Swami Rama Himalayan University
Office of the Registrar

SRHU/Reg/OO/2023-196(i) Date: 10th October, 2023

OFFICE ORDER

I am directed to inform that in accordance with the decision taken by the Academic Council in its 30th Meeting under Agenda Item 30/9, the approved recommendations made by the **Board of Studies** for the following **B.Sc. (Hons.) Programmes** under **Himalayan School of Bio-Sciences**, as enclosed herewith, are being sent for implementation, effective from academic year 2023-24:

1. B.Sc. (Hons.) Biotechnology
2. B.Sc. (Hons.) Microbiology

By Order,

Registrar

Copy to: Hon'ble Chancellor
Hon'ble Vice Chancellor
Director General (Academic Development)
} for kind information please
Controller of Examinations
Principal, Himalayan School of Bio-Sciences

Encls.: As above.

HIMALAYAN SCHOOL OF BIOSCIENCES

BOARD OF STUDIES

BACHELOR OF SCIENCE (HONS.)
MICROBIOLOGY

(Based on NEP 2020)

Effective from Academic session 2023-2024

Swami Rama Himalayan University
Jolly Grant Dehradun-248016

Registrar
Swami Rama Himalayan University

SWAMI RAMA HIMALAYAN UNIVERSITY
HIMALAYAN SCHOOL OF BIOSCIENCES (HSBS)

No.	Contents:
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7.	Approved Copy of the curriculum of B.Sc. (H) Microbiology by the Board of Studies
8.	Question paper style

Registrar
Swami Rama Himalayan University

Swami Rama Himalayan University
Office of the Registrar

SRHU/Reg/OO/2023-139

Date: 10th July, 2023

OFFICE ORDER

In accordance with Statute 5.07 of Swami Rama Himalayan University, the Hon'ble Vice Chancellor has constituted the **Board of Studies** for **UG (B.Sc. Hons.) and PG (M.Sc.) Programmes** under Himalayan School of Bio-Sciences, as under:

	Dr. Sanjay Gupta, Professor & Principal, Himalayan School of Bio-Sciences	Chairperson
As per the provisions of Statute 5.07(b) of the University, 02 (Two) Professors nominated by the Hon'ble Vice Chancellor	Dr. Vivek Kumar, Associate Professor, Himalayan School of Bio-Sciences	Member
	Dr. Vikash Singh Jadon, Associate Professor, Himalayan School of Bio-Sciences	Member
As per the provisions of Statute 5.07(d) of the University, 02 (Two) external subject experts nominated by the Hon'ble Vice Chancellor	Dr. A.K. Dobriyal, Dean, Life Sciences & Professor, Department of Zoology & Biotechnology, HNB Garhwal Central University, Srinagar (Garhwal)	Member
	Dr. Naveen Navani, Professor, Department of Biosciences & Bioengineering, IIT Roorkee	Member
Special Invitee(s)	Dr. Vijay Kumar, Assistant Professor, Himalayan School of Bio-Sciences	
	Dr. Vishal Rajput, Assistant Professor, Himalayan School of Bio-Sciences	

By Order,

Registrar

Copy to: Hon'ble Chancellor
Hon'ble Vice Chancellor
Director General (Academic Development)
} for kind information please
Chairperson, Board of Studies
All above concerned

Swami Rama Himalayan University
Office of the Registrar

SRHU/Reg/Int/2023-351 Date: 28th July, 2023

Meeting Notice

The meeting of the **Board of Studies** for **UG (B.Sc. Hons.) and PG (M.Sc.) Programmes** under **Himalayan School of Bio-Sciences (HSBS)**, will be held on **12th August 2023 (Saturday)** at HSBS.

The 'Agenda' of the meeting shall be as follows:

1. To recommend, upon reference to it by the faculty, the courses of study, curriculum and methods of assessment in the subject or group of subjects within its purview.
2. To recommend programme objective and course outcome.
3. To recommend books, including text-books, supplementary reading, reference books and other study material for such courses of study.
4. To advise the faculty or faculties concerned regarding improvements in the courses of study.
5. To recommend organization of orientation and refresher courses in the subject.

All concerned members of the said 'Board of Studies' are requested to please make it convenient to attend the meeting.

Dr. Susheela Sharma
Registrar

Copy to: Hon'ble Chancellor
Hon'ble Vice Chancellor
Director General (Academic Development)
} for kind information please
Chairperson, Board of Studies
All concerned members of the Board of Studies

Swami Rama Himalayan University
HIMALAYAN SCHOOL OF BIOSCIENCES

CURRICULUM FOR B.Sc. (H) MICROBIOLOGY OF SWAMI RAMA HIMALAYAN UNIVERSITY

GOALS AND OBJECTIVES:

1. GOAL

B.Sc. (H) Microbiology program endeavors to instill in students the skills related to basic and applied aspects of microbiological approaches. The knowledge of microbiology will enable the students to improve the quality of human lives in relation to environment and to exploit microbes and plants in higher food production.

2. Objectives

a) Knowledge:

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

1. Learn the importance of microbes in environment, food processing and preservation, pharmaceuticals and microbe-based industries.
2. To consider the breadth of microbial interaction with other organisms in the ecosystem and the impact of those interactions on human affairs.
3. The graduates will demonstrate the skills necessary to understand and apply scientific concepts and reasoning, including the analysis and interpretation of various types of data.

b) Skills:

At the end of the course the student shall be able to:

1. Plan and interpret laboratory investigations for the plants and microbes.
2. Identify the common laboratory procedures to study the molecular aspects of plants and microbes.
3. The student will study the bioanalytical and molecular tools to apply its knowledge to benefit the human beings.
4. The student will be able design small research proposal.

c) Integration:

The student shall understand the basic and applied aspects of various microbiological fields.

.....	.....
(Dr. A.K. Dobriyal)	(Dr. Naveen Navani)
External Expert/Member	External Expert/Member
.....	.....
(Dr. Sanjay Gupta)	(Dr. Vivek Kumar)
Chairperson	Member

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.....
(Dr. Vikas S. Jadon)
Member

.....
(Dr. Vijay Kumar)
Special Invitee

.....
(Dr. Vishal Rajput)
Special Invitee

Registrar
Swami Rama Himalayan University

BOARD OF STUDIES AUGUST 2023

Minutes of Meeting

In pursuance to the notification no. SRHU/Reg/Int/2023-351) dated 28 July, 2023, the meeting of Board of Studies for B.Sc. (H) Microbiology was held on 12th August, 2023 at 11:00 AM in the Himalayan School of Biosciences.

The following members were present:

1.	Dr. Sanjay Gupta	--	Chairperson
2.	Dr. A. K Dobriyal	--	External Expert
3.	Dr. Naveen Navani	--	External Expert
4.	Dr. Vivek Kumar	--	Member
5.	Dr. Vikas Singh Jadon	--	Member
6.	Dr. Vijay Kumar	--	Special Invitee
7.	Dr. Vishal Rajput	--	Special Invitee

The Chairperson welcomed all the members of the committee.

The members want through the curriculum of B.Sc. (H) Microbiology and found it to be a good and relevant and believe that the curriculum will make a student to deal with various microbiological approaches in relation to microbes, plant and animals.

All the members also found the pattern of examination and method of assessment to be excellent one. All of them were of the opinion that the curriculum be adopted as such without any change.

The meeting ended with vote of thanks to external expert.

.....
(Dr. A.K. Dobriyal)
External Expert/Member

.....
(Dr. Naveen Navani)
External Expert/Member

.....
(Dr. Sanjay Gupta)
Chairperson

.....
(Dr. Vivek Kumar)
Member

.....
(Dr. Vikas S. Jadon)
Chairperson

.....
(Dr. Vijay Kumar)
Special Invitee

.....
(Dr. Vishal Rajput)
Special Invitee

Registrar
Swami Rama Himalayan University

Swami Rama Himalayan University
HIMALAYAN SCHOOL OF BIOSCIENCES
Board of Studies August 2023

Attendance

Date: 12/08/2023

1. Dr. A.K. Dobriyal ..... (Signature)
   Professor
   Department of Zoology & Biotechnology, HNB Garhwal Central University, Srinagar, Uttarakhand

2. Dr. Naveen Navani ..... (Signature)
   Professor
   Department of Biosciences & Bioengineering, IIT, Roorkee, Uttarakhand

3. Dr. Sanjay Gupta ..... (Signature)
   Professor & Principal
   Himalayan School of Biosciences
   Swami Rama Himalayan University
   Jollygrant, Dehradun

4. Dr. Vivek Kumar ..... (Signature)
   Associate Professor
   Himalayan School of Biosciences
   Swami Rama Himalayan University
   Jollygrant, Dehradun

5. Dr. Vikas Singh Jadon ..... (Signature)
   Associate Professor
   Himalayan School of Biosciences
   Swami Rama Himalayan University
   Jollygrant, Dehradun

6. Dr. Vijay Kumar ..... (Signature)
   Assistant Professor
   Himalayan School of Biosciences
   Swami Rama Himalayan University
   Jollygrant, Dehradun

7. Dr. Vishal Rajput ..... (Signature)
   Assistant Professor
   Himalayan School of Biosciences
   Swami Rama Himalayan University
   Jollygrant, Dehradun

Registrar
Swami Rama Himalayan University

SWAMI RAMA HIMALYAN UNIVERSITY, DEHRADUN

Swami Rama Nagar, Jollygrant, Dehradun

HIMALAYAN SCHOOL OF BIOSCIENCES

B.Sc. (Hons) Microbiology

The Credit Based Course Structure: B. Sc. (Hons.) Microbiology and B. Sc. (Hons.) Microbiology with Research- Three Year/Four Year Programme- Choice Based Credit System (CBCS)

B. Sc. Microbiology (three full academic years), B.Sc. (Hons.) Microbiology (four full academic years) and B.Sc. (Hons.) Microbiology with Research (four full academic years) program shall be based on the choice based credit system in which credit defines the quantum of content/ syllabus prescribed for a course system and determines the number of hours of instruction per week.

Total Credits:
48 (DSC/ MC)+ 24 (MNC) +06 (DSE)+ 12 (GE/OE)+ 6 (VA/VAC)+ 12 (SEC)+ 08 (AEC)+ 4 (Minor Project/Educational of Tour) =120 (For three years B. Sc. Microbiology)

120 (For three years B. Sc. Microbiology)+ 22 (DSC)+ 8 (MNC) +6 (DSE/ME)+ 03 (OE)+ 02 (Project)= 161 (For four years B. Sc. (Hons.) Microbiology)

120 (For three years B. Sc. Microbiology)+ 12 (DSC)+ 14 (Research Project)+ 14 (Dissertation)=160 (For four years B. Sc. (Hons.) Microbiology with Research)

Where,
DSC/MC=Discipline Specific Core/ Major Core
MNC= Minor Core
DSE= Discipline Specific Elective
OE= Open Elective
VA/VAC= Value Addition Course
SEC= Skill Enhancement Course
AEC= Ability Enhancement Course

Undergraduate degree programes of either 3 or 4-year duration, with multiple entry and exit points and reentry options within this period, with appropriate certifications such as:
A certificate after completing 1 year (2 semesters) of study in the chosen fields of study,
A diploma after 2 years (4 semesters) of study,
A bachelor's degree after a 3-year (6 semesters) programme of study,
A bachelor's degree with honours after a 4-year (eight semesters) programe of study or a bachelor's degree with research after a 4-year (eight semesters) programe of study if the student completes a rigorous research project in their major area(s) of study.

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Swami Rama Himalayan University

❖ Program Educational Outcomes (PEOs)

PEO 1. Graduates will demonstrate a solid understanding of fundamental microbiological concepts, including microbial structure, metabolism, genetics, and diversity, enabling them to analyze and interpret microbial processes across different environments.

PEO 2. Graduates will develop practical skills in a wide range of microbiology laboratory techniques, including culturing, microscopy, molecular biology, and biochemical assays, preparing them for effective experimentation and analysis.

PEO 3. Graduates will be able to apply their microbiological knowledge and skills to various sectors, such as healthcare, biotechnology, agriculture, and environmental science, contributing to solutions for real-world challenges.

PEO 4. Graduates will demonstrate ethical and professional behavior, effective communication skills, and an understanding of the broader societal implications of microbiological research, preparing them for responsible roles in research, industry, healthcare, and public engagement.

❖ PSO of B.Sc. (H) Microbiology

Program Specific Outcome 1 (PSO1):
Holistic Knowledge Attainment: Gain a comprehensive understanding of microbiology and its diverse branches, encompassing medical microbiology, virology, bioprocess engineering, etc., alongside allied subjects like biotechnology, biostatistics, bioanalytical techniques, IPR, and bioinformatics, all supported by a foundation in computer applications.

Program Specific Outcome 2 (PSO2):
Laboratory Proficiency: Demonstrate adeptness in maintaining microbiology laboratory safety and exhibiting competence in routine and advanced laboratory skills, relevant across a spectrum of allied scientific disciplines. Showcase the ability to collect, analyze, and interpret scientific data effectively.

Program Specific Outcome 3 (PSO3):
Application and Solution Creation: Utilize microbiology and life sciences insights to identify, dissect, and propose solutions for intricate challenges. Apply this knowledge to design responses to multifaceted issues in environmental conservation, biodiversity, healthcare, agriculture, industry, societal welfare, and research.

Program Specific Outcome 4(PSO4):
Preparedness and Career Exploration: Attain the qualifications and skills essential for higher studies and participation in competitive exams. Showcase adept communication, presentation, and writing abilities, while also exploring potential career paths in diverse sectors like pharmaceuticals, diagnostics, hospitals, and industries such as fermentation and food processing.

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❖ **Program outcomes (POs)**

Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery-learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

PO1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning.
PO2	Microbial Knowledge and Understanding: Develop a comprehensive understanding of the fundamental principles of microbiology, including microbial diversity, structure, physiology, genetics, and their interactions with other organisms and the environment.
PO3	Laboratory Skills and Techniques: Acquire proficiency in a wide range of microbiological laboratory techniques, including cultivation, isolation, identification, and molecular analysis of microorganisms, enabling effective experimentation and analysis. Apply microbiological concepts and skills to real-world scenarios in areas such as healthcare, biotechnology, environmental science, agriculture, and food safety, contributing to problem-solving and innovative solutions.
PO4	Ethical and Professional Conduct: Demonstrate ethical behavior, professional integrity, and effective communication skills within interdisciplinary teams, considering societal and environmental implications of microbiological research and applications.
PO5	Certificate and diploma courses promote self-entrepreneurship and self-employability, preparing students for careers in government, academia, research, industry, and success in national and international competitive exam.

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NEP- 2020- Choice Based Credit System/ Bachelor of Science (Hons.) Microbiology (With multiple entry & exit option)

UNDERGRADUATE CERTIFICATE IN MICROBIOLOGY

FIRST SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BMBC 111	General Microbiology	3	0	0	3	25	25	50	100	200
Major Core	BBTC 111	Biochemistry and Metabolism	3	0	0	3	25	25	50	100	200
Minor Core	BBTC 112	Cell Biology	3	0	0	3	25	25	50	100	200
Open Elective	*	To be opted from the list	3	0	0	3	25	25	50	100	200
Skill Enhancement	BMBSE 111	Mushroom Farming	3	0	0	3	25	25	50	100	200
Ability Enhancement Course	AECC 111	Environmental Science I	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BMPC 111	Lab course based on course BMBC 111	0	0	2	1	25	25	50	100	200
Major Core	BMPC 112	Lab course based on course BBTC 111	0	0	2	1	25	25	50	100	200
Minor Core	BMPC 113	Lab course based on course BBTC 112	0	0	2	1	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

- Open Elective- to be offered by another Department

Open Electives:

1. Basic Bioinformatics-1- BBTOE 111
2. Principle of Management- BBTOE 112
3. Principle of Yoga- BBTOE 113

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UNDERGRADUATE CERTIFICATE IN MICROBIOLOGY

SECOND SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BMBC 121	Microbial Physiology & Metabolism	3	0	0	3	25	25	50	100	200
Major Core	BMBC 122	Industrial Microbiology	3	0	0	3	25	25	50	100	200
Minor Core	BBTC 121	HumanPhysiology	3	0	0	3	25	25	50	100	200
Open Elective	*	To be opted from the list	3	0	0	3	25	25	50	100	200
Skill Enhancement	BBTSE 121	Biofertilizers	3	0	0	3	25	25	50	100	200
Ability Enhancement Course	AECC 121	English Communication	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BMPC 121	Lab course basedon course BMBC 121	0	0	2	1	25	25	50	100	200
Major Core	BMPC 122	Lab course basedon course BMBC 122	0	0	2	1	25	25	50	100	200
Minor Core	BMPC 123	Lab course basedon course BBTC 121	0	0	2	1	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

Students exiting the programme after securing 40 credits will be awarded "Undergraduate Certificate (Certificate Course in Microbiology) provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

Open Electives:

1. Bioinformatics-II- BBTOE 121
2. Entrepreneurship Development - BBTOE 122
3. Basics of forensic Sciences- BBTOE 123

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UNDER GRADUATE DIPLOMA IN MICROBIOLOGY

THIRD SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BBTC 231	Molecular Biology	3	0	0	3	25	25	50	100	200
Major Core	BMBC 231	Food &Diary Microbiology	3	0	0	3	25	25	50	100	200
Minor Core	BBTC 233	Chemistry-I	3	0	0	3	25	25	50	100	200
Open Elective	BBTOE 231/ *		3	0	0	3	25	25	50	100	200
Skill Enhancement	BBTSE 231	Microbial Quality Control in Food and Pharmaceutical Industries	3	0	0	3	25	25	50	100	200
Ability Enhancement Course	AECC 231	Environmental Science-II	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BMPC 231	Lab course based on course BBTC 231	0	0	2	1	25	25	50	100	200
Major Core	BMPC 232	Lab course based on course BMBC 231	0	0	2	1	25	25	50	100	200
Minor Core	BMPC 233	Lab course based on course BBTC 233	0	0	2	1	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

Open Electives:

1. Bioethics andBiosafety - BBTOE 231
2. Principles of marketing - BBTOE 232

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UNDER GRADUATE DIPLOMA IN MICROBIOLOGY

FOURTH SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BMBC 241	Virology and Infection	3	0	0	3	25	25	50	100	200
Major Core	BBTC 242	Immunology	3	0	0	3	25	25	50	100	200
Minor Core	BBTC 243	Chemistry-2	3	0	0	3	25	25	50	100	200
Open Elective	*		3	0	0	3	25	25	50	100	200
Skill Enhancement	BBTSE 241	Nano Biotechnology	3	0	0	3	25	25	50	100	200
Ability Enhancement Course	AECC 241	Organizational Behaviour	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BMPC 241	Lab course based on course BMBC 241	0	0	2	1	25	25	50	100	200
Major Core	BMPC 242	Lab course based on courseBBTC 242	0	0	2	1	25	25	50	100	200
Minor Core	BMPC 243	Lab course based on course BBTC 243	0	0	2	1	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

Students exiting the programme after securing 80 credits will be awarded "Undergraduate Diploma" (Diploma Course in Microbiology) provided they secure additional 4 credits in skill based vocational courses offered during first year or second year summer term.

Open Electives:

1. Beverage biotechnology- BBTOE 241
2. Biotechnologyand Human Welfare - BBTOE 242

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Swami Rama Himalayan University

UNDER GRADUATE DEGREE IN MICROBIOLOGY

FIFTH SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BMBC 351	Medical Microbiology	3	0	0	3	25	25	50	100	200
Major Core	BBTC 352	Genetic Engineering: Tools & Techniques	3	0	0	3	25	25	50	100	200
Minor Core	BBTC 351	Bioprocess technology	3	0	0	3	25	25	50	100	200
Discipline Specific Elective (Any one)	BMBDE 351/ BMBDE 352/	Plant Pathology / Microbial Diagnosis in Health Clinics	3	0	0	3	25	25	50	100	200
Value Addition course	BTVAC 351	Intellectual Property Rights	3	0	0	3	25	25	50	100	200
Project 1	MBPR 351	Project/Educational Tour Report I	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BMPC 351	Lab course based on course BMBC 351	0	0	2	1	25	25	50	100	200
Major Core	BMPC 352	Lab course based on course BBTC 352	0	0	2	1	25	25	50	100	200
Minor Core	BMPC 353	Lab course based on course BBTC 351	0	0	2	1	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

Registrar
Swami Rama Himalayan University

UNDER GRADUATE DEGREE IN MICROBIOLOGY

SIXTH SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
MajorCore	BMBC 361	Agriculture Microbiology	3	0	0	3	25	25	50	100	200
MajorCore	BMBC 362	Environmental Microbiology	3	0	0	3	25	25	50	100	200
Minor Core	BBTC 361	Bio-Analytical Tools	3	0	0	3	25	25	50	100	200
Discipline Specific Elective (Any one)	BMBDE 361/ BMBDE 362/	Microbial Analysis of Air and Water/ Pharmaceutical Biotechnology	3	0	0	3	25	25	50	100	200
Value Addition Course	BMBVAC 361	Vermitechnology	3	0	0	3	25	25	50	100	200
Project 2	MBPR 361	Project/Educational Tour Report II	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BMPC 361	Lab course based oncourse BMBC 362	0	0	2	1	25	25	50	100	200
Major Core	BMPC 362	Lab course based oncourse BMBC 361	0	0	2	1	25	25	50	100	200
Minor Core	BMPC 363	Lab course based on course BBTC 361	0	0	2	1	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

Exit Option with "Bachelor's Degree (Bachelor of Science in Microbiology)" after the three years or six semesters with the completion of the course equivalent to minimum 120 credits. Along with entry option to fourth year or seventh semester for those students meeting a minimum CGPA of 7.5 in Bachelor's Degree Examination (BDE).

