I **18 Hrs**

History and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Physiology of immune response: HI and CMI specificity and memory. Cells and organs of the immune system. Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes.

UNIT II **18 Hrs**

Lymphocyte-sub-populations of mouse and man. APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvents. Immunoglobulins - structure, distribution and function. Immunoglobulin super family Isotypic, Allotypic and Idiotypic variants, generation of antibody diversity.

UNIT III **18 Hrs**

Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, structure and function of class I and class II MHC molecules. MHC antigens in transplantation and HLA tissue typing. Transplantation immunology - immunological basis of graft rejection, clinical transplantation and Immunosuppressive therapy. Tumour Immunology - Tumour antigen, Immune response to tumours.

UNIT IV **18 Hrs**

Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins.

UNIT V **18 Hrs**

Immunotechniques - Principle and Applications: Immuno diffusion, Immuno fluorescence, *In-situ* localization technique - FISH and GISH. RIA and ELISA, FACS, Western blot, ELISPOT assay. Agglutination tests. VDRL test. Purification of antibodies, Quantitation of immunoglobulin by RID, EID and nephelometry, CMI techniques and Immunotherapy.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Principles of Cellular and Molecular Immunology	Jonathan M. Austyn	Oxford & IBH	1993
2.	Kuby's Immunology	Goldsby R A et al.	W.H. Freeman & CO	2006
3.	Immunology and Immunotechnology	Rajasekara Pandian M, Senthilkumar Balakrishnan	Panima Publishing Corporation, New Delhi, India	2007
4.	Roitt. S Essential Immunology	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt	Wiley-Blackwell. USA 12 edition	2011
5.	Immunology	Kannan. I.,	MJP Publishers, Chennai	2010
6.	Cellular and Molecular Immunology	Abbas, A.K., A.H.L. Lichtman and S.Pillai	Saunders Elsevier Publications, Philadelphia 6th Edition	2010

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1	Seemi Garhat Bashir	Text Book of Immunology	PHI Learning Pvt. Ltd. New Delhi	2009
2.	Nandini Shetty	Immunology: introductory textbook - I	New Age International, New Delhi	1996

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	S
CO3	S	M	S	S	M
CO4	S	M	M	M	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium

SEMESTER - III

Core Course - IX	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT09	**BIOPROCESS TECHNOLOGY**	**Contact Hours Per Week: 6**

Objectives

- To provide insight knowledge on wide-ranging topics related to bioprocess technology and its applications.
- To give an idea about the avenues of improving the trait of microbes and study the downstream processes for product recovery in fermentation.
- To create adequate industrial knowledge and skills.

Course outcomes

At the end of the Course, the Student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Outline the basis of Bioprocess Engineering	K1
CO2	Relate reactors in fermentation	K2
CO3	Differentiate fermentation processes	K3
CO4	Assess Scale up and Scale down	K4
CO5	Compile the output of fermentation processes	K5

UNIT I **18 Hrs**

Introduction to fermentation. General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes.

UNIT II **18 Hrs**

Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermenters, body construction. Isolation and improvement of Industrially important Microorganisms, Media for Industrial fermentation and Sterilization. Production of citric acid, penicillin and insulin.

UNIT III **18 Hrs**

Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration: Principles, Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid-liquid extraction, aqueous two-phase extraction, supercritical fluid extraction.

UNIT IV **18 Hrs**

Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying. Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing.

UNIT V **18 Hrs**

Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites, Effluent Treatment and Fermentation Economics.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Bioprocess Engineering Basic Concepts	Michael L. Shuler	Prentice Hall of India	**2015**
2.	Bioprocess Engineering Principles	Pauline M. Doran	Academic Press	**2015**
3.	Industrial Microbiology	Patel A.H	Macmillan	2011
4.	Industrial Microbiology	Presscott; Dunn's	CBS Publisher	2005
5.	Bioprocess Sciences and Technology	Min-tzeLiong	Nova Science Pub Inc.	2011
6.	Bioprocess Engineering	Michael L. Shuler, Fikret Kargi	PHI publishers	2003

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1	Bioseparation: Downstream Processing for Biotechnology	P.A. Belter, E.L. Cursler, and W.S. Hu	John Wiley and Sons	1988
2.	Bioseparation Science and Engineering	R.G. Harrison, P.Todd, SR. Rudge and D.P. Petrides.	Oxford Press	2003

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	M
CO3	S	M	S	S	S
CO4	S	M	M	M	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium

