

# **MAHENDRA ARTS & SCIENCE COLLEGE (AUTONOMOUS)**

**(Affiliated to Periyar University, Salem)**

[Accredited by NAAC with “A++” Grade & Recognized u/s 2(f) and 12(B) of the UGC act1956]

**KALIPPATTI – 637501.**



**BACHELOR OF SCIENCE**

**SYLLABUS FOR B.Sc., BIOTECHNOLOGY**

**OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM**

**FOR THE STUDENTS ADMITTED FROM  
THE ACADEMIC YEAR 2023 – 2024 ONWARDS**

# MAHENDRA ARTS & S CIENCE COLLEGE

(Autonomous)

(Affiliated to Periyar University)

Department of Biotechnology

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

### I. PREAMBLE

The Biotechnology Programme has the linkage between basic and applied research and new discoveries and innovations can find direct applications in agriculture, human health and the environment. The breakthroughs in modern biotechnology mainly include our ability to produce useful organisms through genetic engineering and cell fusion techniques and improve bioprocess technology to purify novel molecules generated by such processes. It also involves drug targeting and the development of delivery systems and vaccines. Considering this background, the syllabus is formulated and focused on diverse areas from Cell Biology, Biochemistry, Immunology, Plant Biotechnology, Animal Biotechnology, Genetic Engineering and Bioinformatics with significant laboratory practices which will enable the students to have experience in doing experiments themselves.

### II. GRADUATE 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, and 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 empower students to excel in various research fields of Life Sciences
- ❖ To inculcate a sense of scientific responsibilities and social and environmental awareness
- ❖ To help students build up a progressive and successful career
- ❖ To contribute to the field of biotechnology and allied industries by designing, developing and providing solutions for product development

### IV. PROGRAMME OUTCOMES

- ❖ **PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study.
- ❖ **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
- ❖ **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.
- ❖ **PO4: Problem solving Capacity:** To extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.
- ❖ **PO5: Analytical reasoning:** Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

- ❖ **PO6: Research-related skills:** A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesizing and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.
- ❖ **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
- ❖ **PO8: Scientific reasoning:** Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
- ❖ **PO9: Reflective thinking:** Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.
- ❖ **PO10: Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

## **V. PROGRAMME SPECIFIC OUTCOMES**

On successful completion of Bachelor of Biotechnology programme, the student should be able to:

- ❖ **PSO1: Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to biotechnology. Also, exhibit proficiency in performing experiments in the laboratory.
- ❖ **PSO2: Critical Thinking:** Analyze complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively.
- ❖ **PSO3: Problem Solving:** Employ theoretical concepts and critical reasoning ability with physical, mathematical and technical skills to solve problems, acquire data, analyze their physical significance and explore new design possibilities.
- ❖ **PSO4: Analytical & Scientific Reasoning:** Apply scientific methods, collect and analyze data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models.

- ❖ **PSO5: Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects.
- ❖ **PSO6: Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through ongoing learning and professional development, and contribute to the growth and development of their field.

## **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 the Higher Secondary Examination of Tamil Nadu Higher secondary board or an examination of some other board accepted by the syndicate as equivalent there to with Biology and any one of the following subjects namely Physics, Chemistry, Maths, shall be eligible for admission into B.Sc., programme in Biotechnology.

### **2. Duration of the Programme:**

The programme of study for the Bachelor of Science in Biotechnology shall consist of three academic years divided into six semesters with 140 credits. The programme of study will comprise the course according to the syllabus.

### **3. Programme of Study:**

The programme of study for the UG degree has been divided into the following five categories:

- ❖ **Part I:** Tamil / Other Languages.
- ❖ **Part II:** English Language.
- ❖ **Part III:** Core Courses, Elective Courses: Generic, Discipline Specific.
- ❖ **Part IV:** Skill Enhancement Courses (NME), Skill Enhancement Courses, Foundation Course and Enhancement Compulsory Courses.
- ❖ **Part V:** Value-added Courses, Internship, Extension Activities, etc.

### **4. Extension Activity:**

Every student shall participate compulsorily for a period of not less than three years (6 semesters) in any one of the following programmes. NSS/Sports/YRC/Other Extra-curricular and Co-curricular activities

(Club/IIC/EDC). The student's performance shall be examined by the staff in charge of extension activities along with the Head of the respective department and a senior member of the Department on the following parameters.

- ❖ The marks shall be sent to the Controller of Examinations before the commencement of the final semester examinations.
- ❖ 20% of marks for Regularity of attendance.
- ❖ 60% of marks for Active Participation in classes/ camps/ games/ special Camps/ programmes in the college/ District/ State/ University activities.
- ❖ 10% of marks for Exemplary awards/ Certificates/ Prizes.
- ❖ 10% of marks for Other Social components such as Blood Donations, Fine Arts.
- ❖ The above activities shall be conducted outside the regular working hours of the college. The mark sheet shall carry the gradation relevant to the marks awarded to the candidates.

A - Exemplary - 80 and above

B - Very good - 70-79

C - Good - 60-69

D - Fair - 50-59

E - Satisfactory - 40 – 49

This grading shall be incorporated in the mark sheet to be issued at the end of the semester. (Handicapped students who are unable to participate in any of the above activities shall be required to take a test in the theoretical aspects of any one of the above fields and be graded and certified accordingly).

## **5. Examinations:**

The programme of study shall be based on a semester pattern with Internal Assessment under a 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 subject(s) will be permitted to reappear for the same in the subsequent semester examinations.

## VII. STRUCTURE OF THE PROGRAMME

### SEMESTER – I

Part	Course category	Title of the course	Course code	Hrs/Week		Credits	Int. Marks	Ext. Marks	Total
				L	P				
I	Language - I	Tamil – I	M23UFTA01	6	-	3	25	75	100
II	Language-II	English - I	M23UFEN01	6	-	3	25	75	100
III	Core Course	Core Course-I Cell and Molecular Developmental Biology	M23UBT01	5	-	4	25	75	100
	Generic Elective	Generic Elective - I - Biological Chemistry	M23UBTGE1	3	-	3	25	75	100
	Core Practical	Core Practical - I Cell and Molecular Developmental Biology	M23UBTP01	-	3	3	40	60	100
	Generic Elective Practical	Generic Elective Practical- I Biological chemistry and Fundamentals of Microbiology	M23UBTGEP1	-	3	-	-	-	-
IV	*Skill Enhancement Course (SEC-I) (NME-I)	SEC-I-(NME-I)	M23UCHN01	2	-	2	25	75	100
	Foundation Course	Fundamentals of Biotechnology	M23UBTFC1	2	-	2	25	75	100
<b>Total credits</b>				<b>24</b>	<b>06</b>	<b>20</b>	<b>190</b>	<b>510</b>	<b>700</b>

\* Skill Enhancement Course (SEC-I) (NME-I): Choose any one from the other department offering courses.

**SEMESTER - II**

Part	Course category	Name of the course	Course code	Hrs/ Week		Credits	Int. Marks	Ext. Marks	Total
				L	P				
I	Language- I	Tamil – II	M23UFTA02	6	-	3	25	75	100
II	Language-II	English – II	M23UFEN02	6	-	3	25	75	100
III	Core Course	Core Course II – Genetics	M23UBT02	5	-	4	25	75	100
	Generic Elective	Generic Elective-II-Fundamentals of Microbiology	M23UBTGE2	3	-	3	25	75	100
	Core Practical	Core -Practical II - Genetics	M23UBTP02	-	3	3	40	60	100
	Generic Elective Practical	Generic Elective Practical - I Biological chemistry and Fundamentals of Microbiology	M23UBTGEP1	-	3	3	40	60	100
IV	*Skill Enhancement Course- SEC-II (NME-II)	SEC-II- (NME-II)	M23UCHN02	2	-	2	25	75	100
	*Skill Enhancement Course SEC- III	SEC-III- Vermicompost Technology	M23UBTS01	2		2	25	75	100
<b>Total credits</b>				<b>24</b>	<b>06</b>	<b>23</b>	<b>230</b>	<b>570</b>	<b>800</b>

\* Skill Enhancement Course (SEC-II) (NME-II): Choose any one from the other department offering courses.

\* Skill Enhancement Course (SEC-III): Choose any one from the Biotechnology department offering courses

**SEMESTER – III**

Part	Course category	Name of the course	Course code	Hrs/Week		Credits	Int. Marks	Ext. Marks	Total
				L	P				
I	Language-I	Tamil- III	M23UFTA03	6	-	3	25	75	100
II	Language-II	English - III	M23UFEN03	6	-	3	25	75	100
III	Core Course	Core Course III- Immunology and Immunotechnology	M23UBT03	5	-	4	25	75	100
	Generic Elective	Generic Elective-III Bioinstrumentation	M23UBTGE3	3	-	3	25	75	100
	Core Practical	Core Practical-III Immunologyand Immunotechnology	M23UBTP03	-	3	3	40	60	100
	Generic Elective Practical	Bioinstrumentation bioinformatics and biostatistics	M23UBTGEP2	-	3	-	-	-	-
IV	Skill Enhancement Course SEC	SEC –IV-Bioethics and Bio-safety	M23UBTS02	2	-	2	25	75	100
IV	Skill Enhancement Course SEC	SEC –V-Bio entrepreneurship	M23UBTS03	2	-	2	25	75	100
<b>Total credits</b>				<b>24</b>	<b>06</b>	<b>20</b>	<b>190</b>	<b>510</b>	<b>700</b>

**SEMESTER – IV**

Part	Course category	Name of the course	Course code	Hrs/Week		Credits	Int. Marks	Ext. Marks	Total
				L	P				
I	Language-I	Tamil – IV	M23UFTA04	6	-	3	25	75	100
II	Language-II	English – IV	M23UFEN04	6	-	3	25	75	100
III	Core Course	Core Course IV– Genetic Engineering and rDNA Technology	M23UBT04	5	-	4	25	75	100
	Generic Elective	Generic Elective - IV-Bioinformatics and Biostatistics	M23UBTGE4	3	-	3	25	75	100
	Core Practical	Core Practical IV- Genetic Engineering and rDNA Technology	M23UBTP04	-	3	3	40	60	100
	Generic Elective Practical	Generic Elective- Practical-II- Bioinstrumentation and Bioinformatics	M23UBTGEP2	-	3	3	40	60	100
IV	Skill Enhancement Course SEC-VI	SEC- VI - Fundamentals of Research Methodology	M23UBTS04	2	-	2	25	75	100
	Enhancement Compulsory Course	Environmental Studies	M23UES01	2		2	25	75	100
<b>Total credits</b>				<b>24</b>	<b>06</b>	<b>23</b>	<b>230</b>	<b>570</b>	<b>800</b>

### SEMESTER – V

Part	Course category	Name of the course	Course code	Hrs/Week		Credits	Int. Marks	Ext. Marks	Total
				L	P				
III	Core Course	Core Course V–Plant Biotechnology	M23UBT05	5	-	4	25	75	100
		Core Course VI-Animal Biotechnology	M23UBT06	5		4	25	75	100
		Core course VII Nanobiotechnology	M23UBT07	5	-	4	25	75	100
	Discipline specific elective course-I	Aquaculture	M23UBTDSE1	5		3	25	75	100
		Microbial Genetics	M23UBTDSE2						
		Marine Biotechnology	M23UBTDSE3						
	Discipline specific elective course-II	Enzymology and Enzyme technology	M23UBTDSE4	5		3	25	75	100
		Human Physiology	M23UBTDSE5						
		Molecular Diagnostics	M23UBTDSE6						
Core Practical	Core Practical-V–Plant Biotechnology and Animal Biotechnology	M23UBTPO5		3	3	40	60	100	
V	Internship	Internship/ Industrial Visit/Field**	M23UBTIS01	-	-	2	40	60	100
	Value Education	Yoga	M23UVE01	2	-	2	25	75	100
<b>Total credits</b>				<b>27</b>	<b>3</b>	<b>25</b>	<b>230</b>	<b>570</b>	<b>800</b>

\*\* The students should undergo compulsory two weeks internship programs during the IV Semester vacation. The students should submit the report at the end of the V semester.

\* Discipline Elective I, II: Choose any one from Discipline Elective courses offered for Biotechnology students.

**SEMESTER – VI**

Part	Course category	Name of the course	Course code	Hrs/ Week		Credits	Int. Marks	Ext. Marks	Total
				L	P				
III	Core Course	Core Course VIII - Environmental and Industrial Biotechnology	M23UBT08	5	-	4	25	75	100
	Core Course	Core Course IX- Pharmaceutical Biotechnology	M23UBT09	5	-	4	25	75	100
	Core Course	Core Course X – Food Technology	M23UBT10	4	-	4	25	75	100
	Discipline specific elective course-III	Cancer Biology	M23UBTDSE7	3		3	25	75	100
		Forensic Biotechnology	M23UBTDSE8						
		Dairy Science and Technology	M23UBTDSE9						
	Discipline specific elective course-IV	Tool in Biotechnology	M23UBTDSE10	3		3	25	75	100
		Bioprocessing	M23UBTDSE11						
		Good laboratory practices	M23UBTDSE12						
	Core Practical	Core Practical VI - Industrial and Environmental Biotechnology	M23UBTP06	3	3	3	40	60	100
Project	Project With Viva-Voce	M23UBTPR1	3	5	5	40	60	100	
IV	Skill Enhancement Course	Professional Competency Skill	M23UBTPCS1	3	-	2	40	60	100
V	Extension Activity	Extension Activity	M23UBTUEX01	3	-	1	-	-	-
<b>Total credits</b>				<b>22</b>	<b>08</b>	<b>29</b>	<b>245</b>	<b>555</b>	<b>800</b>
<b>Over all Total credits</b>				<b>145</b>	<b>35</b>	<b>140</b>	<b>1315</b>	<b>3285</b>	<b>4600</b>

\* Discipline Elective III and IV: Choose any one from Discipline Elective courses offered for Biotechnology students.

### Summary of Credits, Hours and Mark Distribution

Part	Course Name	No. of Credits						Total Credits	Total Hours	No. of Courses	Max. Marks
		I	II	III	IV	V	VI				
I	Language Courses-I	3	3	3	3	-	-	12	24	4	400
II	Language Courses-II	3	3	3	3	-	-	12	24	4	400
III	Core Courses	4	4	4	4	12	12	40	49	10	1000
	Core Practical	3	3	3	3	3	3	18	18	6	600
	Discipline Specific Elective Courses	-	-			6	6	12	16	4	400
	Generic Elective Courses	3	3	3	3	-	-	12	12	4	400
	Generic Elective Practical	-	3	-	3	-	-	6	12	2	200
	Project	-	-	-	-	-	5	5	5	5	1
IV	SEC	2	4	4	2			12	12	6	600
	Professional Competency Skill	-	-	-	-	-	2	2	2	1	100
	Internship	-	-	-	-	2	-	2	-	1	100
	ECC	-	-	-	2	2	-	4	4	2	200
	Foundation course	2	-	-	-	-	-	2	2	1	100
V	Extension Activities	-	-	-	-	-	1	1	-	-	-
	Additional Credit for Online Courses*		-	-	-	-	-	-	-	-	-
<b>TOTAL</b>		<b>20</b>	<b>23</b>	<b>20</b>	<b>23</b>	<b>25</b>	<b>29</b>	<b>140</b>	<b>180</b>	<b>46</b>	<b>4600</b>

\*The students will gain one extra credit for successful completion of online courses from SWAYAM / MOOC / Approved Online Certification Course.

**GENERIC ELECTIVE COURSES FOR B.Sc. BIOTECHNOLOGY STUDENTS**

S.NO.	SEM	COURSE CODE	Category	Course Name	CREDIT S
1.	I	M23UBTGE1	Generic Elective I	Biological Chemistry	3
2.	II	M23UBTGE2	Generic Elective II	Fundamentals of Microbiology	3
	II	M23UBTGEP1	Generic Elective Practical I	Practical I Biological Chemistry & Fundamentals of Microbiology	3
3.	III	M23UBTGE3	Generic Elective III	Bioinstrumentation	3
4.	IV	M23UBTGE4	Generic Elective IV	Bioinformatics and Biostatistics	3
5.	IV	M23UBTGEP2	Generic Elective Practical II	Bioinformatics and Biostatistics	3

**DISCIPLINE ELECTIVE COURSES FOR B.Sc. BIOTECHNOLOGY STUDENTS**

S.NO.	SEM	COURSE CODE	Category	Course Name	CREDITS
1.	V	M23UBDSE1	Discipline Specific Elective I	Aquaculture	3
2.		M23UBDSE2		Microbial Genetics	
3.		M23UBDSE3		Marine Biotechnology	
4.		M23UBDSE4	Discipline Specific Elective II	Enzymology and Enzyme Technology	3
5.		M23UBDSE5		Human Physiology	
6.		M23UBDSE6		Molecular Diagnostics	
7.	VI	M23UBDSE7	Discipline Specific Elective III	Cancer Biology	3
8.		M23UBDSE8		Forensic Biotechnology	
9.		M23UBDSE9		Dairy Science and Technology	
10.	VI	M23UBDSE10	Discipline Specific Elective IV	Tools in Biotechnology	3
11.		M23UBDSE11		Bioprospecting	
12.		M23UBDSE12		Good Laboratory practices	

**SKILL ENHANCEMENT COURSE SEC-I (NME) FOR OTHER DEPARTMENT STUDENTS**

S. NO.	SEM	COURSE CODE	CATEGORY	COURSE NAME	CREDITS
1	I	M23UBTN01	SEC (NME)-I	Agricultural Biotechnology	2
2	II	M23UBTN02	SEC (NME)-II	Public Health and Hygiene	2

**SKILL ENHANCEMENT COURSE FOR B.Sc., BIOTECHNOLOGY STUDENTS**

SEM	PART	COURSE CODE	CATEGORY	COURSE NAME	CREDITS
II	IV	M23UBTS01	SEC-III	Vermicompost Technology	2
III	IV	M23UBTS02	SEC-IV	Bioethics and Bio-safety	2
III	IV	M23UBTS03	SEC-V	Bio entrepreneurship	2
IV	IV	M23UBTS04	SEC-VI	Fundamentals of Research Methodology	2

**FOUNDATION COURSE**

SEM	PART	COURSE CODE	COURSE NAME	CREDITS
I	IV	M23UBTFC1	Fundamentals of Biotechnology	2

**GENERIC ELECTIVE SUBJECTS OFFERED FOR OTHER MAJOR STUDENTS**

SEM	PART	COURSE CODE	COURSE NAME	CREDITS
I	III	M23UBCGE1	Biochemistry-I	3
II	III	M23UBCGE2	Biochemistry- II	3
II	III	M23UBCGEP1	Generic Elective Practical- I- Biochemistry	3

## VIII. 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
<b>K1</b>	<b>Part - A</b> 10 Questions - Objectives type *1 Marks (No Choice)	Two Questions from each unit	<b>10</b>	K1- Memory Level K2 - Understanding Level K3 - Application Level K4 - Analytical Level
<b>K1, K2</b>	<b>Part - B</b> 5 Questions *2 Marks (No Choice)	One Question from each unit	<b>10</b>	
<b>K2, K3</b>	<b>Part - C</b> 5 Questions (either or type) * 5 Marks	One Question from each unit	<b>25</b>	
<b>K2, K3, K4</b>	<b>Part - D</b> 3 out of 5 Questions *10 Marks	One Question from each unit	<b>30</b>	

### 2. Question Paper Pattern for Practical Examination

Time: Six Hours

Maximum Marks: 60

#### QUESTION PATTERN

<b>Major Practical</b>	<b>20 Marks</b>
<b>Minor Practical</b>	<b>10 Marks</b>
<b>Spotters (5X4=20)</b>	<b>20 Marks</b>
<b>Viva Voce</b>	<b>05 Marks</b>
<b>Record</b>	<b>05 Marks</b>
<b>Total</b>	<b>60 Marks</b>

### 3. Distribution of Marks:

The following are the distribution of marks for external and internal for End Semester Examinations and continuous internal assessment and passing minimum marks for Theory / Practical / Internship / Project papers of UG programmes.