Registrar
Swami Rama Himalayan University

UNDER GRADUATE DEGREE COURSE IN HONOURS MICROBIOLOGY
(B.SC. HONS. MICROBIOLOGY)

SEVENTH SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BMBC 471	Microbial Genetics	3	0	0	3	25	25	50	100	200
Major Core	BMBC472	Epidemiology	4	0	0	4	25	25	50	100	200
Minor Core	BBTC 471	Biostatistics, and Computers	4	0	0	4	25	25	50	100	200
Discipline Specific Elective (Any one)	BBTDE 471/ BMBDE 471	Mycology, Phycology and Bryology/ MOOC	3	0	0	3	25	25	50	100	200
Value Addition course	BMBVAC 471	Infection and Immunity	3	0	0	3	25	25	50	100	200
Project/Seminar	BMPR 471		-	-	-	2					
Practical											
Major Core	BMPC 471	Lab Course based on course BMBC 471	0	0	2	1	25	25	50	100	200
Total Credits						**20**					

Registrar
Swami Rama Himalayan University

EIGHT SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
MajorCore	BMBC 481	Microbial Ecology	3	0	0	3	25	25	50	100	200
MajorCore	BMBC 482	Microbial Ecotoxicology	3	0	0	4	25	25	50	100	200
Minor Core	BBTC 481	Protein Engineering	4	0	0	4	25	25	50	100	200
Discipline Specific Elective (Any one)	BMBDE 481/ BMBDE 482	Microbial Genomics/ Human Microbiota	3	0	0	3	25	25	50	100	200
Open Elective	BBTOE 481/ BBTOE 482	Epigenetics and Cancer Biology/ Enzymology	3	0	0	3	25	25	50	100	200
Value Addition Course	BMBSE 481	Industrial Waste Management	3	0	0	3	25	25	50	100	200
Practical											
Major Core	BMPC 481	Lab Course based on course BMBC 481	0	0	2	1	25	25	50	100	200
Total Credits						**21**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

Registrar
Swami Rama Himalayan University

UNDER GRADUATE DEGREE COURSE IN MICROBIOLOGY WITH RESEARCH

SEVENTH SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BBTRC 471	Research Methodology	4	0	0	4	25	25	50	100	200
Major Core	BBTRC 472	Research Publications and Ethics	4	0	0	4	25	25	50	100	200
Practical											
Research 1	BMBRM 471	Review of literature/ Minor Project	0	0	0	10	25	25	50	100	200
Research 2	BMBRM 472	Research Seminar Presentation-I	0	0	0	2	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

EIGHT SEMESTER

Course Category	Course Code	Course Name	Periods				Continuous Internal Assessment				Subject Total
			L	T	P	C	SE I	SE II	DDA	External (ESE)	
Theory											
Major Core	BBTRC 481	Research –IPR	4	0	0	4	25	25	50	100	200
Practical											
Dissertation	BMBRD 481	Major Project/ Internship	0	0	0	14	25	25	50	100	200
Research 3	BMBRD 482	Research Seminar Presentation-II	0	0	0	2	25	25	50	100	200
Total Credits						**20**					

L – Lecture, T – Tutorial, P – Practical, C – Credit

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UNDERGRADUATE CERTIFICATE IN MICROBIOLOGY

B. Sc. Microbiology

SEMESTER I

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 111	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	General Microbiology (Major Core)		

COURSE OBJECTIVES: This course is designed to be an introduction to microbiology that will familiarize students with the diversity within the microbial world, biology of bacteria, their metabolism and genetics, and their control. The specific objectives are:

1. To illustrate the criteria used for classification of microorganisms
2. To explain the structure of a prokaryotic cell
3. To give an overview of growth, nutrition and metabolism in bacteria
4. To illustrate the concepts of bacterial recombination

UNIT I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents. Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

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Suggested Reading and Text Books

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5 edition. McMillan.
6. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson
7. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Acquire knowledge about different types of microorganism, characteristic features reproduction and environmental factors influencing their growth
CO2	Comprehend different methods of culturing microbes measurement and analysis of bacterial growth
CO3	Understand various techniques utilized for control of microorganisms along with identification of bacterial water pollutant.
CO4	Identify microbes utilized in food microbiology processes ad their respective impact on health and environment.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 111 CO 1	2	3	-	-	-	3	2	-	-
BMBC 111 CO 2	-	-	3	1	-	2	2	2	1
BMBC 111 CO 3	-	-	3	2	2	2	-	2	1
BMBC 111 CO 4	-	2	-	2	-	2	2	-	-
Average CO (BMBC 111)	2	2.5	3	1.67	2	2.25	2	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 111	Credit	1
Year/Semester	Semester III	L-T-P	0-0-2
Course Title	Lab Course based on BMBC 111(Major Core)		

PRACTICALS

1. Preparation and sterilization of media for bacterial culture.
2. Isolation of bacteria from the soil.
3. Preparation of pure culture of bacteria.
4. Streaking of bacterial culture.
5. Gram staining of bacteria.
6. Determination of bacterial cell size by micrometry.
7. Enumeration of microorganisms.
8. Preparation of bacterial growth curve.
9. Antimicrobial sensitivity test.
10. Demonstration of flagella staining.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Exhibit technical skill to isolate bacterial from various samples, interpret data to derive a conclusion pertaining to microbial load of sample analyzed.
CO2	Identify principle and procedure of staining methods and respective application in biological research.
CO3	Utilization of various techniques to study, enumerate microorganisms and interpret results.
CO4	Conduct experiments related to biochemical activities of bacteria, record and analyze observations.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 111 CO 1	1	3	2	-	-	3	2	-	-
BMPC 111 CO 2	-	-	3	1	-	2	2	2	1
BMPC 111 CO 3	-	-	3	2	1	2	-	2	1
BMPC 111 CO 4	-	2	-	2	-	2	2	-	-
Average CO (BMPC 111)	1	2.5	2.67	1.67	1	2.25	2	2	1

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 111	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Biochemistry and Metabolism (Major Core)		

COURSE OBJECTIVES: This course is aimed to introduce the knowledge of biomolecules and their role in metabolic pathways. Also, it deals with the structure and function of enzymes.

UNIT I

Introduction to Biochemistry. A historical prospective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

UNIT II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Doublehelical model of DNA structure and forces responsible for A, B & Z – DNA.

UNIT III

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites.

UNIT IV

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Suggested Reading and Text Books

1. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular

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Biology of Plants. American Society of Plant Biologists.
2. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WHFreeman and Company, New York, USA.
3. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
4. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
5. Berg, JM, Tymoczko, JL and Stryer, L 2006. Biochemistry. 6th ed. WH Freeman and Co.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Apply knowledge of biomolecules synthesis, metabolic pathways along with their fundamental principles in the field of biochemistry and life science.
CO2	Acquire knowledge of cellular level metabolism, metabolic disorders and their impact on health.
CO3	Understand the designing of recent biochemical techniques and their respective applications.
CO4	Implement and analyze the experimental results by using statistical methods.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 111 CO 1	2	2	-	-	1	1	1	-	1
BBTC 111 CO 2	1	2	3	1	-	1	2	2	1
BBTC 111 CO 3	-	-	3	2	1	2	1	2	-
BBTC 111 CO 4	-	-	2	2	1	-	2	2	1
Average CO (BBTC 111)	1.5	2	2.6	1.6	1	1.3	1.5	2	1

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 112	Credit	1
Year/Semester	Semester I	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 111(Major Core)		

PRACTICALS

1. To study laboratory equipment and glass wares.
2. To prepare solutions of different concentration
3. To prepare buffers of different pH.
4. To perform Qualitative test for carbohydrates
5. To perform a Qualitative test for lipids
6. To perform Qualitative test for proteins and amino acids
7. To determine the Vmax of a given sample.
8. To verify Beer's law.
9. To perform a Quantitative test of proteins.
10. To perform Quantitative test for carbohydrates

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Acquire technical skill related to various techniques and process utilized in biochemical studies
CO2	Identify underlying principle and process of quantitative and qualitative estimation data interpretation and its application in biological studies.
CO3	Ability to carry out enzymatic studies to investigate factors affecting enzymatic activity and design graphical representation.
CO4	Data analysis and perception of testing samples

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 112 CO 1	1	1	3	-	1	2	1	2	1
BMPC 112 CO 2	-	1	3	1	-	-	2	2	-
BMPC 112 CO 3	-	1	3	-	-	1	-	1	-
BMPC 112 CO 4	-	-	1	1	-	-	-	-	3
Average CO (BMPC 112)	1	1	2.5	1	1	1.5	1.5	1.6	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 112	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Cell Biology (Minor Core)		

COURSE OBJECTIVES: Cell is the structural and functional unit of life. It is often referred to as the building block of life as well. The course on cell biology aims to impart knowledge of cell structure and functions of diverse cellular organelles.

UNIT I

Cells and organelles Introduction: Cell as a basic unit of living system, Biochemical composition of cell, the cell theory, ultra structure of cell. Cytoskeleton: The Nature of the Cytoskeleton and endomembrane system, intermediate filaments, microtubules, cilia and centrioles, actin filaments, actin-binding proteins. Cell membranes: Architecture and dynamics (models); Membrane composition, the lipid bilayer/membrane; A summary of membrane functions - simple diffusion, Facilitated transports, Active transport.

UNIT II

Eukaryotic cell organelles and functions. Structure and functions of the following cell organelles: endoplasmic reticulum, Golgi complex, lysosome, ribosome and mitochondria. Principles & applications of differential centrifugation in the fractionation of cellular organelles.

UNIT III

Nucleus and Cell Cycle. Genome organization, structure and function of nucleus, nuclear envelope, structure of chromatin, nucleosome and chromosome, cell cycle, mitosis and meiosis.

UNIT IV

Molecule and Protein Trafficking. The compartmentalization of higher cells, transport of molecules into and out of organelle membranes, the endoplasmic reticulum, transport from the ER through the Golgi Apparatus, transport from the trans Golgi network to lysosomes, transport from the plasma membrane via endosome: Endocytosis, molecular mechanisms of vesicular transport; introduction to transit peptide, signal peptide and translocons.

Suggested Reading and Text Books

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

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2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand and apply the principles, tools and techniques of cell Biology which prepares students for further higher education, basic research and employment.
CO2	Identify and understand the technical skills in the field of cell biology which will enhance their knowledge for analysis and research.
CO3	Provide knowledge in the field of cell biology which covers various health and environmental issues.
CO4	Develop a comprehensive understanding of cell biology principles and their applications in various scientific disciplines

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 112 CO 1	3	3	2	1	2	2	2	1	1
BBTC 112 CO 2	-	1	3	1	-	3	1	1	-
BBTC 112 CO 3	-	-	2	2	-	2	2	-	-
BBTC 112 CO 4	-	-	2	1	1	-	-	2	2
Average CO (BBTC 112)	3	2	2.25	1.25	1.5	2.3	1.6	1	1.5

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 113	Credit	1
Year/Semester	Semester I	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 112 (Major Core)		

PRACTICALS

1. Study of structure of any Prokaryotic and Eukaryotic cell.
2. Study the working and functioning of microscope.
3. Study of plasmolysis and de-plasmolysis.
4. To make the temporary mount of human cheek cells.
5. Cell division in onion root tip/ insect gonads.
6. Preparation of permanent slides of transverse sections (TS) of stem, root and leaf.
7. Study of permanent slides of mitosis and meiosis.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand and apply the principles, tools and techniques of cell Biology which prepares students for further higher education, basic research and employment.
CO2	Identify and understand the technical skills in the field of cell biology which will enhance their knowledge for analysis and research.
CO3	Provide knowledge in the field of cell biology which covers various health and environmental issues.
CO4	Develop a comprehensive understanding of cell biology principles and their applications in various scientific disciplines

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 113 CO 1	1	1	2	1	-	3	2	1	1
BMPC 113 CO 2	-	2	3	1	-	-	2	1	-
BMPC 113 CO 3	-	-	2	2	-	2	3	1	-
BMPC 113 CO 4	-	-	2	1	1	-	-	2	2
Average CO (BMPC 113)	1	1.5	2.25	1.25	1	2.5	2.3	1.25	1.5

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	
Course Code	BMBSE 111	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Mushroom Farming (Skill Enhancement)		

COURSE OBJECTIVES:

1. Understand the stages of mushroom growth, from spore germination to fruiting body formation, and learn practical cultivation techniques for various mushroom species.

2. Gain knowledge of the environmental factors crucial for successful mushroom cultivation, including temperature, humidity, light, and ventilation, and their effects on yield and quality.

3. Acquire hands-on experience in substrate preparation, spawn inoculation, and fruiting body harvesting, enabling you to confidently engage in mushroom cultivation practices.

UNIT I

Introduction to mushrooms and their significance. Mushroom spawn (seed) production/procurement

UNIT II

Mushroom cultivation: Button mushroom, Pearl mushroom, Oyster mushroom, Paddy straw mushroom. Milky mushroom

UNIT III

Cultivation of other economically and medicinally important mushrooms, Mushroom; Sectioning of gills of Agaricus. Insect pest management in cultivated mushrooms, Disease management in cultivated mushrooms

UNIT IV

Value addition to mushrooms (nutrient quality improvement) Mushroom growing unit/ house.

UNIT V

Entrepreneurial skills and economics for small enterprise. Management of spent substrates and waste disposal of various mushroom Health and Safety at workplace.

Suggested Reading and Text Books:

1. Practical Botany (Part I) ISBN #:81-301-0008-8 Sunil D Purohit, Gotam K

Kukda & Anamika Singhvi Edition:2013Apex Publishing House Durga NurseryRoad, Udaipur, Rajasthan (bilingual)

2. Modern Mushroom Cultivation And Recipes (hindi) (hb) ISBN:9788177545180 Edition Singh Riti, Singh UC Publisher: Agrobios (India).

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop practical skills in various mushroom cultivation methods, including substrate preparation, inoculation, and environmental control, enabling the successful cultivation of different mushroom species
CO2	Gain a comprehensive understanding of the life cycle of mushrooms, from spore germination and mycelium growth to fruiting body development, and how environmental factors influence each stage.
CO3	Learn effective farm management practices, including disease prevention, pest control, and optimization of cultivation parameters such as temperature, humidity, and light, to maximize mushroom yields and quality.
CO4	Explore the economic aspects of mushroom farming, including market trends, business planning, and value-added products, preparing students for entrepreneurship or employment in the mushroom cultivation industry.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBSE 111 CO 1	2	3	-	2	1	3	2	1	1
BMBSE 111 CO 2	-	3	2	2	2	3	2	2	2
BMBSE 111 CO 3	2	3	3	1	2	2	3	2	1
BMBSE 111 CO 4	2	3	2	2	-	2	3	2	2
Average CO (BMBSE 111)	2	3	2.3	1.75	1.67	2.5	2.5	1.75	1.5

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	AECC 111	Credit	2
Year/Semester	Semester I	L-T-P	2-0-0
Course Title	Environmental Science 1 (Ability Enhancement)		

COURSE OBJECTIVES: The basic objective of the environmental studies is to enable the students for interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including ecosystem, geosystems, biology, chemistry and global process. They will acquire an attitude of concern for the environment and will be able to critically evaluate the science and policy ramifications of diverse portfolios on air and water quality, natural resources etc.

UNIT I: Introduction to Environmental Sciences and Ecosystems

Multidisciplinary nature of Environmental Sciences; Scope and importance; Concept of sustainability and sustainable development. What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.

UNIT II: Renewable and Non-renewable Resources/ Biodiversity and Conservation

Land resources and land use change; Land degradation, soil erosion and desertification.

Deforestation, Water. Energy resources: Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies. Levels ofbiological diversity: genetic, species and ecosystem diversity; Biogeographic zones ofIndia; Biodiversity patterns and global biodiversity hot spots, India as a mega- biodiversity nation.

UNIT III: Environmental Pollution/ Human Communities and the Environment

Environmental pollution. Climate change, global warming, ozone layer depletion,acid rain and impacts on human communities and agriculture. Disaster management:floods, earthquake, cyclones and landslides. Environmental movements: Chipko,Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

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Suggested Reading and Text Books

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad –380 013, India, Email:mapin@icenet.net (R).
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB).
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001,Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Master foundational knowledge enabling them to have life–long learning related to one's surroundings.
CO2	Develop critical thinking skills in relation to environmental affairs and articulate multidisciplinary context of the subject.
CO3	Acquire knowledge about natural resources and assess aesthetic and ethical importance of all the living flora and fauna.
CO4	Interpret and propose solutions for effective management of different types of environmental pollution

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
AECC 111 CO 1	2	2	2	1	-	1	2	2	3
AECC 111 CO 2	-	1	2	1	3	-	3	1	1
AECC 111 CO 3	-	2	-	3	-	-	2	1	-
AECC 111 CO 4	-	-	1	2	2	-	2	-	2
Average CO (AECC 111)	2	1.66	1.66	1.75	2.5	1	2.25	1.33	2

3: High, 2: Medium, 1: Low

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OPEN ELECTIVES

B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 111	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Basic Bioinformatics 1 (Minor Open Elective)		

COURSE OBJECTIVES: The aim of the course is to introduce students to the basic tenets of bioinformatics. The course provides a strong foundation for developing skills in using biological sequence databases, and tools for biological sequence analysis. The specific objectives of the course are as follows:

1. To teach students about biological sequence data storage.
2. To make students understand about various bioinformatics tools used for DNA, RNA and protein sequence analysis.
3. To impart knowledge about biological sequence alignment.
4. To teach the fundamental principles of molecular phylogeny.

UNIT I

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques

UNIT III

Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

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COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Exhibit sound knowledge pertaining to concept and notion of bioinformatics along with comprehending web based utilization of bioinformatics resources.
CO2	Conceptual comprehension and technical application of various bioinformatics based tools to assess their utilization in bioanalytical techniques including chromatography, mass spectrometry, microarray, restriction digestion, PCR.
CO3	Identify and apply softwares utilized in bioinformatics for sequence alignment phylogenetic analysis and assess applicability of same in biological research.
CO4	Assess applicability of widespread bioinformatics techniques such as homology modeling, gene identification tool, searching databases, genome annotation and simultaneously identify research oriented potential of bioinformatics.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 111 CO 1	3	2	-	-	-	2	-	2	-
BBTOE 111 CO 2	-	2	3	-	1	2	1	2	-
BBTOE 111 CO 3	2	-	3	2	2	2	2	1	-
BBTOE 111 CO 4	-	-	1	1	3	-	-	2	3
Average CO (BBTOE 111)	2.5	2	2.33	1.5	2	2	1.5	1.75	3

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 112	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Principle of Management (Open Elective)		

COURSE OBJECTIVES: On completion of the course, the students will be able to

1. Recall and define key management concepts, theories, and terminology.
2. Explain the purpose and significance of management in organizational success.
3. Evaluate the effectiveness and efficiency of management practices in achieving organizational goals.

UNIT I: Introduction

Definition, nature, scope of management, Managerial roles and skills, ethics, ethical dilemma, Corporate Social Responsibility: concept, need, tools and strategies. Evolution of management thought and Management thinkers. Scientific Management, General administrative theories, Behavioral approach, Systems approach, Contingency approach.

Transaction Methodology – PPTs, Quiz, Case study, critical thinking exercises.

UNIT II: Planning & Decision Making

Types of plans and process of planning, business forecasting. Concept, benefits, limitations and process of Managing by Objectives. Strategic management: process and major kinds of strategies. Decision-Making: steps and approaches, Decision Making in various situations, decision tree.

Transaction Methodology – PPTs, Quiz, Application Based: Preparation Of Business plan, Student Presentation on Latest Business News, Role play.

UNIT III: Organizing

Structure and process of organization, Line & Staff concept; Authority & power: Delegation: concept, Span of Management. Decentralization vs. centralization: concept, reasons, types and advantages vs. disadvantages of decentralization. Coordination: Concept, importance, difficulties and techniques to ensure effective coordination. Concept of staffing. Motivation concept and theories – Maslow, Herzberg, McClelland, Vrooms' Expectancy.

UNIT IV: Control

Meaning, objectives, nature, Characteristics and process of controlling, kinds of control system, pre-requisites and features of effective control system.

Transaction Methodology – PPTs, Quiz, Case Study.

Suggested Readings and Text Books

1. Koontz, Harold and Weihrich, Heinz (2020). Essentials of Management: An International, Innovation and Leadership Perspective, 11th edition; New Delhi: McGraw Hill Education.
2. Robbins, Stephen P, Coulter Mary, Fernandez Agna (2019). Management. 16th edition. Pearson Education.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand the key concepts of management, theories and terminology.
CO2	Evaluate the importance of management studies in organizational success.
CO3	Apply management principles and techniques to solve real-world business problems.
CO4	Analyze case studies or scenarios to identify and propose solutions to management issues

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 121 CO 1	3	2	-	-	1	2		1	-
BBTC 121 CO 2	2	-	1	3	-	3	3	-	2
BBTC 121 CO 3	2	3		-	2	-	3	2	1
BBTC 121 CO 4	2	-	3	1	2	2	-	2	2
Average CO (BBTC 121)	2.25	1.25	1	2	1.67	2.3	1.5	1.25	1.67

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 113	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Principle of Yoga (Open Elective)		

COURSE OBJECTIVES: The objectives of the course are as follows:

1. Students should have an understanding about origin, history and development of Yoga.
2. Understand the principle and practice of each practice.
3. Demonstrate each practice skillfully.
4. Explain the procedure, precaution, benefits and limitations of each practice.

UNIT I: General Introduction to Yoga

Brief introduction to origin of Yoga, History and Development of Yoga, Etymology and Definitions of Yoga, Aim and Objectives of Yoga, Misconceptions about Yoga, True Nature of Yoga, General Introduction to Schools of Yoga, Yoga Practices for Health and Harmony

UNIT II: Yogasukshma and Sthul Vyamaya, Suryanamaskar

Yoga Sukshma Vyayayam- Joint & Glands Of Swami Rama's Teachings

Griva shakti-vikasaka, Skandha-tatha-bahu-mula shakti-vikasaka), Kohini shakti-vikasaka, Bhuja-valli shakti-vikasaka, Purna-bhuja shaktivikasaka, Mani-bandha shakti-vikasaka, Kara-prstha shakti-vikasaka, Karatala shakti-vikasaka, Kati shaktivikasaka, Jangha shakti-vikasaka (for the thighs) (i) & (ii), Janu shakti-vikasaka (for the knees), Pindali shakti-vikasaka (for the calves), Pada-mula shakti-vikasaka, Gulpha-pada-pristha-pada-tala-shakti-vikasaka (for the ankles and the feet), Padanguli shakti-vikasaka (for the toes)

Yoga Sthula Vyayama: Rekha-Gati(Walkingina Straightline), Hrid-Gati(Injanadaur–Thelocomotiveexercise), Utkurdana(Jumpingexercise) Urdhva-Gati(Upwardmovement), Sarvanga-Pusti(Developingtheentirebody)

Surkanamaskara

UNIT III: Shatkarmas & Yogasanas

Shatkriya- Jala Neti, Kapalbhati, Nauli Chalan, JyotiTrataka, Agnisara

Standing- Tadasana,Vrikshasana,Urdhva-Hastottanasana, KatiChakrasana, Ardha Chakrasana, Pada Hastasana, Trikonasana, Parshva Konasana, Veerabhadrasan, Hastapadangusthasana, Garudasana

Sitting- Bhunamanasana, Hanumanasana, Dandasana, Bhadrasana, Vajrasana, Bhramacharyasana, Mandukasana, Utthana Mandukasana, Kagasana, Utkatasana, Gomukhasana, Shashankasana, UttithaPadmasana, Marjariasana,

Backward bending- Makarasana, Bhujangasana, Shalabhasana, Dhanurasana

Forward bending- Janusirasana, Paschimottanasana, SuptaVajrasana, Pavanamuktasana

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Twisting pose- Sitting – Matseyanderasana, Vakrasana,ArdhaMatsyendrasana
Inverted posture- Setubandhasan, Ardh- halasan, Halasan, Karan peedasan, Sarvanagasan
Meditative posture- Sukhasana, Swastikaasana, Sidhhasana, Padmasana
UNIT IV: Pranayama - Nadi Shodhana, Bhramari, Suryabhedan, Ujjayi, Sheetali, Shitkari, Bhastrika

UNIT V: Pranav and Soham Japa, Antaurmouna, Dharana , Practice of Dhayana

Suggested Reading and Text Books

1. Swami Rama, Meditation and its Practise (HI, honesdale USa, 1998
2. Swami Dhirendra Bhramhachari :Yoga Sukshma Vyayama, Dhirendra Yoga Publications, New Delhi, 1980
3. Swami Dhirendra Bhramhachari:Yogasana Vijnana,Dhirendra Yoga Publications, New Delhi, 1966
4. Swami Kuvalyananda:Asana, Kaivalyadhama, Lonavla, 1983
5. Swami Satyananda Saraswati:Asana, Pranayama, Bandha, Mudra,Bihar School of Yoga, Munger, 2005-06

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Students will gain understanding of fundamental concepts and methods of Yogic Science
CO2	Make students familiar with the systems of Yoga styles.
CO3	Understand the principle and practice of Yogic practices.
CO4	Have an understanding about the practices that help practitioners to lead to meditation.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 121 CO 1	2	2	-	-	1	2	2	1	-
BBTC 121 CO 2	-	3	2	3	-	3	3	-	2
BBTC 121 CO 3	-	2	1	-	2	-	3	2	1
BBTC 121 CO 4	-	-	3	1	2	2	-	2	2
Average CO (BBTC 121)	2	2.3	2	2	1.67	2.3	2.67	1.67	1.67

3: High, 2: Medium, 1: Low

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SEMESTER II

B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 121	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Microbial Physiology and Metabolism (Major Core)		

COURSE OBJECTIVES: The objectives of this course are

1.To gain knowledge of various transport systems and protein secretion pathways in bacteria

2.To make student aware the concept osmoregulation.

3.To Gain knowledge of Quorum sensing.

UNIT I: Microbial Growth and Effect of Environment on Microbial Growth

Definitions of growth; Batch culture; Continuous culture; Generation time and specific growth rate; Temperature and pH ranges of growth; Effect of solute and water activity of growth; Effect of oxygen concentration on growth; Nutritional categories of microorganisms.