SEMESTER III

Core Practical - III	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBTP03	**PRACTICAL - III - BIOINFORMATICS, IMMUNOLOGY & BIOPROCESS TECHNOLOGY**	**Contact Hours Per Week: 4**

Objectives

- To establish a study skill on the subject and will improve the student's ability to have hands-on experience on the above core subjects.
- To get training in basic genetic engineering techniques which are essential for them to enrich their technical skills.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn the Bioinformatics tools for sequence retrieval and alignment	K3
CO2	Apply the learned tools for various applications	K3
CO3	Isolate, identify and enumerate immune cells	K4
CO4	Learn the technique of immunodiagnostics	K4
CO5	Study upstream and downstream techniques	K4

(A) Bioinformatics - Practical

1. Sequence retrieval from Genbank.
2. Sequence identity search - Sequence similarity search using BLAST.
3. Sequence similarity search using FASTA.
4. Sequence similarity search using PSI BLAST.
5. ORF gene Search – Genscan.
6. Sequence translation using ExPASy translate tool.
7. Multiple sequence alignment using EBI-CLUSTALW2.
8. PHYLOGENY - Phylogenetic tree.
9. Prediction of tertiary protein structure using SWISS-MODEL server.
10. Validation of the predicted structure using PROCHECK server.
11. Molecular visualization of proteins using RASMOL.
12. Docking of small molecule with protein structure using LeadIT software.

(B) Immunology - Practical

1. Identification of various immune cells from human peripheral blood.
2. Lymphocyte separation and identification by trypan blue method.
3. WBC counting.
4. Preparation of serum and plasma.
5. Preparation of cellular antigen – human RBC.
6. Preparation of antigen-adjuvent mixture for production of polyclonal antibody.
7. Isolation of IgG molecule from serum.
8. Immunodiagnostics: CRP, ASO, WIDAL, RA, Blood grouping and typing, hCG.
9. ELISA.
10. Radial Immunodiffusion.
11. Ouchterlony Immunodiffusion.
12. Immunoelectrophoresis.
13. Rocket electrophoresis.
14. Counter current immunoelectrophoretic.
15. Radioimmuno assay (Demonstration).

(C) Bioprocess Technology - Practical

1. Parts and design of fermenter.
2. Solid state fermentation.
3. Submerged fermentation.
4. Foaming and antifoaming agents.
5. Media preparation and sterilization.
6. Isolation of industrially important microorganisms for microbial processes.
7. Conservation of Bacteria by Lyophilization.
8. Production and estimation of protease.
9. Production and estimation of amylase.
10. Production of wine using grapes.
11. Production and determination of penicillin activity
12. Citric acid production.
13. Use of alginate for cell immobilization.
14. Media standardization (C:N ratio) for maximum biomass production of an industrially important microorganism.
15. Cell disruption (Sonication).

SEMESTER - III

Elective - IV	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE05	**ELECTIVE - IV - NANO BIOTECHNOLOGY**	**Contact Hours Per Week: 4**

Objectives

- To understand the methods of nanoparticles preparation, characterization and its applications in various fields of science for the welfare of humans as well as for the environment.
- To provide an insight into the fundamentals of nanotechnology in biological and biomedical research.
- To understand the mechanistic role of nanoparticles in biological systems.

Course outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the bases for Introduction to Nanotechnology	K1
CO2	Impart understanding on Nanoparticle based Drug Delivery.	K2
CO3	Fabrication of nanomaterials for bone tissue grafting	K3
CO4	Methods of Nanofabrication	K4
CO5	Understand the application of Nanotechnology	K5

UNIT I **12 Hrs**

Introduction to Nanotechnology - Scientific revolution, Feynman's vision, Classification of nanobiomaterials - Types of nanomaterials – nanoparticles, nanotubes, nanowires, Nanofibers, Size deoendent variation in the properties of Nanomaterials, Nature's Nanophenomena.

UNIT II **12 Hrs**

Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nanobiomaterials - Polymer, Ceramic, Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Quantum dots, Magnetic Nanoparticles, Nanofibres, Hydrogels, Films and Scaffolds.

UNIT III **12 Hrs**

Application of Nanomaterials in Bone substitutes and Dentistry, Food and Cosmetic applications, Bio-sensors and Lab-on-a-chip, Bio-devices and implantable devices, Bioremediation, Nanomaterials for anti-microbial coating – medical implants and paints, Application of Nanotechnology in textile industry.