<b>ESE</b>	<b>CIA Total</b>	<b>EA Total</b>	<b>Total Marks Allotted</b>	<b>Passing Minimum for EA</b>	<b>Passing Minimum (ESE)</b>
<b>Theory</b>	25	75	100	30	40
<b>Practical</b>	40	60	100	24	40
<b>Internship/ Project</b>	40	60	100	24	40

The following are the Distribution of marks for the Continuous Internal Assessment in Theory / Practical papers of UG programme.

**THEORY**

## EVALUATION OF INTERNAL ASSESSMENT

Test : 15 Marks

Assignment: 05 Marks

Attendance : 05 Marks

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Total : 25 Marks  
-----**PRACTICAL**

## EVALUATION OF INTERNAL ASSESSMENT

Test : 20 Marks

Attendance : 10 Marks

Observation : 10 Marks

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Total : 40 Marks  
-----**INTERNSHIP/PROJECT****PROJECT**

## EVALUATION OF INTERNAL ASSESSMENT

Review 1 : 10 Marks

Review 2 : 10 Marks

Review 3 : 10 Marks

Pre-Viva : 10 Marks

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Total : 40 Marks  
-----**4. Passing Minimum:**

The Candidates shall be declared to have passed the examination if he/she secures not less than 40 marks in total (CIA mark + Theory Exam mark) with minimum of 30 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 40 marks in total (CIA mark + Practical Exam mark) with minimum of 24 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 failed 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 B.Sc. Biotechnology programme during the IV semester vacation period.

The Internship training should be valued by an internal examiner; however, the Viva-Voce examination should be conducted by the Internal and External examiner/Guide concerned.

- a. The Internship training Report may consist of minimum of 20 pages.
- b. The candidate has to submit the Internship training Report 10 days before the commencement of the V Semester Examinations.

**Project:**

The following guidelines 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 examiner appointed by the College and the internal examiner/supervisor/teacher concerned.
- ❖ The Project Report may consist of minimum of 30 pages.
- ❖ The candidate has to submit the Project Report 10 days before the viva-voce Examinations.
- ❖ 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.

**IX. 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.

**b) Value Added Courses**

- ❖ Students are provided with additional courses during their course of study right from the First year. Students are free to choose the courses. On successful completion of each course, the students will gain one extra credit.

## SEMESTER - I

<b>Core Course-I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT01</b>	<b>CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY</b>	<b>Contact Hour per week: 5</b>

### Objectives

- To understand the structures and the basic components of prokaryotic and eukaryotic cells.
- To study the central dogma of the cell.
- To impart knowledge in cell division and the cell signaling pathways.
- To study the developmental process of organisms.

### Course Outcomes

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	State cell as the fundamental unit of life and to relate the structure of the Eukaryotic cell	K1
CO2	Discuss the structure and the functional aspects of cell organelles and cell membrane.	K2
CO3	Apply the structure and functions of Nucleic acid and mechanism of Replication, Transcription and Translation.	K3
CO4	Examine the response of cells to the intra and extracellular environment, intracellular signaling pathways.	K4
CO5	Inspect the developmental processes of an organism through gametogenesis and fertilization and development and formation of germ layers.	K4

### UNIT- I

**15Hrs**

Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).

### UNIT -II

**15Hrs**

Structure and Functions of Cell Organelles: Cell wall - Cell membrane - Cytoplasm - Nucleus - chromosomes -Endoplasmic reticulum - Ribosomes - Golgi bodies - Plastids - Vacuoles - Lysosomes - Mitochondria - Microbodies

**UNIT –III****15Hrs**

Structure and functions of DNA and RNA - Central Dogma of the cell. DNA -Replication in prokaryotes - Transcription in Prokaryotes and Eukaryotes - RNA Processing - Genetic code- Translation - prokaryotic and eukaryotic translation - Post Translational Modifications

**UNIT- IV****15Hrs**

Cell cycle - Cell cycle checkpoints - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion – Extra Cellular Matrix - Cell to cell communications - Signal transduction - G - Protein Coupled Receptors Signal transduction pathways.

**UNIT- V****15Hrs**

Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Cell Biology, Genetics, Molecular Biology, Evolution and Ecology	Verma P S and Agarwal V K	S Chand	2006
2.	Cell Biology	Rastogi S C	New age International	2019

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Cell and Molecular Biology	Gerald Karp	Wiley	2019
2	Cell Biology	Harvey Lodish	W.H.Freeman & co	2021
3	Cell Biology and Molecular Biology	R. Robertis	Saras Publication	2011

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	S	M	S
<b>CO2</b>	M	S	M	M	M	M
<b>CO3</b>	M	M	S	S	M	S
<b>CO4</b>	M	M	S	S	M	M
<b>CO5</b>	M	M	S	S	S	M

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

## SEMESTER - I

<b>Generic Elective-I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code:</b> <b>M23UBTGE1</b>	<b>BIOLOGICAL CHEMISTRY</b>	<b>Contact hour</b> <b>per week: 3</b>

### Objectives

- To study the structure and function of different biomolecules (proteins, lipids, and carbohydrates) found in living cells.
- To provide fundamental knowledge/overview of enzymes and nucleic acids.
- To understand the concept of various metabolism such as carbohydrate and lipid.

### Course Outcomes

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Relate the importance of Biochemistry through the concept of acids and bases, and chemical bonding.	K1
CO2	Illustrate the formation of different types of solutions, concentrations of solution and preparation of buffer solutions	K2
CO3	Analyze the Structure, Classification, Chemistry and Properties of Carbohydrates and Explain Various Biochemical Cycles involved in Carbohydrate Metabolism.	K3
CO4	Examine the Structure, Classification, Chemistry and Properties of Lipids, Nucleic acid and Explain Various Biochemical Cycles involved in Fatty acid and Nucleic acid Metabolism.	K4
CO5	Elucidate the Structure, Classification, Chemistry and Properties of proteins amino acids and Identify and explain nutrients in foods and the specific functions in maintaining health.	K4

**UNIT-I****12Hrs**

Classification of organic compounds - Hybridization in methane, ethane, acetylene, and benzene. Definition with examples- electrophiles, nucleophiles and free radicals. Types of reactions with an example: addition, substitution, elimination, condensation and polymerization.

**UNIT-II****12Hrs**

Acids & Bases properties and differences, Concepts of acids and bases- Arrhenius, Lowry-Bronsted and Lewis. Concentration of solution, ways of expressing concentrations of solutions – per cent by weight, normality, molarity, molality, mole fraction. pH of solution, pH scale, measurement of pH. Buffer solutions, properties of buffers, Henderson-Hasselbalch equation, mechanism of buffer action of acidic buffer and basic buffer. Properties and characteristics of water.

**UNIT-III****12Hrs**

The chemical foundation of life- Water- Properties, ionization and buffering action in biological system. Classification of carbohydrates- Properties of carbohydrates. Ring structure of sugars and conformations of sugars. Metabolism of Carbohydrates – Glycogenesis, Glycogenolysis, Cori's cycle, Glycolysis, TCA cycle, bioenergetics of carbohydrate metabolism.

**UNIT -IV****12Hrs**

Classification of Lipids. Characteristics, Properties and Biological importance of lipids. Metabolism of Fatty acids, triglycerides, phospholipids, cholesterol. B-oxidation of fatty acids. Classification of nucleic acids. Purine and Pyrimidine bases. Classification of DNA & RNA. Metabolism of Nucleic acids, Salvage pathway.

**UNIT-V****12Hrs**

Classification and structure of amino acids. Structural conformation of proteins. Classification of proteins. Properties and biological importance of amino acids and proteins. Degradation of Amino acids and Urea Cycle. Vitamins and Hormones. Role of hormones in metabolism. Electron transport chain and Photo-phosphorylation.

**TEXTBOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Fundamentals of Biochemistry	J L Jain, Sunjay Jain, Nitin Jain	S. Chand publications	2016
2.	Essentials of Biochemistry	U. Sathyanarayanan	Books and allied (p) Ltd.	2002
3.	A Textbook Of Medical Biochemistry	Chatterjee M N	JPB Publisher	2012
4.	Fundamentals of Biochemistry	A.C. Deb	New central book agencies	2016

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Principles of Biochemistry	Lehninger	WH Freeman and Company NY	2013
2.	Harper's biochemistry	Murray <i>et al.</i> ,	Appleton and Lange Publishers Florida USA	2003
3.	Principles of Biochemistry	Geoffrey L. Zubay, William W. Parson, Dennis E. Vance	W.C. Brown Publishers	1995
4.	Biochemistry – Stanford University	Lubert Stryer	W H Freemann and company San Francisco	2007
5.	A Textbook of Organic Chemistry	Bahl Arun, Bahl B. S.	S. Chand & Sons publications	2016

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	M	M	M	S
<b>CO2</b>	M	S	M	M	M	S
<b>CO3</b>	S	M	M	S	M	M
<b>CO4</b>	M	S	S	S	S	M
<b>CO5</b>	M	M	S	S	S	M

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

## SEMESTER -I

<b>Core Practical-I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTP01</b>	<b>CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY</b>	<b>Contact hour per week: 3</b>

### Objectives

- To provide hands-on training like microscopy, cell counting, mitosis, meiosis cell division and staining of macromolecules in the field of cell biology and plant biology.
- To identify the types of blood cells
- To isolate and identification plant cell and gametes of animal cell.

### Course Outcomes

By the end of the course, the student should be able to:

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Label the microscope and its working principles.	K4
CO2	Examine the Blood cells and Squamous epithelial cells	K4
CO3	Classify the plant, and animal cells.	K3
CO4	Understand the concept of gametes.	K3
CO5	Brief out about cell fractionations	K4

1. Components of a Compound / Light Microscope
2. Blood smear preparation and Identification of Blood cells
3. Buccal smear preparation and Identification of squamous epithelial cells.
4. Isolation and Identification of plant cells..
5. Observation of sperm & Egg.
6. Cell fractionation and Identification of cell organelles (Demo).

### TEXT BOOK:

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Cell and molecular biology: Lab manual	K.V. Chaitanya	PHI publishers	2013

**SEMESTER - II**

<b>Generic elective Practical I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTGEP1</b>	<b>BIOLOGICAL CHEMISTRY AND FUNDAMENTALS OF MICROBIOLOGY</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To give hands-on training on qualitative analysis of biomolecules, paper chromatography, thin layer chromatography quantitative titration and colorimetric methods to determine the number of biomolecules in the sample.
- To delivered the various sterilization techniques and media preparation and microbial isolation methods.
- To identify the bacterial morphological features and biochemical studies.

**Course Outcomes**

By the end of the course, the student should be able to:

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Perform and estimate the amount of chemical substance present in a solution qualitatively. To analyze and detect the nature of various organic class of compounds qualitatively.	K4
CO2	Qualitatively analyze the carbohydrates and amino acids and report the type of carbohydrate based on specific tests. Differentiate the carbohydrates based microscopic examination of the crystal.	K4
CO3	Understand the methods of acidimetry, alkalimetry and permanganometry.	K3
CO4	Quantify Ascorbic acid in lemon by Dichlorophenol indo phenol dye method, Glycine by sorensens formal titration method.	K4
CO5	Estimate Glucose, Cholesterol and Proteins.	K4
CO6	Describe the general Laboratory safety & Sterilization Techniques	K4

CO7	Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques	K4
CO8	Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques.	K3
CO9	Perform the Motility of organisms.	K4
C10	Able to characterize and identify bacteria using Biochemical tests.	K4

### **BIOLOGICAL CHEMISTRY**

1. Distinguish between aliphatic and aromatic compounds.
2. Distinguish between Saturated and unsaturated compounds
3. Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose & starch.
4. Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine, Proline and Cysteine
5. Estimation of Glycine- Formal Titration
6. Determination of Ascorbic acid – DCPIP method.
7. Estimation of glucose – DNS Method
8. Estimation of Cholesterol- Zak's method
9. Estimation of proteins – Bradford's method

### **TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Laboratory Manual in Biochemistry	J. Jayaraman	New Age International Pvt Ltd Publishers	2011
2.	Introductory Practical Biochemistry	S. K. Sawhney Randhir, Singh	Alpha Science International Ltd	2005
3.	Biochemical calculations	Irwin H. Segel	,Liss, Newyork	1991
4.	A lab manual	James G Cappucino and N. Sherman MB	Benjamin Cummins, New York	1996

5.	Laboratory manual in General Microbiology	Kannan. N	Palani Publications	1996
6.	Practical Microbiology	R C Dubey and D K Maheswari	S. Chand Publishing	2002

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Practical Chemistry	Dr. O P Panday, D N Bajpai, Dr. S Giri	S Chand, Revised edition	2016
2.	Microbiology Practical Manual	Amita J, Jyotsna A and Vimala V	Elsevier India	2018
3.	Handbook Medical Laboratory Technology	Talib VH	CBS	2019

**SEMESTER - II**

<b>Foundation Course</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code:</b> <b>M23UBTFC1</b>	<b>FUNDAMENTALS OF</b> <b>BIOTECHNOLOGY</b>	<b>Contact hour</b> <b>per week: 2</b>

**Objectives**

- To provide knowledge about the structure and function of Prokaryotic cells.
- To impart knowledge on cell division in Prokaryotes and Eukaryotes.
- To Understand basis of plant kingdom and human physiology.

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Recall the ultra structure of prokaryotes	K1
CO2	Illustrate the structure and functions of eukaryotes.	K2
CO3	Represent the overview of cell divisions.	K2
CO4	Memorize the structure and classification of plant and animal kingdom.	K3
CO5	Point out the various physiological characteristics of human.	K4

**UNIT-I****6Hrs**

**Ultrastructure of Eubacteria-** Cell membrane- Extra mural layer - Slime - Capsule - Cytoplasmic inclusions – Mesosomes - Nuclear material - Reserve materials - Pigments - Cell appendages – Flagella - Pili.

**UNIT-II****6Hrs**

**Ultrastructure and functions of Eukaryotic cell organelles** - Cell wall - Cell membrane - Mitochondria - Chloroplast - Endoplasmic reticulum - Golgi complex.

**UNIT- III****6Hrs**

**Cell division in Bacteria** – Binary fission-Cell division in Eukaryotes - Mitosis and Meiosis. Reproduction in Microbes.

**UNIT-IV****6Hrs**

Botany: Ultra structure of plant cell. General characters of Thallophyta Bryophyta, Pteridophyta - Angiosperms. Zoology: Ultrastructure of Animal cell. General characteristics of Vertebrate –Invertebrate

**UNIT-V****6Hrs**

Human physiology-Digestive System and Excretion, Respiratory System, Nervous System

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Microbiology	Michael J. Pelczar, Jr. E.C.S. Chan, Moel	McGraw Hill Book R.Krieg, Company	1986
2.	Modern Concepts In Biotechnology	Kumar H D	Vikas	2013
3.	Plant Anatomy	Pandey B.P.	S. Chand &Co. De, New Delhi	2007

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Outlines of Zoology, Vol. I & II	Ekambarantha Ayyar, and Ananthakrishnan, T.N.	Viswanathan and co Madras.	1993
2.	Human Physiology	Dr. C. Chatterjee I & II	Medical Allied Agency, Kolkatta	1995
3.	Text Book of Animal Physiology,	SambasiviahI, Kamalakara Rao.A. P. Augustine Chellappa,S	S.Chand & Co., NewDelhi .	1983
4	Microbiology 2nd edition	Prescott, L.MJ.P. Harleyand C. A.Klein	Wm,C. Brown publishers	1995

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	S	S	M
<b>CO2</b>	S	S	M	M	S	M
<b>CO3</b>	S	M	M	S	M	S
<b>CO4</b>	M	M	S	M	S	S
<b>CO5</b>	M	M	S	S	M	S

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

## SEMESTER-II

<b>Core Course - II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT02</b>	<b>GENETICS</b>	<b>Contact hour per week:5</b>

### Objectives

- To study the classical genetics and advanced genetics, storage and processing of genetic information.
- To provide fundamental knowledge on mutagens, DNA repairs, Genetic disorders.
- To gain knowledge of gene frequency, and factors affecting gene frequency.

### Course Outcomes

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Recite about the Mendelian and Non-mendelian inheritance	K1
CO2	Interrelate the concept of linkage and crossing over.	K2
CO3	Distinguish the properties of genetic materials and processing of genetic information.	K3
CO4	Enumerate the Mutagens, Mutations, DNA Repairs and Genetic disorders in human.	K4
CO5	Categories Eugenics, Euphenics and Euthenics and in-depth Knowledge on population Genetics.	K3

### UNIT-I

**15Hrs**

Mendel's experiments, Monohybrid cross, Dihybrid cross, Mendel's laws. Incomplete dominance. Multiple alleles – In Drosophila.

### UNIT-II

**15Hr**

Linkage - linkage in Drosophila - Morgan's experiments, factors affecting linkage. Crossing over - types, mechanism, significance of crossing over. Cytoplasmic inheritance -Carbon dioxide sensitivity in Drosophila and milk factor in mice. Sex –Linked Inheritance and Sex- Determination in Man.

**UNIT-III****15Hrs**

Fine structure of the gene and gene concept. Identification of the DNA as the genetic material - Griffith experiments, Avery, McLeod and McCarty. Microbial Genetics- bacterial recombination, Conjugation, Transformation

**UNIT -IV****15Hrs**

Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations - Numerical and Structural, Pedigree Analysis - Mendelian inheritance in human (Cystic Fibrosis, Muscular Dystrophy).