UNIT II: Nutrient Uptake and Transport

Passive and facilitated diffusion Primary and secondary active transport; Concept of uniport, symport and antiport.

UNIT III: Chemoheterotrophic Metabolism

Concept of aerobic and anaerobic respiration; Sugar degradation pathways: EMP, ED, Pentose phosphate pathway, TCA cycle; Fermentation: Alcohol fermentation and Pasteur effect, Lactate fermentation (Homofermentative and heterofermentative pathways), Concept of linear and branched fermentation pathways; Electron transport chain: Components of respiratory chain, Comparison of mitochondrial and bacterial ETC, Electron transport phosphorylation, Uncouplers and inhibitors.

UNIT IV: Chemolithotrophic and Phototrophic Metabolism

Chemolithotrophic metabolism: Introduction to aerobic and anaerobic chemolithotrophy with an example each, Hydrogen oxidation (Definition and reaction), Methanogenesis (Definition and reaction); Phototrophic metabolism: Introduction, Groups of phototrophic microorganisms, Anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria.

UNIT V: Nitrogen Metabolism

An overview, Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, Dissimilatory nitrate reduction (Denitrification, nitrate/nitrite and

nitrate/ammonia respiration, fermentative nitrate reduction).

Suggested Reading and Text Books

1. Foster, J.W. and Spector, M.P. Microbial physiology. John Wiley and Sons, New York
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York
3. Wiley,J.M.Sherwood L.M.and Woolverton,C.J.Prescott, Harley and Klein's Microbiology. McGraw-Hill, New York.
4. Foster, J.W. and Spector, M.P. Microbial physiology. John Wiley and Sons, New York.
5. Madigan, M.T., Martinko, J.M.and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.
6. Brun, Y.V. and Shimkets, L.J. Prokaryotic development. ASM Press, Washington, D.C.
7. Rose, A.H. Advances in microbial physiology. Academic Press, New York.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a thorough comprehension of microbial physiology, focusing on cellular processes, energy metabolism, and biochemical pathways that drive microbial growth, adaptation, and survival.
CO2	Acquire the ability to analyze and interpret intricate metabolic pathways, including glycolysis, citric acid cycle, electron transport chain, and biosynthesis, elucidating how microorganisms extract energy and synthesize essential biomolecules.
CO3	Explore microbial responses to changing environments, studying how microorganisms regulate gene expression, enzyme activity, and metabolic fluxes to adapt to varying nutrient availability, stress conditions, and energy sources.
CO4	Understand the practical applications of microbial physiology and metabolism in biotechnology, industrial fermentation, and bioremediation. Learn how to harness microbial metabolic processes for the production of biofuels, bioproducts, and the cleanup of environmental pollutants.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 121 CO 1	2	3	-	2	1	3	2	1	1
BMBC 121 CO 2	1	3	2	2	2	3	2	1	1
BMBC 121 CO 3	1	3	2	1	2	2	3	2	1
BMBC 121 CO 4	1	3	2	1	2	2	3	2	2
Average CO (BMBC 121)	1.25	3	2	1.5	1.75	2.5	2.5	1.5	1.25

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 121	Credit	1
Year/Semester	Semester II	L-T-P	0-0-2
Course Title	Lab course based on BMBC 121 (Major Core)		

PRACTICALS

1. Study and plot the growth curve of E. coli by tubidio metric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on growth of E.coli.
4. Effect of pH on growth of E.coli .

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop practical proficiency in performing a variety of laboratory techniques used to study microbial physiology and metabolism, including culture maintenance, enzyme assays, metabolic pathway analysis, and growth kinetics determination.
CO2	Gain the ability to collect, analyze, and interpret experimental data related to microbial growth, enzyme activity, and metabolic pathways, facilitating a deeper understanding of microbial responses to different environmental conditions.
CO3	Acquire skills in designing controlled experiments, optimizing protocols, and troubleshooting issues that may arise during laboratory work, enhancing critical thinking and problem-solving capabilities.
CO4	Establish a connection between theoretical concepts learned in the classroom and practical applications in the laboratory, reinforcing the understanding of microbial physiology and metabolism by directly observing the outcomes of metabolic processes.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 121 CO 1	2	2	3	3	2	3	3	2	2
BMPC 121 CO 2	1	2	3	1	1	3	2	1	2
BMPC 121 CO 3	1	2	3	2	3	3	2	2	1
BMPC 121 CO 4	2	2	3	3	2	3	2	2	2
Average CO (BMPC 121)	1.5	2	3	2.25	2	3	2.25	1.75	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 121	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Human Physiology (Minor Core)		

COURSE OBJECTIVES: The objectives of the course are as follows:

1. To examine basic concepts of mammalian physiology
2. To understand mechanisms of digestion, respiration, circulation and endocrine function
3. To explore the physico-chemical basis and operation of each organ system.

UNIT I: Digestion and Respiration

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice. Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III: Muscle physiology and osmoregulation

Structure of cardiac, smooth & skeletal muscle, threshold stimulus. Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction. Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

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Suggested Reading and Text Books

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt AsiaPTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Applied knowledge of biomolecules, metabolic pathways along with their fundamental principles in the mammalian body at the cellular level and system level.
CO2	Understand the designing of recent physiological techniques with related to human health system.
CO3	Enhanced knowledge and appreciation of mammalian physiology and understand the functions of important physiological systems including the cardio, respiratory, renal, digestive and endocrine systems.
CO4	Practicing group learning through scientific inquiry into the nature of mechanical, physical, and biochemical functions of different systems of animal.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 121 CO 1	2	2	-	-	1	2	2	1	-
BBTC 121 CO 2	-	3	2	3	-	3	3	-	2
BBTC 121 CO 3	-	2	1	-	2	-	3	2	1
BBTC 121 CO 4	-	-	3	1	2	2	-	2	2
Average CO (BBTC 121)	2	2.3	2	2	1.67	2.3	2.67	1.67	1.67

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 122	Credit	1
Year/Semester	Semester II	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 121		

PRACTICALS

1. Determination of Hemoglobin
2. Preparation of temporary slide of a mammalian tissue sample
3. Estimation of bleeding time and clotting time of the human being
4. Identification of blood cells by differential staining
5. Perform differential leukocyte count (DLC) in the blood sample
6. Counting of mammalian RBCs
7. Estimation of blood glucose level by glucometer
8. Identification of blood group in humans
9. Demonstration of action of an enzyme (catalase enzyme)
10. Separation of plasma and serum from the whole blood
11. Recording of human blood pressure. animal

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Demonstrate the experimental techniques related to mammalian body at the cellular level.
CO2	Understand the designing of recent physiological techniques and their conducting experiments in laboratories.
CO3	Generate and interpret the test hypotheses, analyze the data by using modern methods.
CO4	Practicing group learning through scientific inquiry into the nature of mechanical, physical and biochemical functions of different systems of animal.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 122 CO 1	-	1	3	2	1	3	-	2	-
BMPC 122 CO 2	1	2	3	-	1	3	1	3	-
BMPC 122 CO 3	-	2	2	-	2	1	-	2	1
BMPC 122 CO 4	1	-	2	2	-	-	3	2	1
Average CO (BMPC 122)	1	1.67	2.5	2	1.3	2.3	2	2.25	1

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 122	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Industrial Microbiology (Major Core)		

COURSE OBJECTIVES: The specific objectives of the course are as follows:

1. To familiarize students with the production of industrial chemicals.
2. To impart knowledge about metabolic engineering of secondary metabolism.
3. To teach students about the enzyme and cell immobilization techniques relevant to industrial processing.
4. To make students understand the different methods of experimental model for design of fermentation systems.
5. To teach about the enzyme kinetics used in fermentation technology.

UNIT I

Brief history and developments in industrial microbiology, Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fed-batch and continuous fermentations. Isolation of industrially important microbial strains; Primary and secondary screening, strain development, preservation and maintenance of industrial strains, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract

UNIT II

Components of a typical bioreactor, types of bioreactors-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Measurement and control of fermentation parameters; pH, temperature, dissolved oxygen, foaming and aeration

UNIT III

Down-stream Processing; Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products.

UNIT IV

Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations. Enzyme immobilization; Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

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Suggested Reading and Text Books

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Gain a thorough understanding of the principles and processes involved in industrial fermentation, including microbial growth, metabolism, and fermentation kinetics.
CO2	Analyze and optimize fermentation processes by monitoring and controlling key parameters, such as pH, temperature, nutrient availability, oxygenation, and sterility, to maximize product yield and quality.
CO3	Develop problem-solving skills to identify and address challenges in industrial fermentation, including contamination, substrate limitations, metabolic limitations, and scale-up issues.
CO4	Data analysis and perception of biological samples.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 122 CO 1	2	2	2	-	1	1	2	1	2
BMBC 122 CO 2	-	3	3	2	-	2	2	1	-
BMBC 122 CO 3	-	2	3	2	-	-	2	2	2
BMBC 122 CO 4	-	-	3	2	1	2		2	2
Average CO (BMBC 122)	2	2.33	2.75	2	1	1.66	2	1.5	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTPC 122	Credit	1
Year/Semester	Semester II	L-T-P	0-0-2
Course Title	Lab Course based on BMBC 122 (Major Core)		

PRACTICALS

1. Isolation and screening of bacterial and fungal cultures for enzyme production.
2. Estimation of enzyme production by microbial culture via liquid state fermentation.
3. Estimation of enzyme production by microbial culture via solid state fermentation.
4. Media formulation for enhanced enzyme production by microbial culture via liquid and solid state fermentation.
5. Optimization of culture conditions for enhanced enzyme production by microbial culture via liquid and solid state fermentation.
6. Production of wine from fruit juice.
7. Monitoring of sugar reduction during wine production.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop hands-on proficiency in performing industrial fermentation experiments, including inoculum preparation, media formulation, fermentation setup, monitoring key parameters, and sample analysis.
CO2	Apply statistical tools and experimental design techniques to optimize fermentation processes, identify critical parameters, and enhance product yield, purity, and productivity.
CO3	Develop problem-solving skills to troubleshoot common issues in industrial fermentation, such as contamination, low yields, and inconsistent product quality, and implement quality control measures to ensure reliable and consistent production.
CO4	Data analysis and perception of biological samples.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 122 CO 1	2	3	3	2	2	2	-	2	-
BMPC 122 CO 2	2	3	3	2	2	2	2	2	-
BMPC 122 CO 3	-	-	2	2	2	-	2	-	-
BMPC 122 CO 4	-	-	3	-	1	-	-	2	2
Average CO (BMPC 122)	2	3	2.75	2	1.75	2	2	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTSE 121	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	BIOFERTILIZERS (Skill Enhancement)		

COURSE OBJECTIVES: This course aims to provide students with a comprehensive understanding of the use and application of biofertilizers in agriculture and sustainable farming practices.

UNIT I

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

UNIT II

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

UNIT III

Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

UNIT IV

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

UNIT V

Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

Suggested Reading and Text Books

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay -Publication, New Delhi.

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4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of biofertilizers, including their types, composition, production methods, and mechanisms of nutrient release in plants.
CO2	Acquire knowledge on the selection criteria for biofertilizers based on crop requirements, soil conditions, and environmental factors, and gain practical skills in the proper application of biofertilizers in agricultural systems.
CO3	Understand the role of biofertilizers in sustainable nutrient management practices, including their ability to enhance soil fertility, promote plant growth, improve nutrient uptake efficiency, and minimize environmental impacts.
CO4	Learn methods for evaluating the quality and efficacy of biofertilizers, including microbial analysis, nutrient content determination, and field trials, to ensure their effectiveness and reliability in agricultural applications.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTSE 121 CO 1	2	1	1	-	2	2	-	-	1
BBTSE 121 CO 2	-	2	2	2	1	2	2	1	1
BBTSE 121 CO 3	-	2	3	-	-	3	2	2	-
BBTSE 121 CO 4	-	1	1	2	2	2	-	1	1
Average CO (BBTSE 121)	2	1.5	1.75	2	1.67	2.25	2	1.3	1

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	AECC 121	Credit	2
Year/Semester	Semester II	L-T-P	2-0-0
Course Title	English Communication (Co-curricular)		

COURSE OBJECTIVES:

1. To define and explain various techniques of word formation; and develop skills of sensible writing and vocabulary building.
2. To illustrate and elaborate fundamental techniques and features of writing skills.
3. To demonstrate and discuss various types of common errors committed by users of English and solve exercises to develop their understanding in use of grammatically correct sentences.
4. To organize language lab activities and workshops to develop oral communication skills

UNIT I: Listening Skills

Process of listening, Difference between Listening and Hearing, Active Listening and Reflective response, Barriers to Effective Listening, Improvement of Listening Skills, Listening Comprehension-Identification of General Content and Specific Information.

UNIT II: Reading Skills

Importance of Reading, Types of Reading, Comprehension of different kinds of Text – General and Technical, Developing skills for skimming and scanning, Improvement of Reading skills with the aid of newspapers ,unseen passages , short stories and technical reports.

UNIT III: Speaking Skills

Importance of speaking, Phonetics -Stress, Intonation and Pronunciation, Self-Introduction, Describing objects, Expressing opinions, Showing agreement and disagreement, Offering suggestions, Extempore, JAM Sessions, Role Play.

UNIT IV: Writing Skills

Importance of Writing, Rules for Effective writing, Progression of ideas, Flow of thoughts, Formal Letter Writing, Paragraph Writing-Writing of descriptive and narrative paragraphs.

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*The nuances of grammar [Parts of Speech, Forms of Verb, Subject Verb Agreement, Prepositions, Use of Dictionary, Homophones, Antonyms, Synonyms, Words often confused and misused, Idioms] will be taught in the above four units as and how.

Suggested Reading and Text Books

1. Nelson, Gale and Loius Colaianni (2000). The Joy of Phonetics and Accent. Joy Press.

2. Hargie, Owen and David Dickson (2004). Skilled Interpersonal Communication – Research, Theory & Practice, 4 th edition. Routledge.

3. Technical Communication- Principles and Practice, Meenakshi Raman & Sangeeta Sharma, Oxford University Press, 2nd Edition.

4. Daly, John A. and John M. Wiemann (1994). Strategic Interpersonal Communication, Lawrence Erlbaum Associates.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand the meaning and the process of communication along with its types and barriers.
CO2	Develop proficiency in English Language through vocabulary building and correct use of grammar.
CO3	Acquire competency in reading and listening by understanding the skills involved and assessing & analyzing literary texts critically.
CO4	Form a clear concept of writing style in technical communication and develop technical writing skills.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
AECC 121 CO 1	-	2	-	3	1	-	-	1	3
AECC 121 CO 2	2	2	-	2	2	-	3	-	3
AECC 121 CO 3	2	2	1	3	2	-	-	-	3
AECC 121 CO 4	2	2	-	2	1	-	-	2	3
Average CO (AECC 121)	2	2	1	2.5	1.5	-	3	1.5	3

3: High, 2: Medium, 1: Low

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OPEN ELECTIVES

B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 121	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Bioinformatics II (Open Elective)		

COURSE OBJECTIVES: The aim of the course is to introduce students to the basic tenets of bioinformatics. The course provides a strong foundation for developing skills in using biological sequence databases, and tools for biological sequence analysisTo teach students about biological sequence data storage.

1. To make students understand about various bioinformatics tools used for DNA, RNA and protein sequence analysis.
2. To impart knowledge about biological sequence alignment.
3. To teach the fundamental principles of molecular phylogeny.

UNIT I

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT II

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Exhibit sound knowledge pertaining to concept and notion of bioinformatics along with comprehending web based utilization of bioinformatics resources.
CO2	Conceptual comprehension and technical application of various bioinformatics based tools to assess their utilization in bioanalytical techniques including chromatography, mass spectrometry, microarray, restriction digestion, PCR.
CO3	Identify and apply softwares utilized in bioinformatics for sequence alignment phylogenetic analysis and assess applicability of same in biological research.

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CO4	Assess applicability of widespread bioinformatics techniques such as homology modeling, gene identification tool, searching databases, genome annotation and simultaneously identify research oriented potential of bioinformatics.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 121 CO 1	-	-	3	2	-	3	-	-	-
BBTOE 121 CO 2	1	2	-	-	-	-	3	-	2
BBTOE 121 CO 3	-	-	2	2	2	-	-	2	-
BBTOE 121 CO 4	-	-	2	1	2	3	2	-	2
Average CO (BBTOE 121)	1	2	2.3	1.67	2	3	2.5	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 121a	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Entrepreneurship Development (Open Elective)		

COURSE OBJECTIVES:

1. To understand the meaning and importance of Entrepreneurship .
2. To understand the various forms of business organisation .
3. To analyze the importance of finance in an enterprise .
4. To analyze the importance of marketing management in an enterprise.
5. To understand the meaning of international business.

UNIT I: Introduction

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II: Establishing an Enterprise

Forms of Business Organization, Project Identification, Selection of the product, Project formulation,Assessment of project feasibility.

UNIT III: Financing the Enterprise

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV: Marketing Management

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

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UNIT V: Entrepreneurship and International Business

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

Suggested Reading and Text Books

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Identify and understand the basic of Entrepreneurship and Business management along with imparting ability to work in team
CO2	Provide sound knowledge pertaining to application of business strategies and impact of same to society and environment.
CO3	Explore knowledge regarding entrepreneurship developments for selection of products and markets in National and International business.
CO4	Appraise and develop management skills as life learning process for designing and development of startups or scientific project.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 122 CO 1	-	-	2	2	1	2	-	2	-
BBTOE 122 CO 2	-	-	1	2	2	1	-	2	1
BBTOE 122 CO 3	-	-	-	3	2	-	-	2	2
BBTOE 122 CO 4	-	1	-	2	3	-	2	2	1
Average BBTOE 122)	-	1	1.5	2.25	2	1.5	2	2	1.33

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 123	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Basics of Forensic Science (Open Elective)		

COURSE OBJECTIVES: This is an introductory course on forensic sciences with the following objectives:

1. To familiarize students with the fundamental principles of forensic sciences.
2. To impart knowledge about the injuries and deaths and how they are assessed.
3. To make students understand the process of documentation of crime scenes.
4. To impart the knowledge about the importance of cyber security in forensic sciences.

UNIT I

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects,method of assessing various types of deaths.

UNIT II

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

UNIT III

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification.

UNIT IV

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Suggested Reading and Text Books

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

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2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University ofDelhi, Delhi (2002).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and InvestigativeTechniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G.Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

COURSE OUTCOMES (CO): On completion of this course, the students will be able to:

CO	Description
CO1	Understanding Forensic Principles: Develop a foundational understanding of the principles and concepts underlying forensic sciences, including crime scene investigation, evidence collection, preservation, and analysis.
CO2	Knowledge of Forensic Techniques: Acquire knowledge of various forensic techniques used in the analysis of physical evidence, such as fingerprint analysis, DNA profiling, ballistics, toxicology, and forensic anthropology
CO3	Application of Scientific Methods: Apply scientific methodologies and analytical skills to interpret and evaluate forensic evidence, understand the limitations and reliability of different techniques, and draw conclusions based on scientific findings.
CO4	Ethical and Legal Considerations: Demonstrate an understanding of the ethical and legal considerations in forensic sciences, including the proper handling of evidence, maintaining chain of custody, and adherence to professional standards and guidelines.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 123 CO 1	2	2	3	-	-	3	2	2	-
BBTOE 123 CO 2	-	-	2	1	-	-	2	3	-
BBTOE 123 CO 3	-	-	3	2	-	2	-	2	3
BBTOE 123 CO 4	-	-	-	2	2	-	-	2	3
Average (BBTOE 123)	2	2	2.67	1.67	2	2.5	2	2.25	3

3: High, 2: Medium, 1: Low

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SEMESTER III

UNDER GARDUATE DIPLOMA COURSE IN MICROBIOLOGY

B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 231	Credit	3
Year/Semester	Semester III	L-T-P	3-0-0
Course Title	Molecular Biology (Major Core)		

COURSE OBJECTIVES: The objectives of the course are as follows:

1. To make the student understand the Mendelian and non-Mendelian genetics of inheritance.
2. To make the student understand the allele and gene interactions.
3. To make the student learn the fundamentals of chromosome and gene organization.
4. To impart the knowledge about sex determination among humans and animals.
5. To teach the concepts of extra-chromosomal inheritance

UNIT I

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II

DNA damage, repair and homologous recombination: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains

Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV

Regulation of gene expression and translation: Regulation of gene expression in prokaryotes:

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Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Posttranslational modifications of proteins.

Suggested Reading and Text Books

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand basic and advanced molecular biology concepts and techniques.
CO2	Appraise domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement
CO3	Identify underlying principle of working of various instrument and technique used in molecular biology and application of same in scientific research.
CO4	Demonstrate an understanding of molecular pathways that are altered in DNA and various DNA repair and its mechanism

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 231 CO 1	2	2	2	-	-	3	2	-	-
BBTC 231 CO 2	-	-	-	3	1	-	1	2	2
BBTC 231 CO 3	-	-	3	1	1	3	2	2	-
BBTC 231 CO 4	-	3	1	-	-	-	2	-	-
Average CO (BBTC 231)	2	2.5	2	2	1	3	1.75	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 231	Credit	1
Year/Semester	Semester III	L-T-P	0-0-1
Course Title	Lab course based on BBTC 231(Major Core)		

PRACTICALS

1. Safety guidelines of genetics laboratory and good laboratory practices.
2. Preparation of solutions for Molecular Biology experiments.
3. Isolation of chromosomal DNA from bacterial cells.
4. Isolation of Plasmid DNA by alkaline lysis method.
5. Agarose gel electrophoresis of genomic DNA & plasmid DNA
6. Isolation of DNA from plant tissue using classical methods
7. Elution of nucleic acids from agarose gel
8. Primer Designing Demonstration of Thermal Cycler

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand basic and advanced molecular biology concepts and techniques.
CO2	Identify the enzymes, organelles and molecules involved in replication, transcription and translation and learn the role of each.
CO3	Develops understanding of various molecular biology techniques, working and principle of various instruments used in molecular biology and their respective application.
CO4	Develop knowledge of interpretation of experimental data and evaluation of experimental result to derive a solution to a problem

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 231 CO 1	2	2	3	2	2	2	2	-	-
BBTC 231 CO 2	-	3	-	-	2	3	-	-	-
BBTC 231 CO 3	-	-	3	-	2	3	1	-	-
BBTC 231 CO 4	2	-	3	2	2	-	2	2	2
Average CO (BBTC 231)	2	2.5	3	2	2	2.67	1.67	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 231	Credit	3
Year/Semester	Semester III	L-T-P	3-0-0
Course Title	Food & Diary Microbiology (Major Core)		

COURSE OBJECTIVES: The objectives of this course are

1. To aware the student principles of food preservation.
2. To make student to aware spoilage of fermented foods
3. To aware the student Food Safety and Quality Assurance

UNIT I: Food as a substrate for microbial growth

Microbial growth in food- Intrinsic and extrinsic factors, Microorganisms important in food industry: Molds yeast, Bacteria-General characteristics, classification and importance.

UNIT II: Food Preservation

Principles of food Preservation, Methods of food preservation-Physical methods-asepsis, high temperature, low temperature, drying, Smoking. Chemical methods (chemical preservatives and food additives), canning.

UNIT III: Food borne diseases

Infection and Intoxication of Clostridium, Escherichia, Staphylococcus and salmonella

UNIT IV: Contamination and spoilage of foods

Contamination of food from green plants and fruits/animal/sewage/soil/water/air/during handling and processing. Causes of spoilage in food.

Characterization of contamination and spoilage of cereals, vegetables, fruits, milk and meat. Spoilage of canned foods.

UNIT V: Dairy Microbiology

Normal flora of milk and milk products, Fermented milk products: Acidophilus milk, yoghurt, cheese and determination of quality of milk by MBRT and Resazurin test. Probiotics-definition, examples and benefits.

Suggested Reading and Text Books:

1.Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge.
2. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw Hill, New Delhi.
3. Stanbuty, P.F. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.