UNIT IV **12 Hrs**

Nanomaterials for diagnosis and therapy, Implications of drug delivery, Nano-carriers for application in medicine, polymeric nanoparticles as drug carriers, Drug release mechanism, Targeted Drug Delivery using nanocarriers, Nanoparticle technologies for cancer therapy and diagnosis, Point of Care and Personalized medicine, Magnetic nanoparticles for imaging and Hyperthermia.

UNIT V **12 Hrs**

Nanotoxicology, Portals of Entry of the nanoparticles into the Human Body, Bio-toxicity of Nanoparticles, Nanoparticles in Mammalian systems and Health threats, Biological response and cellular interaction of implant materials and scaffolds, Risk assessment and Safety Regulation of nanoparticles.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Nanotechnology	Mark Ratner; Danil Ratner	Pearson Education	2002
2.	Nanotechnology	S. Shanmugam	MJP publication	2011
3.	Advanced nanomaterials	Kurt E. Geckeler, Hiroyuki Nishide	Wiley VHC	2010

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1	Nanotechnology and tissue engineering	T. Laurencin, Lakshmi S. Nair	CRC press	2012
2.	Handbook of carbon nanomaterials	Francis D Souza, Karl M. Kadish	World scientific publishing co. pte. Ltd	2011

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	M
CO3	S	M	S	S	S
CO4	S	M	M	M	M
CO5	S	M	S	M	M

S- Strong; **M**-Medium

SEMESTER - III

Elective - IV	M.Sc. Biotechnology	Credits:3
Course Code: M23PBTE06	**ELECTIVE - IV - MOLECULAR DEVELOPMENTAL BIOLOGY**	**Contact Hours Per Week: 4**

Objectives

- To provide a broad, comprehensive look at embryology with special emphasis on vertebrate models, focusing on both classical experiments and modern molecular and genetic techniques.
- To understand the mechanisms involved in growth and development of complex organisms.
- To enable the students to learn the actual pathway of physiological metabolism of major invertebrates and vertebrates including humans.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Illustrate the structure and function of developmental biology, Gametogenesis	K1
CO2	Discuss basic fertilization process of animals	K2
CO3	Demonstrate the functions of embryonic development process	K3
CO4	Illustrate the organ development of vertebrate animals	K4
CO5	Demonstrate the impact of gene in developmental biology and developmental disorders	K5

UNIT I **12 Hrs**

Definition and scope of developmental biology. Gametogenesis - Spermatogenesis and Oogenesis. Structure of Sperm and oocyte. Instructive and permissive interactions, competence, epithelial - mesenchymal interactions. Important signaling pathways in vertebrate development.

UNIT II **12 Hrs**

Fertilization - Definition, mechanism of fertilization in mammal & sea urchin. Types of fertilization. Nieuwkoop center, Molecular role of organizer.

UNIT III **12 Hrs**

Cleavage in Xenopus, Chick and mammals, Regulation of cleavage cycle. Morphogenetic movements, Gastrulation in Xenopus, Chick and mammals. Fate Maps.

UNIT IV **12 Hrs**

Vertebrate Development: Formation of the neural tube, myogenesis, and hematopoiesis. Mechanism of vertebrate eye development.

UNIT V **12 Hrs**

Drosophila Maternal effect genes, induction at single cell level - differentiation of photoreceptors in ommatidia. Developmental disorders Spina bifida, Anenecephaly, and craniorachischis, Cyclopia, Thanotrophic dysplasia.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Developmental Biology	Scott F Gilbert	Sunderland (MA)	2000
2.	Principles of Development	Lewis Wolpert; Rosa Beddington	Oxford University Press	2001
3.	Developmental Biology	Scott F. Gilbert	Sinauer Associates Inc. 9th Edition	2010

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Developmental Biology	Subramoniam, T.	Narosa publications 1st Edition	2002
2.	Developmental Biology	Richard M. Twynman	Viva Publications, New Delhi, 2nd Edition	2001

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	M	S	M	S
CO3	S	M	S	S	S
CO4	S	M	M	S	S
CO5	S	M	S	S	M

S- Strong; **M**-Medium

SEMESTER - III

SEC - III	M.Sc. Biotechnology	Credits: 2
Course Code: M23PBTS03	SEC – III - DIAGNOSTIC BIOTECHNOLOGY	Contact Hours Per Week: 3

Objectives

- To understand the molecular techniques and utilizing these techniques in diagnosis.
- To develop skills by understanding technical details of the assays to be applied for developing novel tests for improved diagnosis.