**UNIT-V****15Hrs**

Population Genetics – Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Elements of Genetics	Dr. Veer Bala Rastogi	Kedar Nath Ram Publications	2020
2.	Genetics	Verma, P.S. and Agarwal, V.K	S.Chand& Co., New Delhi	1995
3.	Cell and Molecular Biology	Verma, P.S., and Agarwal, V.K	S.Chand and Co., New Delhi	1995

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Genetics	Gupta P K	Rastogi publications	2018
2.	Microbial Genetics	David Freifelder	Jones and Bartlett Publishers	1987
3.	Principles of Genetics	Robert H Tamarin	McGraw-Hill	2001
4.	Principles of Genetics	Gardner; Simmons	Wiley	2006

## Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	M	S	S	S
<b>CO2</b>	S	S	M	M	S	S
<b>CO3</b>	S	M	M	S	M	S
<b>CO4</b>	M	M	S	M	S	M
<b>CO5</b>	M	M	S	S	M	S

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

**SEMESTER-I**

<b>Generic Elective - II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTGE2</b>	<b>FUNDAMENTALS OF MICROBIOLOGY</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To provide knowledge on the understanding of the concepts and fundamental principles of microbiology and the basis in microbial techniques and microbial diseases.
- To understand the various methods of sterilization techniques.
- To provide the knowledge about insecticide, biofertilizer and probiotics.

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Recall the History of microbiology and classification of Microorganisms.	K1
CO2	Analyze various microbiological techniques and media preparation and storage methods.	K3
CO3	Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.	K4
CO4	Compare the importance between Bio insecticides and Bio fertilizers; Prebiotics and Probiotics.	K3
CO5	Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications.	K2

**UNIT-I****12Hrs**

History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology – Role of microbes in biotechnology.

**UNIT-II****12Hrs**

Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation- plating methods - staining methods (Gram's, capsule, spore, LCB mount)- methods of preservation and storage of microbes.

**UNIT-III****12Hrs**

Sterilization methods - physical and chemical methods- Mode of action- Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL.

**UNIT-IV****12Hrs**

Bioinsecticides - *Bacillus thuringiensis*, Baculoviruses- Biofertilizers- *Azospirillum* and blue green algae - single cell protein – prebiotics and probiotics- Dairy products (Cheese and Yoghurt).

**UNIT-V****12Hrs**

Microbial Disease - host - pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria).

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Microbiology.	Pelczar.M. J., Chan E.C.S. and Noel. R.K.	McGraw –Hill, New York.	2007
2.	A textbook of Microbiology	Dubey R.C. and Maheswari, S.	New Delhi: S. Chand & Co.	2003
3.	Modern Concepts In Microbiology	Kumar H D; Swathi kumar	Anjanaa Book house	2006
4.	Essentials of Microbiology	Dr. S. Rajan	Anjanaa Book house	2015

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Microbiology	Prescott, Harley, Klein	McGraw – Hill	2016
2.	Textbook book of Microbiology	Ananthanarayanan, Paniker, Kapil	Orient BlackSwan	2013
3.	Microbiology. An Introduction	Tortora, G.J., Funke, B.R., Case, C.L.	A La Carte Pearson.	2013

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	M	S	S	S	M
<b>CO2</b>	M	S	S	M	M	S
<b>CO3</b>	S	S	M	M	S	M
<b>CO4</b>	M	M	S	M	S	S
<b>CO5</b>	M	M	M	S	S	S

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

**SEMESTER - II**

<b>Core Practical-II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTP02</b>	<b>GENETICS</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To give hands on training in theoretical and practical introduction to important methods and techniques in genetics and molecular biology.
- To impart knowledge for the preparation of culture medium for the *Drosophila*
- To know the various cell division of somatic (mitotic stages) and reproductive cells (meiotic stages)

**Course Outcomes**

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

CO1	Demonstrate the basic principles of important techniques in Molecular biology and Genetics.	K3
CO2	Analyze the Polytene chromosome of the organisms	K4
CO3	Identify Barr bodies from Buccal smear	K4
CO4	Demonstrate the Preparations and maintenance of culture medium	K4
CO5	Demonstrate Human karyotyping	K3

1. Mitotic stages of onion (*Allium cepa*) root tip
2. Meiotic stages of cockroach testes/ Flower bud.
3. Giant chromosomes from *Chironomus* larvae/ *Drosophila* salivary glands.
4. Preparations of culture medium and culture of *Drosophila*.
5. Identifications of mutants of *Drosophila*.
6. Human karyotyping (Demo).

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Practical Manual on "Fundamentals of Genetics"	Kaushik Kumar Panigrahi	Odisha University of Agriculture & Technology	2019
2.	Laboratory Manual in Biochemistry	J. Jayaraman	New Age International Pvt Ltd Publishers	2011
3.	Introductory Practical Biochemistry	S. K. Sawhney Randhir, Singh	Alpha Science International Ltd	2005
4.	Biochemical calculations	Irwin H.Segel	Liss, Newyork	1991

**SEMESTER - II**

<b>Generic elective Practical I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTGEP1</b>	<b>BIOLOGICAL CHEMISTRY AND FUNDAMENTALS OF MICROBIOLOGY</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To give hands-on training on qualitative analysis of biomolecules, paper chromatography, thin layer chromatography quantitative titration and colorimetric methods to determine the number of biomolecules in the sample.
- To delivered the various sterilization techniques and media preparation and microbial isolation methods.
- To identify the bacterial morphological features and biochemical studies.

**Course Outcomes**

By the end of the course, the student should be able to:

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Perform and estimate the amount of chemical substance present in a solution qualitatively. To analyze and detect the nature of various organic class of compounds qualitatively.	K4
CO2	Qualitatively analyze the carbohydrates and amino acids and report the type of carbohydrate based on specific tests. Differentiate the carbohydrates based microscopic examination of the crystal.	K4
CO3	Understand the methods of acidimetry, alkalimetry and permanganometry.	K3
CO4	Quantify Ascorbic acid in lemon by Dichlorophenol indo phenol dye method, Glycine by sorensens formal titration method.	K4
CO5	Estimate Glucose, Cholesterol and Proteins.	K4
CO6	Describe the general Laboratory safety & Sterilization Techniques	K4

CO7	Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques	K4
CO8	Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques.	K3
CO9	Perform the Motility of organisms.	K4
C10	Able to characterize and identify bacteria using Biochemical tests.	K4

### **MICROBIOLOGY**

1. Sterilization techniques – Preparation of Media
2. Inoculation techniques- Pour plate, spread plate
3. Isolation of bacteria from various sources and dilution techniques.
4. Staining techniques: Simple, Gram's, Capsule (Negative), Spores.
5. Preparation of temporary mounts- Lactophenol cotton blue staining.
6. Motility tests: Hanging drop technique.
7. Biochemical characterization - catalase, oxidase, IMVIC test and TSI
8. Antibiotic sensitivity test (demonstration).

### **TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Laboratory Manual in Biochemistry	J. Jayaraman	New Age International Pvt Ltd Publishers	2011
2.	Introductory Practical Biochemistry	S. K. Sawhney Randhir, Singh	Alpha Science International Ltd	2005
3.	Biochemical calculations	Irwin H.Segel	,Liss, Newyork	1991
4.	A lab manual	James G Cappucino and N. Sherman MB	Benjamin Cummins, New York	1996
5.	Laboratory manual in General Microbiology	Kannan. N	Palani Publications	1996

6.	Practical Microbiology	R C Dubey and D K Maheswari	S. Chand Publishing	2002
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**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Practical Chemistry	Dr. O P Panday, D N Bajpai, Dr. S Giri	S Chand, Revised edition	2016
2.	Microbiology Practical Manual	Amita J, Jyotsna A and Vimala V	Elsevier India	2018
3.	Handbook Medical Laboratory Technology	Talib VH	CBS	2019

## SEMESTER - II

<b>SEC-III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code: M23UBTS01</b>	<b>VERMICOMPOST TECHNOLOGY</b>	<b>Contact hour per week: 2</b>

### Objectives

- To provide the basic idea about our vermicomposting technology and developing organic fertilizers and environmental conservation.
- To understand various applications of earthworm's inorganic solid waste.
- To provide the knowledge on Chemical composition and economic importance of vermiwash.

### Course Outcomes

After completing this course, students will be able to:

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	State that vermicomposting is an eco-friendly, economically and socially acceptable technology	K1
CO2	Illustrate that Vermi-technology is useful for the stabilization and recycling of both industrial and domestic organic waste.	K2
CO3	Apply vermi-technology to manufacture the vermicompost in small-scale industry.	K3
CO4	Apply vermi-technology for the production of vermicompost in large scale level.	K3
CO5	Brief out that the Earthworms have the capacity to absorb heavy metals into their body tissues and converting the soil without heavy metals.	K4

### UNIT-I

**6Hrs**

Types, Collection and Preservation of Earthworms - Types and basic characteristics of species suitable for vermicomposting; Role of earthworms in soil fertility, Biology of *Lampito maruitti*; Collection and Preservation of Earthworms.

### UNIT-II

**6Hrs**

Culturing techniques of earthworms and composting materials General method; Pot method; Wooden box method; Propagation; Factor affecting

culturing of earthworm; Vermicomposting materials; Preliminary treatment of composting materials.

**UNIT-III**

**6Hrs**

Small scale techniques of Vermicomposting-Indoor dual bin method; Bed method; Pit method; Heap method; Expandable worm tower assembly method; Hanging basket method; Physical, chemical and biological properties of vermicompost.

**UNIT-IV**

**6Hrs**

Large scale techniques of Vermi composting Outdoor dual bin; Raised cage; Dual pit; Commercial model; Trickling filter vermicomposting; Keep it simple and saveplan.

**UNIT-V**

**6Hrs**

Vermiwash and Economics- Chemical composition of vermiwash; Techniques of vermiwash production: Advantages of Vermicomposting; Prospects of vermi-culture as self-employment venture.

**TEXTBOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	The Earth wormbook	Ismail,S.A.,other	India Press, Goa	2007
2.	Vermicomposting and vermiwash	Somani, L. L.	Agrotech Publishing Academy, Udaipur.	2008
3.	Earthworm in Agriculture	Talashil karand Dosani	Agrobios(India),Jodhpur	2005
4.	Vermi biotechnology from soil health to human health	Ranganathan, L.S	Agrobios, India.	2006

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	S	M	S
<b>CO2</b>	M	M	S	S	M	M
<b>CO3</b>	S	S	M	S	M	S
<b>CO4</b>	S	M	S	S	M	M
<b>CO5</b>	M	S	S	M	S	S

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

## Generic Elective Courses Offered for other major Students

### SEMESTER I

#### **GENERIC ELECTIVE - I – BIOCHEMISTRY- I**

<b>Generic Elective-I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code:</b> <b>M23UBCGE1</b>	<b>BIOCHEMISTRY- I</b>	<b>Contact hour</b> <b>per week: 3</b>

#### **Objectives**

- To study the structure and function of different biomolecules (proteins, lipids, and carbohydrates) found in living cells.
- To provide fundamental knowledge/overview of enzymes and nucleic acids.
- To understand the concept and steps involved in metabolism of Nucleic acids.

#### **Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Relate the importance of Biochemistry through the concept of acids and bases, and chemical bonding.	K1
CO2	Illustrate the formation of different types of solutions, concentrations of solution and preparation of buffer solutions	K2
CO3	Analyze the Structure, Classification, Chemistry and Properties of Carbohydrates and Explain Various Biochemical Cycles involved in Carbohydrate Metabolism.	K3
CO4	Examine the Structure, Classification, Chemistry and Properties of Lipids, Nucleic acid and Explain Various Biochemical Cycles involved in Fatty acid and Nucleic acid Metabolism.	K4
CO5	Elucidate the Structure, Classification, Chemistry and Properties of proteins amino acids and Identify and explain nutrients in foods and the specific functions in maintaining health.	K4

**UNIT-I****9Hrs**

Classification of organic compounds - Hybridization in methane, ethane, acetylene, and benzene. Definition with examples- electrophiles, nucleophiles and free radicals. Types of reactions with an example: addition, substitution, elimination, condensation and polymerization.

**UNIT-II****9Hrs**

Acids & Bases properties and differences, Concepts of acids and bases- Arrhenius, Lowry-Bronsted and Lewis. Concentration of solution, ways of expressing concentrations of solutions – per cent by weight, normality, molarity, molality, mole fraction. pH of solution, pH scale, measurement of pH. Buffer solutions, properties of buffers, Henderson-Hasselbalch equation, mechanism of buffer action of acidic buffer and basic buffer. Properties and characteristics of water.

**UNIT-III****9Hrs**

The chemical foundation of life- Water- Properties, ionization and buffering action in biological system. Classification of carbohydrates- Properties of carbohydrates. Ring structure of sugars and conformations of sugars. Metabolism of Carbohydrates – Glycogenesis, Glycogenolysis, Cori's cycle, Glycolysis, TCA cycle, bioenergetics of carbohydrate metabolism.

**UNIT -IV****9Hrs**

Classification of Lipids. Characteristics, Properties and Biological importance of lipids. Metabolism of Fatty acids, triglycerides, phospholipids, cholesterol. B-oxidation of fatty acids. Classification of nucleic acids. Purine and Pyrimidine bases. Classification of DNA & RNA. Metabolism of Nucleic acids, Salvage pathway.

**UNIT-V****9Hrs**

Classification and structure of amino acids. Structural conformation of proteins. Classification of proteins. Properties and biological importance of amino acids and proteins. Degradation of Amino acids and Urea Cycle. Vitamins and Hormones. Role of hormones in metabolism. Electron transport chain and Photo-phosphorylation.

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Fundamentals of Biochemistry	J L Jain, Sunjay Jain, Nitin Jain	S. Chand publications	2016
2.	Essentials of Biochemistry	U. Sathyanarayanan	Books and allied (p) Ltd.	2002
3.	A Text-book of Inorganic Chemistry	P.L. Soni	Chand & Sons publications	2008
4.	Fundamentals of Biochemistry	A.C. Deb	New central book agencies	2016

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Principles of Biochemistry	Lehninger	WH Freeman and Company NY	2013
2.	Harper's biochemistry	Murray <i>et al.</i> ,	Appleton and Lange Publishers Florida USA	2003
3.	Principles of Biochemistry	Geoffrey L. Zubay, William W. Parson, Dennis E. Vance	W.C. Brown Publishers	1995
4.	Biochemistry – Stanford University	Lubert Stryer	W H Freemann and company San Francisco	2007
5.	A Textbook of Organic Chemistry	Bahl Arun, Bahl B. S.	S. Chand & Sons publications	2016

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	M	M	M	S
<b>CO2</b>	M	S	M	M	M	S
<b>CO3</b>	S	M	M	S	M	M
<b>CO4</b>	M	S	S	S	S	M
<b>CO5</b>	M	M	S	S	S	M

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

## Generic Elective Courses Offered for other major Students

### SEMESTER II

<b>Generic elective - II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBCGE2</b>	<b>GENERIC ELECTIVE-II- BIOCHEMISTRY- II</b>	<b>Contact hour per week: 3</b>

#### Objectives

- To provide knowledge about the synthesis and metabolisms of biomolecules, metabolic pathways and their regulations inside the living cells.
- To classify, occurrence, deficiency symptoms of vitamins and fats.
- To understand the classification and the metabolic disorder of hormone

#### Course Outcomes

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

CO1	Define the concepts of thermodynamics and metabolism	K1
CO2	Illustrate the nature of the carbohydrate metabolism	K2
CO3	Paraphrase the protein and nucleic acid metabolisms	K2
CO4	Explain the overall process of lipid metabolism	K3
CO5	Elaborate the mechanisms of metabolic control played by the vitamins and hormones	K4

#### UNIT-I

**9Hrs**

Bioenergetics- Laws of Thermodynamics, Redox potential, Respiratory chain, Oxidative phosphorylation (Theories and Mechanism).

#### UNIT-II

**9Hrs**

Carbohydrate metabolism - Glycolysis, Pyruvate Oxidation and Citric acid cycle HMP shunt, Gluconeogenesis, Glycogenesis, Glycogenolysis.

#### UNIT-III

**9Hrs**

Protein metabolism - Transamination, oxidative and non-oxidative deamination, decarboxylation - urea cycle. Nucleic acid metabolism - De novo and salvage pathway.

**UNIT-IV****9Hrs**

Lipid metabolism- Biosynthesis of fatty acids and Oxidation of fatty acids (alpha, beta and omega oxidation). Cholesterol Biosynthesis.

**UNIT-V****9Hrs**

Vitamins: Classification, occurrence, deficiency symptoms, and biochemical functions of fat-soluble and water-soluble Vitamins. Hormones – Definition, Classification of Hormones. Metabolic disorders.

**TEXTBOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Fundamentals of Biochemistry	J.L. Jain	S.Chand publications	2004
2.	Schaum's Outline of Biochemistry	Philip W Kuchel	Schaum's Outlines	1997

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Harper's Biochemistry	Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell	Prentice Hall International. Inc	2006
2.	Fundamentals of Biochemistry	Donald Voet, Judith G.Voet and Charlotte W Pratt	John Wiley & Sons, NY	1999
3.	Lehninger Principles of Biochemistry	David L. Nelson, Michael M. Cox	W H Freeman & Co	2017
4.	Biochemistry	Christopher K. Mathews, K. E. Van Holde, Dean R. Appling	Pearson College Div	2012

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	S	M	S	M
<b>CO2</b>	S	S	M	S	M	M
<b>CO3</b>	M	S	S	M	S	S
<b>CO4</b>	S	M	S	S	M	S
<b>CO5</b>	S	M	S	M	S	S

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

## Semester - II

<b>Generic elective</b> <b>Practical - I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code:</b> <b>M23UBCGEP1</b>	<b>BIOCHEMISTRY</b>	<b>Contact hour</b> <b>per week: 3</b>

### Objectives

- To preparation of buffer solution (Phosphate, Acetate and Citrate) and determination of pH
- To quantify the number of biomolecules by titration and colorimetric methods in the sample.
- To give hands on training on qualitative analysis of biomolecules, paper chromatography, thin layer chromatography

### Course Outcomes

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Preparation of buffer with different pH	K3
CO2	Preparation of starch from potato and caesin from milk	K4
CO3	Qualitatively analyze the carbohydrate, amino acid samples by simple color reactions	K4
CO4	Measure the amount of amino acid in sample by titration method	K3
CO5	Quantitatively measure the amount of reducing sugar in sample	K4
CO6	Estimate the ascorbic acid	K4
CO7	Measure the amount of protein and cholesterol level of sample	K3
CO8	Separate amino acid by paper and thin layer chromatography	K4

1. Distinguish between aliphatic and aromatic compounds.
2. Distinguish between Saturated and unsaturated compounds
3. Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose & starch.
4. Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine, Proline and Cysteine

5. Estimation of Glycine- Formal Titration
6. Determination of Ascorbic acid – DCPIP method.
7. Estimation of glucose – DNS Method
8. Estimation of Cholesterol- Zak's method
9. Estimation of proteins – Bradford's method
10. Preparation of buffer solution (Phosphate, Acetate and Citrate) and determination of pH.
11. Estimation of starch from potato.
12. Preparation of casein from milk.
13. Determination of Acid number.
14. Determination of specific activity of salivary amylase enzyme
15. Estimation of ascorbic acid by 2,6 Dichloro phenol Indophenol method
16. Qualitative analysis of carbohydrates
17. Qualitative analysis of amino acids
18. Estimation of amino acid by formal titration method
19. Estimation of reducing sugar by DNS method
20. Estimation of protein by Biuret method
21. Estimation of cholesterol by Zak's method
22. Separation of amino acid by paper and thin-layer chromatography

**TEXT BOOK:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Practical Clinical Biochemistry	Harold Varley	CBS publications	2005

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	An Introduction To Practical Biochemistry	David Plummer	Tata McGraw Hill Education	2006
2.	Laboratory Manual For Practical Biochemistry	Shivaraja Shankara	Jaypee Brothers Medical Publishers	2013
3.	Practical Biochemistry	Damodaran Geetha K	Jaypee Brothers Medical Publisher	2016

## Non-Major Elective Courses Offered for other major Students

### SEMESTER-I

<b>NME-I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code: M23UBTN01</b>	<b>AGRICULTURAL BIOTECHNOLGY</b>	<b>Contact hour per week:2</b>

#### **Objectives**

To introduce the principles, practices and application of agricultural biotechnology.