4. Banwart, G.J. Basic food microbiology.CBS Publishers and Distributors, New Delhi.
5. Robinson, R.K. Dairy microbiology. Elsevier Applied Sciences, London.
6. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop an understanding of microbial hazards in food and dairy products, including pathogenic bacteria, fungi, viruses, and their impact on food safety and quality.
CO2	Acquire proficiency in a range of microbiological analysis techniques used to detect and quantify microorganisms in food and dairy products, including methods for enumeration, isolation, and identification.
CO3	Quality Assurance and Control:** Learn to implement microbiological quality assurance and control measures in food and dairy processing, ensuring compliance with regulatory standards and industry best practices.
CO4	Understand strategies for managing foodborne pathogens, including preventive measures, HACCP principles, and emerging technologies to ensure safe and hygienic food and dairy production.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 231 CO 1	2	3	2	2	3	3	3	2	2
BMBC 231 CO 2	2	3	3	3	3	3	3	2	2
BMBC 231 CO 3	2	3	3	3	3	3	3	2	2
BMBC 231 CO 4	2	3	3	2	3	3	3	3	2
Average CO (BMBC 231)	2	3	2.75	2.5	3	3	3	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 232	Credit	1
Year/Semester	Semester III	L-T-P	0-0-2
Course Title	Lab Course based on BMBC 231		

PRACTICALS

1. Assay of quality of milk sample using MBR Test.
2. Adulteration tests for milk.
3. Microbial production of curd.
4. Isolation and identification of *Lactobacillus* from fermented dairy products.
5. Isolation and biochemical identification of microorganisms from contaminated food and dairy samples.
6. Production of sauerkraut.
7. Estimation of lactic acid production in sauerkraut.
8. Effect of salt concentration on lactic acid production in sauerkraut.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Gain hands-on experience in applying various microbial analysis techniques to food and dairy samples, including culturing, staining, and microscopic examination, enhancing your proficiency in microbiological methods.
CO2	Learn to detect and identify common foodborne pathogens using advanced laboratory techniques, contributing to your ability to ensure food safety.
CO3	Apply microbiological quality control measures to assess the microbial quality of food and dairy products, preparing you to implement rigorous quality assurance protocols in food production.
CO4	Develop skills in interpreting microbiological data obtained from laboratory analyses and effectively communicate findings through accurate and concise reports, ensuring compliance with industry standards.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 232 CO 1	2	3	2	2	3	3	3	2	2
BMPC 232 CO 2	2	3	3	3	3	3	3	2	2
BMPC 232 CO 3	2	3	3	3	3	3	3	2	3
BMPC 232 CO 4	2	3	3	2	3	3	3	3	3
Average CO (BMPC 232)	2	3	2.75	2.5	3	3	3	2.25	2.5

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 233	Credit	3
Year/Semester	Semester III	L-T-P	3-0-0
Course Title	Chemistry- I (Minor Core)		

COURSE OBJECTIVES: The course aims to teach the principles of chemistry. The specific objectives of the course are:

1. To teach students the basic concepts of chemistry.
2. To make students understand the importance of chemistry in sustainable development.
3. To teach students the fundamental principles of biocatalysis, photochemistry and electrochemistry.
4. To teach students about chemistry in daily practice

UNIT I

Stereochemistry: Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformation: Restricted rotation about single bonds, Various conformations of ethane, butane and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism.

UNIT II

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti- Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercurationdemercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes.

UNIT III

Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkylbenzenes. Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group).

UNIT IV

Elimination Reactions: Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination). Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Oxidation Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate Introduction and reactions of Alcohols, Aldehydes, Ketones and Nitro compounds

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Suggested Reading and Text Books

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Longman, London & New York.
3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. College Practical Chemistry, Universities Press.
4. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
5. R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.
6. Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand
7. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
8. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
9. T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.
10. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons.
11. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Apply the scientific knowledge of electronic configuration, periodic properties of elements in each group in the periodic tables, analyse the problems with the help of analytical knowledge related to industry or Society or health and communicate effectively.
CO2	Impart essential theoretical knowledge on atomic structure, periodic properties, Chemical bonding, isomerism, stereochemistry for scientific problems and demonstrate the knowledge to applied sciences for lifelong learning.
CO3	Develop skills for quantitative estimation using the different branches of Volumetric analysis, statistical knowledge with life-long learning skills in society and industry and also inculcate habit of working in a team
CO4	Know, recall and explain the fundamental principles of chemistry that include General Inorganic chemistry, Fundamental organic Chemistry and learning of analytical laboratory learning skill for the analysis and interpretation of data for the professional ethics.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 233 CO 1	2	3	-	-	-	3	2	-	-
BBTC 233 CO 2	-	3	-	1	-	2	2	2	2
BBTC 233 CO 3	-	-	3	2	-	2	-	2	3
BBTC 233 CO 4	2	2	2	-	1	2	2	-	-
Average CO (BBTC 233)	2	2.67	2.5	1.5	1	2.25	2	2	2.5

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 233	Credit	1
Year/Semester	Semester III	L-T-P	0-0-2
Course Title	Lab Course Based on BBTC 233 (Minor Core)		

PRACTICALS

1. Purification of organic compounds by crystallization using the following solvents: (a) Water (b) Alcohol
2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
3. Determination of optical- 1g of starting compound. Recrystallize the product and determine the melting point of activity by using polarimeter Organic preparations: Carry out the following preparations using 0.5 the recrystallized sample.
4. To prepare acetanilide by the acetylation of aniline.
5. To prepare p-bromoacetanilide.
6. Benzolyation of aniline or β-naphthol by Schotten-Baumann reaction
7. Hydrolysis of benzamide or ethyl bezoate.
8. Semicarbazone derivative of one the following compounds: acetone, ethyl methylketone, diethylketone, cyclohexanone, benzaldehyde.
9. Nitration of nitrobenzene.
10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

COURSE OUTCOMES (COS): On completion of this course, the students will be:

CO	Description
CO1	Understand and explain scientifically the various chemistry related problems in industry.
CO2	Develop an understanding of the role of the chemist in tasks employing physical chemistry.
CO3	Ability to demonstrate the significance of Buffer solutions, knowledge of electrochemistry as well as conductivity.
CO4	Ability to analyze and generate experimental skills, this will help students in employment in industries.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 233 CO 1	2	3	-	-	-	3	2	-	-
BBTPC 233 CO 2	-	3	2	1	-	2	-	2	2
BBTPC 233 CO 3	2	-	3	2	-	2	2	2	2
BBTPC 233 CO 4	-	2	3	2	2	2	2	-	-
Average CO (BBTPC 233)	2	2.67	2.67	1.67	2	2.25	2	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTSE 231	Credit	3
Year/Semester	Semester III	L-T-P	3-0-0
Course Title	Microbial Quality Control in Food and Pharmaceutical Industries (Skill Enhancement)		

COURSE OBJECTIVES:

1. To understand the concepts of global scenario of Health & safety.
2. To analyses the gaps between reference standards & pertinent conditions of safety in India.
3. Students should be able to analyses and solve basic agronomical issues.
4. To be efficient in the operation of industrial hygiene equipment.
5. To understand the effects of various gases & treatments.

UNIT I: Physical and Chemical Hazards

Recognition, Evaluation and Control of Physical Hazards- Noise and Vibration - Effects and ControlMeasures- Thermal Stress - Parameter Control, Radiation - Types - Source - Effect and Control- Illumination & Lighting. Recognition, Evaluation and Control of Chemical Hazards- Types - Dust-Fumes -Mist -Vapor-Fog etc., Air Contaminants- Evaluation - Types of Sampling- Air Sampling System-Method Analysis-Control Measures.

Unit II: Occupational Health

Concept and Spectrum of Health-Functional Units and Activities of Occupational Health Services- Occupational and Work Related Disease-Levels of Prevention of Diseases - Notifiable Occupational Diseases such as Silicosis- Asbestosis- Pneumoconiosis-- Aluminosis and Anthrax. Lead- Nickel,

Chromium and Manganese Toxicity-Gas Poisoning (such as CO, Ammonia, Coal Dust etc.,) their effects and Prevention- Cardio Pulmonary Resuscitation- Audiology-Hearing Conservation Programme-Effects of Ultra Violet Radiation and Infrared Radiation on Human Systems Industrial Toxicology-Local and Systemic and Chronic Effects Temporary and Cumulative Effects- Carcinogens Entry into Human System Ergonomics, Personnel Protective Equipment, Personnel Monitoring.

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Unit III: Personal Hygiene and First Aid

Hygiene Concepts-Correct and Clean Dresses-Clean Body - Washing - Good Habits-Oral and Stomach Hygiene-Cleaning - Compressed Air and Degreasing Agents-Long Hair and Nails and Torn and loosely Hanging Clothes-Smoking - Lavatories Maintenance- Living in Unhygienic Areas. First aid concept- -First Aid Boxes-Legal Requirements, Industrial Hygiene, Medical Surveillance, Medical Surveillance Program Development, Recommended Medical Programme, Emergency Treatment, Non-Emergency Treatment, Exposures to Hazardous Materials.

Suggested Reading and Text Books:

1. Adams, M.R., Moss, M.O. (2008). Food Microbiology, 3rd Ed. Royal Society of Chemistry.
2. Jay, J.M., Loessner, M.J., Golden, D.A. (2005). Modern Food Microbiology, 7th Ed. Springer.
3. Leistner, L. (2000). Basic Aspects of Food Preservation by Hurdle Technology. International Journal of Food Microbiology, 55(1-3), 181-186.
4. Splitter, E.J. (2009). Introduction to Food Microbiology. CRC Press.
5. Baird, R.M. (2004). Foodborne Microorganisms of Public Health Significance. Food Safety Authority of Ireland.
6. Presser, K.A., Ratkowsky, D.A., Ross, T. (1997). Modelling the Growth Rate of Escherichia coli as a Function of Temperature. Applied and Environmental Microbiology, 63(3), 715-719.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Acquire practical skills in performing microbial analysis of food and pharmaceutical products, using various techniques such as enumeration, identification, and characterization of microorganisms.
CO2	Understand and apply quality control procedures specific to the food and pharmaceutical industries, including Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), and Hazard Analysis and Critical Control Points (HACCP).
CO3	Microbial Safety and Contamination Prevention: Identify potential sources of microbial contamination in food and pharmaceutical processes and develop strategies to prevent and control contamination, ensuring product safety and compliance with regulatory standards.
CO4	Demonstrate knowledge of documentation and record-keeping requirements for microbial quality control in food and pharmaceutical industries, ensuring traceability and accountability in the production process.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTSE 231 CO 1	2	3	3	2	-	3	2	-	-
BBTSE 231 CO 2	-	3	3	2	-	2	2	2	2
BBTSE 231 CO 3	-	2	3	2	2	2	2	2	3
BBTSE 231 CO 4	2	2	3	2	2	2	2	2	-
Average CO (BBTSE 231)	2	2.5	3	2	2	2.25	2	2	2.5

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	AECC 231	Credit	2
Year/Semester	Semester III	L-T-P	2-0-0
Course Title	Environmental Sciences II		

COURSE OBJECTIVES:

1. Understand environmental systems and ecological principles.
2. Analyze human impacts and policies for environmental management.
3. Learn sustainable resource management and conservation techniques.
4. Develop critical thinking, communication skills, and ethical awareness for addressing global environmental challenges.

UNIT I: Pollution

Introduction, Definitions and Causes and effects, control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution e.g., Nuclear pollution

UNIT II: Social Issues and the Environment

From unsustainable to sustainable development · Urban problems and related to energy · Water conservation, rain water harvesting, watershed management · Resettlement and rehabilitation of people; its problems and concerns. Case studies. · Environmental ethics: Issues and possible solutions · Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. · Wasteland reclamation · Consumerism and waste products

UNIT III: Environment Pollution Act

Environmental Protection Act · Air (Prevention and Control of Pollution) Act · Water (Prevention and control of Pollution) Act · Wildlife Protection Act · Forest Conservation Act · Issues involved in enforcement of environmental legislation · Public awareness.

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COURSE OUTCOMES (CO): On completion of this course the students will be able to:

CO	Description
CO1	Remember about pollution and its types, control, social issues of the environment and pollution acts.
CO2	Understand the various types of protection acts, pollution and social issues.
CO3	Explain the concept of control measures of pollution and social issues.
CO4	Explain types pollution and act of pollution.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
AECC 231 CO 1	2	2	2	1	-	1	2	2	3
AECC 231 CO 2	-	1	2	1	3	-	3	1	1
AECC 231 CO 3	-	2	-	3	-	-	2	1	-
AECC 231 CO 4	-	-	1	2	2	-	2	-	2
Average CO (AECC 231)	2	1.66	1.66	1.75	2.5	1	2.25	1.33	2

3: High, 2: Medium, 1: Low

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OPEN ELECTIVES

B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 231	Credit	3
Year/Semester	Semester III	L-T-P	3-0-0
Course Title	Bioethics and Biosafety		

COURSE OBJECTIVES:

1. To understand importance of bioethics and biosafety.
2. To understand legal social and economic impacts of biotechnology.
3. To understand regulatory guidelines and their importance.
4. To understand importance of patent.
5. To understand procedure to apply for patent.
6. To understand procedure of assessment of biosafety for biotech foods.
7. To understand ethical implications of biotechnology.

UNIT I

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT III

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

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Suggested Reading and Text Books

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Impart knowledge and skills to develop moral and professional ethics related to healthcare as well as to become entrepreneurs.
CO2	Development of skills about broader global ethical issues through case studies in healthcare.
CO3	Development of scientific knowledge regarding laboratory and manufacturing practices for safety regulation in disposal of hazardous chemicals in the environment.
CO4	Development of knowledge regarding protection of their inventions and technologies.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 231 CO 1	2	2	-	3	-	2	3	3	-
BBTOE 231 CO 2	-	-	-	3	2	-	-	3	-
BBTOE 231 CO 3	-	2	3	-	-	3	2	-	2
BBTOE 231 CO 4	-	-	3	-	2	-	3	-	2
Average CO (BBTOE 231)	2	2	3	3	2	2.5	2.67	3	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 232	Credit	3
Year/Semester	Semester III	L-T-P	3-0-0
Course Title	Principle of Marketing		

COURSE OBJECTIVES: On completion of the course, the students will be able to:

1. Recall and define key marketing concepts, terminology, and frameworks.
2. Demonstrate an understanding of consumer behavior and the marketing mix.

UNIT I: Introduction

Definition, Scope and core concepts of marketing – company orientation toward the marketplace, emerging trends in Indian marketing environment. Evolution of marketing – department, organizing the marketing departments, Marketing Relations with other departments, marketing orientation for the whole company.

UNIT II: Customer Satisfaction, Value & Retention

Customer satisfaction, Value and retention – Definition of customer value and satisfaction, delivering customer value and satisfaction, Attracting and retaining customers, customer profitability.

Marketing Intelligence System, Marketing research system: Suppliers of Marketing Research, Marketing Research process, Barriers to the ease of marketing research and means to overcome them.

UNIT III: Market Segmentation, Targeting & Positioning

Market segmentation, Target Marketing, & positioning –Levels and patterns of market segmentation, Bases for market segmentation. Targeting, product positioning, Types and bases of positioning, product differentiation.

UNIT IV: Managing Marketing Mix

Managing marketing mix –Concept and components of marketing mix

Product and product mix decisions branding, packaging, labelling, new product development, and Product life cycle management.

Pricing strategies and Objectives, Distribution, Marketing Channels, Managing marketing channels

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and Conflict, Promotion Mix. People, Process, Physical evidence.

Suggested Readings and Text Books:

1. Ramaswamy and Namkumari (2018). Marketing Management, Global Perspective Indian Context, 6th edition. Sage.

2. Kotler, Philip (2017). A Framework of Marketing Management, 6th edition. Pearson Education.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Apply marketing concepts and theories to analyze and solve real-world marketing problems.
CO2	Analyze and evaluate market segmentation, targeting, and positioning strategies.
CO3	Assess the effectiveness of marketing channels and distribution strategies.
CO4	Create and propose innovative marketing strategies to address market challenges or capitalize on opportunities.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 241 CO 1	2	3	2	2	3	3	3	3	2
BBTC 241 CO 2	2	3	2		1	2	1	1	
BBTC 241 CO 3	1	2	3	2	3	3	3	2	2
BBTC 241 CO 4		3	3	1	2	3	2	2	1
Average CO (BBTC 241)	1.25	2.75	2.5	1.25	2.25	2.75	2.25	2	1.25

3: High, 2: Medium, 1: Low

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SEMESTER IV

B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 241	Credit	3
Year/Semester	Semester IV	L-T-P	3-0-0
Course Title	Virology and Infection (Major Core)		

COURSE OBJECTIVES: The objectives of this course are

1. To learn about morphology Plant and animal viruses.
2. Understand the fundamental concepts of virology, including viral structure, replication cycles, and genetic variation.
3. Explore the diverse roles of viruses in human health, agriculture, and ecosystems, including viral pathogenesis, immunity, and epidemiology.

UNIT I

History of Virology and Biosafety: History and principles of virology , virus taxonomy. Structures of animal and plant virus and their morphology. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of virology laboratory.

UNIT II

Virus Replication: Structure and replication strategies of bacteriophages - T7, λ, ΦX174, and plant viruses - ss RNA virus (TMV) and ds DNA virus (CaMV). Structure and replication strategies of animal viruses - Influenza virus, Adeno virus and Retrovirus, Corona Virus. Induction of interferon. Antiviral agents (chemical and biological) and their mode of actions.

UNIT III

Interferon and Antiviral Agents: Viral Interference and Interferons. Nature and source of interferons, Classification of interferons. Induction of interferon. Antiviral agents (chemical and biological) and their mode of actions.

UNIT IV

Cultivation of Viruses and Viral Vaccines: Cultivation of viruses in embryonated egg, tissue culture and laboratory animals. Conventional vaccines-killed and attenuated. Modern vaccines-Recombinant proteins, subunits, DNA vaccines, peptides, immune-modulators (cytokines). Vaccine .

UNIT V

Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Quantitative diagnostic methods-Haemagglutination, complement fixation, neutralization, Nucleic acid based diagnosis-PCR, microarray and nucleotide sequencing. Application of Microscopic techniques.

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Suggested Reading and Text Books:

1. Rothman, K.J. and Greenland, S. Modern epidemiology. Lippincott-Raven, Philadelphia.
2. Dockrell,H.,Zuckerman,M.,Roitt,I.M.andChiodini,P.L.Mim'smedicalmicrobiology.Elsevier, London
3. Gordis, L. Epidemiology. Saunders, Philadelphia.
4. Anderson,R.M.andMay,R.M.Infectiousdiseasesofhumans:Dynamicsandcontrol.OxfordUnive rsity Press, Oxford

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of viruses, including their structure, classification, replication cycles, and the molecular mechanisms of viral infections.
CO2	Gain insight into the interaction between viruses and host cells, exploring the mechanisms by which viruses enter cells, replicate, and spread, leading to infections.
CO3	Understand the epidemiology of viral infections, including transmission routes, outbreak patterns, and the impact of infections on public health and global populations.
CO4	Learn about strategies for preventing and controlling viral infections, including vaccination, antiviral therapies, and public health measures, contributing to informed approaches for managing viral outbreaks.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 241 CO 1	2	3	2	2	2	3	3	2	-
BMBC 241 CO 2	2	3	2	3	2	3	3	2	1
BMBC 241 CO 3	2	3	3	3	2	3	3	2	2
BMBC 241 CO 4	2	3	2	2	3	3	3	3	2
Average CO (BMBC 241)	2	3	2.25	2.5	2.25	3	3	2.25	1.666666667

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 241	Credit	1
Year/Semester	Semester IV	L-T-P	0-0-2
Course Title	Lab Course based on BMBC 241 (Major Core)		

COURSE OBJECTIVES: To develop knowledge and understanding of viral isolation and cultivation methods, and the common serological techniques followed in laboratory diagnosis of viral infection.

PRACTICALS

1. Isolation of coliphages from sewage water sample.
2. Isolation of Microorganism from plant leaves.
3. Study of Morphological detection of different Viral disease.
4. Study of Viral protein by SPVD Software.
5. Demonstration of animal cell culture.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop proficiency in using microscopy techniques to visualize and identify viral particles, enhancing your ability to distinguish between different types of viruses.
CO2	Gain hands-on experience in culturing and propagating viruses in cell cultures, contributing to your understanding of viral replication and propagation mechanisms.
CO3	Learn to perform serological assays, including enzyme-linked immunosorbent assays (ELISA) and immunofluorescence assays, for detecting viral antigens and antibodies.
CO4	Acquire skills in molecular techniques such as polymerase chain reaction (PCR) and nucleic acid sequencing, allowing you to identify and characterize viral genomes accurately.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 241 CO 1	2	3	3	2	2	3	3	2	2
BMPC 241 CO 2	1	3	3	3	2	3	3	2	2
BMPC 241 CO 3	2	3	3	3	2	3	3	2	2
BMPC 241 CO 4	1	3	3	2	3	3	3	3	2
Average CO (BMPC 241)	1.5	3	3	2.5	2.25	3	3	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 242	Credit	3
Year/Semester	Semester IV	L-T-P	3-0-0
Course Title	Immunology (Major Core)		

COURSE OBJECTIVES: The specific objectives of the course are as follows:

1. To familiarize students with the structure and function of the immune system.
2. To impart knowledge about the key components participating in fighting the disease.
3. To make students understand immunodiagnostic methods like RIA and ELISA.
4. To teach students about vaccines and modes of vaccination.

UNIT I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II

Regulation of immunoglobulin gene expression – Clonal selection theory, allotypes & idiotypes,

allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial

vaccines, viral vaccines, vaccines to other infectious agents, passive& active immunization. Introduction to immunodiagnostics – RIA, ELISA.

Suggested Reading And Text Books

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-

3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
4. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
5. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Acquire knowledge about structural and functional organization of immune system.
CO2	Outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate, principles of immunological methods and data interpretation.
CO3	Comprehend and appraise mechanisms of inflammation, vaccination, immune-deficiencies, complement system and allergic reactions and their application in health and medicine.
CO4	Explore and analyze applicability of immunological studies, tools and techniques in disease diagnosis and addressing health related issues.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 242 CO 1	2	3		2	3	3	3	3	2
BBTC 242 CO 2	2	3	2	1	2	3	2	2	
BBTC 242 CO 3	2	3	2	1	2	3	2	2	2
BBTC 242 CO 4		3	3	2	2	3	2	2	2
Average CO (BBTC 242)	2	3	2.3	1.5	2.25	3	2.25	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTPC 242	Credit	1
Year/Semester	Semester IV	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 242 (Major Core)		

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Exhibit analytical skills to conduct laboratory diagnosis of infectious diseases (ELISA,) and identify their application in medicine.
CO2	Understand the link of Immunology to other disciplines of health and experimental biosciences with the acknowledgment to the practical part of theoretical studies.
CO3	Acquiring the ability to integrate experimental design, data analysis, appreciation of the scientific method, refining the career &educational opportunities in various disciplines of science.
CO4	Demonstrate ability to conduct qualitative & quantitative immunological estimations and analysis along with data analysis to derive a conclusion.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 242 CO 1	1	3	3	2	3	3	3	3	2
BMBC 242 CO 2	2	3	3	1	2	3	2	2	2
BMBC 242 CO 3	2	3	3	1	2	3	2	2	2
BMBC 242 CO 4		3	3	2	2	3	2	2	2
Average CO (BMBC 242)	1.67	3	3	1.5	2.25	3	2.25	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 243	Credit	3
Year/Semester	Semester IV	L-T-P	3-0-0
Course Title	Chemistry- II (Minor Core)		

COURSE OBJECTIVES: This course is aimed to introduce the knowledge of biomolecules and theirrole in metabolic pathways. Also, it deals with the structure and function of enzymes.

UNIT I

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose.

UNIT II

Amino Acids, Peptides and Proteins: Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

UNIT III

Enzymes and correlation with drug action: Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allostericinhibition).