Course Outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understanding of disease types and their diagnosis. Obtain knowledge about ethical and regulatory aspects of conducting diagnostic tests	K1
CO2	Learn the technical aspects of various diagnostic methods which will help in application of these techniques to design and develop new clinical tests.	K2
CO3	Understand the uniqueness and pitfalls of biological assays to analyse and apply them to develop clinical tests.	K3
CO4	Develop skills to interpret the results of molecular techniques when performing them practically	K4
CO5	Know about how important diseases are diagnosed using molecular diagnostic methods.	K5

UNIT I **9 Hrs**

Definition - History – Diseases- infectious, physiological and metabolic errors, and inherited diseases. Biomarkers- types, potential uses and limitations. Diagnostics – types and importance in clinical decision making. Benefits of molecular diagnostics over conventional diagnostics. Ethical issues related to molecular diagnostics. Clinical specimens: National and International guidelines for Sample collection - method of collection, transport and processing of samples, Personal safety and laboratory safety.

UNIT II **9 Hrs**

PCR based assays: Real-time PCR, ARMS, allele specific, multiplex, methylation analysis, MLPA, single-stranded conformational polymorphism analysis, heteroduplex analysis, competitive oligonucleotide priming, DHPLC, DGGE, CSCE. Micro arrays: SNP chromosomal microarrays, EST.

UNIT III **9 Hrs**

Major Histocompatibility Complex (MHC), HLA typing RFLP, PCR based methods, SSO, SSP and SBT methods. Role of Molecular diagnostics in bone marrow transplantation and organ transplantation. Bone marrow transplant engraftment analysis. Diagnosis of inherited diseases - Thalassemia, Cystic Fibrosis. Neonatal and Prenatal disease diagnostics- Prenatal and preimplantation diagnosis. Noninvasive: Triple test, Ultrasonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling.

UNIT IV **9 Hrs**

Molecular oncology testing in malignant disease - Acute and Chronic leukemias, Melanoma, colon, lung and breast cancers. Circulating tumour cell testing (CTC). Molecular diagnosis of various viral diseases: Dengue, Chikungunya and SARS. Direct detection and identification of pathogenic organisms that are slow growing or currently lacking a system of *in vitro* cultivation as well as genotypic markers of microbial resistance to specific antibiotics - 16s rRNA typing.

UNIT V **9 Hrs**

Serology – Antigen - antibody reactions – Agglutinations (blood grouping, WIDAL) Hemagglutination, Precipitation (VDRL), Complementation fixation test, Immunodiffusion, Immunoelectrophoretic (rocket, counter current). ELISA, RIA. Quantitative study of Antigen - Antibody precipitin reactions, Western blot analysis for HIV.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Clinical Biochemistry	Smith A.F; Beckett G.J	Blackwell	1993
2.	Enzymes - Biochemistry, Biotechnology, Clinical Chemistry	Trevor Palmer	Eastwest	2008
3.	Tietz textbook of clinical chemistry and molecular diagnostics	Carl Burtis, Edward Ashwood, David Bruns	Elsevier Press, 5th Edition	2012
4.	Molecular Diagnostics	George Patrinos Wilhelm Ansorge Phillip B. Danielson	Academic Press, 3rd Edition	2016

REFERENCE BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Medical Microbiology	Jawetz, Melnick and Adelberg's,	Mc Graw Hill, 23rd Edition	2004
2.	Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications	Lela Buckingham	FA Davis Publishers	2011

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	S
CO3	S	M	S	S	S
CO4	S	M	M	M	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium

INTERNSHIP

Internship	M.Sc. Biotechnology	Credits: 2
Course Code: M23PBTIS01	INTERNSHIP	Contact Hours Per Week: -

Objectives

- To gain hands on training and expertise in handling sophisticated instruments and acquire in depth knowledge in their applications.

Course Outcomes

The student will learn to

CO Number	CO Statement	Knowledge Level
CO1	Understand working principles and the techniques of various processes	K2
CO2	Apply standard operating procedures followed in industries	K3
CO3	Prepare to face challenges & gain confidence in the field of study.	K3
CO4	Critically assess the utilization of sophisticated instruments and expensive consumables	K5
CO5	Develop work ethics to be followed in a scientific laboratory	K5

SEMESTER – IV

Core Course - X	M.Sc. Biotechnology	Credits: 4
Course Code: M23PBT10	RESEARCH METHODOLOGY	Contact Hours Per Week: 6

Objectives

- To impart the essential components of research and tools involved in data analysis
- To understand the core concepts of methodologies & ethics to pursue research.
- To understand the ways to present the research in readable form.