#### **Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Describe the fundamental principles of crop improvement, hybridization and plant breeding, micro-propagation and plant tissue culture technique	K1 & K3
CO2	Understand the mechanism of biological nitrogen fixation, production of bio-fertilizers and applications	K2
CO3	Knowledge about microbes-based bio-fertilizers and bio-pesticides	K3
CO4	Develop a deeper understanding of biodiversity and biosafety	K1
CO5	Understand the role of Transgenic plants in quality modifications, and its current status	K1

#### **UNIT-I**

**6hrs**

Introduction to Agricultural biotechnology. Crop improvement hybridization and plant breeding techniques. Micropropagation and plant tissue culture technique and its application in agriculture. Somatic hybridization, haploid production and cryopreservation.

#### **UNIT-II**

**6hrs**

Mechanism of biological nitrogen fixation process. Production of biofertilizers and applications of rhizobium, azotobacter, azolla and mycorrhiza. Use of plant growth regulators in agriculture and horticulture.

**UNIT-III****6hrs**

Microbes based Biofertilizers: *Azolla* and *Anabena*, *Rhizobium*, *Azotobacter*, *Azospirillum*, *Mycorrhiza*. Biopesticide – Trichoderma, BT and NPV.

**UNIT-IV****6hrs**

Biodiversity Legislation in India; Indian Biodiversity Act and provisions on crop genetic resources. Convention on Biological Diversity (CBD) and Cartagena protocol on Biosafety. Conservation strategies for seed gene bank; Impact of GE crops on Biodiversity.

**UNIT-V****6hrs**

Transgenic plants in quality modifications–Starch, Oil, Protein, and Golden Rice. Current status of transgenics, Biosafety norms and controlled field trails and release of transgenic (GMO).

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Environmental microbiology	Grant W.D. and Long P. E	Springer	1981
2.	Handbook on Agriculture, Biotechnology and development	Stuart J. Smyth, Peter W.B. Phillips, David Castle	Edward Elgar Publishing Inc.	2014

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Agricultural Biotechnology	Kumar HD	Daya Publishing house	2005
2.	Agricultural Biotechnology	Rajmohanjoshi	Isha Books, Delhi	2006
3.	Text book of Agricultural Biotechnology	AhindraNag	PHI Learning Private Limited, New Delhi	2008

### Mapping with Programme Specific Outcomes

<b>Cos</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	S	S	S	M	M
<b>CO2</b>	S	M	S	M	M
<b>CO3</b>	S	S	S	S	S
<b>CO4</b>	S	M	M	M	M
<b>CO5</b>	M	M	S	S	M

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

**SEMESTER-II**

<b>NME-II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code: M23UBTN02</b>	<b>PUBLIC HEALTH AND HYGIENE</b>	<b>Contact hour per week:2</b>

**Objectives**

To focus on health, maintenance of body weight, dieting. To knowledge about personal hygiene, food contamination, role of international control of health and WHO.

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Describe the basic concept of health and ecology of health	K1
CO2	Understand the concept of body weight, BMI and diet	K2
CO3	Describe the necessity of exercise, weight control and dieting	K3
CO4	Understand the basic knowledge about hygiene, food contamination, methods of disease transmission	K2
CO5	Understand the importance of eating, drinking, lightening, WHO	K2

**UNIT-I****6hrs**

Health definitions of health, dimensions of health, concept to wellbeing, determinants of health, and ecology of health.

**UNIT-II****6hrs**

Body weight and composition for Health and Sports – Ideal body weight, values and limitations of the BMI, composition of the body; Diet during training, dietary supplements for athletes.

**UNIT-III****6hrs**

Exercise and Health-related fitness-Health-related fitness, physical activity for health benefits, types of exercise, effective weight control-dieting or exercise.

**UNIT-IV****6hrs**

Hygiene-Meaning and importance; Hygienic practices of employees, personal hygiene and contamination of food products, methods of disease transmission.

**UNIT-V****6hrs**

Drug Abuse and health laws – Hygiene of eating and drinking, Ventilation and lighting, Health laws for food safety and hygiene, international control of health, WHO, Health destroying habits and addictions - Pan, Ganja, Drinking, Smoking, Tea and Coffee.

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Principles of food sanitation	Marriott, G. Norman	Van Nostrand Reinhold company, New York	1985
2.	Catering management- Anintegrated approach	Sethi,M. and Matha,S.,	Wiley EasternLtd., New Delhi.	
3.	Test book of preventive and social medicine	K. Park	15 <sup>th</sup> edition, MIS Banarsidas Bhano Publishers, Jabalpur	1997.
4.	Nutrition for Health, fitness and Sports	Melvin H. Williams	7 <sup>th</sup> edition, MC Graw Hill international Edition	2005
5.	Nutrition and Metabolism	Michael J.Gibney, Ian A Macdonald and Helen M.Roche	Blackwell Publishing company, Bangalore	2008

**Mapping with Programme Specific Outcomes**

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
<b>CO1</b>	S	S	M	M	S
<b>CO2</b>	S	S	M	S	S
<b>CO3</b>	M	S	S	S	S
<b>CO4</b>	S	S	S	M	S
<b>CO5</b>	S	M	S	S	S

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

**SEMESTER III**

<b>Core Course III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT03</b>	<b>IMMUNOLOGY AND IMMUNOTECHNOLOGY</b>	<b>Contact hour per week: 5</b>

**Objectives**

- To provide knowledge about the immune cells and their mechanism and antigen - antibody reactions.
- To design a model of Immunoglobulin/Antibodies.
- To illustrate various mechanisms that regulate immune responses and maintain tolerance and the adverse effect of immune system including Allergy.

**Course Outcomes**

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

CO1	List out the role of immune cells and their mechanism in body defense mechanism.	K1
CO2	Demonstrate the antigen -antibody reactions in various immune techniques.	K2
CO3	Distinguish the Antigen -Antibody interactions and to demonstrate immunological techniques.	K3
CO4	Analyze the production of vaccines.	K3
CO5	Enumerate the immune associated disease, hypersensitivity reactions.	K4

**Unit I****15Hrs**

Introduction to Immunology. Cells involved in immune response. Primary and Secondary lymphoid organs – Thymus, Bone marrow, Lymph nodes and Spleen. Hematopoiesis – development of B and T lymphocytes. Types of immunity – Innate and acquired.

**Unit II****15Hrs**

Antigen: Characteristics and types. Antibody – Structure, Types, Properties and their Biological Function. Production of antibodies- Hybridoma technology: Applications of Monoclonal antibodies in biomedical research.

**Unit III****15Hrs**

Antigen – Antibody interactions, Immunodiffusion and Immunoelectrophoresis. Principle and application of ELISA and RIA and Fluorescent antibody technique and Western Blotting. Purification of antibodies.

**Unit IV****15Hrs**

The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of C' proteins. Cytokines- Structure and Function. Vaccines – Types, Production and application.

**Unit V****15Hrs**

Hypersensitivity Reactions and Types. Major Histocompatibility Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing.

**TEXT BOOK:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Cellular and Molecular Immunology	Jordon s pober	Saunders Elsevier Publications, Philadelphia	2010
2.	Instant Notes In Immunology	lydgard P M et al. et al.	New Age International	1996
3.	Immunology.,	Kannan, I.	MJP Publishers Chennai	2010

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Essential Immunology, 12th edition,	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt,	Wiley- Blackwell. USA.	2011
2.	Kuby Immunology	Thomas J. Kindt, Barbara A. Osborne and Richard A Goldsby	6th edition, W. H. Freeman and Company	2006
3.	The Experimental Foundations of Modern Immunology. 3 <sup>rd</sup> Edition.	William R Clark.	John Wiley and Sons Inc. New York.	1991

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	S	M	S	M
<b>CO2</b>	M	S	S	S	S	M
<b>CO3</b>	M	S	M	M	M	S
<b>CO4</b>	S	M	M	M	M	S
<b>CO5</b>	M	M	S	M	S	S

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

**SEMESTER III**

<b>Generic Elective III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTGE3</b>	<b>BIOINSTRUMENTATION</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To exemplify the structure of atoms and molecules by using the principles of Spectroscopy.
- To evaluate by Separating and purifying the components and the applications of imaging techniques.
- To categorize the working principle and applications of fluorescence and radiation-based techniques.

**Course Outcomes**

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

CO1	Practice, experiment with and apply the basic instruments in the laboratory.	K3
CO2	Summarize the functionality of Beer – Lambert’s law in identifying and quantifying a biomolecule.	K1
CO3	Classify the various separation techniques for separating biomolecules based on chromatography and electrophoretic techniques.	K2
CO4	Examine the clinical important isotopes and detection of isotopes.	K4
CO5	Elucidate the separation techniques for separating biomolecules using centrifugal force by centrifugation.	K4

**Unit I****9Hrs**

pH – Definition – pH meter. Measurement of pH and calibration of pH meter - Buffers – Preparation of Buffers. Microscopy: Principle and applications of Compound, Bright field, Phase contrast and Fluorescence Microscope.

**Unit II****9Hrs**

Spectra – Absorption and Emission Spectra – Beer Lambert’s law – Colorimeter, UV-Visible Spectrophotometer. Mass spectroscopy - Atomic absorption spectrometer (AAS) - Nuclear magnetic resonance spectrometer (NMR).

**Unit III****9Hrs**

Chromatography - Principles – Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography Gas Liquid Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis –Agarose Gel Electrophoresis – SDS- PAGE and Iso-electric focusing.

**Unit IV****9Hrs**

Radioactivity – Isotopes – Clinically important isotopes – Measurement of Radioactivity – GM Counters, Scintillation Counters – Autoradiography – Applications.

**Unit V****9Hrs**

Centrifugation – Principles - RCF, Sedimentation concept - - Different types of centrifuge – Types of rotors – Centrifugation types: Differential and Density gradient centrifugation – Ultra Centrifuge.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biophysical Chemistry, Principles and Techniques	Upadhyay and UpadhyayNath.	Himalaya Publishing House	2009
2	Bioinstrumentation	L.Veerakumari	Kindle Edition	2006
3	Instrumental Methods of Analysis	Skoog D.A.F. James Holler and Stanky, R.Crouch,	Cengage Learning	2007
4	Analytical Biochemistry & Separation Techniques	Palanivelu P	Twenty first century publications.	2000
5	Understanding Bioinstrumentation	Prakash M	Discovery Publishing House Pvt Ltd	2009

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Principles and techniques of Biochemistry and Molecular Biology	Keith Wilson, John Walker	Cambridge University Press	2010
2.	Principles of Biochemistry	David L. Nelson, Michael M Cox. Lehninger	W.H. Freeman, Newyork	2008
3.	Handbook of Biomedical Instrumentation	Khandpur R S	McGraw Hill Education	2014
4	Principles of Applied Biomedical Instrumentation	L.A Geddes and L.E. Baker	Wiley-India	2008
5	Instrumental Methods of Chemical Analysis	Sharma B K	GOEL Publishing House	2005

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	S	M	S	S
<b>CO2</b>	S	S	M	S	S	M
<b>CO3</b>	M	M	S	M	M	S
<b>CO4</b>	S	M	S	S	M	S
<b>CO5</b>	S	M	S	M	S	S

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

**SEMESTER III**

<b>Core Course Practical-III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTP03</b>	<b>IMMUNOLOGY AND IMMUNOTECHNOLOGY</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To acquire skills in instrument handling, develop practical skill in immunology and acquire skills in separation techniques
- To examine and analyzing the blood cells and its type (RBC and WBC)
- To demonstrate about handling of laboratory animals and ELISA techniques

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Perform blood grouping and determine blood type.	K3
CO2	Able to count WBC and RBC.	K4
CO3	Conduct serological diagnostic tests such as ASO, CRP, RA and Widal test.	K4
CO4	Acquire technical skills required for immunodiffusion and know the principle behind the techniques.	K4
CO5	Able to Demonstrate ELISA, Handling of Laboratory animals.	K3

1. Separation of serum and plasma.
2. Blood grouping and Rh typing.
3. WBC counting.
4. RBC counting.
5. Differential blood count.
6. WIDAL slide test.
7. ASO test.
8. Double Immunodiffusion.
9. Single Radial Immunodiffusion.

10. ELISA- Demonstration.

11. Handling of laboratory animals- Demonstration.

12. Skin test- Demonstration.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Hand Book of Practical and Clinical Immunology	Talwar	CBS	2006
2	Immunology Theory and Practical	Asim Kumar Roy	Kalyani Publications.	2019

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Practical Immunology	Frank C. Hay, Olwyn M. R. Westwood.	Wiley-Blackwell	2008
2	Manual of Clinical Lab Immunology	Rose	ASM.	1992
3	Immunology Lab Manual	Wilmore Webley	LAD Custom Publishing	2016
4	Immunobiology- the immune system in health and disease.	Janeway Travers.	Current Biology Ltd	1997
5	Roitt's Essential Immunology	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt.	Wiley-Blackwell	2006

**SEMESTER III**

<b>Generic Elective Practical-III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTGEP2</b>	<b>BIOINSTRUMENTATION</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To demonstrate the basics of instrumentation by analysis and acquire skills in handling instruments and in separation techniques.
- To acquire skills on electrophoresis technique- SDS-PAGE
- To provide the handling techniques of fraction of biomolecules by centrifuge techniques.

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Practice, experiment with and apply the basic instruments in the laboratory such as weighing balance, pH meter, shaker, incubator etc. in various research processes.	K3
CO2	Predict the functionality of Beer – Lambert’s law in identifying and quantifying biomolecules.	K4
CO3	Employ the separation techniques for separating biomolecules based on paper chromatography.	K4
CO4	Employ the separation techniques for separating biomolecules based on Thin layer chromatography.	K3
CO5	Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.	K4

1. Preparation of buffer (Phosphate Buffer)
2. Determine of pH of biological samples using pH meter.
3. UV spectra of nucleic acids and protein.
4. Chromatography analysis of sugar, amino acids, lipids by paper and thin layer chromatography.
5. Electrophoresis technique- SDS-PAGE.

6. Fractionation of biological material into its various components by centrifuge.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Abstract Laboratory Manual for Bio-instrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology	Himanshu Sharma and Pramod K. Singh	Sharda University	2018
2	Analytical techniques in Biotechnology – A complete laboratory manual	Bhomwik	MGH Publisher	2011

**REFERNCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Analytical Biochemistry and Separation techniques – A laboratory manual	P. Palanivelu	Twenty first century publishers	2017

**SEMESTER III**

<b>SEC-IV</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code: M23UBTS02</b>	<b>BIOETHICS AND BIO-SAFETY</b>	<b>Contact hour per week:2</b>

**Objectives**

- To understand and apply Human rights in National and International level.
- To learn about the bioethical issues in Assisted reproductive techniques and in the field of biotechnology.
- To impart the knowledge about patents, copyrights and biosafety guidelines.

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Recall about the classification and scope of human rights.	K1
CO2	Understand the impact of gene cloning in societal problems	K2
CO3	Categorize the ethical aspects related to biological, biomedical, health care and biotechnology research.	K3
CO4	Summarize about the patent and copyrights.	K2
CO5	Elucidate about the Biosafety and GLP guidelines	K4

**UNIT-I****6Hrs**

Human Rights: Definition, Classification and Scope of Human Rights. United Nations Commission for Human Rights, National and State Human Rights Commission. Article 21 of Indian Constitution – UDHR. Social issues of Human rights.

**UNIT-II****6Hrs**

Impact of gene cloning & Bioethics-Issues concerning reproduction, Birth, life and Death (Artificial insemination, egg donation, IVF, embryo transplants, Prenatal diagnosis and sex selection & Abortion).

**UNIT-III****6Hrs**

Bioethics of IPR - ethical criteria in biotechnology- animal ethics; Licensing of animal house - Human cloning - Ethical issues - Ethical clearance norms for conducting studies on human subjects.

**UNIT-IV****6Hrs**

Patents - Introduction -Treaties and Conventions of Patents, Patent Cooperation Treaty - TRIPS Basis of Patentability – Non-Patentable Inventions - Patent Application Procedure in India. Other Forms of IP: Copyright - Trade Mark – Industrial designs – Farmer’s Rights. Patenting of Biotechnology products and processes.

**UNIT-V****6Hrs**

Biosafety - General guidelines - Risk assessment studies- Hazardous materials used in Biotechnology- Handling and Disposal - Good Laboratory practices & Good manufacturing practices, Containment facilities and Biosafety practices - Regulation on field experiments and release of GMO’s - Labelling of GM foods - Guidelines for research in transgenic plants and Animals.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Bioethics	Ignacimuthu, S	Narosa Publication house	2009
2.	Bioethics and Biosafety in Biotechnology	V. Sree Krishna .	New Age International	2007
3.	International Human rights	Rhona Smith	Blackstone Press.	2003

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biosafety	Trayer, P.C, Fredrick.R., and Koch, M.	Michigan State University	2002
2.	Contemporary issues in Bioethics,	Beauchamp & Leroy	Wardsworth Pub. Co. Belmont	1999
3.	Biotechnology and safety assessment	John.A.Thomas	Blackstone Press.	2004

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	S	M	S
<b>CO2</b>	M	M	S	S	S	M
<b>CO3</b>	M	S	M	S	S	S
<b>CO4</b>	S	M	S	M	S	S
<b>CO5</b>	M	S	S	S	M	M

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

**SEMESTER III**

<b>SEC-V</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code: M23UBTS03</b>	<b>BIO-ENTREPRENEURSHIP</b>	<b>Contact hour per week:2</b>

**Objectives**

- To identify the challenges of being a Bioentrepreneur and Business proposal for starting a company
- To learn about Vermicomposting and Sericulture and Mushroom Cultivation
- To learn the technique of Single cell protein Cultivation

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	To be familiar with the different schemes offered by Government institutions to support entrepreneurs and also provides the basic knowledge on project proposal preparation, feasibility analysis, execution and management.	K1
CO2	To have a fundamental idea about the principles of management, learn to make a business proposal, arrange for financial resources and maintenance of business establishment by accounting practices and other essential concepts required for executing a business plan.	K2
CO3	Understand the entrepreneurial process of vermicomposting and sericulture	K3
CO4	Able to understand the techniques of Mushroom Cultivation	K2
CO5	To know the technique of Single cell protein Cultivation	K4

**UNIT-I****6Hrs**

Basics of Bio entrepreneurship -Biotechnology in a Global scale; types of Bio-industries – Biopharma, Bioagri and Bioservice innovations – Successful Entrepreneur – Creativity, Leadership, Managerial skills, Team building, Decision making; Public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India)

**UNIT-II****6Hrs**

Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. Market Conditions, Identifying the need of the customers.