UNIT IV

Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

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Suggested Reading and Text Books

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson
4. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H.
5. Freeman.
6. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.
7. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand the thermodynamics terminology, types of reaction process, feasibility of reaction and concepts of heat, work or mass in thermodynamics.
CO2	Understanding of electrochemical equipments, application of electrochemical series and reactivity of metals.Also acquire knowledge about electrolytes, pH of solutions, concept of solubility and buffers which is highly applicable to identify the chemical nature of solution.
CO3	Understand basics of ideal and non-ideal solution, Raoults law application and idea of vapour pressure of solution.
CO4	Design a system component or aqueous chemical process involving ideal and non ideal system.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 243 CO 1	2	3	2	2	3	3	3	3	2
BBTC 243 CO 2	1	3	2	1	2	3	2	2	2
BBTC 243 CO 3	1	3	2	1	2	3	2	2	1
BBTC 243 CO 4		3	3	2	2	3	2	2	2
Average CO (BBTC 243)	1.3	3	2.25	1.5	2.25	3	2.25	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 243	Credit	1
Year/Semester	Semester IV	L-T-P	0-0-1
Course Title	Lab Course based on BBTC 243		

PRACTICALS

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower
10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Facilitate the learner to make solutions of various concentrations.
CO2	Apply knowledge to identify the nature of organic compounds and learn chemical formula of inorganic salts.
CO3	Ability to perform and estimate the strength of given ion or compounds by titrations.
CO4	After performing and understanding the laboratory experiments students can apply for employments in field of analysis techniques.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 243 CO 1	2	3	2	2	3	3	3	3	2
BBTPC 243 CO 2	1	3	2	1	2	3	2	2	2
BBTPC 243 CO 3	1	3	2	1	2	3	2	2	1
BBTPC 243 CO 4		3	3	2	2	3	2	2	2
Average CO (BBTPC 243)	1.3	3	2.25	1.5	2.25	3	2.25	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTSE 241	Credit	3
Year/Semester	Semester IV	L-T-P	3-0-0
Course Title	Nano Biotechnology		

COURSE OBJECTIVES

1. Introduce students to the principles and applications of nanotechnology in the field of biotechnology, exploring nanoscale tools and techniques for bioengineering and biomedical applications.

2. Foster understanding of the synergistic potential of nanotechnology and biotechnology, enabling students to apply innovative nano-biotechnological approaches in various scientific and industrial contexts.

UNIT I

Basic Concepts of Nanoscience: Importance of & quot; Nano" dimension, size matters: bulk vs nanomaterials, nanotechnology exists in nature, brief history of nanotechnology, applications of nanotechnology, challenges and future prospects.

UNIT II

Synthesis of Nanomaterials: Bottom-up and bottom-down approaches: milling, arc discharge, laser ablation, spray pyrolysis, chemical vapor deposition, physical vapor deposition, wet chemical synthesis of nanoparticles, self-assembled monolayer,

UNIT III

Characterization of nanostructures, Spectroscopy: UV-Vis, FTIR; Electron microscopy: Scanning electron microscopy, EDX, Transmission electron microscopy, Atomic force microscopy.

UNIT IV

Engineered Nanomaterials for Biological Applications: Current status of nanobiotechnology, biological applications of functionalized nanomaterials, Bionanomotors, Nano-antimicrobials, Immobilized nanoparticles for water disinfection and Biopesticides delivery applications.

UNIT V

Biomedical Applications and Nanotoxicity: Lipid nanoparticles for drug delivery applications, magnetic nanoparticles based hyperthermia treatment of cancer, Nano-biosensors, Cytotoxic and

genotoxic effects of nanomaterials, toxic effects on environment, impact of nanotechnology on society and industry.

Suggested Reading and Text Books

1. Cao G (2004). Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press.
2. Niemeyer CM, Mirkin CA & Wiley-VCH (2004). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley Publishing.
3. Leggett GJ & Jones RAL (2005). Bio nanotechnology: In Nanoscale Science and Technology. John Wiley & Sons.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Acquire a strong foundation in the principles and concepts of nanotechnology, understanding its applications in biotechnology and the manipulation of materials at the nanoscale.
CO2	Familiarize with cutting-edge nanoscale tools and techniques used in biotechnological research, enabling the design and engineering of novel biomaterials and nano-devices.
CO3	Explore the integration of nanotechnology with biotechnology in various biomedical applications, including drug delivery, diagnostics, tissue engineering, and nanomedicine.
CO4	Develop the ability to apply nano-biotechnological approaches in research, fostering innovation and addressing contemporary challenges in fields such as environmental monitoring, agriculture, and personalized medicine.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTSE 241 CO 1	2	3	2	2	3	3	3	3	2
BBTSE 241 CO 2	1	3	3	2	2	3	3	2	2
BBTSE 241 CO 3	1	3	3	2	2	3	3	2	1
BBTSE 241 CO 4	2	3	3	2	2	3	2	2	2
Average CO (BBTSE 241)	1.5	3	2.75	2	2.25	3	2.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	AECC 241	Credit	2
Year/Semester	Semester IV	L-T-P	2-0-0
Course Title	Organizational Behaviour		

COURSE OBJECTIVES: On completion of the course, the students will be able to:

1. Identification and description of the factors influencing employee motivation, job satisfaction, and performance.
2. Develop an insight of organizational culture, structure, and leadership on employee behavior.
3. Evaluate the impact of organizational factors on employee behaviours.
4. Evaluate the effectiveness of different leadership styles and approaches in different organizational contexts.

UNIT I: Introduction

Concept and scope of organizational behaviour, historical development of organizational behaviour, organization behaviour processes, emerging trends and hanging profiles of workforce.
Transaction Methodology – Classroom Teaching, Quiz, and Assignment.

UNIT II: Individual Processes

Concept, nature and theories of Personality, values, attitudes, perception, learning and motivation.
Transaction Methodology – Classroom Teaching, Quiz, and Case discussion.

UNIT III: Team Processes

Interpersonal communication, group dynamics, teams and teamwork, leadership, individual and group decision-making, conflict and negotiation in the workplace, power and politics.
Transaction Methodology – Classroom Teaching, Quiz, and Role Plays.

Unit IV: Organizational Processes

Elements of organization structure, organizational structure and design, organizational culture, organizational change.
Transaction Methodology – Classroom Teaching, Quiz, and Assignment.

Suggested Reading and Text Books

1. Aswathappa, K. (2019). Organizational Behaviour Himalaya Pub. House. 15th edition, Himalaya Publishing House.

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2. Nafsaneh; Robert B. Denhardt; Janet V. Den Robbins, S.P. and Judge, T.A. (2018) Essentials of Organizational Behavpior. 14th Edition, Pearson

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Demonstrate an understanding of the impact of organizational culture, structure, and leadership on employee behavior.
CO2	Apply concepts of organizational culture and change management to improve organizational effectiveness.
CO3	Analyze and assess the influence of organizational factors on employee attitudes and behaviors.
CO4	Design and develop strategies for enhancing organizational culture and fostering employee engagement

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 241 CO 1	3	3		1		3	3	2	3
BBTOE 241 CO 2	3	2	3	1	1	3	3	3	1
BBTOE 241 CO 3	2	2	1	1	2	1	2	1	2
BBTOE 241 CO 4	2	2	1	1	1	2	2	1	2
Average CO (BBTOE 241)	2.5	2.5	1.25	1	1	2.25	2.5	1.75	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 241	Credit	2
Year/Semester	Semester IV	L-T-P	2-0-0
Course Title	Beverage Biotechnology (Open Elective)		

COURSE OBJECTIVES

1. To provide scientific knowledge related to various techniques associated with Food and Beverages Biotechnology.
2. To impart laboratory skills for handling analytical tools in Food and Beverages industry and research institution.
3. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
4. To demonstrate the operating procedures associated with upstream and downstream process related to Food and Beverages.

UNIT I

Food and Microorganism: Microorganism in food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes

UNIT II

Contamination and spoilage of different kinds of food & beverages: Cereals & cereal products, sugar and sugar products, vegetables and fruits, meat, fish, poultry & eggs, sea food, milk & milk products, canned foods, Alcohol & alcoholic beverages fruit juices & soft drinks etc.

UNIT III

Biotechnology of food and feed; cultures & fermentation, Beverage production: Alcohol & alcoholic beverages, fruit furies, soft drinks, feed production, SCP, fats, amino acid, food additives.

UNIT IV

Food, Beverages & Disease: Food borne illness due to bacterial food poisoning, infection and intoxication. Food-borne disease outbreaks, Disease-investigation, Materials & Equipments, laboratory testing, field analysis, interpretation of data and preventive measures.

UNIT V

Food hygiene: Food sanitation, Bacteriology of water and food products, food manufacturing practice. Hazard Analysis Critical Points. Processing Industry and Microbial criteria of food. Principles of food preservation: Preservation by high temperature, low temperatures, Drying, Food additives and Radiation.

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Suggested Reading and Text Books

1. Food Sciences and Food biotechnology- G.F.G. Lopez, G. Canaas, E.V.Nathan
2. Genetically Modified Foods- M.Ruse, D. Castle (Eds.)
3. Biotechnology of Food Crops in Developing Countries- T.Hohn and K.M. Leisinger (Eds.)
4. Biotechnology and Food Process Engineering- H.G. Schwartzberg, M.A. Rao (Eds.)
5. Food Biotechnology- (Eds.) R.Angold, G.A.Beech, J.Taggart.
6. Food Biotechnology—Microorganisms- (Ed.) Y.H. Hui et al.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the principles of beverage production, including the role of microorganisms in fermentation, flavor development, and quality enhancement.
CO2	Acquire practical skills in utilizing microbial techniques for the production of various beverages, such as alcoholic and non-alcoholic drinks. Understand the fermentation process, substrate utilization, and control of microbial activities.
CO3	Learn methods for quality control, including microbial contamination prevention, monitoring fermentation progress, and sensory analysis to assess flavor, aroma, and overall beverage quality.
CO4	Explore innovative approaches in beverage biotechnology, such as the use of probiotics, natural flavor enhancers, and sustainable practices. Understand the impact of biotechnological advancements on the beverage industry and its environmental implications.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 241 CO 1	2	3	3	2	2	3	3	3	2
BBTOE 241 CO 2	1	2	3	2	2	3	2	2	2
BBTOE 241 CO 3	1	2	3	2	2	3	3	2	1
BBTOE 241 CO 4	2	2	3	2	2	3	2	2	2
Average CO (BBTOE 241)	1.5	2.25	3	2	2	3	2.5	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 242	Credit	3
Year/Semester	Semester IV	L-T-P	3-0-0
Course Title	Biotechnology and Human Welfare (Open Elective)		

COURSE OBJECTIVES: The course introduces students to the fundamentals of biotechnology, current trends and careers in biotechnology, regulatory, and ethical aspects of biotechnology. The knowledge and skills gained in this course will provide students with a broad understanding of biotechnology and its impact on society.

UNIT I

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, Alcohol and antibiotic formation.

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT II

Environment: Chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

Health: Development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in E.coli, human genome project.

Forensic Science: Solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

Suggested Reading and Text Books

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

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COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Gain knowledge about the diverse applications of biotechnology in human welfare, including healthcare, agriculture, environmental conservation, and pharmaceutical development.
CO2	Explore the ethical considerations and societal impact of biotechnological interventions, addressing issues related to genetic manipulation, privacy, equity, and responsible innovation.
CO3	Examine the role of biotechnology in developing diagnostic tools, vaccines, therapies, and personalized medicine, contributing to improved healthcare and disease management.
CO4	Learn about biotechnological approaches to enhance food security, promote sustainable agriculture, and address environmental challenges, fostering sustainable development and human well-being.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 242 CO 1	2	3	2	3	3	3	3	3	2
BBTOE 242 CO 2	1	3	2	3	2	3	2	3	2
BBTOE 242 CO 3	1	3	2	2	2	3	3	3	1
BBTOE 242 CO 4	1	3	3	2	2	3	2	3	2
Average CO (BBTOE 242)	1.25	3	2.25	2.5	2.25	3	2.5	3	1.75

3: High, 2: Medium, 1: Low

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SEMESTER V
BACHLORES DEGREE IN MICROBIOLOGY
B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 351	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Medical Microbiology (Major Core)		

COURSE OBJECTIVES: This course provides learning opportunities in the
1. Basic principles of medical microbiology and infectious disease.
2. It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora.
3. The course provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.

UNIT I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

UNIT II

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, M.tuberculosis, M. leprae.*

UNIT III

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, Y. pestis, V. cholera, T. pallidum, Rickettsiaceae, Chlamydiae.*

UNIT IV

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Pox virus, Herpes virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT V

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides)* and opportunistic fungal infections (*Candidiasis, Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

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Suggested Readings and Text Books

1.Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology.(edited by Paniker CKJ). University Press Publication.

2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.

4. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. Appleton-Centuary-Crofts publication.

5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the microbiological agents responsible for infectious diseases, including bacteria, viruses, fungi, and parasites, and their role in human health.
CO2	Explore the mechanisms of microbial pathogenesis and host immune responses to infections, understanding how pathogens evade immune defenses and cause diseases.
CO3	Diagnostic Techniques:** Gain proficiency in a range of diagnostic techniques used to identify and characterize microbial pathogens in clinical specimens, including microscopy, culturing, serological tests, and molecular methods.
CO4	Learn about antimicrobial therapies, resistance mechanisms, and strategies to combat emerging infectious diseases, while understanding the importance of public health measures in disease prevention and control.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 351 CO 1	2	3	2	2	2	3	2	2	2
BMBC 351 CO 2	2	3	2	3	1	3	2	2	2
BMBC 351 CO 3	1	3	2	2	2	3	3	2	3
BMBC 351 CO 4	2	3	2	2	3	3	2	3	2
Average CO (BMBC 351)	1.75	3	2	2.25	2	3	2.25	2.25	2.25

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 351	Credit	1
Year/Semester	Semester V	L-T-P	0-0-2
Course Title	Lab Course Based on BMBC 351 (Major Core)		

PRACTICALS

1. Microbiological examination of food.
2. Assay of quality of milk sample using MBRT test.
3. Adulteration tests for milk.
4. Microbial production of curd.
5. Isolation and identification of *Lactobacillus* from fermented dairy products.
6. Isolation and biochemical identification of microorganisms from contaminated food and dairy samples.
7. Production of sauerkraut.
8. Estimation of lactic acid production in sauerkraut.
9. Effect of salt concentration on lactic acid production in sauerkraut.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop proficiency in using microscopy techniques to identify different types of microbial pathogens in clinical specimens, enhancing your ability to recognize key morphological features.
CO2	Gain hands-on experience in culturing and isolating pathogenic microorganisms from clinical samples, contributing to your understanding of microbial growth and isolation methods.
CO3	Learn to perform antimicrobial susceptibility testing to determine the effectiveness of antibiotics against specific pathogens, enhancing your skills in guiding appropriate treatment choices.
CO4	Acquire skills in performing serological tests, such as enzyme-linked immunosorbent assays (ELISA), and molecular techniques like polymerase chain reaction (PCR) for identifying and characterizing microbial pathogens.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 351 CO 1	2	2	3	1	-	2	2	-	-
BMPC 351 CO 2	-	2	3	-	-	2	2	-	-
BMPC 351 CO 3	-	-	3	2	2	1	-	2	3
BMPC 351 CO 4	-	-	3	2	2	1		3	3
Average CO (BMPC 351)	2	2	3	1.66	2	1.5	2	2.5	3

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 351	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Bioprocess Technology (Minor Core)		

COURSE OBJECTIVES: The specific objectives of the course are as follows:

1. To impart the knowledge of cultivation and growth kinetics of microorganisms.
2. To make students understand the basic concept of sterilization and different parts of a bioreactor.
3. To teach the application of bioprocess technology in industries.
4. To make students understand about thermal death kinetics of microorganisms.

UNIT I

Introduction to bioprocess technology.

Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II

Airlift; Cyclone Column; Packed Tower and their application in production processes.

Principles of upstream processing – Media preparation, Inoculation development and sterilization.

UNIT III

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa.

Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV

Introduction to downstream processing, product recovery and purification. Effluent treatment.

Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

Suggested Reading And Text Books

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Inculcate technical skills related to designing of bioreactors/fermentors, media preparation and related downstream techniques.
CO2	Understand the design of bioprocess vessels and needs of various parts of fermenter along with their operation in laboratory as well as industrial level.
CO3	Designing and development medium for microbial cell cultivation for conducting various applications of fermentation in industry and research.
CO4	Development of computational skills to control bioprocess parameters and inculcate knowledge related to fermented product recovery and purification in industrial scale.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 351 CO 1	2	3	2	2	3	3	3	3	2
BBTC 351 CO 2	1	3	3	2	2	3	3	2	2
BBTC 351 CO 3	1	3	3	2	2	3	3	2	1
BBTC 351 CO 4	2	3	3	2	2	3	2	2	2
Average CO (BBTC 351)	1.5	3	2.75	2	2.25	3	2.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 352	Credit	1
Year/Semester	Semester V	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 351 (Minor Core)		

PRACTICALS

1. Bacterial growth curve.
2. Estimation of Biomass Production.
3. Determination of the specific growth rate and generation time of a bacterium during submerged fermentation.
4. Estimation of the effect of temperature and pH on the growth of microbes.
5. Estimation of the effect of substrate concentration on the growth of *E.coli.*
6. Estimation of Monod Parameters for microbial growth kinetics.
7. Calculation of thermal death point (TDP) of a microbial sample.
8. Isolation of industrially important microorganisms from natural resource.
9. Screening of microbes for the production of enzymes.
10. Optimization of production and analysis of ethanol.
11. Biological treatment of wastewater originating from an industrial source.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Impart Knowledge regarding of microbial growth kinetics and fermentation reaction in laboratory for production of value added products.
CO2	Acquire operating skills for fermenter and the needs of various parts of fermenter in laboratory as well as industrial level.
CO3	Acquire knowledge regarding preparation of fermentative media for microbial cell cultivation for conducting various applications of fermentation in industry and research.
CO4	Development of knowledge regarding isolation of industrially important microorganism from natural resource for fermentation process in laboratory scale.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 351 CO 1	2	3	2	2	2	3	3	3	2
BBTPC 351 CO 2	1	3	3	2		3	3	2	2
BBTPC 351 CO 3		2	2	2	2	3	3	2	1
BBTPC 351 CO 4	2	2	3	2	2	3	2	2	2
Average CO (BBTPC 351)	1.67	2.5	2.5	2	2	3	2.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 352	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Genetic Engineering: Tools and Techniques (Major Core)		

COURSE OBJECTIVES: The specific objectives of the course are as follows:

1. To impart knowledge about different components such as vectors, restriction enzymes, ligases, polymerases, alkaline phosphatases used for making recombinant DNA molecule.
2. To make students understand the different techniques such as PCR, transformation, site-directed mutagenesis, etc.
3. To teach the basics of gene transfer technique in plants.
4. To understand Agrobacterium Ti plasmid biology been utilized for making genetically-modified plants.

UNIT I

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice. Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

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Suggested Reading and Text Books

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press. Washington.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7 edition. Blackwell Publishing, Oxford, U.K.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop good understanding of various modern tools and techniques related to recombinant DNA molecule technology applicable in scientific research advancement.
CO2	Apply the basic and advanced recombinant DNA techniques such as gene therapy which explore research in higher education and applicable in the modern medicinal treatment system.
CO3	Identify and analyze various tools and techniques utilized recombinant DNA technology.
CO4	Identify the ethical values related to transgenic and recombinant DNA technology.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 352 CO 1	2	3	2	2	3	3	3	3	2
BBTC 352 CO 2	1	3	3	2	2	3	3	2	2
BBTC 352 CO 3	1	3	3	2	2	3	3	1	1
BBTC 352 CO 4	2	3	3	3	2	3	2	3	2
Average CO (BBPC 352)	1.5	3	2.75	2.25	2.25	3	2.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 353	Credit	1
Year/Semester	Semester V	L-T-P	0-0-2
Course Title	Lab Course Based on BBTC 352 (Major Core)		

PRACTICALS

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Plasmid DNA isolation and electrophoresis of DNA from *E. coli*.
4. Restriction digestion of plasmid DNA.
5. Restriction mapping of DNA.
6. Ligation of DNA molecules.
7. Preparation of competent cells.
8. Transformation of competent cells.
9. Designing of primers for polymerase chain reaction (PCR).
10. Perform PCR to amplify a DNA fragment.
11. Isolation of recombinant protein from bacterial cells.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Identify research prospects of recombinant DNA technology.
CO2	Interpret the test hypotheses, analyze the data of RDT by using modern methods.
CO3	Develop laboratory skills for academic and professional enhancement.
CO4	Apply the basic and advanced recombinant DNA techniques experiments applicable in scientific research and different industries.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 352 CO 1	2	3	3	2	3	3	3	3	2
BBTPC 352 CO 2		3	3	2	2	3	3	2	2
BBTPC 352 CO 3		3	3	2	2	3	3	2	
BBTPC 352 CO 4	2	3	3	2	2	3	2	2	2
Average CO (BBTPC 352)	2	3	3	2	2.25	3	2.75	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBDE 351	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Plant Pathology (Discipline Specific Elective)		

COURSE OBJECTIVES: The main objectives are

1. Introduce the subject of Plant Pathology, its concepts and principles
2. Stages in development of disease, host pathogen interaction and control of plant diseases

UNIT I: Introduction and History of Plant Pathology

Concept of plant disease: Definitions of disease, disease cycle and pathogenicity, Types of plant pathogens, Basic idea of monocyclic, polycyclic and polyetic diseases, Disease triangle and disease pyramid; Significant landmarks in the field of plant pathology: Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor and Van Der Plank

UNIT II: Stages in the Development of Disease

Stages: Infection, invasion, colonization, dissemination of pathogens and perennation.

UNIT III: Host-Pathogen Interaction

Microbial pathogenicity: Virulence factors of pathogens in disease development; Effects of pathogens on host physiological processes (Photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction); Genetics of plant diseases: Concept of resistance (R) gene and avirulence (avr) gene, Types of plant resistance (True and apparent resistance); Defense mechanisms in plants: Inducible structural defenses (Histological cork layer, abscission layer, tyloses, gums), Inducible biochemical defenses (Hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, phenolics, quinones and oxidative bursts).

UNIT IV: Plant Diseases

Symptoms, causative organisms, disease cycle and control measures of plant diseases: Fungal diseases (Late and early blight of potato, white rust of crucifers, wilt of tomato, powdery mildew, black rust and loose smut of wheat, red rot of sugarcane), Bacterial diseases (Blight of rice, citrus canker and crown gall), Viral diseases (Papaya ring spot and tomato yellow leaf curl).

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UNIT V: Control of Plant Diseases

Principles and practices involved in the management of plant diseases by different methods: Regulatory (Quarantine, crop certification, use of pathogen free propagative material), Cultural (Host eradication, crop rotation, sanitation, polyethylene traps and mulches), Chemical (Fungicides and antibiotics), Biological (Biopesticides, viral proteins, antisense RNA and RNAi).

Suggested Readings

1. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New AgeInternational (P) Limited, New Delhi.
2. Rangasami G. and Bagyarai, D.J. Agricultural microbiology. Prentice-Hall, New Delhi.
3. Agrios, G.N. Plant pathology. Academic Press, San Diego.
4. Mathews, R.E. Functionals of plant virology. Academic Press, San Diego.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Developed basic concepts of causation of diseases in plants by the different types of microorganisms namely bacterial, fungal and viral
CO2	Knowledge of important plant diseases, their etiology, salient characteristics and control measures
CO3	Developed skills to analyze the diseased plant samples in the laboratory
CO4	Identify the salient features of the disease-causing microbe and the lesions produced on the plant parts

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBDE 351 CO 1	2	3	2	2	2	3	2	2	2
BMBDE 351 CO 2	2	3	2	3	1	3	2	2	2
BMBDE 351 CO 3	1	3	2	2	2	3	3	2	3
BMBDE 351 CO 4	2	3	2	2	3	3	2	3	2
Average CO (BMBDE 351)	1.75	3	2	2.25	2	3	2.25	2.25	2.25

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBDE 352	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Microbial Diagnosis in Health Clinics (Discipline Specific Elective)		

COURSE OBJECTIVES: The major objective of this course is to

1. Introduce the students to the importance of diagnosis of pathogens in controlling diseases.
2. Familiar with various approaches used for diagnosis along with their advantages and limitations.
3. The importance of antimicrobial resistance and methods to determine it are also covered in this course.