Course outcomes

At the end of the Course, the Student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the bases for research	K1
CO2	Know about research proposal and dissertation writing.	K2
CO3	Know about Statistical application in research	K3
CO4	Know about office tools used in research	K4
CO5	Know about search engines.	K3

UNIT I **18 Hrs**

Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals.

UNIT II **18 Hrs**

Review of literature, Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography.

UNIT III **18 Hrs**

Standard Deviation- T test. Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking. Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two-factor factorial design.

UNIT IV **18 Hrs**

Spreadsheet Tool: Introduction to spreadsheet application, features and functions using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Presentation Tool: Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool.

UNIT V **18 Hrs**

Web Search: Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo, Pubmed, Science direct, Scopus etc, and Using advanced search techniques.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Design and Analysis of Experiments	Montgomery, Douglas C.	Wiley India, 5th edition	2007
2.	Applied Statistics and Probability for Engineers	Montgomery, Douglas C. and Runger, George C.	Wiley India, 3rd edition	2007

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Research Methodology- Methods and Techniques	Kothari C.K.	New Age International, New Delhi, 2 edition	2004
2.	Management Research Methodology; Integration of Principles, Methods and Techniques	Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M.	Pearson Education, New Delhi	2006

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	M
CO3	S	M	S	S	S
CO4	S	M	M	M	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium

SEMESTER – IV

Elective - V	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE07	**ELECTIVE - V - STEM CELL BIOLOGY**	**Contact Hours Per Week: 5**

Objectives

- To provide students with knowledge of wide-ranging topics related to stem cells, regenerative medicine and tissue engineering.
- To study the current scenario of tissue engineering applications in bioartificial organs development and transplantation.

Course Outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the major discoveries of stem cell biology	K1
CO2	Provide basic knowledge about stem cell niche and functions	K2
CO3	Enlighten the students on stem cell isolation and culture techniques	K3
CO4	Update the knowledge on stem cell cycle	K4
CO5	Assess and appraise applications of embryonic stem cells.	K5

UNIT I **15 Hrs**

Stem cells - Definition, characterization, pluripotency, self-renewal and differentiation. Types of stem cells- Embryonic stem cells, adult stem cells and mesenchymal stem cells, adipose stem cells.

UNIT II **15 Hrs**

Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells.

UNIT III **15 Hrs**

Stem cell isolation and culture techniques. Characterization of stem cells.

UNIT IV **15 Hrs**

Stem cell cycle. Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation. JAK -STAT pathway, Ras\Raf pathway, PI3K cell signaling, p53 check points, Role of LIF pathway in cell cycle control.

UNIT V **15 Hrs**

Applications of embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Stem Cells	Potten.C.S	Academic Press	2002

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Stem Cell Biology and Gene Therapy	Quesenberry PJ, Stein GS	Wiley	1998
2.	Stem Cells Handbook	Stewart Sell	Humana Press; Totowa NJ, USA	2003

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M
CO2	M	M	S	S	M
CO3	S	M	S	S	S
CO4	S	M	M	M	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium.

SEMESTER – IV

Elective: V	M.Sc. Biotechnology	Credits: 3
Course Code: M23PBTE08	**ELECTIVE - V - BIOETHICS, BIOSAFETY, CLINICAL TRIALS, IPR AND ENTREPRENEURSHIP**	**Contact Hours Per Week: 5**

Objectives

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development.
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.
- To become familiar with ethical issues in biological research.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the basics of biosafety and bioethics and its impact on biological sciences and the importance of human life.	K1
CO2	Apply the knowledge to recognize the importance of biosafety guidelines and good clinical practices.	K2
CO3	Acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.	K3
CO4	Evaluate the benefits of GM technology and importance of IPR	K4
CO5	Analyze the importance of protection of new knowledge and innovations and its role in business and entrepreneurship	K5

UNIT I **15 Hrs**

Introduction to Bioethics Need for bioethics in social and cultural issues. Bioethics & GMO's Issues and concerns pertaining to genetically modified foods & food crops, Organisms and their possible health implications and mixing up

with the gene-pool. Bioethics in medicine protocols of ethical concerns related to prenatal diagnosis, gene therapy, Organ transplantation, Xenotransplantation, Containment facilities for genetic engineering experiments, regulations on field experiments and release of GMO`s labeling of GM foods.

UNIT II **15 Hrs**

Clinical trials – Regulations. Bioethics and cloning permissions and procedures in animal cloning, Human cloning, Risks and hopes. Bioethics in Research Stem cell research, Human Genome Project, Use of animals in research, human volunteers for clinical research, Studies on ethnic races. Ethics in patient care, Informed consent.