**UNIT-III****6Hrs**

Vermicomposting–Earthworms-Ecologicaltypes-Vermiculture-Compostpit-Vermi bed- applications. Sericulture-Mulberry Cultivation-Silk worm Rearing-Economics of silkworm Production-Chawki Rearing-Sericulture in India.

**UNIT-IV****6Hrs**

Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting; Mushroom diseases, Medicinal and Nutritional properties of mushroom. Aquaponics- Systems-Fish and Vegetables-Nutrients and Biofilters-Advantages and Disadvantages.

**UNIT-V****6Hrs**

Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: Spirulina Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biotechnology entrepreneurship: Starting, managing, and leading biotech companies.	Shimasaki, D.	Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.	2014
2.	Contemporary issues in Bioethics,	Beauchamp & Leroy	Wardsworth Pub. Co. Belmont	1999

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biosafety	Trayer, P.C, Fredrick.R., and Koch, M.	Michigan State University	2002
2.	Biotechnology and safety assessment	John.A.Thomas	Blackstone Press.	2004

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	S	M	S
<b>CO2</b>	M	S	S	M	S	M
<b>CO3</b>	M	S	M	S	S	S
<b>CO4</b>	S	M	S	M	S	S
<b>CO5</b>	M	S	S	S	M	M

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

## SEMESTER IV

<b>Core Course IV</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT04</b>	<b>GENETIC ENGINEERING AND rDNA TECHNOLOGY</b>	<b>Contact hour per week: 5</b>

### Objectives

- To demonstrate the basic principles of genetic engineering techniques and illustrate the specificity of vectors for cloning and advantages and molecular markers identification
- To understand Gene transfer techniques by Viral and Nonviral mediated gene transfer mechanisms.
- To exhibit knowledge in sequencing technologies and protein engineering techniques and the strategies of Recombinant DNA Technology in r medicine, Industry and agriculture.

### Course Outcomes

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

CO1	Identify the molecular cloning strategies and techniques used to probe DNA for specific genes of interest	K1
CO2	Summarize the tools and techniques in rDNA technology and types of Vectors	K2
CO3	Relate the role of restriction and modifying enzymes in recombinant DNA Technology	K3
CO4	Compare the techniques involved in construction of genomic DNA library and cDNA library	K4
CO5	Apply the protocols for analyzing gene transfer methods and to explore knowledge on hybridization-based markers	K3

### UNIT-I

**15Hrs**

Genetic Engineering – Introduction, Tools in recombinant DNA technology – recombinant DNA – cloning strategies (enzymes, vectors, host) – Introduction of rDNA into host cells.

**UNIT-II****15Hrs**

Identification, selection and screening for Recombinants. DNA sequencing - Construction of Genomic DNA library and cDNA library), Chromosome walking. Human Genome Project. Polymerase Chain reaction- Methodology and its Types.

**UNIT-III****15Hrs**

Gene transfer techniques – Viral mediated gene transfer, Selectable markers and reporter genes - Non viral mediated gene transfer - Physical methods: Microinjection - Electroporation - Particle Bombardment, Chemical methods: Calcium phosphate - DEAE dextran - Liposomes

**UNIT-IV****15Hrs**

Gene Expression – Expression system and their applications - protein based products – Protein engineering– production of protein from cloned genes. Site directed Mutagenesis, Restriction Fragment Length Polymorphism (RFLP).

**UNIT-V****15Hrs**

Application of Recombinant DNA technology in medicine, industry, agriculture and r-DNA technology - merits and demerits.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Gene Cloning and DNA Analysis: An Introduction	Brown T.A	Wiley - Blackwell	2015
2	An Introduction to Genetic Engineering	Desmond S.T. Nicholl	Cambridge university press	2008
3	Principles of Gene Manipulation	R.W. Old & S.B. Primrose	Blackwell Science.	2013

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	From Genes to Clones Introduction to Gene Technology	Ernst L Winnacker	Panima Publising Corporation	2018
2	Introduction to Gene Cloning	Anton Byron	Oxford Book Company	2019
3	Recombinant DNA technology	Monika Jain	Alpha Science International	2012
4	Principles of gene manipulation	Primrose.S.B	Blackwell Scientific limited	2014

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	S	S	M	S
<b>CO2</b>	S	M	M	S	S	M
<b>CO3</b>	M	M	S	S	S	S
<b>CO4</b>	S	S	S	S	M	S
<b>CO5</b>	M	S	S	S	M	S

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

**SEMESTER IV**

<b>Generic Elective IV</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTGE4</b>	<b>BIOINFORMATICS AND BIOSTATISTICS</b>	<b>Contact hour per week:3</b>

**Objectives**

- To acquire knowledge about the Developments, Applications of Bioinformatics databases, tools and software of bioinformatics and explain different types of Biological Databases.
- To understand the basics of sequence alignment, sequence analysis and Protein structure prediction method.
- To correlate and analyze biological data through various statistical methods and interpret biological data via various probabilistic distribution methods.

**Course Outcomes**

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

CO1	State fundamentals of DNA databank, protein data bank and sequence alignment tool	K1
CO2	Compare the handling biological databases and analysis.	K2
CO3	Analyze the phylogenetic analysis and molecular docking.	K3
CO4	Understand the practical skills in Statistics	K2
CO5	Correlate the measures of central tendency like mean median-mode	K4

**UNIT-I****9Hrs**

Introduction to Bioinformatics – Genome, Transcriptome and Proteome, Gene prediction rules and software. Nucleic acid Databases – Primary and Secondary Databases – Structure Database – CATH, SCOP – Data base Searching – BLAST and FASTA, BLOSSUM.

**UNIT-II****9Hrs**

Sequence analysis (Proteins and Nucleic acids), Comparison of Protein sequences and Database searching – methods for protein structure prediction - Homology modeling of proteins, visualization tools (RASMOL).

**UNIT-III****9Hrs**

Multiple Sequences alignment – methods- Evolutionary analysis, clustering. Phylogenetic trees - Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis. History of Drug Discovery- Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.

**UNIT-IV****9Hrs**

Statistics – collection, classification, tabulations of Statistical Data – Diagrammatic representation – Graphs – Sampling method and standard error. Measures of central tendency – measures of dispersion

**UNIT-V****9Hrs**

Correlations and regression. Probability distribution-Binomial, Negative binomial, multinomial distribution, Poisson distribution. Tests of significance – t tests – F tests – Chi square test. Analysis of variance – Statistical Soft wares.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Proteomics: from protein sequence to function	Pennington, S.R. and Punn, M.J.	Viva books Pvt. Ltd	2002
2.	Bioinformatics methods and application.	Rastogi, S.C, Mendiratta, N,Rastogi, P	Prentice-Hall of India private limited	2004
3.	An Introduction to Biostatistics	N.Gurumani	MJP Publishers	2011
4.	Fundamentals of Biostatistics	VerbalaRastogi.	Ane books Pvt Ltd Publisher	2011

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Introduction to Bioinformatics	Attwood, T.K. and Parry-Smith, D.J	Pearson Education.	2008
2	Bioinformatics: sequence and genome analysis	David Mount	Taylor &Francis, UK	2009
3	Instant Notes in Bioinformatics	D.R.Westhead	Taylor &Francis, UK	2009
4	Biostatistical Analysis	Zar J H	Pearson Education Pvt Ltd	2010
5	Biostatistics	P.N.Arora and P.K. Malhan	Himalaya publishing House	2013

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	S	M	M	S
<b>CO2</b>	S	M	S	M	S	S
<b>CO3</b>	S	S	S	M	S	M
<b>CO4</b>	S	S	M	S	M	S
<b>CO5</b>	S	S	M	M	S	S

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

**SEMESTER IV**

<b>Core course Practical-IV</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTP04</b>	<b>GENETIC ENGINEERING AND rDNA TECHNOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To isolate the Genomic, Plasmid DNA and RNA.
- To predict the molecular weight of DNA by agarose gel electrophoresis.
- To demonstrate working principles of PCR, RFLP and other important Genetic Engineering techniques.

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	Gain knowledge on isolation techniques	K3
CO2	Learn about gene transfer mechanism	K4
CO3	Prepare the competent cells and perform bacterial transformation.	K4
CO4	Determine the restriction digestion of DNA	K3
CO5	Determine the restriction fragment length polymorphism.	K4

1. Isolation of genomic DNA
2. Isolation of plasmid DNA
3. Isolation of RNA
4. Types of vectors
5. Production of competent cells for transformation
6. Bacterial transformation
7. Restriction Digestion of DNA
8. Restriction fragment length polymorphism (DEMO)
9. PCR (DEMO)

**TEXT BOOK:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Laboratory Manual for Genetic Engineering	S. John Vennison	Kindle Edition	2009

**SEMESTER IV**

<b>Generic elective</b> <b>Practical-II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code:</b> <b>M23UBTGEP2</b>	<b>BIOINSTRUMENTATION</b> <b>BIOINFORMATICS AND</b> <b>BIOSTATISTICS</b>	<b>Contact hour per</b> <b>week:3</b>

**Objectives**

- To analyze the biological databases and able to perform BLAST and FASTA.
- To represent data in to graphical form and test the level of significance of biological data and interpret the results.
- To calculate the dispersion using MS EXCEL

**Course Outcomes**

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

<b>CO Number</b>	<b>CO Statement</b>	<b>Knowledge Level</b>
CO1	To know about the biological databases	K3
CO2	To know about binding proteins	K4
CO3	Learn about MS excel	K3
CO4	Data Analysis and Interpretation	K4
CO5	Determine averages of the biological data	K4

1. Biological database (NCBI, Swissprot and PDB)
2. BLAST, FASTA, ORF
3. Identification of functional domains in nucleotide binding proteins using a domain analysis server like SMART.
4. Preparation of bar diagram, line diagram, pie diagram using MS EXCEL.
5. Calculation of central tendency- mean, geometric mean, median using MS EXCEL.
6. Calculation of dispersion- mean deviation, quartile deviation and standard deviation using MS EXCEL.
7. Calculation of student's test using MS EXCEL.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Proteomics: from protein sequence to function	Pennington, S.R. and Punn, M.J.	Viva books Pri. Ltd	2002
2.	Genotype to phenotype	Maleolm and Goosfship. J	Bios Scientific Publishers Ltd	2001
3.	Bioinformatics: Methods and Protocols.	Misener, S. and Krawetz. S. A	Humana press.	2000
4.	Introduction to Bioinformatics	Attwood, T.K. and Parry-Smith, D. J	Pearson Education Asia	1999
5.	Principle of genome analysis	Primrose, S. B	Blackwell Science	1998

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biological sequence analysis.	Durbin, R., Eddy, S., Krogh, A. and Mitchison, G.	Cambridge University Press.	1998
2.	Computers and Machine: Evaluation methods in medicinal information	Friedman, C.P. and Wyatt. J.C.	Springer-verlag	1997

**SEMESTER IV**

<b>Skill Enhancement Course-VI</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code: M23UBTS04</b>	<b>FUNDAMENTALS OF RESEARCH METHODOLOGY</b>	<b>Contact hour per week:2</b>

**Objectives**

- To familiar with Introduction, types and methods of research.
- To learn about Statistical sampling and Data Analysis and know about research investigation questions.
- To impart knowledge on layout, impact factor, ethical issues related to publishing and methods to search required information.

**Course Outcomes**

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

CO1	Recite idea of research among students, understand the existing social issues in research, frame hypothesis, design the wet lab procedures and interpret the results.	K1
CO2	Illustrate about Introduction, types and methods of research.	K2
CO3	Simplify the skills of scientific reading, writing and presentations of research	K3
CO4	Analyze the mechanism of separation and imaging techniques	K4
CO5	Brief out the statistical analysis of biological data	K4

**UNIT-I****6Hrs**

Objectives, Motivation to perform research. Types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature- review and its consolidation; Library research; field research; laboratory research.

**UNIT-II****6Hrs**

Basic concepts of Statistical sampling methods, Sample Size, Sampling Frame, Sampling Error, Characteristics of a good sample, Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages)

**UNIT-III****6Hrs**

Research Question & Investigation Question, Hypothesis, Qualities of a good Hypothesis, features of a good research design, Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

**UNIT-IV****6Hrs**

Layout of a Research Paper, Journals in Life Science, Impact factor of Journals, Ethical issues related to publishing: Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

**UNIT-V****6Hrs**

Methods to search required information effectively, Reference Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Softwares for detection of Plagiarism.

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Research methodology	C R Kothari	New age International publishers	2023

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Research methodology and Biostatistics	Suresh K sharma	Elseiver, India	2016

**Mapping with Programme Specific Outcomes**

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
<b>CO1</b>	M	S	S	M	M	M
<b>CO2</b>	S	M	M	M	S	S
<b>CO3</b>	S	M	S	M	S	M
<b>CO4</b>	S	S	M	S	M	S
<b>CO5</b>	M	S	S	S	M	S

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

**SEMESTER IV**

<b>Enhancement Compulsory Course</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 2</b>
<b>Course Code: M23UES01</b>	<b>ENVIRONMENTAL STUDIES</b>	<b>Contact hour per week:2</b>

**Objectives**

- To provide a general outline on ecosystem, ecological succession and natural resources.
- To understand about biodiversity and its conservation in National and global level.
- To analyze the source, causes of environmental pollution and its Environmental laws and regulation.

**Course Outcomes**

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

CO1	Recall the scope, functions and energy flow of the ecosystem.	K1
CO2	Compare and contrast about renewable and non-renewable resources.	K2
CO3	Summarize the hotspots and conservation of biodiversity on National and global level	K2
CO4	Distinguish between different sources and effects of environmental pollution	K3
CO5	Brief out the social issues and environment protection act.	K4

**UNIT-I****6Hrs**

Environment – definition – scope – structure and function of ecosystems- producers, consumers and decomposers - energy flow in the ecosystem - ecological succession – food chain, food webs and ecological pyramids – concept of sustainable development.

**UNIT-II****6Hrs**

Natural resources: renewable - air, water, soil, land and wildlife resources. Non – renewable – mineral coal, oil and gas. Environmental problems related to the extraction and use of natural resources.

**UNIT-III****6Hrs**

Biodiversity – definition – values – consumption use, productive social, ethical, aesthetic and option values threats to bio diversity – hotspots of bio diversity – conservation of bio - diversity: *in - situ, ex - situ*. Bio – wealth - National and global level.

**UNIT-IV****6Hrs**

Environmental Pollution: definition – causes, effects and mitigation measures – air pollution, water pollution, soil pollution noise pollution, thermal pollution – nuclear hazards– solid wastes, acid rain – climate change and global warming. Environmental laws and regulations in India.

**UNIT-V****6Hrs**

Social Issues and the Environment - urban problems related to energy. Water conservation, rain water harvesting, watershed management, wasteland reclamation, Environment Protection Act- Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act, wildlife Protection Act, forest Conservation Act.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Environmental Studies	Kumarasamy K	Bharathidasan University	2005
2.	Environmental Studies	Anubha Kaushik	New Age International Publishers, NewDellhi	2012
3.	Environmental Studies	Sushmita Baskar and R. Baskar	Unicorn Books Publishers	2007
4.	Textbook of Environmental Studies	Erach Bharucha	Second edition Orient Black Swan Publishers	2013

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Environmental Pollution: Causes, Effects and Control.	K.C. Agarwal	Nidhi Publishers (India), Bikanir.	2001
2.	Essentials of Ecology and Environmental Sciences	S.V.S.Rana	Prentice Hall of India Private Limited, New Delhi, India.	2005
3.	Modern Concepts of Ecology	H.D.Kumar	Vikas Publishing House Private Ltd.	1982
4.	Environmental Studies	Sanjay Kumar Batra, Kanchan Batra, Harpreet Kaur and Parul Pant	Taxmans publication	2018
5.	Ecology: From Individuals to Ecosystems	Michael Begon, Colin R. Townsend, and John L. Harper	Blackwell Publishing company	2006

**SEMESTER V**

<b>Core Course V</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT05</b>	<b>PLANT BIOTECHNOLOGY</b>	<b>Contact hour per week:5</b>

**Objectives**

- To explore the history of Plant Biotechnology and state the importance of organization of plant genome
- To illustrate about mechanism of plant hormones, various culture medium preparations for plant production and its applications.
- To gain knowledge about vector for gene transfer to produce transgenic plants and develop molecular techniques for crop improvement.

**Course Outcomes**

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

CO1	State the techniques of Plant Tissue Culture lab organization & measures adapted for aseptic manipulation	K1
CO2	Classify the different types of plant hormone and their molecular action.	K2
CO3	Elaborate the media composition and micropropagation techniques	K3
CO4	Examine the methods of gene transfer, molecular markers and marker assisted selection	K4
CO5	Apply the transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement	K4

**UNIT-I****15Hrs**

History of plant biotechnology, Conservation of Plant using Biotechnology. Plant genome organization: structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome and mitochondrial genome.

**UNIT-II****15Hrs**

Auxins, cytokinins and gibberlins – molecular basis of action – phytochrome – role in photomorphogenesis – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening.

**UNIT-III****15Hrs**

Media composition (MS media) - Micropropagation techniques - direct and indirect organogenesis - somoclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation, fusion and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.

**UNIT-IV****15Hrs**

Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Ti and Ri Plasmid vectors and their utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia, nif gene.