UNIT I: Importance of Diagnosis of Diseases

Bacterial, viral, fungal and protozoan diseases of various human body systems; Disease associated clinical samples for diagnosis.

UNIT II: Collection of Clinical Samples

Procedure of collection of clinical samples (Oral cavity, throat, skin, blood, CSF, urine and faeces) and precautions required; Method of transport of clinical samples to laboratory and storage.

UNIT III: Direct Microscopic Examination and Culture

Examination of sample by staining: Gram staining, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria; Preparation and use of culture media – Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar; Distinct colony properties of various bacterial pathogens.

UNIT IV: Serological and Molecular Methods

Serological methods: Agglutination, ELISA, Immunofluorescence; Nucleic acid based methods: PCR, Nucleic acid probes; Kits for rapid detection of typhoid, dengue and HIV, Swine flu.

UNIT V: Testing for Antibiotic Sensitivity in Bacteria

Importance; Determination of resistance/sensitivity of bacteria using disc diffusion method; Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.

Suggested Reading and Text Books

1. Ananthanarayan R. and Paniker CKJ (2009). Textbook of microbiology. University Press Pvt. Ltd.

2. Brooks GF, Carroll KC, Butel JS, Morse SA and Mietzner TA (2013). Jawetz, Melnick and Adelber Medical microbiology. McGraw Hill Publication.
3. Randhawa VS, Mehta G. and Sharma KB. (2009). Practicals and viva in medical microbiology. Elsevier India Pvt. Ltd.
4. Tille P. (2013). Bailey's and Scott's Diagnostic microbiology. Mosby, St. Louis
5. Collee JG, Fraser AG, Marmion BP and Simmons A. (2007). Mackie and Mccartney Practical medical microbiology. Elsevier Publishers.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Importance and challenges in detecting pathogens.
CO2	Fair understanding of various methods used for collection, transport and storage of clinical samples
CO3	Understanding of the applicability of various detection methods in the form of kits for rapid detection of pathogens.
CO4	Understanding of various methods for determination of antimicrobial resistance in bacterial pathogens

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBDE 352 CO 1	2	3	1	2	2	3	2	2	2
BMBDE 352 CO 2	2	3	2	2		3	2	2	2
BMBDE 352 CO 3	2	3	3	2	2	3	3	2	2
BMBDE 352 CO 4	2	3	3	2	2	3	2	3	2
Average CO (BMBDE 352)	2	3	2.25	2	2	3	2.25	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BTVAC 351	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Intellectual Property Rights (Value Addition Course)		

COURSE OBJECTIVES: The course aims to explain students about intellectual property rights and patents. The specific objectives of the course are as follows:

1. To make students aware of types of IPRs and their utility.
2. To make students understand the procedure of filing a patent.
3. To teach students about the bioethical and biosafety practices related to biotechnology.
4. To familiarize students with copyright, trademarks, designs and information technology act.

UNIT I: Introduction to IPR

Basic understanding of intellectual property rights; utility of IPRs; different types of IPRs; introduction to Indian patent law; world trade organization and its related intellectual property provisions world organizations: WIPO and TRIPS agreement, international treaties and conventions on intellectual property.

Intellectual/industrial property and its legal protection in research, design and development. Forms of protection of IPRs: Introduction to copyrights and its applicability; fundamental concepts and importance of trademarks and trade secrets; geographical indications; design layout design of integrated circuits.

UNIT II: Patents

Methods of patenting and general concept of patent; patenting agencies; use of technical information in patent documents; revocation of patent; patenting of biological material like microorganisms, plant and animal, patenting in biotechnology, economic, ethical and depository considerations. Nature of Copyright. Trademarks; registration of trademarks; rights of holder and assignment and licensing of marks.

Suggested Readings and Text Books

1. Pandey, N and Dharni, K 2014. Intellectual Property Rights, 1st ed. PHI Learning Pvt. Ltd.
2. Tomkowicz, R 2011. Intellectual Property Overlaps: Theory, Strategies and Solutions, 1st ed.

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Routledge.

3. Bouchoux, DE 2013. Intellectual property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, 4th ed. Cenage Learning.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of intellectual property rights, including patents, trademarks, copyrights, trade secrets, and their significance in protecting innovations and creative works.
CO2	Apply knowledge of intellectual property laws and regulations to identify and safeguard intellectual property assets, preventing infringement and unauthorized use.
CO3	Explore strategies for leveraging intellectual property to create business value, commercialize innovations, and enhance competitiveness in the global market.
CO4	Recognize ethical and legal implications of intellectual property rights, promoting responsible and fair practices in the acquisition, protection, and enforcement of IP assets.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BTVAC 351 CO 1	2	3	-	3	2	2	3	3	2
BTVAC 351 CO 2	-	2	-	3	2	2	3	2	2
BTVAC 351 CO 3	-	2	-	3	3	-	3	2	3
BTVAC 351 CO 4	-	2	-	3	2	-	3	2	2
Average CO (BTVAC 351)	2	2.25	-	3	2.25	2	3	2.25	2.25

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	MBPR 351	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Project/Educational Tour Report I		

COURSE OBJECTIVES: The objectives of this course are

1. To make the students industry, university and research institute deployable.
2. To provide an opportunity to students to gain practical knowledge.
3. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/ under the guidance of faculty member/supervisor from industry/research organizations or submit an educational tour report by the guidance of internal supervisor. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	To acquire knowledge pertaining to recent development and advancements in biotechnology and allied sciences.
CO2	To attain technical exposure in analytical tools and techniques and professional working environment.
CO3	Enhance and master presentation writing and communication skills
CO4	Inculcate ability to work in a team to achieve set goals.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BTPR 351 CO 1	2	3	3	2	2	3	2	2	-
BTPR 351 CO 2	-	3	3	2	3	2	2	3	3
BTPR 351 CO 3	-	-	-	3	3	-	-	3	3
BTPR 351 CO 4	-	-	-	3	3	-	2	3	3
Average CO (BTPR 351)	2	3	3	2.5	2.75	2.5	2	2.75	3

3: High, 2: Medium, 1: Low

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SEMESTER VI

B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Agriculture Microbiology (Major Core)		

COURSE OBJECTIVES: The objectives of this course are

1. To learn about understand the physico-chemical characteristics of soil.
2. To gain knowledge about biocontrol Agents for Agriculturally Important Crop Plants
3. To gain knowledge about isolation, purification, mass multiplication of Biofertilizer.

UNIT I

Soil Microorganisms: Development and significant contributions in the field of soil microbiology (Beijerinck and Winogradsky), physical and chemical properties of soil, classification of soils, soil profile, soil microflora and soil as a natural habitat for microbes.

UNIT II

Organic Matter Decomposition: Soil organic matters and humus. Microbial decomposition of plant and animal residues by microorganisms. Organic matter dynamics in soil: Degradation of cellulose, hemicelluloses and lignin. Factors affecting organic matter decomposition. Soil microbial biomass as an index of soil fertility.

UNIT III

Rhizosphere and Rhizoplane microorganism: Microorganisms in the rhizosphere, root surfaces and phylloplane; Composition of root exudates; Factors affecting exudation; Rhizosphere effect; Factors affecting microbial community in soil. Mechanism of plant growth promotion. Biofertilizers

UNIT IV

Plant Diseases: Plant diseases Mode of entry of pathogens, disease symptoms, Bacterial diseases: Crown gall, Citrus cancer; Viral diseases, viroids TMV; Fungal diseases: Late blight of potato , Loose smut of wheat. Control of plant diseases Principles and practices, cultural practices, chemical methods, biological methods and genetic engineering for disease resistant plants. Biopesticides

UNIT V

Genetic Engineering in Agriculture: Significance of Agrobacterium tumefaciens and viral vectors in development of transgenic plants- brief technique used. Brief discussion of Bt- cotton, release of GMOs

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Suggested Reading and Text Books:

1. Gupta, S.K, Biofertilizers, Kedar Nath Ram Nath, Meerut.
2. Subba Rao,N.S(1995).SoilmicroorganismsandplantgrowthOxfordandIBHpublishing co. Pvt. Ltd., New Delhi.
3. Kannaiyan, S. (2003). Bioetchnology of biofertilizers, CHIPS, Texas.
4. Rai, M.K. (2005).Hand book of microbial biofertilizers, The Haworth Press, Inc. New York.
5. Reddy, S.M. etal. (2002). Bioinoculants for sustainable agriculture and forestry. Scientific Publishers.
6. Saleem, F. and Shakoori, A.R. (2012). Development of bioinsecticide. Lap Lambert Academic Publishing GmbH and Company.
7. Aggarwal, S.K. (2005). Advanced environmental biotechnology. APH publication

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop an understanding of the diversity and roles of microorganisms in soil ecosystems, including their contributions to nutrient cycling, organic matter decomposition, and plant-microbe interactions.
CO2	Explore the interactions between microorganisms and plants, focusing on beneficial relationships such as symbiosis, mycorrhizal associations, and biological nitrogen fixation.
CO3	Learn about the practical applications of microorganisms in agriculture, including biofertilizers, biopesticides, and bioremediation strategies, contributing to sustainable farming practices.
CO4	Understand the role of microorganisms in plant diseases and their management, studying the mechanisms of pathogenesis, as well as strategies for biological control and disease suppression.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 361 CO 1	2	3	2	2	2	3	2	2	2
BMBC 361 CO 2	2	3	2	2		3	2	2	2
BMBC 361 CO 3	2	3	3	2	1	3	3	2	2
BMBC 361 CO 4	2	3	3	2	1	3	2	3	2
Average CO (BMBC 361)	2	3	2.5	2	1.25	3	2.25	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 361	Credit	1
Year/Semester	Semester VI	L-T-P	0-0-2
Course Title	Lab Course Based on BBTC 362 (Major Core)		

PRACTICALS

1. Isolation of microorganisms from soil.
2. Isolation and identification of PGPR from soil.
3. Isolation and Identification of Azotobacter sp. from soil.
4. Biochemical characterization test.
5. IMVIC TEST
6. Production of Biofertilizer from Rhizospheric soil.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Gain hands-on experience in analyzing soil samples for microbial diversity and population counts, enhancing your ability to assess the microbial composition of different soil types.
CO2	Learn to culture and prepare microbial inoculants, such as biofertilizers and beneficial microorganisms, contributing to your skills in promoting sustainable agricultural practices.
CO3	Explore plant-microbe interactions through practical experiments, including the assessment of mycorrhizal colonization, nitrogen fixation, and disease suppression in plants.
CO4	Acquire skills in diagnosing plant diseases caused by microbial pathogens, including isolation and identification techniques, and testing potential biocontrol agents for disease management.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 361 CO 1	2	3	2	2	2	3	2	2	2
BMPC 361 CO 2	2	3	2	2		3	2	2	2
BMPC 361 CO 3	2	3	3	2	1	3	3	2	2
BMPC 361 CO 4	2	3	3	2	1	3	2	3	2
Average CO (BMPC 361)	2	3	2.5	2	1.25	3	2.25	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 362	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Environmental Microbiology (Major Core)		

COURSE OBJECTIVES: The students will understand

1. The microorganisms and their habitats
2. Biological waste water treatment, solid waste management,
3. Bioremediation, biodegradation and indicator organisms.

UNIT I

Introduction to environmental pollutants: Pollution of air, water and land with reference to their causes, nature of pollutions, impact and control strategies; noise pollution. Application of biotechnology in environment protection, Scope of environmental biotechnology

UNIT II

Biological waste water treatment: Principles and Microbiology of waste water treatment, unit operations: Aerobic process (Activated sludge, Oxidation ditches, Trickling filters, towers, rotating discs, rotating drums, oxidation ponds). Anaerobic processes and digester dynamics (Anaerobic filters, Up flow anaerobic sludge blanket reactors), and other emerging biotechnological processes in waste water treatment for municipal, industrial waste waters.

UNIT III

Solid waste management: Landfills, recycling and processing of organic residues, Composting technologies. Biofuel production: biogas, bioethanol, biohydrogen and biodiesel, Composition of sewage; strength of sewage, Concept about BOD and COD.

UNIT IV

Bioremediation and Biodegradation: Introduction and types of bioremediation, bioremediation of surface soil, polluted water and sludge, Microbial Systems for Heavy Metal Accumulation,, metal Bioleaching and bio-oxidation. Factors affecting biodegradation, microbial degradation of xenobiotic compounds and hydrocarbons.

UNIT V

Water potability: Concept of indicator organisms, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

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Suggested Readings and Text Books

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. Benjamin/Cummings Science Publishing, USA.
2. Atlas RM. (1989). Microbiology: Fundamentals and Applications. MacMillan Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. Pearson/ Benjamin Cummings.
4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
6. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
7. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology, Academic Press.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Gain knowledge on ecological role of microbes in the environment
CO2	Assimilate information on microbial communities in the environment
CO3	Obtain knowledge on microbiological aspects and management of waste water and solid waste
CO4	Learn about the microbial bioremediation of pesticides, hydrocarbons, oil spills

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 362 CO 1	2	3	1	2	2	3	2	2	2
BMBC 362 CO 2	1	3	2	2	2	3	3	1	2
BMBC 362 CO 3	2	3	2	2	2	3	3	2	1
BMBC 362 CO 4	2	3	2	2	2	3	2	3	2
Average CO (BMBC 362)	1.75	3	1.75	2	2	3	2.5	2	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 362	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Lab Course Based on BBTME 362b		

PRACTICALS

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) of water sample.
3. Calculation of Total Solids (TS) of water sample.
4. Calculation of BOD of water sample.
5. Calculation of COD of water sample.
6. Bacterial Examination of Water by MPN Method.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Understanding of environmental pollutants, methods for their estimation and control.
CO2	Practical knowledge of the methods for measurement and their quantitative as well as qualitative estimation.
CO3	Expertise in instrument and sample handling for the preparation and analysis of samples.
CO4	Proficiency in data analysis and perception of samples.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 362 CO 1	1	2	3	-	-	3	3	-	-
BMPC 362 CO 2	-	2	3	-	-	3	-	2	-
BMPC 362 CO 3	-	-	3	2	2	-	-	2	2
BMPC 362 CO 4	-	-	3	-	2	-	-	2	2
Average CO (BMPC 362)	1	2	3	2	2	3	3	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Bio Analytical Techniques (Minor Core)		

COURSE OBJECTIVES: The aim of the course is to

1. Acquaint the students with various techniques used in different branches of life science/biotechnology and the underlying principles involved in them.
2. The course also aims to make student learn about operational procedures of modern instruments for analytical works.

UNIT I

Basic knowledge of the principles and applications of Microscopy

Light, phase contrast, fluorescence, Confocal Microscopy, Scanning and Transmission Electron microscopy, (SEM, TEM). Spectroscopic methods: principle and applications of UV-visible, IR, NMR, ESR and X-ray spectroscopy.

UNIT II

Analytical separation methods: Principles and techniques:

Chromatography: Adsorption chromatography, Partition chromatography, Gas chromatography, liquid chromatography, Paper chromatography, thin layer chromatography, Gel filtration chromatography, ion exchange chromatography, affinity chromatography, HPLC.

UNIT III

Centrifugation-basic principles, common centrifuges used in the laboratory (clinical, high speed centrifuges). Types of rotors (fixed angle, swing bucket)

Ultracentrifugation: Sedimentation rate: zonal centrifugation, equilibrium density gradient, centrifugation sedimentation constants.

UNIT IV

Electrophoresis-General principle, application and types: Paper electrophoresis, Gel electrophoresis (Native, Denaturing & reducing), Disc Gel electrophoresis, Iso-electrofocussing (IEF).

UNIT V

Applications of radioisotopes in biology. Properties in UNITs of radioactivity. Measurement of radioactivity: (Basic knowledge) GM Counter, gamma counter, liquid scintillation counter

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Suggested Reading and Text Books:

1. Sharma VK (1991). Techniques in Microscopy and Cell Biology Tata McGraw Hill.
2. Albert's et al (1989).Molecular Biology of the cell (2nd ed.).
3. Robyt JF & White BJ (1990) Biochemical Technique: Theory & Practical. Waveland Press, Inc.
4. Wilson & Walker (2005): Practical Biochemistry (6th edn) University of Hertfordshire Cambridge University Press.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop hands-on proficiency in a variety of bioanalytical techniques, including spectrophotometry, chromatography, electrophoresis, and immunoassays, enhancing your ability to accurately analyze biological samples.
CO2	Acquire the skills to interpret and analyze complex biological data generated from various techniques. Understand how to interpret spectra, chromatograms, electrophoresis patterns, and assay results to draw meaningful conclusions.
CO3	Learn how to apply bioanalytical techniques to solve research questions in the fields of biology, biotechnology, and medicine. Gain insights into their applications in protein analysis, nucleic acid characterization, drug discovery, and disease diagnostics.
CO4	Understand the importance of quality assurance and validation in bioanalytical methods. Learn how to ensure accuracy, precision, and reliability in experimental results through proper calibration, standardization, and validation procedures.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 361 CO 1	2	3	3	2	-	3	2	2	-
BBTC 361 CO 2	-	2	3	2	2	2	3	2	-
BBTC 361 CO 3	-	2	3	3	2	2	3	3	2
BBTC 361 CO 4	2	2	3	3	2	2	2	2	2
Average CO (BBTC 361)	2	2.25	3	2.5	2	2.25	2.5	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 363	Credit	1
Year/Semester	Semester VI	L-T-P	0-0-2
Course Title	Lab Course Based on BBTC 361 (Minor Core)		

PRACTICALS

1. Centrifugation principle and separation of precipitate by centrifugation.
2. Native gel electrophoresis of proteins.
3. Separation of protein sample by SDS-polyacrylamide gel electrophoresis.
4. Separation of amino acids by paper chromatography.
5. Verification of Beer's law and determine the molar extinction coefficient of NADH.
6. Brightfield microscopy of the onion membrane cells.
7. Identification of lipids in a given sample by TLC.
8. Study of DNA blotting.
9. Demonstration of preparation of the sub-cellular fractions of rat liver cells.
10. Study the applications of spectroscopy.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Exhibit working and operating knowledge regarding various tools and techniques in the field of applied science.
CO2	Apply modern techniques and their statistical knowledge for solving various scientific problems in industry and research institution
CO3	Development of the scientific knowledge regarding safety regulations for handling of scientific instruments in Industry.
CO4	Demonstrating the working of bio-analytical techniques associated like HPLC, SDS PAGE, centrifugation, etc.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 363 CO 1	2	3	3	2	-	3	2	2	2
BMPC 363 CO 2	-	2	3	2	2	2	3	2	2
BMPC 363 CO 3	2	2	3	3	2	2	3	3	2
BMPC 363 CO 4	-	2	3	3	2	2	2	2	2
Average CO (BMPC 363)	2	2.25	3	2.5	2	2.25	2.5	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBDE 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Microbial Analysis of Air and Water (Discipline Specific Elective)		

COURSE OBJECTIVES: The objectives of this course are

1. To develop an understanding about air borne microorganism sand their impact on human health.
2. To gain knowledge about water borne pathogens, water borne diseases and microbiological analysis of water.
3. To develop curiosity to control air and water pollution.

UNIT I: Aeromicrobiology

Bioaerosols; Air born microorganisms (Bacteria, viruses and fungi) and their impact on Human health and environment; Significance in food and pharma industries and operation theatres; Allergens.

UNITII: Collection and Analysis of Air Sample

Bioaerosol sampling; Airsamplers; Methods of sampling and analysis; Culture media for bacteria and fungi; Identification characteristics.

UNIT III: Water Microbiology

Water-borne pathogens; Water-borne diseases

UNIT IV: Microbiological Analysis of Water

Sample collection, Treatment and safety of drinking (potable) water, Water purification, Methods to detect potability of water samples: (a) Standard qualitative procedure (MPN test) (b)Membrane filter technique and (c)Presence/absence tests

UNITV: Control Measures

Air: Fate of bioaerosols; I (U.V. light, H.E.P.A filters, desiccation and incineration); Water: Precipitation, Chemical disinfection, Filtration, High temperature and U.V. light treatment.

Suggested Reading and Text Books:

1. Atlas, R.M. and Bartha, R. Microbialecology: Fundamentals and applications . Benjamin /Cummings Science Publishing, USA.
2. Atlas, R.M. and Bartha, R. Microbialecology: Fundamentals and applications . Benjamin /Cummings Science Publishing, USA.

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3. Evans,G.M.andJohn,J.C.F.Environmentalbiotechnology:Theoryandapplications.JohnWileyan dSons,NewYork.
4. DaSilva,N.,Taniwaki,M.H.,Junqueira,V.C.,Silveira,N.,Nascimento,M.S.,Gomes,
5. Madigan,M.T.,Martinko,J.M.andParker,J.Brockbiologyofmicroorganisms.PrenticeHall,New Jersey.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop proficiency in using specialized techniques to sample and detect microbial populations in air and water samples, including microbial enumeration, staining, and microscopy.
CO2	Water Quality Assessment: Learn to assess water quality by analyzing microbial indicators, pathogens, and other microorganisms, understanding their impact on human health and environmental integrity.
CO3	Gain insights into the diversity and concentrations of airborne microorganisms, studying their sources, dispersion, and potential implications for indoor and outdoor environments.
CO4	Understand the principles of environmental monitoring and surveillance of air and water, exploring the significance of microbial analysis in identifying pollution sources and ensuring public health.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBDE 361 CO 1	1	2	3	-	-	3	3	-	-
BMBDE 361 CO 2	-	2	3	-	-	3	-	2	-
BMBDE 361 CO 3	-	-	3	2	2	-	-	2	2
BMBDE 361 CO 4	-	-	3	-	2	-	-	2	2
Average CO (BMBDE 361)	1	2	3	2	2	3	3	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBDE 362	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Pharmaceutical Biotechnology (Discipline Specific Elective)		

COURSE OBJECTIVES: The objectives of this course are

1. To understand the Concept, need and importance of Biotechnology in Pharmaceutical Biotechnology & Drug Designing.
2. To demonstrate the scientific method and the use of problem-solving within the field of Pharmaceutical Biotechnology & Drug Designing.
3. To develop scientific knowledge regarding vaccines and role of biotechnology in development of pharmaceutical drugs.
4. To demonstrate the scientific method and the use of Drug targeting and drug delivery systems.

UNIT I

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.

UNIT II

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.

UNIT III

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines,

UNIT IV

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation.

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UNIT V

Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.

Suggested Reading and Text Books

1. Leon Lachman. Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger, 1986
.
2. Remington's Pharmaceutical Science, Mark Publishing and Co.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	introduction to Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling.
CO2	Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling.related research institution. decision making for higher studies, employment and advanced research in industrial and academic scale.
CO3	Knowledge of the pharmaceutical sciences and drug designing in biological systems information and the explanation of the key concepts and applications in health, agriculture and environment, alongwith associated social and environmental issues.
CO4	Knowledge Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBDE 362 CO 1	2	3	2	2	2	3	2	2	2
BMBDE 362 CO 2	2	3	3	3	3	3	3	2	2
BMBDE 362 CO 3	2	3	3	3	3	3	3	2	3
BMBDE 362 CO 4	2	3	2	3	2	3	2	3	2
Average CO (BMBDE 362)	2	3	2.5	2.75	2.5	3	2.5	2.25	2.25

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBVAC 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Vermitechnology (Value Addition Course)		

COURSE OBJECTIVES: The specific objectives of the course are:

1. Understand the principles and processes of vermicomposting.
2. Gain practical skills in vermiculture management and composting system setup.
3. Recognize the benefits and applications of vermicompost in agriculture and waste management.
4. Develop critical thinking, research, and communication skills related to vermitechnology and sustainable practices.