UNIT III **15 Hrs**

Biosafety – Biological risk assessment. Biological agents and hazard groups. Criteria in biological risk assessment. Guidelines for categorization of genetically modified plants for field test. Regulation, national and international guidelines of biosafety, rDNA guidelines, Regulatory requirements for drugs and Biologics GLP. Biosafety levels, Safety equipment and biological safety cabinets.

UNIT IV **15 Hrs**

IPR: Introduction to Intellectual Property rights, Patenting – Factors for patentability – Novelty, Non-obviousness, marketability. Procedures for registration of patents. Copyright works, ownership, transfer and duration of Copyright. Renewal and termination of copyright. Industrial Designs - Need for protection of industrial designs. Procedure for obtaining design protection. Infringement, right of goodwill, Passing Off. Trademarks - Introduction to Trademarks. Need for protection of trademarks. Classification of trademarks. Indian trademarks law. Procedural requirements of protection of trademarks.

UNIT V **15 Hrs**

Geographical Indications - Indication of source and geographical indication. Procedure for registration, duration of protection and renewal. infringement, penalties and remedies. Layout- designs of integrated circuits: Conditions and procedure for registration. Duration and effect of registration protection of plant variety and plant breeders' rights in India. Protection of traditional knowledge, Bioprospecting and biopiracy. India's new IP Policy (2016), Govt of India's steps to promote IPR. Career opportunities in IP. Entrepreneurship: Definition and importance, characteristics and functions of an entrepreneur.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Bioethics & Biosafety	Sateesh MK	IK International publications	2008
2.	Intellectual Property Rights	Ganguli P	Tata Mcgraw Hill	2001
3.	Issues of Intellectual Property Rights	Ramesh Chandra	Isha Books	2004
4.	Intellectual Property Rights in Agricultural Biotechnology	Erbisch F.h., Maredia K.M	Universities Press	2000

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Law of Intellectual Property Rights	Shiv Sahai Singh	Deep & Deep Publications (p) Ltd	2004
2.	Intellectual Property Rights, Innovation and Software Technologies	Elad Harison	Edward Elgar Publishing Limited, UK	2008
3.	Intellectual Property Rights: Heritage, Science and Society Int. Treaties	Subbian A, Bhaskaran S	Deep & Deep Publications	2007

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	M	S	M	S
CO3	S	M	S	M	S
CO4	S	M	M	S	M
CO5	S	M	S	M	M

S- Strong; **M**-Medium

SEMESTER - IV

SEC - IV	M.Sc. Biotechnology	Credits: 2
Course Code: M23PBTS04	**SEC - IV - PHARMACOPHORE ANALYSIS**	**Contact Hours Per Week: 4**

Course Objectives

- To understand the basics of bioinformatics, chemo-informatics and how useful for drug designing and discovery process.
- To understand the principle and applications of molecular docking and molecular dynamics simulation.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the chemistry of drugs with respect to their biological activity	K1
CO2	The Concept of QSAR and docking	K2
CO3	Various strategies to develop new drug like molecules	K3
CO4	The role of drug design in drug discovery process	K4
CO5	The design of new drug molecules using molecular modeling software	K5

UNIT I **12 Hrs**

Various approaches used in drug design. Physicochemical parameters used in quantitative structure activity relationship (QSAR) such as partition coefficient, Hammett‘s electronic parameter, Tafts steric parameter and Hansch analysis.

UNIT II **12 Hrs**

Quantitative Structure Activity Relationship (QSAR) Qualitative versus Quantitative SAR, Types of physicochemical parameters, Lipophilicity effects: Hansch equation, Electronic effects: Hammett equation, Steric effects: Taft equation. QSAR Methods: Hansch analysis and Free Wilson analysis. 3D-QSARapproaches like COMFA and COMSIA.

UNIT III **12 Hrs**

Pharmacophore modeling Concept of pharmacophore, pharmacophore mapping and pharmacophore-based screening. Analog based drug design: Bioisosterism-classification and bioisosteric replacement.

UNIT IV **12 Hrs**

Molecular Modeling: Introduction to molecular modeling - Molecular mechanics - Introduction, force field, potential free energy surface, energy minimization methods, global and local energy minimum conformations. Molecular docking - Rigid, semi-flexible and flexible docking, Docking components: Binding site identification, search algorithms, scoring functions and binding free energy.