**UNIT-V****15Hrs**

Crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Transgenic plants- plant vaccines, genetically modified organisms - future perspectives & ecological impact of transgenic plants.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Applied Plant Biotechnology	Chopra V L; Malik V S; Baht R	Dominant publishers and distributors.	2000
2.	Applied Plant Biotechnology.	Ignacimuthu.	Tata McGraw – Hill.	1996
3.	Plant cell and tissue culture	Narayanaswamy S	Tata McGraw Hill Publishing Company limited	1994
4.	Introduction to Plant Biotechnology	Chawla, H.S	Science Publishers	2009

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Plant Biotechnology	Adrian Slater; Nigel Scott; Mark Fowler	Oxford University Press	2008
2.	Plant Biotechnology	Hammond J; Mcgarvey P; Yusibov V	Springer	2000
3.	Plant Biochemistry & Molecular Biology	Heldt HW	Oxford University Press	1997
4.	Plant tissue culture concepts and laboratory exercise	Trigiano, R.N. and Gray, D.J	CRC Press. BocaRatin	1996
5.	Plant tissue culture	Street, H.E	Blackwell Scientific Publications	1977

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	S	M	M	S
<b>CO2</b>	S	M	M	M	S	M
<b>CO3</b>	S	M	S	S	M	S
<b>CO4</b>	M	S	S	S	M	S
<b>CO5</b>	S	M	S	M	S	S

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

**SEMESTER V**

<b>Core Course VI</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT06</b>	<b>ANIMAL BIOTECHNOLOGY</b>	<b>Contact hour per week:5</b>

**Objectives**

- To understand the basic concepts of Animal cell culture and cell laboratory
- To describe the media preparation, maintenance, application of cell lines and discuss the strategies for gene
- To learn about stem cell technology in production of transgenic animals and Assisted reproductive technology.

**Course Outcomes**

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

CO1	List the basic patterns of animal cell culture and controlling characters	K1
CO2	Illustrate the media requirements for animal cell culture, properties of animal cell culture medium and maintenance of medium.	K2
CO3	Categorize the gene transfer technology and gene expression	K4
CO4	Compare the transgenic animal and stem cell technology	K3
CO5	Brief out the applications of animal biotechnology in various fields	K4

**UNIT-I****15Hrs**

Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipment's required for animal cell culture.

**UNIT-II****15Hrs**

Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation, Cell banking procedures. Biology of cultured cells- Apoptosis and cell death.

**UNIT-III****15Hrs**

Transfection of cells in culture- Animal viral vectors for transfection, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, Gene targeting, gene silencing and Gene knockout and their applications.

**UNIT-IV****15Hrs**

Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products -Transgenic Animals.

**UNIT-V****15Hrs**

Collection and preservation of embryos, Semen banking, AI, IVF and ICSI. Case Study-any two relevant studies.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Trends in Biotechnology	Ramasamy.P	University of Madras of Publications, Pearl Press	2002
2.	Basic Biotechnology	Ignacimuthu.	Tata McGraw-Hill.	1996
3.	Animal Biotechnology	K. Srivastava <i>et al</i>	Oxford & IBH Publishing Co. Pvt. Ltd.	2009
4.	In vitro Cultivation of Animal Cells (Biotol)	B.C. Currell <i>et al</i>	Butterworth-Heinemann Ltd.	1994
5.	Animal Biotechnology	Ranga M M	Agrobios	1899

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Culture of Animal cells – A Manual of Basic Technique	R. Ian Freshney	WILEY LISS & Publications	2002
2.	Molecular Biotechnology: Principle and applications of recombinant DNA	Glick, B.R. and Pasternark	Tata McGraw-Hill.	2002
3.	Recombinant DNA and Biotechnology: A guide for teachers	Kreuzer, H. and Massey, A	ASM Press Washington.	2001
4.	Biotechnology	Traven.	Tata McGraw – Hill.	2001
5.	Molecular biology and Biotechnology	Walker, J.M. and Gingold, E.B.	Panama Publishing Corporation.	1999

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	S	M	M	M
<b>CO2</b>	S	S	M	S	M	M
<b>CO3</b>	S	M	S	M	M	S
<b>CO4</b>	S	M	M	S	S	S
<b>CO5</b>	M	S	M	S	S	S

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

**SEMESTER V**

<b>Core Course VII</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT07</b>	<b>NANO BIOTECHNOLOGY</b>	<b>Contact hour per week:5</b>

**Objectives**

- To get an outline about Nano biotechnology and its research in India.
- To know about nanoparticles and their analysis using Advanced Instrumentation.
- To get an insight about Nano devices, Nano Biosensors and their applications.

**Course Outcomes**

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

CO1	State the fundamental knowledge of nanobiotechnology	K1
CO2	Interrelate the various types of nanoparticle characterization techniques.	K2
CO3	Apply the knowledge of nanomaterials in the production of nanofibers.	K3
CO4	Analyze the importance of nanoparticles and its application in Nano biotechnology	K4
CO5	Brief out about nanobiosensors and their applications	K4

**UNIT-I****15Hrs**

Glimpse of Nanotechnology based material in ancient India: Wootz steel (iron carbide) and the Delhi iron pillar (anticorrosive nanomaterial), Bhasma (nanomaterial as medicine). Contributions of Indian Research Institutes in the field of nanobiotechnology

**UNIT-II****15Hrs**

Metals: Silver nanoparticle synthesis and its analyses by UV-spectroscopy and FT-IR. Self-Assembly nanomaterial: Cell membrane and its analyses by SEM

**UNIT-III****15Hrs**

Nano-thin films: Chitosan thin film, Nanodevices (nanorobots), Nanotubes: Microtubules assembly and its importance, Nano shells- Dendrimers: Liposomes, Nanofibers: Collagen, Fibronectin & elastin, nano fluidics: Extracellular matrix assembly and its importance.

**UNIT-IV****15Hrs**

Agriculture: Crop production- Nano fertilizers technology, Biomaterial to improve shelf life of vegetables. Medicine: Collagen thin films in wound healing mechanism, Nanoscale devices – DNA microarray for disease diagnosis, Antibodies and Targeted drug delivery system.

**UNIT-V****15Hrs**

Nano biosensors (Firefly-luciferase) and its applications, Introduction to Biomimetics (Gecko foot effect, Lotus leaf effect: Paint and fabrics, Box fish-based Car).

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biophysics	Vasantha Pattabhi and N. Gautham	Narosa Publishing House	2009
2.	Essentials of Biophysics	Narayanan.P	New Age International (P) Ltd. Publishers	2010
3.	Green biosynthesis of nanoparticles: Mechanisms and applications	Rai, Mahendra, and Clemens Posten	CAB	2013
4.	Nanotechnology	Shanmugam.S	MJP publishers	2010
5.	Textbook of Nanoscience and Nanotechnology	Pradeep T	McGraw Hill publications	2012

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biochemistry	D.Voet&J.G.Voet	John Wiley & Sons	2010
2.	Biochemistry	Lubert Stryer	WH.Freeman	1995
3.	Bionanotechnology	David S. Goodsell	John Wiley & Sons Inc., publications	2004
4.	Nanostructures and Nanomaterials, synthesis, properties and applications,	Guozhong Cao	Imperial College Press	2004
5.	Nanobiotechnology	C.M.Niemeyer, C.A. Mirkin	WILEY-VCH Verlag GmbH & Co. KG, Weinheim	2007

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	S	M	M
<b>CO2</b>	M	S	S	M	S	M
<b>CO3</b>	S	S	M	S	M	S
<b>CO4</b>	M	S	S	M	M	S
<b>CO5</b>	M	S	S	S	M	S

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

**SEMESTER V**

<b>Discipline Specific Elective I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTDSE1</b>	<b>AQUACULTURE</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To understand aquaculture systems, conditioning factors, fish feeding behaviour and breeding and rearing techniques.
- To design & construct fish farm and learn the new techniques in aquaculture.
- To understand fish feeding behavior and to predict of disease.

**Course Outcomes**

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

CO1	Memorize about Marine Ecosystem and Resources.	K1
CO2	Organize the fish culture techniques for Indian major carps and Murrels.	K3
CO3	Summarize the various types of feedings and breeding	K2
CO4	Generalize the transport of fish seed and Brood fish.	K3
CO5	Sketch the detailed techniques applied aquaculture and fishing technology.	K4

**UNIT-I****9Hrs**

Origins and growth of aquaculture, Present status in National level; Fish pond construction- site selection; types of ponds, water quality analyses, liming and fertilization, morphology and commercial values of cultivable fishes, culture practice, predator fishes, weed fishes' control and its Environmental impacts

**UNIT-II****9Hrs**

Fin fish culture - Composite fish culture (Indian Major Carps and Murrels); Marine water fish culture. Seaweed culture - Culture of marine prawns, edible and pearl oysters, Seaweeds- types and their culture practices.

**UNIT-III****9Hrs**

Live feed organisms – Artemia and rotifers culture; Fish feed and its types  
Consequences of artificial feeding; Natural, supplementary and artificial breeding;

Breeding – Bundh breeding and induced breeding; rearing of hatchlings, fry and fingerlings

**UNIT-IV**

**9Hrs**

Transport of fish seed and Brood fish. Causes of mortality in transport. Methods for packaging and transport. Use of chemicals in live fish transport. Anesthetic drugs. Antiseptics and Antibiotics

**UNIT-V**

**9Hrs**

Applied aquaculture: Identification of cultivable fish species; Morphometry of pond (Enclosed rectangular method/Shore length/ shore area and shore line development). Fishing technology (crafts and gears). Home aquarium and agency involved in aquaculture.

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Prevention and control of fish and prawn diseases	Biswas, K. P.	Narendra publishing house, New Delhi.	2000
2	Textbook of fish culture	Hute, M. and Kahn, H.	Blackwell Scientific Publication, Australia.	2000
3	Nutrition in Aquaculture	Ninawe, A. S and Khadkar, G. D	Narendra publishing House, New Delhi	2009
4	Manual of ornamental fishes and farming, Technologies	Jameson, J.D. and Santhanam. R.	Peejay, Thoothukkudi	1996
5	Text book of Aquaculture	Srinivasulu, M., Reddy, K.R.S., Rao, S.	Discovery Publishing House New Delhi	1999

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	M	M	S	S
<b>CO2</b>	S	M	M	S	S	S
<b>CO3</b>	S	M	S	M	M	M
<b>CO4</b>	M	M	S	S	M	M
<b>CO5</b>	M	M	S	M	S	S

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

**SEMESTER V**

<b>Discipline Specific Elective I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTDSE2</b>	<b>MICROBIAL GENETICS</b>	<b>Contact hour per week: 3</b>

**Objectives**

- To gain knowledge on the structure, characters of Genetic materials and replication of DNA.
- To learn transcription and translation process in prokaryotes and Eukaryotes.
- To perceive Genetic alterations and their repair mechanisms and methods of genetic exchange.

**Course Outcomes**

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

CO1	Identify the basics structure of DNA and RNA, and Organization of genes in prokaryotes & Eukaryotes.	K1
CO2	Illustrate the entire concept of replication in Prokaryotes & Eukaryotes and role of enzymes in replication.	K2
CO3	Outline the gene expression by translation and transcription process and regulation of gene expression.	K3
CO4	Categorize about the Mutation, their types and repair mechanism	K4
CO5	Compare the Genetics exchanges in microbes	K2

**UNIT-I****9Hrs**

DNA and RNA as genetic material, Characters of a genetic material, Chemistry & Molecular structure of DNA, Topology of DNA, Structure and types of RNA. Bacterial chromosome, Organization of genes in prokaryotes & Eukaryotes.

**UNIT-II****9Hrs**

Replication of DNA – Replication in prokaryotes & Eukaryotes –Mechanism &enzymology of replication – Theta replication & Rolling circle replication.

**UNIT-III****9Hrs**

Transcription in prokaryotes and eukaryotes, Post transcriptional modifications. – Genetic code – Translation of proteins, Post translational modifications. Regulation of gene expression in prokaryotes – Operon concept – lac & trp Operon

**UNIT-IV****9Hrs**

Mutation - spontaneous and induced Mutagen & Mutagenesis – DNA repair mechanism.

**UNIT-V****9Hrs**

Genetic exchange – Transduction (specialized & generalized), Transformation, Conjugation - Hfr mapping, genetic recombination.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Principles of Genetics	Gardner, E. J, Simmons, M J& D P Snustard	John Wiley & Sons. NY	1991
2	Microbial Genetics	David Freifelder .S	Jones & Bartlett, Boston.	1987
3	Principles of Genetics	Robert H .Tamarin	WmC Brown Publishers.	2000

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Genes VII	Benjamin Lewin	Oxford University Press	1990
2	From Genes To Clones Introduction To Gene Technology	Ernst L Winnacker	Panima Publising Corporation	1992

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	S	S	S	S
<b>CO2</b>	S	S	M	M	S	M
<b>CO3</b>	S	S	M	S	M	S
<b>CO4</b>	S	M	M	S	M	S
<b>CO5</b>	S	M	M	M	S	S

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

**SEMESTER V**

<b>Discipline Specific Elective I</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTDSE3</b>	<b>MARINE BIOTECHNOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To explain important features of microbial diversity with reference to different niches in Oceans.
- To understand the medicinal compounds from flora and fauna.
- To explain fundamental principles of aquaculture and the important marine sources for valuable products.

**Course Outcomes**

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

CO1	Define the Marine Ecosystem and Resources.	K1
CO2	Examine the Marine microbial habitats and importance of probiotic bacteria.	K3
CO3	Analyze the bioactive compounds from Marine sources	K2
CO4	Transfer the techniques of Fish chromosome manipulation, Artificial Insemination, and Cryopreservation.	K3
CO5	Estimate the Marine biotech products of Chitin, Chitosan and Heparin	K4

**UNIT-I****9Hrs**

Marine Ecosystems & Its functioning, Ocean currents, Physical & chemical properties of seawater, Ecological divisions of the Sea- Euphotic-Mesopelagic-Bathopelagic- Benthos-Intertidal, Estuarine- Salt Marsh- Mangrove- Coral Reef.

**UNIT-II****9Hrs**

Marine microbial habitats- Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Biofouling, Biofilm, Antifouling, Anticorrosion. Probiotic bacteria and their importance in aquaculture.

**UNIT-III****9Hrs**

Definitions- Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- marine toxins- antiviral and antimicrobial agents.

**UNIT-IV****9Hrs**

Culture aspect-Seaweed (*Kappaphycus alvarezii*), Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis- Androgenesis- Polyploidy, Artificial Insemination, Eyestalk ablation- Transgenesis and Cryopreservation.

**UNIT-V****9Hrs**

Economical importance of Agar- Agarose - Alginate- Carrageenan- Chitin- Chitosan- Heparin.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	New Developments in Marine Biotechnology	Italy, E (Eds).	Plenum Pub. Corp.	1998
2	Molecular Genetics of Marine Organisms	Milton Fingerman and Rachakonda Nagabhushanam	Science Pub Inc	1996
3	Marine Biotechnology	David H. Attaway	Pharmaceutical and Bioactive Natural Products.	2001
4.	Biotechnology in the Marine Sciences	Rita R. Colwell	Wiley Interscience	1984

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives	Scheupr, P.J. (Ed.),	Academic Press.	1984
2	Biological Oceanography - An Introduction,	Biological Oceanography - An Introduction,	Elsevier, 314 pp	1997

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	S	S	S	S
<b>CO2</b>	S	S	M	M	S	M
<b>CO3</b>	S	S	M	S	M	S
<b>CO4</b>	S	M	M	S	M	S
<b>CO5</b>	S	M	M	M	S	S

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

**SEMESTER V**

<b>Discipline Specific Elective-II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits:3</b>
<b>Course Code: M23UBTDSE4</b>	<b>ENZYMOLGY AND ENZYME TECHNOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To educate the basics of enzyme nomenclature, properties, extraction and isolation techniques.
- To examine kinetics of catalysed reaction and understand the mechanism of catalysis.
- To learn about enzyme immobilization techniques and application of enzymes in various industries.

**Course Outcomes**

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

CO1	Recall the basics of enzyme nomenclature and properties.	K1
CO2	Illustrate the kinetics of catalysis, inhibition of enzymes.	K2
CO3	Examine the Concept of active site.	K3
CO4	Enumerate the immobilization of enzymes and its application.	K4
CO5	Elaborate the application of enzymes over various industries.	K4

**UNIT-I****9Hrs**

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

**UNIT-II****9Hrs**

Kinetics of catalysed reaction: Single substrate reactions, bi-substrate reactions, concept of Michaelis – Menten equation, Limitations of Michaelis-Menten Kinetics, line weaver burk plot. Enzyme inhibition and its types- Reversible and Irreversible inhibition.

**UNIT-III****9Hrs**

Concept of active site. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attack, metal ion catalysis.

**UNIT-IV****9Hrs**

Enzyme immobilization, methods of immobilization, Advantages of immobilization and their industrial application.

**UNIT-V****9Hrs**

Application of Enzymes-Food Industry-Dairy and bakery products, meat products, fruit products, beer and wine. Technical application- paper recycling, laundry and detergents textile processing. Ethanol production. Application in Disease diagnosis

**TEXT BOOK:**

S. No	Name of the book	Name of the authors	Publishers	Year
1	Fundamentals of Enzymology	Nicholas C.Price and Lewis Stevens	Oxford University Press, New Delhi	2010

**REFERENCE BOOKS:**

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

**Mapping with Programme Specific Outcomes**

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
<b>CO1</b>	S	M	S	M	M	M
<b>CO2</b>	M	S	S	S	M	M
<b>CO3</b>	M	S	S	M	M	S
<b>CO4</b>	S	M	M	M	S	M
<b>CO5</b>	S	M	M	S	S	S

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

**SEMESTER V**

<b>Discipline Specific Elective-II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits:3</b>
<b>Course Code: M23UBTDSE5</b>	<b>HUMAN PHYSIOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To illustrate about digestive secretions, absorptive mechanisms and comprehend the process of gaseous exchange in tissues and lungs.
- To obtain an insight about skeletal, muscular and cardiovascular system.
- To understand about neuron structure, sensory physiology and overview of renal system and physiology of reproductive system.

**Course Outcomes**

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

CO1	State the basic physiological principles of various organs in the human body.	K1
CO2	Illustrate the physiology of digestive and respiratory systems and its functions.	K2
CO3	Summarize on cardiovascular system and skeletal system	K2
CO4	Compare and contrast the physiology of nervous and sensory system	K3
CO5	Brief out about the excretory and reproductive systems.	K4

**UNIT-I****9Hrs**

Digestive System: Overview of the digestive system, secretions of digestive tract, digestive hormones, process of digestion, absorption, assimilation of carbohydrates, proteins, fats, nucleic acids. Absorption of vitamins, minerals and water

**UNIT-II****9Hrs**

Respiratory System: Overview of the respiratory system, pulmonary ventilation, Alveolar ventilation, composition and partial pressure of inspired air, alveolar air and expired air, exchange and transport of respiratory gases.

**UNIT-III****9Hrs**

Skeletal System: Introduction to human skeletal system, skeletal divisions and functions of skeleton. Muscle physiology and Cardiovascular System: overview of muscle tissue, contraction and relaxation of skeletal muscle, cardiac muscle tissue and cardiac conduction system, cardiac cycle, cardiac output, blood pressure and E.C.G.