UNITI

Introduction to vermiculture. definition, meaning, history, economic important, their value in maintenance of soil structure, role as four r's of recycling reduce, reuse, recycle, restore.

UNIT II

Methods of identification of the species of earthworms. Role of earthworms in bio transformation of the residues generated by human activity and production of organic fertilizers.

UNIT III

Biology of Eisenia fetida. a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of Eisenia fetida: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).

UNIT IV

Biology of Eudrilus eugeniae. c) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. d) Vital cycle of Eudrilus eugeniae: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).

Suggested Reading and Text Books

1. Edwards, Clive A., and Norman Q. Arancon. "Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management." CRC Press, 2010.
2. Ndegwa, Pius M., ed. "Vermicomposting for Sustainable Organic Waste Management." Springer, 2019.
3. Domínguez, Jorge, and Clive A. Edwards, eds. "Earthworm Ecology: From Darwin to Vermiculture." CRC Press, 2011.
4. Gutiérrez-Miceli, Federico A., et al. "Vermicompost in Sustainable Agriculture: Potential and Effects on Soil Physical, Chemical, and Biological Properties."

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Springer, 2015.
5. Atiyeh, Raafat M., et al. "The Art and Science of Composting: A Resource for Farmers and Compost Producers." CRC Press, 2011.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the principles of vermicomposting, including the biology of earthworms, organic waste degradation, and the role of microorganisms in the process.
CO2	Acquire practical skills in various vermicomposting techniques, including bin design, substrate preparation, earthworm management, and optimizing environmental conditions.
CO3	Learn how vermitechnology can contribute to sustainable waste management practices, reducing organic waste volume, producing nutrient-rich compost, and minimizing environmental impact.
CO4	Explore the applications of vermitechnology in enhancing soil fertility, plant growth, and crop yield through the production of vermicompost and its beneficial effects on soil structure and nutrient content.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBVAC 361 CO 1	3	2	2	2	2	3	2	2	2
BMBVAC 361 CO 2	2	2	3	3	3	3	3	2	2
BMBVAC 361 CO 3	2	2	3	3	3	3	2	1	3
BMBVAC 361 CO 4	2	3	2	3	2	3	2	3	2
Average CO (BMBVAC 361)	2.25	2.25	2.5	2.75	2.5	3	2.25	2	2.25

3: High, 2: Medium, 1: Low

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B. Sc. Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	MBPR 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Project/Educational Tour Report II		

COURSE OBJECTIVES: The objectives of this course are

1. To make the students industry, university and research institute deployable.
2. To provide an opportunity to students to gain practical knowledge.
3. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/ under the guidance of faculty member/supervisor from industry/research organizations or submit an educational tour report by the guidance of internal supervisor. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings and Text Books: NA

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	To acquire knowledge pertaining to recent development and advancements in biotechnology and allied sciences.
CO2	To attain technical exposure in analytical tools and techniques and professional working environment.
CO3	Enhance and master presentation writing and communication skills
CO4	Inculcate ability to work in a team to achieve set goals.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BTPR 361 CO 1	2	3	3	2	2	3	2	2	-
BTPR 361 CO 2	-	3	3	2	3	2	2	3	3
BTPR 361 CO 3	-	-	-	3	3	-	-	3	3
BTPR 361 CO 4	-	-	-	3	3	-	2	3	3
Average CO (BTPR 361)	2	3	3	2.5	2.75	2.5	2	2.75	3

3: High, 2: Medium, 1: Low

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SEMESTER VII

Degree Course in Honours Microbiology [B.Sc. (Hons.) Microbiology]

B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 471	Credit	3
Year/Semester	Semester VII	L-T-P	3-0-0
Course Title	Microbial Genetics (Major Core)		

COURSE OBJECTIVES

1. Understand Genetic Mechanisms: Gain a deep understanding of the molecular and cellular mechanisms of genetic inheritance, mutation, recombination, and regulation in microorganisms.
2. Analyze Microbial Genetic Variation: Learn how to analyze and interpret genetic variation within microbial populations, exploring the impact of genetic diversity on microbial physiology, adaptation, and evolution.

UNIT I

Prokaryotic Genomes, Physical organization of bacterial genomes (Structure of the bacterial nucleoid, Replication and partitioning of the bacterial genome and Genome of Archaea).

UNIT II

Mechanism of genetic exchange: Plasmid and bacterial sex, Types of plasmids (F Plasmid: a Conjugate plasmid', Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes. Transposable elements (Insertion sequence and transposons.

UNIT III

Integrons and Antibiotic: Resistance cassettes, Multiple Antibiotic Resistant bacteria, Mu virus); Bacterial Genetics (Mutant phenotype, DNA mediated Transformation; Conjugation (Cointegrate Formation and Hfr Cells, Time–of–Entry Mapping, F' Plasmid); Transduction (Generalized transduction, Specialized Transduction)- gene mapping.

UNIT IV

Molecular Mechanism of gene regulation in prokaryotes Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept– lac, trp, Ara operons.

UNIT V

Bacteriophages: Stages in the Lytic Life Cycle of a typical phage, Properties of a phage infected

bacterial culture, Specificity in phage infection, E. coli PhageT4, E. coli Phage T7, E. coli phage lambda, Immunity to infection, Prophage integration, Induction of prophage, Induction & Prophage excision, Repressor, Structure of the operator and binding of the repressor and the Cro product, Decision between the lytic and lysogenic Cycles, Transducing phages, E. coli phage phiX174, filamentous DNA phages, Single stranded RNA phages, The lysogenic Cycle.

Suggested Reading and Text Books

1. Cronan J. and Freifelder D., Microbial Genetics; Second Edition
2. Khalifa AE; Fundamentals of Microbial Genetics; Lamber Academic Pub.
3. Sundara R.S. Microbial Genetics; Amol Publications Pvt Ltd
4. Modern Microbial Genetics, Second Edition; Editor(s): Uldis N. Streips, Ronald E. Yasbin; Wiley-Liss, Inc.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the principles and mechanisms of microbial genetics, including gene transfer, recombination, mutation, and regulation.
CO2	Acquire the ability to analyze and interpret genetic data, such as genetic maps, mutation frequencies, and gene expression profiles, to draw meaningful conclusions about microbial traits and behavior.
CO3	Gain practical skills in performing genetic experiments, such as transformation, conjugation, mutagenesis, and gene expression analysis, to study microbial genomes and genetic variations.
CO4	Develop critical thinking and research skills to address real-world challenges in microbial genetics, proposing solutions for practical applications and scientific advancements.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 471 CO 1	3	3	-	-	-	3	-	-	-
BMBC 471 CO 2	-	-	3	-	-	3	3	-	2
BMBC 471 CO 3	-	3	3	-	-	-	-	3	-
BMBC 471 CO 4	-	-	3	-	2	-	3	2	-
Average CO (BMBC 471)	3	3	3	0	2	3	3	2.5	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 471	Credit	3
Year/Semester	Semester VII	L-T-P	3-0-0
Course Title	Lab Course Based on BBTC 471		

PRACTICALS

1. To isolate the plasmid DNA from bacterial culture.
2. To prepare the competent cells.
3. To introduce a foreign DNA plasmid into bacterial cells using a transformation technique.
4. To induce mutations in bacterial cells and screen for specific phenotypic changes.
5. To identify genes critical for specific phenotypes using transposon mutagenesis.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop practical skills in performing microbial genetics experiments, including transformation, conjugation, mutagenesis, and gene expression analysis.
CO2	Acquire the ability to analyze and interpret genetic data obtained from laboratory experiments, drawing meaningful conclusions about microbial genetic traits and behavior.
CO3	Gain hands-on experience in working with microbial organisms, genetic tools, and equipment used in the laboratory setting.
CO4	Learn to design and execute microbial genetics experiments, ensuring proper controls and replicates for reliable and valid results.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 473 CO 1	-	2	3	2	-	3	1	2	-
BBTPC 473 CO 2	2	-	3	1	2	3	2	2	-
BBTPC 473 CO 3	-	-	3	3	-	3	-	3	3
BBTPC 473 CO 4	-	-	3	2	2	-	-	2	3
Average CO (BBTPC 473)	2	2	3	2	2	3	1.5	2.25	3

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 472	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Epidemiology		

COURSE OBJECTIVES: The objectives of this course are

1. To instill detailed study of the molecular and cellular components that comprises the immune system including their function and interaction.
2. To appraise study of the different analytical techniques for the disease diagnosis.
3. To broaden the area of understanding the structure, function, components of immune system.

UNIT I

Define microbial epidemiology and its role in understanding the distribution, transmission, and control of microbial diseases. Microbial Agents: Study various types of microorganisms, including bacteria, viruses, fungi, and parasites, and their characteristics relevant to epidemiology.

UNIT II

Transmission Dynamics: Explore the modes of transmission for different microbial agents, including direct contact, droplet, airborne, vector-borne, and waterborne transmission. Outbreak Investigations: Learn the steps involved in investigating microbial disease outbreaks, from case identification and confirmation to source tracing and control measures.

UNIT III

Understand the application of molecular techniques, such as genotyping and sequencing, in tracing the source and transmission of microbial pathogens.

Surveillance Systems: Explore surveillance systems for monitoring microbial diseases at local, national, and global levels, and their role in early detection and response.

UNIT IV

Infection Control Measures: Study infection prevention and control strategies, including isolation precautions, vaccination, antimicrobial stewardship, and hygiene practices. Emerging and Re-emerging Infections: Analyze the factors contributing to the emergence and re-emergence of microbial diseases, and strategies for surveillance and containment.

UNIT V

One Health Approach: Explore the interconnectedness of human, animal, and environmental health in the context of microbial diseases, emphasizing a holistic approach to disease control.

Suggested Reading and Text Books

1. Medical Microbiology: Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller

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2. Infectious Disease Epidemiology: Theory and Practice: Kenrad E. Nelson and Carolyn Masters Williams
3. Microbial Epidemiology: A Quantitative Approach: Martin E. Hugh-Jones

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the transmission dynamics of microbial agents, including bacteria, viruses, fungi, and parasites, and their modes of spread within populations.
CO2	Acquire skills in investigating and managing outbreaks of microbial diseases, including identifying sources, tracking transmission chains, and implementing effective control measures.
CO3	Learn to analyze disease patterns and trends, using epidemiological methods to assess the burden of microbial diseases, identify at-risk populations, and evaluate the impact of interventions.
CO4	Understand the role of microbial epidemiology in shaping public health interventions, including vaccination strategies, infection prevention and control measures, and policies to mitigate disease impact.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 472 CO 1	3	2	2	2	2	3	2	2	2
BMBC 472 CO 2	2	2	3	3	3	3	3	2	2
BMBC 472 CO 3	2	2	3	2	3	3	2	2	2
BMBC 472 CO 4	2	2	2	2	2	3	2	3	2
Average CO (BMBC 472)	2.25	2	2.5	2.25	2.5	3	2.25	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 471	Credit	3
Year/Semester	Semester VII	L-T-P	3-0-0
Course Title	Biostatistics and Computers		

COURSE OBJECTIVES: The objectives of this course are

1. To learn to define and find the solution of arithmetic mean, median and mode, Quartiles, deciles and percentiles.
2. To demonstrate knowledge of chi square test, t-test, distributions, correlation and regression.
3. To develop the concepts of moments, skewness and kurtosis and determining whether the given distribution is normal or not.
4. To understand and illustrate the theory and applications of the probability.
5. To demonstrate computer programming and components of a computer system.

UNIT I

Relation of Life Science with mathematics, Linear function concept, 0.5 coordinate system, trigonometry relations, differentiation & integration concept, logarithms, complex numbers, Plotting of graphs, matrices.

UNIT II

Importance of statistics in biomedical research. Mean, Mode, median, range, mean deviation, standard deviation, standard error, skewness & kurtosis. Correlation & Regression. Probability: Theorems, Addition rules, multiplication rules, probability applications, probability distributions-Binomial, Poisson & Normal Distributions.

UNIT III

Chi square test-characteristics of Chi square test, validity of Chi square test, applications of Chi square test. Test for significance- comparison of means of two samples, comparison of means of three or more samples (f-test, t-test).

UNIT IV

Need for computer language, reading C Programs, Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).Data storage device, Memory concepts. Software and types of software. Applications of common packages, Microsoft Office: Microsoft word, Microsoft excel, Microsoft Power Point.

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Suggested Reading and Text Books

1. Hoel, P.G: Elementary Statistics John Wiley & Sons, Inc. New York.
2. Mahajan: Methods in Biostatistics (4thed.) Jaypee Bros. 1984.
3. Sokal & Rohlf: Introduction to Biostatistics, Freeman, Toppan, 1993.
4. D. Rajaraman & V. Rajaraman: Computer primer (2nded.) Prentice Hall of India, New Delhi.
5. Roger Hunt & John Shelley: Computer and Commonsense Prentice Hall of India, New Delhi.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a solid understanding of fundamental statistical concepts and techniques, enabling you to analyze and interpret data effectively in various biological and health-related contexts.
CO2	Acquire practical skills in using statistical software and computer programs to manipulate, visualize, and analyze biological data. Learn how to perform descriptive statistics, hypothesis testing, regression analysis, and more.
CO3	Learn how to apply biostatistical methods to design experiments, conduct surveys, and analyze research data. Understand how to select appropriate statistical tests and interpret results for hypothesis validation.
CO4	Gain competence in using computers as tools for data management, statistical analysis, and scientific communication. Learn to create graphs, generate reports, and present research findings using computer software.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 471 CO 1	1	3	3	1	2	3	1	2	2
BMBC 471 CO 2	2	2	3	1	2	2	2	2	1
BMBC 471 CO 3	-	-	3	2	-	-	2	-	-
BMBC 471 CO 4	-	2	3	2	2	3	2	2	2
Average CO (BMBC 471)	1.5	2.3	3	1.5	2	2.67	1.75	2	1.67

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBDE 471	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Mycology, Phycology and Bryophytes		

COURSE OBJECTIVES: The objectives of this course are

1. Understand the classification, morphology, and ecological roles of fungi, algae, and bryophytes.
2. Understand the life cycles, reproductive strategies, and physiological adaptations of these organisms to different environments.
3. Examine the economic significance of fungi, algae, and bryophytes in agriculture, industry, and medicine, as well as their ecological roles in ecosystems.

UNIT I

General characters of Algae. Classification of Algae- Fritsch (1935) classification, Criteria for algal classification. Cell structure, EM studies of algal cell, cell wall, flagella, chloroplast, pyrenoid, eye spot, pigments- their importance in classification. General account of thallus structure, reproduction, relationship and life cycle of important groups Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae, Charophyceae

UNIT II

Economic importance of algae: Algal Biofertilizers and its role in soil fertility, algae in industry (Bio-fuel and Bio-pigments), algae as food and medicine. biological importance of phytoplanktons and water blooms, Diatomaceous earth.

UNIT III

General characters of fungi. Classification of fungi. Alexopolous, Mims and Blackwell(1996), ultra structure of cell, unicellular, multicellular organization, hyphal growth, cell wall composition, nutrition (saprophyte, biotrophic, symbiotic, predaceous), reproduction, heterothallism, parasexuality. General account of Myxomycota, Mastigomycota, Zygomycota, Ascomycota, Basidiomycota and Mitosporic fungi. Kinds of spores and their dispersal.

UNIT IV

Economic importance of fungi. Decomposition of organic matter, coprophilous fungi, lignin degrading fungi, degradation of pesticides. Role of fungi as symbionts- Lichens, Mycorrhiza- ectotrophic, orchidaceous and Ericoid mycorrhiza- their distribution and significance. Fungal Endophytes. Edible fungi.

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UNIT V

Classification of Bryophytes- by Proskauer (1957). General account of major groups of bryophytes (Hepaticopsida, Anthoceoratopsida and Bryopsida). Origin of Bryophytes. Range of thallus structure, evolution of gametophytes and sporophytes. Reproduction and life cycle. Ecological and economic importance of bryophytes.

Suggested Reading and Text Books

1. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). Introductory Mycology (4th ed.). John Wiley & Sons.
2. Lee, R. E. (2018). Phycology (5th ed.). Cambridge University Press.
3. Schofield, W. B., & Pressel, S. (2016). Bryophyte Biology (2nd ed.). Cambridge University Press.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the taxonomy, classification, and diversity of fungi, algae (phycology), and bryophytes, including their morphological and ecological characteristics.
CO2	Learn about the life cycles, reproductive strategies, and ecological roles of fungi, algae, and bryophytes, emphasizing their importance in various ecosystems.
CO3	Acquire skills in identifying and classifying fungi, algae, and bryophytes through practical exercises, using keys, microscopy, and field observations.
CO4	Understand the ecological significance of fungi, algae, and bryophytes in terms of nutrient cycling, symbiotic relationships, habitat formation, and their contributions to ecosystem health.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTDE 471 CO 1	2	2	1	2	2	3	2	2	2
BBTDE 471 CO 2	2	2	2	3	3	2	2	2	1
BBTDE 471 CO 3	2	2	2	2	3	2	2	2	1
BBTDE 471 CO 4	2	2	2	2	2	2	2	2	2
Average CO (BBTDE 471)	2	2	1.75	2.25	2.5	2.25	2	2	1.5

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBVAC 471	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Infection and Immunity		

COURSE OBJECTIVES: The objectives of this course are

1. To learn about infection and infectious agents and their modes of infection
2. To learn about role of cells and molecules of immune system in infections.
3. Explore human immune responses, including innate and adaptive immunity, and immune evasion mechanisms.
4. Learn strategies for disease prevention and control, such as vaccination, antimicrobial therapy, and public health measures.

UNIT I: Infectious Agents

Infection and its types; Infectious agents: Viruses, Bacteria, Fungi, Protozoa, Helminthes(worms), Parasites, Prions; Pathogens and immunity; Immunogenicity of pathogens; Virulence and susceptibility; Pathogen associated molecular patterns.

UNIT II: Immune Regulation of Infection

Barriers preventing establishment of infection; Mechanism of establishment of infection: Invasion, Survival in intracellular and cytoplasmic space, Role of molecular factors in establishment of infection, Role of cells and molecules of immune system in infection, Adoptive immunity to infection, Immune elimination of infection, Mechanisms of escape from immune-mediated destruction, Infection in immuno-compromised host.

UNIT III: Immune Responses to Infection

Immune alteration during early and late phases of infection; Immunological basis of infection; Infection and antigen presentation; Recognition of molecular pattern of pathogen; Phagocytosis and killing of infectious agents; Humoral and cell-mediated immunity against infection; Infection associated immunosuppression; Immunodeficiency and infection; Acquired immuno-deficiencies; Nosocomial and community acquired infections; Coinfections; Immunity in local and systemic infection (Bacterimia and viremia); Septic infection and immunity; Immunological memory against infection and secondary responses; Immunization: Active and passive; Vaccination.

UNIT IV: Immunity against Bacterial, Viral and Prions Infections

Immune responses and immunological control of bacterial infection (Staphylococcus and Mycobacterium), viral diseases (Influenza and hepatitis) and prion infections.

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UNIT V: Immunity against Fungal and Parasite Infections

Immune responses and immunological control of fungal infection (Candidiosis and aspergillosis) and parasitic diseases (Malaria, leishmaniasis, schistisomasis and filarisas).

Suggested Readings and Text Books

1. Ananthanarayan, R.and Paniker, C.K.J. (2005). Textbook of Microbiology. University Press Publication, 7thed.
2. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. (2013). Prescott'Microbiology.
3. Brooks GF, Carroll KC, Bute lJS and Morse SA. (2013). Jawetz, Melnick and Adelberg's medical microbiology. McGraw Hill Publication, 26thed.
4. Goering, R.,Dockrell,H.,Zuckerman ,M.andWakelin,D.(2007).Mims'Medical microbiology. Elsevier, London, 4thed.
5. Madigan,M.T.,Martinko,J.M.,Dunlap,P.V.andClark,D.P.(2014).Brockbiologyofmicroorganism s.Pearson International Edition, 14thed.

On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the components of the immune system, including cells, tissues, and molecules involved in both innate and adaptive immunity.
CO2	Learn about the immune responses elicited by various infectious agents, including bacteria, viruses, fungi, and parasites, and understand how the immune system detects and combats infections.
CO3	Explore the concept of immunopathology, understanding how immune responses can lead to diseases such as autoimmune disorders, allergies, and immunodeficiencies.
CO4	Gain insights into the principles of vaccination, including the types of vaccines, mechanisms of action, and their role in preventing infectious diseases and promoting herd immunity.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBVAC 471 CO 1	2	3	1	2	2	3	2	2	2
BMBVAC 471 CO 2	2	3	2	2	2	3	1	2	2
BMBVAC 471 CO 3	2	3	2	2	2	2	1	2	2
BMBVAC 471 CO 4	2	3	3	3	2	3	2	2	2
Average CO (BMBVAC 471)	2	3	2	2.25	2	2.75	1.5	2	2

3: High, 2: Medium, 1: Low

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SEMESTER VIII

B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 481	Credit	3
Year/Semester	Semester VIII	L-T-P	3-0-0
Course Title	Microbial Ecology		

COURSE OBJECTIVES: The candidates will

1. Understand microbial interactions with environment.
2. Also appreciate the role of microbes in waste treatment and biodeterioration.

UNIT I

History, significance and developments in the field of microbial ecology, Contributions of Beijerinck, Winogradsky, Kluyver, Van Niel, Martin Alexander, Selman A. Waksman.

UNIT II

Microorganisms & their natural habitats A. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora B. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats, C. Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes D. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. E. Extreme Habitats: Extremophiles

UNIT III

Biological Interactions, A. Microbe–Microbe Interactions Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents, B. Microbe–Plant Interactions, Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic - biofertilizers), C. Microbe–Animal Interaction, Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont

UNIT IV

Carbon cycle: Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin) Nitrogen cycle: Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution. Phosphorous cycle: Phosphate immobilization and phosphate solubilization Sulphur Cycle: Microbes involved in sulphur cycle.

UNIT V

Solid Waste Management Sources and types of solid waste, methods of disposal of solid waste (incineration, composting, sanitary landfill), Composition of sewage; strength of sewage (BOD and COD); Primary, secondary (aerobic – oxidation pond, trickling filter, rotating biological contractor/biodisc system, activated sludge process and anaerobic – septic tank, inhoff tank, anaerobic digestor) and tertiary sewage treatment

Suggested Readings and Text Books

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. Benjamin/Cummings Science Publishing, USA.
2. Atlas RM (1989). Microbiology: Fundamentals and Applications MacMillan Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. Pearson/ Benjamin Cummings.
4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Gain knowledge about the role and infections caused in air
CO2	Obtain complete knowledge on Microorganism inhabiting extreme environments
CO3	Assimilate knowledge on Solid waste treatment and Utilization of solid wastes
CO4	Know in-depth information on Waste water treatment and its different methods. Attain information on Biodeterioration

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 481 CO 1	2	3	2	2	2	3	2	2	2
BMBC 481 CO 2	1	2	2	2	2	3	1	1	2
BMBC 481 CO 3	1	2	2	2	2	3	2	2	2
BMBC 481 CO 4	2	3	3	2	2	3	2	2	2
Average CO (BMBC 481)	1.5	2.5	2.25	2	2	3	1.75	1.75	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMPC 481	Credit	1
Year/Semester	Semester VIII	L-T-P	0-0-2
Course Title	Lab Course based on BMBC 481 (Major Core)		

PRACTICALS

1. To analyse the pH of the soil
2. To analyse the moisture content, water holding capacity of soil.
3. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
4. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
5. Isolation of Rhizobium from root nodules of legumes.
6. Isolation of Azotobacter/Azospirillum from soil.
7. Assessment of microbiological quality of water.
8. Determination of BOD of waste water sample.
9. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

Suggested Reading and Text Books

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. Benjamin/Cummings Science Publishing, USA.