UNIT V **12 Hrs**

Introduction to bioinformatics, chemoinformatics. ADME databases, chemical, biochemical and pharmaceutical databases.

TEXT BOOKS

S. No.	Title of the Book	Author	Publishers	Year
1.	Pharmaceutical Biotechnology	Purohit S S; Kakrani H.N; Saluja A.K	Agrobios (India)	2021
2.	Text Book of Drug Design and Discovery	Povl Krogsgaard-Larson; Tommy Liljefors; ULF Medsen	Taylor Francis	2002
3.	Chemical Applications of Molecular modeling	Goodman JM	Royal Society of Chemistry, Cambridge, UK.	1998

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Introduction to the principles of Drug Design	Smith HJ., Williams H	CRC Press, Boston	1998
2.	Molecular Modelling in Drug Design	Cohen C.	Academic Press, New York	1996

Mapping with Programme Specific Outcomes

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	S
CO2	M	M	S	S	S
CO3	S	M	S	S	M
CO4	S	M	M	M	M
CO5	S	M	S	M	S

S- Strong; **M**-Medium

SEMESTER - IV

Project	M.Sc. Biotechnology	Credits: 6
Course Code: M23PBTPR1	**PROJECT**	**Contact Hours Per Week: 15**

Objectives

To imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of pursuing research.

SEMESTER - II

EDC - I	Other Department	Credits: 4
Course Code: M23PBTED1	**EDC - I - AGROBIOTECHNOLOGY**	**Contact Hours Per Week: 4**

Course Objectives

- To emphasis on development of entrepreneurial potential and skills amongst the students in agricultural biotechnology.

Course Outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	State the vermicomposting, humus feeders, humus formers, types of earthworm, bio-fertilizers, bio-stimulants, chemical fertilizers, forming types, pesticides, bio-magnification and organic farming.	K1
CO2	Understand the knowledge of biofertilizer production and its uses.	K2
CO3	Make knowledgeable and learn about chemical fertilizers of merits and demerits	K3
CO4	Understand the significance of management of pests and diseases.	K4
CO5	Knowledge about farm implementation, economic importance of vermicomposting.	K5

UNIT I **12 Hrs**

Vermicomposting - Definition, introduction and scope: Ecological classification: Humus feeders, Humus formers, Useful, local and exotic species of earthworms, Vermicomposting - Methods - Advantages -Nutritional Composition of Vermicompost.

UNIT II **12 Hrs**

Bio-fertilizers: Introduction, Nitrogen fixing Bacteria, mycorrizha and phosphate solubilizing Bacteria. Types of organic manure-Green manure, farm yard manure, farm compost, urban waste compost, rural waste compost. Bio-stimulants: Humic acid, fulfic acid, algenic acid, protein hydrolysate, panchagavya and vitamins.

UNIT III **12 Hrs**

Chemical Fertilizers: Chemical fertilizers and their impact on environment. Pollution of soil, surface and ground water due to over use of fertilizers and remedial measures. Vertical farming and urban farming – Hydrophonics, aquaphonics and aerophonics. Terrace garden Water less agriculture.

UNIT IV **12 Hrs**

Pesticides: Introduction, relevance in management of pests and diseases, ill-effects with particular reference to bio-magnification and other environmental hazards. Insects repellents: Soil nematode: issues and control / Management system.

UNIT V **12 Hrs**

Organic Farming: Economics of Farming: Economics and basic knowledge of farm implements - ploughs, spray pumps, tractors. Harvesters and thrashers – harvest combines, reapers, chaff cutters, sugarcane crushers.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Biology and Ecology of Tropical Earthworms	Priyasankar Chaudhuri Satyendra M Singh	Discovery Publishing House Pvt Ltd	2014
2.	Agroecology: The Science of Sustainable Agriculture	Altieri, M.	CRC Press	2018
3.	Sustainability through organic farming.	Joshi, M., Setty, T.K.P. and Prabhakarasetty	Kalyani Publishers	2006
4.	Handbook on Herbicides	Daiki Kobayashi Eito watanabe	Nova Science Publishers	2013
5.	Principles of Agronomy.	Reddy, T. Y. and Reddy, G.H. S	Kalyani Publishers.	2013