**UNIT-IV****9Hrs**

Nervous System: Overview of nervous system, classification of nervous system, signal transmission at synapse, neurotransmitters. Special Senses: Physiology of Olfaction, Gustation, Vision, Hearing and equilibrium

**UNIT-V****9Hrs**

Excretory System: Overview of renal system, Renal physiology: - glomerular filtration, tubular reabsorption and secretion, production of dilute and concentrated urine. Reproductive System: Overview of male and female reproductive system, spermatogenesis, oogenesis and follicular development, menstrual cycle, physiology of pregnancy, parturition and lactation,

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Essentials of Medical Physiology	K. Sembulingam and Prema Sembulingam	CBS Publishers and Distributors Pvt Ltd	2012
2.	Human Physiology	Chatterjee.C.	Medical agency allied	2019
3.	Principles of Anatomy and Physiology	Tortora and Grabowski,	JohnWiley&Sons,Inc.	2003

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Textbook of medical physiology	A.C. Guyton	Saunders, an imprint of Elsevier Inc	2006
2.	Human Physiology	Laurale Sherwood	Cengage Learning	2012
3.	A Text Book of Human physiology	Sarada Subrahmanyam	S Chand & Company	2010

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	M	M	M	M
<b>CO2</b>	S	M	M	S	M	S
<b>CO3</b>	M	M	S	M	S	S
<b>CO4</b>	S	S	M	S	S	M
<b>CO5</b>	S	M	S	M	S	S

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

**SEMESTER V**

<b>Discipline Specific Elective-II</b>	<b>B.Sc. Biotechnology</b>	<b>Credits:3</b>
<b>Course Code: M23UBTDSE6</b>	<b>MOLECULAR DIAGNOSTICS</b>	<b>Contact hour per week:3</b>

**Objectives**

- To give an outline on types of diseases and its diagnostic techniques
- To explain various DNA and Protein based molecular techniques.
- To discuss about Neonatal, Prenatal disease diagnostics and Molecular diagnosis of degenerative diseases and infectious disorders.

**Course Outcomes**

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

CO1	Define about diseases and its types, various diagnostic techniques.	K1
CO2	Classify the DNA based molecular techniques for diagnosis.	K2
CO3	Summarize the protein based molecular technique for diagnosis.	K2
CO4	Categorize the neonatal and prenatal disease diagnostics.	K3
CO5	Correlate the diagnostic techniques for degenerative and inherited disorders.	K4

**UNIT-I****9Hrs**

Definition - History – Diseases- infectious, physiological and metabolic errors, and inherited diseases. Diagnostics – types and importance in clinical decision making. Benefits of molecular diagnostics over conventional diagnostics. Ethical issues related to molecular diagnostics

**UNIT-II****9Hrs**

DNA based molecular techniques: DNA sequencing: Next generation sequencing methods in diagnosis- whole genomic sequencing (WGS), whole transcriptomic sequencing (WTS), exome sequencing, SNP chromosomal microarrays, relative-quantitative PCR, methylation analysis, MLPA, mutation screening panels (xTAG, Luminex), and SNP testing.

**UNIT-III****9Hrs**

Protein microarray, LC-MS, MALDI-TOF, Isotope coated affinity tag (ICAT), SILAC, i-TRAQ, Multiple Reaction Monitoring (MRM), Shotgun proteomics, 2D-DIGE. Immunoassays –Immunohistochemistry.

**UNIT-IV****9Hrs**

Neonatal and Prenatal disease diagnostics- Prenatal and pre-implantation diagnosis. Non-invasive: Triple test, Ultrasonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling. Molecular diagnosis for early detection of cerebral palsy.

**UNIT-V****9Hrs**

Molecular diagnosis of degenerative diseases and infectious disorders Muscular Dystrophy, Cardiovascular diseases: CVD gene mutations- LDL and LDL receptor, Lecithin cholesterol acyl transferase (LCAT), Hepatic triglyceride lipase (HTGL), Cholesterol ester transfer protein (CETP), Common polymorphisms of predisposition to CVD.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Tietz textbook of clinical chemistry and molecular diagnostics	Carl Burtis, Edward Ashwood, David Bruns	Elsevier Press	2011

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Molecular Diagnostics: Current Technology and Applications.	Juluri R Rao, Colin Craig Fleming	Horizon Scientific Press.	2009
2.	Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications	Lela Buckingham	John Wiley & Sons, Inc.	2011

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	M	S	M	M
<b>CO2</b>	S	M	M	M	S	S
<b>CO3</b>	S	M	M	S	M	S
<b>CO4</b>	M	S	S	S	S	M
<b>CO5</b>	M	S	S	M	S	S

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

**SEMESTER - V**

<b>Core Course Practical V</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTP05</b>	<b>PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To explain plant tissue culture, callus development and technical skills in Protoplast isolation and Nucleus localization.
- To make use of the techniques used in preparing tissue culture medium and evaluate cell counting and viability.
- To examine the importance of trypsinization in monolayer and subculture and cryopreservation.

**Course Outcomes**

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

CO1	To gain knowledge on the media preparation and techniques	K4
CO2	Learning different pathways of plant regeneration under in vitro conditions - organogenesis and somatic embryogenesis.	K3
CO3	To learn the cell culture techniques of using body fluids	K3
CO4	To understand the role of sterilization of media	K4
CO5	To isolate the DNA and RNA from plant	K4

1. Plant tissue culture media preparation & sterilization techniques.
2. Callus induction
3. Isolation of plant protoplast & viability test.
4. Localization of nucleus using nuclear stain.
5. Preparation of Animal Tissue culture medium and membrane filtration
6. Preparation of Single Cell Suspension & Cell counting
7. Cell viability Test
8. Isolation of plant DNA and plant RNA(Demo)
9. Isolation of Agrobacterium plasmid DNA (Demo)
10. Trypsinization of monolayer and subculturing (Demo)

11. Measurement of phagocytic activity (Demo)

12. MTT Assay (Demo)

13. Cryopreservation and thawing (Demo)

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Practical Biotechnology and Plant Tissue Culture	Madhavi Adhav	S.Chand& Company Ltd.	2009
2.	Plant Biotechnology: Practical Manual	C. C. Giri, Archana Giri,	I.K. International Pvt Ltd.	2007
3.	Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application	IKarl-Hermann Neumann, Ashwani Kumar, Jafargholi Iman	Springer	2009
4.	Environmental Biotechnology Theory and Lab Practices	Debajit Borah	Hardcover – Global Vision Publishing House	2018

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Public Health Management Principles and Practice	S. Lal, Vikas	CBS Publishers and Distributors Pvt Ltd	2018
2.	Biotechnology procedures and experiments handbook	S. Harisha	Infinity Science Press LLC	2012

## SEMESTER-VI

<b>Core Course- VIII</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT08</b>	<b>ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY</b>	<b>Contact hour per week:5</b>

### Objectives

- To know about the environmental issues and its management strategies and safety and learn about waste water treatment, solid waste management in various industries.
- To illustrate the significance of bioreactors in bioprocess engineering and culture methods.
- To explain Downstream processing and importance of microorganisms in ore leaching, production of various products and Biofertilizers.

### Course Outcomes

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

CO1	State the impact of environmental pollution and its remediation measures.	K1
CO2	Extend the knowledge for waste water treatment	K2
CO3	Explain the bioprocess engineering, basic techniques, methods and functions.	K3
CO4	Bring out the selective methods to purify the fraction to develop as commercial purpose	K3
CO5	Correlate the various techniques for isolation, recovery and purification of a protein and evaluate the outcome.	K4

### UNIT-I

**15Hrs**

Environmental Pollution – Sources and types - Water, Air, Thermal, Industrial and Radiation - Global environmental changes. Global warming, Green house effect, acid rain, ozone depletion, and photochemical smog. Environmental issues, management strategies and safety, Biotechnological approaches for management.

### UNIT-II

**15Hrs**

Waste water treatment: Aerobic and anaerobic methods (Primary, Secondary and Tertiary) –Use of aquatic plants in waste water treatment. Solid waste management. Bioenergy and SCP from waste. Drinking water treatment.

Biotechnological approach to industrial effluent (Paper, Tannery, Textile) Pesticide waste disposal.

**UNIT-III**

**15Hrs**

Bioprocess Engineering-Steps in bioprocess development. Design of bioreactors - Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Bioreactor configurations and types: Factors affecting broth viscosity, Mixing in Fermenters. Fermentation systems (Batch culture & Continuous culture)

**UNIT-IV**

**15Hrs**

Downstream processing Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, membrane processes, Drying, Crystallization, Whole broth processing. Microbial enzymes- Amylase & protease, Immobilization of enzymes: Methods, Properties, Applications, Advantages and Disadvantages of Immobilization. Microbial Polysaccharide production: Xanthan, Dextran.

**UNIT-V**

**15Hrs**

Ore leaching (methods and examples), MEOR, Production of antibiotics - Penicillin - streptomycin. Alcoholic beverages: Wine, Beer -Biofertilizers- Rhizobium & Azotobacter.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Introduction to Environmental Biotechnology	Chatterji, A.K.	Prentice-Hall of India, New Delhi.	2002
2.	Textbook of Environmental Biotechnology	Pramod Kumar and Vipin Kumar	WPI publishers	2019
3.	Environmental Science and Biotechnology Theory and Techniques	Murugesan, A G., Rajakumari, C.,	MJP publishers, Chennai.	2005

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Principles of Fermentation Technology	Peter F. Stanbury, Allan Whitaker, Stephen J. Hall	Elsevier Science Ltd	2013
2.	Industrial Microbiology: An Introduction	Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton	Blackwell Science Ltd	2001
3.	Modern Industrial Biotechnology & Microbiology	Nduka Okafor	Science Publishers, Edenbridge Ltd.	2017
4.	Industrial Microbiology: An Introduction	Waites, Morgan, Rockey and Higton	Blackwell Science	2007

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	M	M	S	M
<b>CO2</b>	M	S	S	M	S	M
<b>CO3</b>	S	S	M	M	M	S
<b>CO4</b>	M	S	S	S	S	M
<b>CO5</b>	S	S	M	S	S	M

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

## SEMESTER-VI

<b>Core Course- IX</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT09</b>	<b>PHARMACEUTICAL BIOTECHNOLOGY</b>	<b>Contact hour per week:5</b>

### Objectives

- To understand the series of processes involved in drug development, patenting and drug approval.
- To learn about drug formulation, drug delivery system and production of Biopharmaceutical products.
- To be familiar with drug toxicity analysis and know about the National and International Drug approval agencies.

### Course Outcomes

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

CO1	Define the specific pharmacology of the major classes of drugs, important distinctions among members of each class	K1
CO2	Summarize the knowledge for the biotechnology protein products	K2
CO3	Categorize the pharmaceutical biological important products	K3
CO4	Analyze the medicinal and pharmaceutical importance of drug compounds	K4
CO5	Enumerate the Scope and career opportunities in pharmaceutical sectors.	K4

### UNIT-I

**15Hrs**

Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.

### UNIT-II

**15Hrs**

Production of recombinant proteins - Development of Nucleic acid-based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy

**UNIT-III****15Hrs**

Human Insulin (Humulin), Growth hormones (Humatrope) - Blood coagulating factor (factor VIII - Kogenate) - Erythropoietin - (Epogen) Granulocyte colony stimulating factors (Neulasta) - Interferons (Avonex) - Antimicrobial peptides ( $\beta$  - defensin 2) - Vaccines (Pentavac), Biologics (Humira - Adalimumab), - Cancer based biologics (rituximab).

**UNIT-IV****15Hrs**

Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management

**UNIT-V****15Hrs**

National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Text Book of Pharmaceutical Biotechnology	Chandrakant Kokate and Pramod H.J	Elsevier	2011
2.	Pharmaceutical Biotechnology: Fundamentals and Applications	Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd	Springer	2019
3.	Pharmaceutical Biotechnology	Purohit S S; Kakrani H.N; Saluja A.K	Agrobios(India)	2015
4.	Rational Design of stable formulation Theory and Practice	John F. Corpenner, Mark C. Manning	Springer Science	2012

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biopharmaceuticals; biochemistry and Biotechnology	Gary Walsh	John Wiley & Sons Ltd.	2003
2.	Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications	Oliver Kayser and Heribert Warzecha	Wiley - Blackwell.	2012
3.	Drugs of abuse	Simon Wills	Pharmaceutical Press	2005
4.	Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development	Hiten J. Gutka, Harry Yang, Shefali Kakar	Springer	2018
5.	Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation	Yui-Wing F. L. and Stuart S.	Academic Press	2019

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	M	S	M
<b>CO2</b>	S	S	M	M	S	M
<b>CO3</b>	M	S	S	S	M	S
<b>CO4</b>	M	S	S	M	S	S
<b>CO5</b>	S	M	S	S	S	M

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

## SEMESTER-VI

<b>Core Course- X</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 4</b>
<b>Course Code: M23UBT10</b>	<b>FOOD TECHNOLOGY</b>	<b>Contact hour per week:5</b>

### Objectives

- To understand the basic concepts of the food industry and its application.
- To learn about the classification of cereals and millets, fats and oils fruits and vegetables and understand the concept of red and white meat.
- To impart about the food adulteration and biosensors to detect them.

### Course Outcomes

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

CO1	Relate the basic concepts of the food industry	K1
CO2	Understand basic composition & structure of food grain	K2
CO3	Classify the developments and current status of fruits and vegetables storage and processing	K3
CO4	Interrelate the compositional and technological aspects of meat, milk, and fish	K2
CO5	Analyze the type of adulterants and food additives	K4

### UNIT-I

**15Hrs**

Historical evolution of food processing technology- Biotechnology relating to the food industry –Regulatory and social aspects of biotechnology in foods- Application of biotechnology in waste treatment of food industries.

### UNIT-II

**15Hrs**

Cereals and Millets- Wheat- composition, types (hard, soft/ strong, weak). Rice- and composition, parboiling of rice- advantages and disadvantages. Structure and composition of Fats and Oils. Refining of oils, types- steam refining, alkali refining, bleaching, steam deodorization, hydrogenation. Rancidity –Types- hydrolytic and oxidative rancidity and its prevention.

**UNIT-III****15Hrs**

Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Dietary fibre. Post-harvest changes in fruits and vegetables – Climacteric rise, horticultural maturity, physiological, physiological changes and pathological changes during the storage of fruits and vegetables.

**UNIT-IV****15Hrs**

Concept of red meat and white meat, composition of meat, marbling, post-mortem changes in meat- rigor mortis, tenderization of meat, ageing of meat. Composition and nutritive value of egg, characteristics of fresh egg, deterioration of egg quality, difference between broiler and layers.

**UNIT-V****15Hrs**

Types of food adulterants – test to detect adulterants in foods – metal contaminants - contaminants of processed foods- Food products as analytical samples, Food additives, FSSAI regulations, Methods of fortifying and enriching foods.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Food Science	Bawa. A.S, O.P Chauhan et al.	New India Publishing agency,	2013
2.	Food science	B. Srilakshmi	New Age Publishers	2002
3.	Fats In Food Technology	Kanes K Rajah	Blackwell	2014
4.	Advances in Food Biotechnology	Ravishankar Rai, V	John Wiley & Sons	2015
5.	Introduction to Food Biotechnology	Perry Johnson- Green	<i>CRC Press</i>	2018

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Food Science	Roday,S	Oxford publication	2011
2.	Outlines of Dairy Technology	De Sukumar	Oxford University Press	2007
3.	Food Chemistry	Meyer	New Age	2004
4.	Food Biotechnology	Foster, G.N	John Wiley & Sons	2020
5.	Food Biotechnology	Anthony Pometto, Kalidas Shetty, GopinadhanPaliyath, Robert E. Levin	<i>CRC Press</i>	2005

**Mapping with Programme Specific Outcomes**

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	S	M	S	S	M
<b>CO2</b>	M	S	S	M	S	S
<b>CO3</b>	M	S	M	S	S	M
<b>CO4</b>	S	M	S	M	S	M
<b>CO5</b>	S	M	S	S	M	M

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

**SEMESTER VI**

<b>Discipline Specific Elective-III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits:3</b>
<b>Course Code: M23UBTDSE7</b>	<b>CANCER BIOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To understand the basics of cancer biology and learn the role of cancer at the molecular level.
- To learn about the types, detection and treatment of various cancer.
- To know about the Prevention of Cancer and environmental factors.

**Course Outcomes**

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

CO1	State the mutation concept and basic aspects of cancer	K1
CO2	Illustrate the cancer as a genetic diseases and mutations play in the development of cancer	K2
CO3	Classify the various types of cancer - Leukemia, Sarcoma, Prostate and Cervical cancer	K2
CO4	Point out the technologies and methods used to detect and treatment of cancer	K4
CO5	Distinguish the preventive measures of cancer	K3

**UNIT-I****9Hrs**

Cancer: Introduction; Origin of Cancer- The Mutation Concept, The Epigenetic Concept, Viral Concept, Unified genetic concept of cancer; Difference between Normal and Cancer cells; Signs and symptoms.

**UNIT-II****9Hrs**

Cancer as a genetic disease; Genetic Alterations in Cancer cells, Point mutation, splice mutation, alternate splicing; Mutation in regulatory sequences, deletions, Insertion, Chromosome abnormalities, Genetic defects and the time course of hereditary cancer

**UNIT-III****9Hrs**

Types of Cancer: - Blood & Lymph – Leukemia, Malignant lymphoma, Bone- Soft tissue Sarcoma, Thorax- Breast cancer, Male genitalia- Prostate cancer, Female

genitalia- Cervical cancer; Tumor suppressor genes; Classification of Tumor suppressor genes.

**UNIT-IV**

**9Hrs**

Detection and Treatment: - Early detection, Molecular detection of Carcinomas, Cancer warning signals; Markers in blood urine; Therapies- Chemotherapy, Gene therapy, Radiotherapy, Biological therapy (Immuno therapy).