REFERENCE BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Organic Agriculture	Kristensen, P., Taji, A. and Reganold, J.	A Global Perspective. CSIRO Press	2006
2.	Handbook of Agricultural Sciences	Singh, S.S., Gupta. P. and Gupta, A.K	Kalyani Publishers, New Delhi	2004
3.	Agricultural Biotechnology	H.D. Kumar	Daya Publishing House	2005
4.	Agricultural Biotechnology	S Geetha, S Jebaraj and P Pandiyarajan	Agrobios	2008
5.	Principles of Organic Farming	D. Udhaya Nandhini, E. Somasundaram, and M. Meyyappan	New India Publishing Agency	2019
6.	Pesticides, Insecticides, Fungicides and herbicieds	H. Panda	National Institute of Industrial Research	2003

Mapping with Programme Specific Outcomes

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	S	M	M
CO2	M	M	M	S	S
CO3	S	S	M	M	S
CO4	S	M	S	S	M
CO5	S	S	S	M	S

S- Strong; **M**-Medium

SEMESTER - II

EDC - I	Other Department	Credits: 2
Course Code: M23PBTED2	EDC - I - HEALTH CARE AND ENVIRONMENTAL BIOTECHNOLOGY	Contact Hours Per Week: 4

Course Objectives

- To make the students understand public health and keep a healthy environment.

Course outcomes

At the end of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Define public health, epidemiology, Global warming, Acid rain, Pollution, Biosensor, Environmental monitoring, Bioremediation, Biodegradation, Xenobiotics and Wastewater treatment.	K1
CO2	Demonstrate the importance of public health and its problems, Concepts and uses of Epidemiology, Basic concepts and global issues, Biodegradation of xenobiotics and Wastewater treatment process	K2
CO3	Apply the knowledge about environment and health, types of epidemiology, bioremediation of environmental pollutants, phytoremediation and industrial effluent treatment methods	K3
CO4	Illustrate the health problems in India role of genetics in health and disease, pollution measurements, degradation process of hydrocarbon and physical, chemical and biological treatment processes.	K4
CO5	Assess the health problems in developed and developing countries, role of genetics in health and disease, environmental pollutants in soil and water-oils, heavy metals and detergents and explain the phytoremediation and treatment methods of sugar, distillery, dairy, tannery, and pharmaceutical industries.	K5

UNIT I **12 Hrs**

Introduction to Public Health Evolution of Public Health. Important Public Health Acts, Health problems of developed and developing countries, Health problems in India, Environment and Health.

UNIT II **12 Hrs**

Basic Epidemiology Definition and Concepts of Epidemiology, Concepts of Health and Disease. Role of Genetics in Health and Disease, Levels of Prevention, Types of Epidemiology, Uses of Epidemiology.

UNIT III **12 Hrs**

Basic concepts and global issues-Global warming & Acid rain. Pollution measurements- air and water. Biosensor in environmental monitoring. Bioremediation of environmental pollutants in soil and water- oils, heavy metals and detergents.

UNIT IV **12 Hrs**

Biodegradation of xenobiotics- Ecological considerations, decay behavior and degradative plasmids, hydrocarbon, hydrocarbon substitutes, pesticides and surfactants. Phytoremediation.

UNIT V **12 Hrs**

Air pollution and its control through biotechnology. Wastewater treatment: Physical, chemical and biological treatment processes. Various industrial effluent treatment methods- Sugar, distillery, dairy, tannery, and pharmaceutical industries.

TEXT BOOKS

S. No.	Title of the book	Author	Publishers	Year
1.	Environmental Science and Biotechnology: theory and Techniques	Murugesan AG and Rajakumari C.	MJP Publishers, 1st Edition	2019
2.	Environmental Biology	Matthew R. Fisher	Open Oregon Education publication	2021
3.	Ecology and Environment	Sharma PD	Rastogi Publications, 13th Edition	2017

REFERENCE BOOKS

S. No.	Title of the Book	Author	Publishers/ Edition	Year of Publication
1.	Environmental Biotechnology and cleaner Bioprocesses	Eugenia J. Olguin	Tayloir and Francis	2000
2.	Basic Concepts in Environmental Biotechnology	Neetu Sharma, Abhinashi Singh Sodhi, Navneet Batra	CRC Press	2021
3.	Introduction to Environmental Biotechnology	A. K. Chatterji	Kindle Edition, 3rd Edition	2011
4.	Environmental Biotechnology: Concepts and Applications	Hans-Joachim Jördening, Josef Winter	Wiley-VCH	2004
5.	Environmental Biotechnology	Alan Scragg	Oxford University Press, 2nd Edition	2005

Mapping with Programme Specific Outcomes

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S
CO2	S	S	S	S	M
CO3	S	S	M	S	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S-Strong; **M**-Medium