**UNIT-V**

**9Hrs**

Prevention: - Tobacco smoking, sunlight, diet, ionizing radiation, alcohol drugs, promiscuity, lifestyle and cancer prevention, Environmental factors and cancer, potentially carcinogenic substances for humans.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Biology of Cancer	A. Sarkar	Discovery Publishing House	2011
2.	Principles and Management of Cancer	Ranajit Sen	B.I. Publications	2004
3.	Cancer- Causes and Prevention	Dr M.R.Ahuja	UBS Publishers Distributors	1997

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Textbook of Cancer Biology	Francesco Pezzella, Mahvash Tavassoli, David J. Kerr	Oxford University Press	2019
2.	Introduction to Cancer Biology	Robin Hesketh	Cambridge University Press	2012

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	M	S	S	M	M
<b>CO2</b>	M	S	M	S	M	M
<b>CO3</b>	M	M	S	S	S	S
<b>CO4</b>	S	S	S	M	S	M
<b>CO5</b>	S	S	M	S	M	S

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

**SEMESTER VI**

<b>Discipline Specific Elective-III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits:3</b>
<b>Course Code: M23UBTDSE8</b>	<b>FORENSIC BIOTECHNOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To gain insight into Forensic Biotechnology and various investigation protocols.
- To know about blood related issues and study the molecular approaches for investigation.
- To understand DNA fingerprinting

**Course Outcomes**

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

CO1	Define the history and the development of forensic science and its significance.	K1
CO2	Interpret the art of collecting, packaging and preserving different types of physical and trace evidence at crime scenes.	K2
CO3	Explain about the blood grouping, typing, blood stains, collection and storage of allied body fluids	K3
CO4	Distinguish the PCR, RFLP, AFLP, Chromatography Techniques	K4
CO5	Analyze the DNA Profiling, Isolation of DNA from blood samples, DNA testing	K4

**UNIT-I****9Hrs**

Definition and scope of Forensic Biotechnology, History and development, Forensic genetics, Forensic agriculture.

**UNIT-II****9Hrs**

Crime scene investigation; collection, preservation, packing and forwarding of physical and trace evidence. Questioned documents – identification of handwriting, signature and detection of forgery.

**UNIT-III****9Hrs**

Serology - Fresh blood grouping and typing, stains of bloods. Identification of blood stains, collection and storage of allied body fluids (semen, saliva and blood). Case studies.

**UNIT-IV****9Hrs**

PCR, RFLP, AFLP, Microscopy (Electron, Fluorescent) and Chromatography (Paper, TLC & HPLC) in forensic investigation.

**UNIT-V****9Hrs**

DNA Profiling, Isolation of DNA from blood samples, DNA testing in cases of disputed paternity and maternity.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Textbook of Forensic Medicine & Toxicology	Nageshkumar G Rao	Jaypee	2013
2.	The Essentials of Forensic Medicine & Toxicology	K.S. Narayan reddy and O.P. Murty	Jaypee	2017
	Forensic Analytical Technique	Barbara H. Stuart	Wiley	2013

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Forensic Science: A very short introduction	Jim Fraser	Oxford university press	2010
2.	An introduction to Forensic Genetics	William Goodwin, Adrian Linacre, SibteHadi	John Wiley & Sons	2007
3.	Fundamentals of Bioanalytical Techniques and Instrumentation	Ghosal S. and Avasthi A.S	Delhi, PHI	2018

## Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	M	S	M	M
<b>CO2</b>	S	M	M	S	M	M
<b>CO3</b>	S	M	S	S	M	S
<b>CO4</b>	M	S	S	M	S	M
<b>CO5</b>	M	S	S	M	S	S

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

**SEMESTER VI**

<b>Discipline Specific Elective-III</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTDSE9</b>	<b>DAIRY SCIENCE AND TECHNOLOGY</b>	<b>Contact hour per week:3</b>

**Objectives**

- To provide knowledge about composition, properties of milk and its nutritive values of milk products.
- To explain the merits and demerits of artificial insemination
- To study the economical importance of dairy cattle breeding.

**Course Outcomes**

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

CO1	State the composition and properties of milk in the various animals.	K1
CO2	Summarize the awareness of nutritive values such as Physicochemical constants of milk	K2
CO3	Compare the merits and demerits of artificial insemination	K3
CO4	Brief out the economical importance of dairy cattle	K4
CO5	Bring out the knowledge about dairy cattle breeding	K2

**UNIT-I****9Hrs**

**Composition of Milk:** Definition, composition (cow milk, buffalo, goat, sheep and human), **Physico-chemical** (Colour, Flavour, Density and Specific gravity, Freezing point, Boiling point, Surface tension, Viscosity, Specific heat, Refractive index, Electrical conductivity) of milk, Germicidal property, PH and acidity, Ionic balance

**UNIT-II****9Hrs**

**Nutritive value of milk.** Physicochemical constants of milk fat, RM value, Polenske Value, saponification value, Iodine number, Refractive index Platform tests; Tests for detection of adulteration of milk; Preservatives and Neutralizers. FSSAI Specifications for milk.

**UNIT-III****9Hrs**

Artificial insemination- advantages and disadvantages- Differences between natural service and artificial insemination- Oestrous cycle; Symptoms of heat in

cows and buffaloes. Conception, Pregnancy diagnosis in cattle. Multiovulation and embryo transfer technique. Cloning

**UNIT-IV**

**9Hrs**

Economic traits of Dairy cattle - factors influencing yield and composition of milk. Methods of selection of dairy animals – progeny testing program.

**UNIT-V**

**9Hrs**

Systems of Dairy cattle breeding. Inbreeding, out breeding, Cross breeding, Grading up. Breeding systems suitable to enhance milk production in India (Cross breeding of cattle and Grading up of buffaloes).

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Food Microbiology	W Frazier	McGraw Hill Education	2017
2.	Handbook of Milk Microbiology	Srivastava, Manish L	Astral international Pvt Ltd	2016

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Dairy science and technology	Pieter, Walstra	Taylor and Francis publishing company	2005
2.	Food science and technology	Deepak Mudgil, Sheweta Mudgil	Scientific Publisers	2023

**Mapping with Programme Specific Outcomes**

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
<b>CO1</b>	M	S	M	M	M	S
<b>CO2</b>	S	S	M	M	S	M
<b>CO3</b>	M	S	M	M	S	S
<b>CO4</b>	S	S	M	S	S	M
<b>CO5</b>	S	M	S	M	S	S

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

## SEMESTER-VI

<b>Discipline Specific Elective-IV</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTDSE10</b>	<b>TOOLS IN BIOTECHNOLOGY</b>	<b>Contact hour per week:3</b>

### Objectives

- To introduce the concepts of gene and genomics.
- To familiarize in gene cloning vectors used for gene manipulation;
- To enhance knowledge about selection strategies and screening of transformants and describe the applications of gene cloning.

### Course Outcomes

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

CO1	Recall the concepts of gene and genomics	K1
CO2	Illustrate about vectors used for gene cloning.	K2
CO3	Analyze the principle tools that are used for gene manipulation.	K3
CO4	Bring out the importance of selection and screening of transformants.	K4
CO5	Elaborate the principal applications of gene cloning.	K4

### UNIT-I

**9Hrs**

Gene and Genomes: Prokaryotic and Eukaryotic Genomes - Structure of Gene - DNA as the genetic material; Extra chromosomal DNA: Plasmid, mitochondrial DNA and chloroplast DNA

### UNIT-II

**9Hrs**

Cloning Vectors: Plasmid, phagemid, cosmid, Artificial Chromosomes (BAC) - Transformation techniques: Electroporation, CaCl<sub>2</sub> method.

### UNIT-III

**9Hrs**

Tools for Gene Manipulation: Gel Electrophoresis: AGE and PAGE; Restriction Enzymes, Ligases, Modifying Enzymes - Markers for Selection: selectable and scorable - Examples.

### UNIT-IV

**9Hrs**

Selection Strategy and Screening for Transformants: Selection of rDNA Clones: Blue-White Selection, Colony Hybridization, PCR, Molecular analysis: Western blotting, Southern Blotting and Northern Blotting.

**UNIT-V****9Hrs**

Application of Cloning: Over expression of Biomolecules (Insulin) - Gene therapy-  
GMO – Application and Biosafety issues.

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Biomedical Instrumentation and Measurement	Leslie Cromwell; Weihell J; Erich A P	Prentice Hall India Learning Private Limited	1990
2.	Important tools and techniques in biotechnology	Vikas Singh	Shanti Prakashan publishers	2016

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Advances in Plant breeding strategies- Breeding, Biotechnology and Molecular tools	Jameel M.Al-Khayri, Sri Mohan Jain	Springer	2018
2.	Analytical Biotechnology	Thomas G M Schalkhammer	Birkhauser Verlag	2002

**Mapping with Programme Specific Outcomes**

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
<b>CO1</b>	S	M	M	M	S	M
<b>CO2</b>	S	M	M	S	S	M
<b>CO3</b>	S	M	M	S	M	S
<b>CO4</b>	M	S	M	S	S	S
<b>CO5</b>	S	M	S	M	S	S

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

## SEMESTER-VI

<b>Discipline Specific Elective-IV</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTDSE11</b>	<b>BIOPROSPECTING</b>	<b>Contact hour per week:3</b>

### Objectives

- To provide a brief introduction to microbial ecology and diversity.
- To learn about biogeography-mapping and conservation of microbial gene pools.
- To impart knowledge on convention of biological diversity and study the objectives of global diversity hotspots.

### Course Outcomes

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

CO1	Recognize the major areas of microbial diversity and biodiversity.	K1
CO2	Summarize on microbial ecology and extremophiles	K2
CO3	Inspect the Biogeographical-Mapping and paradigm shift	K3
CO4	Explain the prospecting and conservation of microbial gene pools.	K3
CO5	Brief out the regulatory legislation and convention in bioprospecting for commercialization.	K4

### UNIT-I

**9Hrs**

Introduction to microbial diversity-species concept for prokaryotic and eukaryotic microorganisms, speciation and bacterial phylopecies, approaches to identification and eukaryotic diversity.

### UNIT-II

**9Hrs**

Microbial ecology-Culture dependent and independent microbiology, resuscitation of uncultured microorganisms, soils the metagenomic approach, deep biospheres, icy biosphere. Extremophiles – pH, temperature, salinity and pressure. Role of oligobacteria, anaerobes – sulfate reducing bacteria and microbes from marine sponges.

**UNIT-III****9Hrs**

Biogeography-Mapping, Ubiquitous dispersal of free-living microorganisms, microbial endemism and biogeography, The Yellowstone national park microbial database and map server. The paradigm shift in microbial prospecting, genomics, bacterial proteomics, phenomics, phylogeny and functionality.

**UNIT-IV****9Hrs**

Prospecting and conservation of microbial gene pools-Screening for bioactivity (antimicrobials & pharmacologically), plant growth promoting agents, biotreatment, bioprospecting novel antifoulants and anti-biofilm agents from microbes. Extinction and the loss of evolutionary history.

**UNIT-V****9Hrs**

Convention on Biological Diversity- Historical context of present bioprospecting, convention on biological diversity and benefit sharing, the INBio experiences, contracts for bioprospecting, natural products research partnerships with multiple objectives in global diversity hotspots.

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	An advanced text book on Biodiversity	K V Krishnamurthy	Oxford and IBH Publishers	2018
2.	Bioprospecting-Success, potential and constraints	Russell Paterson and Nelson Lima	Springer	2017

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Microbial Diversity and Bioprospecting	Alan T. Bull	American society of microbiology	2003
2.	Bioprospecting in Life Sciences	Rajendra Kumar Behara	Narosa Publishing house	2019

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	M	S	S	M	M	M
<b>CO2</b>	S	S	M	S	M	M
<b>CO3</b>	S	M	S	M	S	S
<b>CO4</b>	S	M	S	S	M	S
<b>CO5</b>	M	S	S	M	S	S

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

## SEMESTER-VI

<b>Discipline Specific Elective-IV</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTDSE12</b>	<b>GOOD LABORATORY PRACTICES</b>	<b>Contact hour per week: 3</b>

### Objectives

- To be familiar with the types of labs associated with biotechnology and its physical chemical characteristics.
- To know about the Lab ethics and have knowledge of the instrument calibration and its importance.
- To understand about good lab guidelines and bio-waste management.

### Course Outcomes

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

CO1	State the organization of biotechnology laboratory and its characteristics.	K1
CO2	Understand about the laboratory ethics and regulatory affairs.	K2
CO3	Classify the calibration and importance of instrument used in laboratory.	K3
CO4	Elaborate about GLP and its industry standards.	K4
CO5	Elucidate the types and safety methods for the disposal of biowaste.	K4

### UNIT-I

**9Hrs**

Biotechnology lab organization - Types of labs associated with Biotechnology (General lab, microbial culture lab, plant tissue culture lab, Fermentation lab, computational stimulation lab), Physical chemical characteristics: hygroscopic, corrosive, volatile properties; Fire and explosion hazard data, Health hazards (how to use UV-illuminator), Fumigation technique.

### UNIT-II

**9Hrs**

Lab ethics - Regulatory affairs: Methods and types of documentation (pre-lab writes, result recording and post lab report: interpretation of result), Dilution factor calculation, Molarity, percentage, dilution of concentrated solution, metric units (kg to gms and vice -versa).

**UNIT-III****9Hrs**

Instrument calibration and importance - Principles, use and maintenance of laboratory instruments like Autoclave, hot air oven, Incubators, Centrifuge, Calorimeter, pH meter, Haemocytometer, Microtome, , Bio safety cabinets.

**UNIT-IV****9Hrs**

GLP & Biotechnology Industry standards - Good Laboratory guidelines, Elements of GLP, Standard Operating Procedures and its importance, Quality Assurance & Quality control, Internal audit basics, ISO, BIS and HACCP standards.

**UNIT-V****9Hrs**

Types of wastes and safe disposal methods - Definition, types- Biological and chemical waste, methods of Safe Disposal, treatment methods of Ethidium Bromide solutions, Electrophoresis Gels, Contaminated Gloves, debris, Wastes containing sodium azide, Silver staining solutions, Perchloric acid, Nanoparticle wastes, Spill management, Awareness and training for personnel.

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Good laboratory practices and compliance monitoring	Trupti Patil- Dongare	PharmaMed Press	2021

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Principles of Good Laboratory Practices	Pradeep Deshmukh	Adhyyan Books	2020
2.	Textbook of Medical Laboratory technology	Praful B Godkar, Darshan P Godkar	Bhalani publishing house	2024

### Mapping with Programme Specific Outcomes

<b>COs/PSOs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>
<b>CO1</b>	S	M	M	S	M	M
<b>CO2</b>	S	M	S	M	M	S
<b>CO3</b>	S	S	M	S	M	M
<b>CO4</b>	M	S	M	S	S	M
<b>CO5</b>	S	M	S	M	S	S

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

## SEMESTER-VI

<b>Core Course Practical- VI</b>	<b>B.Sc. Biotechnology</b>	<b>Credits: 3</b>
<b>Course Code: M23UBTP06</b>	<b>ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY</b>	<b>Contact hour per week:3</b>

### Objectives

- To integrate appropriate aspects of microbiology and biochemical engineering.
- To learn about the practical applications towards process design and scale-up.
- To study the advantages and drawbacks of applying biotechnological methods to environmental problems

### Course Outcomes

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

CO1	Students can able to isolate the microorganisms and determine their growth curve, generation time.	K4
CO2	To analyze the water samples, perform immobilization and production of Wine, Biogas and compost.	K3
CO3	Examine skills in bio fertilizer production and microbial identification.	K4
CO4	Enumerate the basic skills to analyze raw milk and determine the pasteurization efficacy.	K3
CO5	Brief out the performance efficiency tests of biofertilizers and biopesticides, microbial polysaccharide production.	K4

1. Isolation of Air borne Pathogens
2. Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.
3. Water analysis – MPN and BOD.
4. Immobilization of whole yeast cells/ enzyme by Alginate beads.
5. Production of wine
6. Production of Biogas – *In vitro* & Compost Making.

7. Biofertilizer production/Spirulina production - field visit. (Report should be included in the record)
8. Isolation and identification of starter organisms from Idli batter/ curd
9. Grading of raw milk (Dye reduction test).
10. Determination of efficiency of Pasteurization by quantitative phosphatase test.
11. Preparation and Efficiency testing of Biofertilizer/ Biopesticide(Demo)
12. Production of microbial Polysaccharide. (Demo)

**TEXT BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	Laboratory Manual of Microbiology and Biotechnology	Aneja K R	MEDTECH	2014
2.	Food Microbiology	Vijaya Ramesh	MJP Publishers	2007

**REFERENCE BOOKS:**

<b>S. No.</b>	<b>Title of the Book</b>	<b>Author</b>	<b>Publishing Company</b>	<b>Year of Publication</b>
1.	A Manual of Laboratory Techniques	Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed	National Institute of Nutrition, ICMR	1983

## SEMESTER-VI

<b>Professional Competency Skill</b>	<b>B.Sc. Biotechnology</b>	<b>Credits:2</b>
<b>Course Code: M23UBTPCS1</b>	<b>CRYOGENICS AND CRYOBIOLOGY</b>	<b>Contact hour per week:2</b>

### Objectives

- To introduce to cryobiology and history of cryopreservation progress
- To understand the factors that influence the cryopreservation and learn the basic concepts in ice physics and cryobiology.
- To comprehend application of cryobiology in various biological field.

### Course Outcomes

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

CO1	State the detailed concept of cryopreservation, Nature's adaptation and the application of Cryobiology.	K1
CO2	Illustrate the fundamentals of cryopreservation procedures involving freezing of biological materials.	K2
CO3	Compare the function relations and their use in cryobiological applications.	K4
CO4	Distinguish Hibernation, heterothermy, hibernaculum and thermoregulation.	K2
CO5	Generalize the Application of Cryobiology, cryosurgery and cryoablation.	K3

### UNIT-I

**6Hrs**

Introduction to Cryobiology, cryopreservation - natural cryopreservation, temperature, risks, slow, permeable freezing, vitrification, uses freezable tissues, equipment, limitations.

### UNIT-II

**6Hrs**

Liquid nitrogen - uses, safety, production; glass transition- introduction, transition temperature  $T_g$ , Kauzmann's paradox, the glass transition, specific materials, silica, polymers, mechanism of vitrification, electronic structures; ex-situ conservation; cryoprotectants; cryostasis; neuropreservation.

**UNIT-III****6Hrs**

Cryopreservation in nature – antifreeze protein, antifreeze, psychrophile, insect winter ecology, cryogenic treatment, cryogenic seal, cryogenic fuel, energy storage, crystal, cryotank, absolute zero, target temperature management.

**UNIT-IV****6Hrs**

Hibernation, heterothermy, hibernaculum, hypothermia, chilblains, frost bite, trench feet, thermoregulation.

**UNIT-V****6Hrs**

Application of Cryobiology - cloning, molecular cloning, organ transplantation, sperm bank, semen extender, in-vitro fertilization, embryo transfer, cryosurgery, cryoablation.

**TEXT BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Introduction to cryobiology	Colby Gunn	Larsen and Keller education	2017
2.	Cryobiology	Michael Cedric	Syra wood Publishing house	2018

**REFERENCE BOOKS:**

S. No.	Title of the Book	Author	Publishing Company	Year of Publication
1.	Current trends in cryobiology	Audry U Smith	Springer	2013
2.	Cryopreservation- concepts and application	Marianne Wilde	Callisto reference	2017

**Mapping with Programme Specific Outcomes**

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
<b>CO1</b>	M	M	S	S	M	S
<b>CO2</b>	M	S	S	S	M	M
<b>CO3</b>	S	S	M	S	M	S
<b>CO4</b>	S	M	M	S	S	S
<b>CO5</b>	M	S	S	S	S	M

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