2. Atlas RM (1989). Microbiology: Fundamentals and Applications MacMillan Publishing Company, New York.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Gain knowledge about the role and infections caused in air
CO2	Obtain complete knowledge on Microorganism inhabiting extreme environments
CO3	Assimilate knowledge on Solid waste treatment and Utilization of solid wastes
CO4	Know in-depth information on Waste water treatment and its different methods. Attain information on Biodeterioration

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMPC 481 CO 1	2	2	3	2	2	3	2	2	2
BMPC 481 CO 2	2	2	3	2	2	3	3	2	2
BMPC 481 CO 3		2	3	2	2	3	2	2	2
BMPC 481 CO 4	2	2	3	2	2	3	2	2	2
Average CO (BMPC 481)	2	2.25	3	2	2	3	1.75	2	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTC 481	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Protein Engineering (Minor Core)		

COURSE OBJECTIVES

The objective of this course are as follows:

1. Explore the principles of protein structure and how it relates to function, providing a foundation for designing novel protein variants.
2. Learn the basics of rational protein design, including computational methods and structure-based approaches, to engineer proteins with specific functionalities.
3. Study directed evolution techniques to create protein variants with improved properties through mutation and selection, enhancing their performance for various applications.
4. Understand the practical applications of protein engineering in biopharmaceuticals, enzymes, and other biotechnological and medical contexts, emphasizing the role of engineered proteins in addressing real-world challenges.

UNIT I

Protein Structure Prediction: Primary structure and its determination, secondary structure prediction and determination of super-secondary structure and its domain in proteins, quaternary structure, methods to determine tertiary and quarternary structures, post transational modification. The proteome and genome, life and death of protein, Codon biasing & codon optimization.

UNIT II

Structure function relationship of proteins: DNA binding proteins, prokary otic and eukaryotic transcription factors, DNA Polymerases, Membrane protein and receptors, bacterial rhodophsin, epidermal growth factors, insulin and ODGF receptors and their interaction with effectors, protein phosphorylation, nucleotide binding proteins, enzyme serine proteases, ribonucleases, lysozyme.

UNIT III

Electrophoretic Analysis of Proteins: Two-dimensional polyacrylamide gel electrophoresis for

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proteome analysis: Brief history of 2-DE, 2-De with immobilized pH gradients, sample preparation, Solubilisation, reduction, The first dimension; IEF with IPG, Equilibration between dimensions, The second dimension: SDS-PAGE, resolution, Organic dyes and silver stains, Reverse stains, Colloidal dispersion stains, organic fluorophore stains, metal chelate stains.

UNIT IV

Mass Spectroscopy Analysis of Protein: Background to mass spectrometry, Correlative mass spectrometric-based identification strategies, de novo sequencing using mass spectrometric data, separation methods for phosphorylation site analysis, present and future challenges and opportunities. Data acquisition, digital image processing, Protein spot detection and quantitation, gel matching, data analysis, data presentation, databases.

UNIT V

New Approaches in Proteomics: Protein arrays, use of automated technologies to generate protein array and chips and the application of protein chips in proteomics. Mixing proteomes, protein expression profiling, identification of protein-protein interactions and protein complexes, mapping protein complexes, new approaches in proteomics.

Suggested Readings and Text Books

1. Protein Engineering and Design, T.A. Brown, CRC Press (2005).
2. Introduction to Protein Structure, Carl Branden, John Tooze, Garland Science (1999).
3. Protein Engineering: Methods and Protocols,edited by Dolores J. Cahill, Humana Press (2004).
4. Principles of Protein Structure, G.E. Schulz, R.H. Schirmer, Springer (2005).
5. Protein Engineering: A Practical Approach, Nigel M. Hooper, Humana Press (2000).
6. Introduction to Protein Engineering, Terje Traaseth, CRC Press (2019).
7. Protein Engineering for Industrial Biotechnology, Prof. Dr. Tilman Schirmer, Wiley (2000).

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a clear understanding of protein structure-function relationships, enabling the analysis of protein characteristics for engineering purposes.

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CO2	Acquire the ability to apply rational design principles to modify protein structures for desired functions, using computational tools to predict and guide modifications.
CO3	Gain hands-on experience in implementing directed evolution techniques, empowering you to engineer proteins with enhanced properties through iterative mutation and selection processes.
CO4	Apply your knowledge and skills to real-world scenarios by designing and discussing engineered proteins for specific applications in biotechnology, medicine, and other relevant fields.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 481 CO 1	2	3	-	-	-	3	2	-	-
BBTC 481 CO 2	-	3	3	1	-	2	2	2	1
BBTC 481 CO 3	-	3	3	2	2	2	-	2	1
BBTC 481 CO 4	-	2	-	2	-	2	2	-	-
Average CO (BBTC 481)	2	2.5	3	1.67	2	2.25	2	2	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBC 482	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Microbial Ecotoxicology (Major Core)		

COURSE OBJECTIVES

1. Introduce the fundamental concepts of microbial ecotoxicology, focusing on the interactions between microorganisms and environmental pollutants.
2. Explore the diversity and adaptation of microbial communities in response to different types of contaminants.
3. Investigate the role of microorganisms in pollutant transformation and bioremediation processes.
4. Understand the ecological implications of toxic pollutants on microbial communities and ecosystem stability.

UNIT I

Introduction to Microbial Ecotoxicology, Definition and scope of microbial ecotoxicology, Environmental pollutants and their sources, Impact of pollutants on microbial communities

UNIT II

Microbial Adaptation to Pollutants: Mechanisms of microbial resistance and detoxification. Influence of pollutants on microbial growth and activity. Microbial indicators of environmental pollution

UNIT III: Pollutant Transformation and Bioremediation: Microbial degradation of organic pollutants. Role of microorganisms in heavy metal immobilization. Bioremediation strategies and limitations.

UNIT IV

Ecological Consequences of Ecotoxicological Events: Disruption of microbial food webs. Effects of pollutants on ecosystem services. Restoration and resilience of ecosystems

UNIT V

Advanced Techniques in Microbial Ecotoxicology: Molecular tools for assessing microbial responses to contaminants. Metagenomics and metatranscriptomics in ecotoxicological research. Biomarkers for microbial ecotoxicity assessment.

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Suggested Reading and Text Books

1. K. G. Mukerji and C. Manoharachary. (Eds.). (2012). Fungal Biology (4th ed.). Springer.
2. R. M. Atlas and R. Bartha. (2012). Microbial Ecology: Fundamentals and Applications* (4th ed.). Benjamin Cummings.
3. H. J. B. Birks, A. F. Lotter, S. Juggins, and J. P. Smol. (2012). *Tracking Environmental Change Using Lake Sediments: Data Handling and Numerical Techniques* (2nd ed.). Springer.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of ecotoxicological concepts, focusing on the interactions between microorganisms, pollutants, and ecosystems.
CO2	Learn about microbial responses to various environmental stressors, including pollutants, contaminants, and changes in physical and chemical conditions.
CO3	Acquire skills in assessing the ecological impacts of microbial pollutants on aquatic and terrestrial ecosystems, studying shifts in microbial community structure and function.
CO4	Explore strategies for mitigating and managing microbial ecotoxicological issues, including bioremediation, ecological restoration, and the development of sustainable environmental management practices.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 482 CO 1	2	3	1	2	2	3	2	2	2
BMBC 482 CO 2	2	3	2	2	2	3	1	2	2
BMBC 482 CO 3	2	3	2	2	2	2	1	2	2
BMBC 482 CO 4	2	3	3	3	2	3	2	2	2
Average CO (BMBC 482)	2	3	2	2.25	2	2.75	1.5	2	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 481	Credit	3
Year/Semester	Semester VIII	L-T-P	3-0-0
Course Title	Epigenetics and Cancer Biology		

COURSE OBJECTIVES: The objectives of this course are

1. To provide the basic knowledge of cancer biology and their molecular aspects.
2. To provide the basic knowledge of morphological and ultrastructural properties of cancerous cells.
3. To provide the basic knowledge about cancer biology, cancer biochemistry mode of infection of cancerous cells, possible treatments and preventions.
4. To instill the concept and fundamentals about the classification of carcinogenesis and therapies of cancer.

UNIT I

Introduction, growth characteristics of cancers cells; Morphological and ultrastructural properties of cancer cells. Types of growth: hyperplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms. Differences between benign and malignant tumors. Epidemiology of cancer. Cancer biology and biochemistry

UNIT II

Carcinogenesis- radiation and chemical carcinogenesis- stages in chemical carcinogenesis- Initiation, promotion and progression. Free radicals, antioxidants in cancer; Viral carcinogenesis - DNA and RNA Viruses. Hormone mediated carcinogenesis in humans. Cell Cycle Regulation- Tumor suppressor genes p53, p21, Rb, BRACA1 and BRACA2. Apoptosis in cancer-Cell death by apoptosis, role of caspases; Death signaling pathways-mitochondrial and death receptor pathways. Detection of Cancers, Different forms of therapy.

Suggested Reading and Text Books

1. The Biological Basis of Cancer: R. G. McKinnell, et al 2nd Ed, Cambridge University Press, 2006.
2. The Biology of Cancer: R. A. Weinberg. Garland Science. 2006.
3. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication.
4. Virology a practical approach, Maly B.W.J. IRL Press, Oxford, 1987.
5. Introduction to modern Virology, Dunmock N.J and Primrose.S.B., Blackwel Scientific

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Publications. Oxford, 1988.
6. An Introduction to Cellular & Molecular Biology of Cancer, Oxford Medical publications, 1991.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a deep understanding of epigenetic modifications, including DNA methylation, histone modifications, and non-coding RNAs, and their role in regulating gene expression and cellular function.
CO2	Gain insights into the epigenetic alterations associated with cancer development and progression, exploring how aberrant epigenetic changes contribute to oncogenesis and tumor heterogeneity.
CO3	Acquire practical skills in using cutting-edge techniques such as ChIP-seq, DNA methylation profiling, and RNA interference to study epigenetic changes in cancer cells and tissues.
CO4	Understand the potential of targeting epigenetic modifications as therapeutic strategies for cancer treatment, evaluating the challenges and opportunities of epigenetic-based therapies.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTOE 481 CO 1	2	3	3	2	-	3	2	3	-
BBTOE 481 CO 2	-	3	3	1	1	2	2	2	1
BBTOE 481 CO 3	2	2	3	2	2	2	1	2	1
BBTOE 481 CO 4	-	2	-2	2	1	2	2	2	2
Average CO (BBTOE 481)	2	2.5	1.75	1.75	1.3	2.25	1.75	2.25	1.3

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTOE 482	Credit	3
Year/Semester	Semester VIII	L-T-P	3-0-0
Course Title	Enzymology		

COURSE OBJECTIVES: The course aims to impart the knowledge about fundamental principles of enzyme reactions, and applications of enzyme engineering. The specific objectives of the course are:

1. To make students understand the mechanism of enzyme action.
2. To teach students Michaelis-Menten equation for enzyme kinetics.
3. To teach students the regulation of enzyme kinetics
4. To impart knowledge about enzyme engineering and its applications.

UNIT I

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis- Menten equation and its derivation.

UNIT II

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis.

UNIT III

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT IV

Enzyme technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

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Suggested Reading and Text Books

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition,McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons,1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004.
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	To explain the methods of enzyme isolation, crystallization, purification and reactions of enzymes, zymogens and course of action of enzyme and kinetics.
CO2	To acquire knowledge about classification and enzyme inhibition, types of inhibition, role of Ki in Acid Base catalysis.
CO3	To apply the contextual knowledge of isoenzymes and recognize their role in clinical field with its types and reference to LDH.
CO4	To compare the different methods of enzyme immobilization and exploring theoretically these methods with industries, functional relationship of enzyme.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTME 241b CO 1	2	3	3	2	3	3	3	3	2
BBTME 241b CO 2	1	3	3	1	2	3	2	2	2
BBTME 241b CO 3	1	3	2	1	2	3	2	2	1
BBTME 241b CO 4	1	3	3	2	2	3	2	2	2
Average CO (BBTME 241b)	1.25	3	2.75	1.5	2.25	3	2.25	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BTVAC 481	Credit	3
Year/Semester	Semester IV	L-T-P	3-0-0
Course Title	Industrial Waste Management (VAC)		

COURSE OBJECTIVES: The Industrial Waste Management course aims to provide students with a comprehensive understanding of the principles, methods, and technologies used to manage and mitigate industrial waste. Students will learn about the environmental impact of industrial waste, regulations governing waste management, and sustainable practices to promote effective waste reduction and disposal.

UNIT I: Introduction to Industrial Waste Management

Definition and types of industrial waste. Environmental impacts of industrial waste. Industrial waste generation sources and patterns

UNIT II: Waste Management Regulations and Policies

National and international waste management regulations. Hazardous waste identification and classification. Waste handling permits and compliance

UNIT III: Waste Minimization and Resource Efficiency

Waste reduction techniques in industrial processes. Resource recovery and recycling methods. Life cycle assessment and eco-design principles

UNIT IV: Waste Treatment Technologies

Physical, chemical, and biological treatment methods. Incineration, pyrolysis, and gasification processes. Wastewater treatment and effluent disposal

UNIT V: Safe Disposal and Landfill Management

Landfill design and operation. Environmental considerations for landfill sites. Leachate management and remediation. Circular economy approaches in industrial waste management. Zero-waste initiatives and green chemistry applications. Case studies on successful waste management implementation

Suggested Reading and Text Books

1. Industrial Wastewater Treatment: A Guidebook" by Charles N. Haas and John C. Crittenden, CRC Press, 2006.
2. Industrial Waste Management: Processing, Disposal, and Recycling by Nelson L. Nemerow and Franklin J. Agardy, CRC Press, 2002.

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3. Handbook of Industrial and Hazardous Wastes Treatment by Lawrence K. Wang, Yung-Tse Hung, and Howard H. Lo, CRC Press, 2004.
4. Industrial Waste Management: Principles and Environmental Applications by A. D. Patwardhan, Tata McGraw-Hill Education, 2010.
5. Industrial Waste Management: An Advanced Course by Kanti Lal Sonthalia, New Age International, 2002.
6. Waste Treatment and Disposal by Paul T. Williams, John Wiley & Sons, 2005.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Identify and categorize various types of industrial waste and their potential environmental impacts.
CO2	Understand the legal and regulatory frameworks governing industrial waste management at local, national, and international levels.
CO3	Evaluate and apply appropriate waste management strategies, including waste reduction, recycling, treatment, and safe disposal methods.
CO4	Implement sustainable practices to minimize waste generation and promote resource efficiency in industrial processes.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BTVAC 481 CO 1	2	3	2	2	3	3	3	3	2
BTVAC 481 CO 2	2	3	3	2	2	3	3	2	2
BTVAC 481 CO 3	2	3	3	2	2	3	3	2	1
BTVAC 481 CO 4		3	3	2	2	3	2	2	2
Average CO (BTVAC 481)	2	3	2.75	2	2.25	3	2.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTDE 481	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Microbial Genomics (Discipline Specific Electives)		

COURSE OBJECTIVES

1. Introduce the fundamentals of microbial genomics, including DNA sequencing technologies and bioinformatic analysis.
2. Explore the genomic diversity of microorganisms and their adaptation to different environments.
3. Investigate the role of microbial genomics in understanding pathogenicity, antibiotic resistance, and virulence factors.
4. Understand the principles of comparative genomics and phylogenetic analysis for microbial classification.
5. Analyze the genomic basis of microbial interactions, such as symbiosis and microbial communities.

UNIT I

Introduction to Microbial Genomics: Genomic revolution and its impact on microbiology. DNA sequencing technologies and applications. Bioinformatic tools for genome assembly and annotation

UNIT II

Genomic Diversity and Adaptation: Microbial genome structure and organization. Horizontal gene transfer and genetic plasticity. Genomic adaptations to different ecological niches

UNIT III

Microbial Pathogenesis and Virulence Factors: Genomic basis of microbial pathogenicity. Antibiotic resistance and its genetic determinants. Virulence factors and host-pathogen interactions

UNIT IV

Genomics of Microbial Interactions: Symbiosis and mutualistic interactions. Quorum sensing and microbial communication. Impact of microbial genomics on microbiome research

UNIT V

Microbial Genomics in Biotechnology and Agriculture: Genomics-guided bioprospecting for novel enzymes and biomolecules. Applications of microbial genomics in agriculture and biocontrol. Genomic approaches for optimizing microbial bioprocesses. Metagenomics and its applications in environmental studies.

Suggested Readings and Text Books

1. J. W. Dale and S. Park. (2012). Molecular Genetics of Bacteria (4th ed.). Wiley-Blackwell.

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2. T. M. Coenye and P. Vandamme. (2013). Burkholderia: Molecular Microbiology and Genomics. Horizon Scientific Press.
3. S. R. E. Farmer, B. R. Howieson, and A. K. May. (2014). Nitrogen Fixation: Methods and Protocols (2nd ed.). Humana Press.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of microbial genome structure, organization, and the principles of gene arrangement, including coding and non-coding regions
CO2	Acquire skills in utilizing bioinformatics tools and techniques for genome sequence analysis, annotation, comparative genomics, and prediction of gene functions.
CO3	Learn about functional genomics approaches, including transcriptomics, proteomics, and metabolomics, to study gene expression, protein functions, and metabolic pathways in microorganisms.
CO4	Explore the role of genomics in understanding microbial evolution, horizontal gene transfer, adaptation, and the development of microbial diversity and virulence.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBDE 481 CO 1	2	3	2	2	3	3	3	3	2
BMBDE 481 CO 2	2	3	3	2	2	3	3	2	2
BMBDE 481 CO 3	2	3	3	2	2	3	3	2	1
BMBDE 481 CO 4		3	3	2	2	3	2	2	2
Average CO (BMBDE 481)	2	3	2.75	2	2.25	3	2.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Microbiology

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBMDE 482	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Human Microbiota (Discipline Specific Electives)		

COURSE OBJECTIVES

1. Understand the fundamentals of human microbiota, including its composition, diversity, and ecological interactions.
2. Explore the dynamic relationship between the human host and its microbial inhabitants and their impact on physiological processes.
3. Investigate the role of the human microbiota in maintaining immune homeostasis and protecting against pathogens.

UNIT I

Introduction to Human Microbiota: Definition and concept of the human microbiome. The evolution and diversity of human-associated microbes. Microbial niches within the human body

UNIT II

Microbiome-Host Interactions: Microbiome-host coevolution and mutualistic relationships. Role of the microbiome in nutrient metabolism and energy extraction. Influence of the microbiome on host immune responses.

UNIT III

Factors Shaping the Human Microbiome: Impact of lifestyle, diet, and environmental factors on the human microbiome. The microbiome-gut-brain axis and its relevance to mental health. Role of the microbiome in gastrointestinal health and disorders. Link between the microbiome and metabolic diseases (e.g., obesity, diabetes). Microbiota dysbiosis and its association with autoimmune disorders

UNIT IV

Cutting-edge Techniques in Microbiome Research: Metagenomics, metatranscriptomics, and other omics approaches. Bioinformatic tools for microbiome data analysis.

UNIT V Therapeutic Applications of the Human Microbiome: Probiotics, prebiotics, and their impact on microbiome composition. Fecal microbiota transplantation and emerging treatment approaches

Suggested reading and Text Books

1. Jeremy P. Burton and Gregor Reid. (2011). The Human Microbiota and Probiotics: Implications

for Health and Disease. CABI
2. Rodney R. Dietert. (2018). The Human Superorganism: How the Microbiome Is Revolutionizing the Pursuit of a Healthy Life. Dutton.
3. Lynne V. McFarland. (2016). Establishing, Evaluating, and Refining an In Vitro Model of the Human Intestinal Microbiota. Springer.

COURSE OUTCOMES (COs): On completion of this course, the students will be:

CO	Description
CO1	Develop a comprehensive understanding of the human microbiota, including its composition, diversity, and the factors influencing its establishment and maintenance
CO2	Learn about the interactions between the human microbiota and the host, including the role of microbiota in immune modulation, metabolism, and overall human health.
CO3	Acquire knowledge about the concept of dysbiosis and its associations with various diseases, such as gastrointestinal disorders, autoimmune diseases, and metabolic syndromes.
CO4	Explore the therapeutic potential of manipulating the human microbiota through probiotics, prebiotics, fecal microbiota transplantation (FMT), and other interventions to improve health outcomes.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBDE 482 CO 1	3	2	1	-	-	3	2	-	1
BMBDE 482 CO 2	2	3	2	-	2	2	3	2	-
BMBDE 482 CO 3	-	-	3	3	2	2	3	2	2
BMBDE 482 CO 4	-	2	3	2	2	-	3	-	2
Average CO (BMBDE 482)	2.5	2.3	2.25	2.5	2	2.3	2.75	2	1.67

3: High, 2: Medium, 1: Low

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B. Sc. (Hons) Microbiology with Research

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTRC 471	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Research Methodology		

COURSE OBJECTIVES: The objectives of this course are

1. To introduce with meaning, functions of research and research process.
2. To highlights the various postulates of research problems, research Design, interpretation and report writing.
3. To expose the student to concepts of measure of central tendency and variation and their application to analyze the statistical data.
4. To acquire the knowledge of correlation, regression, data analysis and hypothesis testing using suitable test of statistical significance.

UNIT I: Meaning &Functions of Research

Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.

UNIT II: Research Problem and Research Design

Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.

UNIT III: Interpretation and Report

Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report

UNIT IV: Statistical Techniques and Tools -I

Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution

UNIT V: Statistical Techniques and Tools –II

Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard

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error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)

Suggested Reading and Text Books

1. Kothari C.R., Research Methodology Methods & Techniques, New Age international Publishers.
2. Gupta G. and Gupta M., Research Methodology, PHI Learning Private Ltd.
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical statistics, , Sultan Chand & Sons, NewDelhi.

COURSE OUTCOMES (COs)

CO1.	Developed understanding on various kind of research, objectives of doing research, researchprocess and research design.
CO2.	Obtain skills to analyze data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
CO3.	Analyzing, Applying, remembering, understanding the detailed and complete study relatedto of Statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
CO4.	Evaluating, analyzing, applying, remembering, and understanding the properties of mechanism of research methodology

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTRC 471 CO 1	1	3	3	-	-	3	2	3	1
BBTRC 471 CO 2	1	2	3	2	-	3	2	2	2
BBTRC 471 CO 3	1	2	3	-	2	3	2	3	1
BBTRC 471 CO 4	1	1	3	2	1	3	2	3	1
Average CO (BBTRC 471)	1	2	3	2	1.5	3	2	2.75	1.25

3: High, 2: Medium, 1: Low

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B. Sc. (Hons) Microbiology with Research

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTRC 472	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Research Publication and Ethics		

COURSE OBJECTIVES: The objectives of this course are to provide knowledge about quality and ethics publication with concept of plagiarism.

UNIT I: Meaning & Functions of Research

Philosophy: Definition, introduction of concept, branches of Philosophy, Introduction of Metaphysics, Epistemology, Ethics/ Moral, Political and Aesthetics Philosophy
Moral philosophy, nature of moral judgments and reactions.

UNIT II: Research Problem and Research Design

Ethics: Definition with respect to science and research, Intellectual honesty and research integrity
Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data

UNIT III: Interpretation and Report Writing

Publication ethics: Definition, introduction and importance, Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: Definition, concept, Introduction about authorship and contributorship, Violation of Publication Ethics, Identification of publication, complaints and appeals

UNIT IV: Statistical Techniques and Tools -I

Introduction about Journals & Publishers, Predatory publishers and journals, Quality of Journals & Publication, Introduction about Scopus/SCI, eSCI/Web of Science Indexing (Scopus.com) etc., Software tool to identify predatory publications developed by SPPU Plagiarism tools , Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.

Suggested Readings and Text Books

1. Dutta, Sumanta, Research and Publication Ethics, Bharti Publications.
2. Yadav S.K., Research and Publication Ethics, Anne Publications.

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COURSE OUTCOMES (COs)

CO1.	Recognize the basics of philosophy of science with research ethics.
CO2.	Familiarize with important issues in research ethics, integrity & scientific misconduct. Alyze the best practices for publications, publication ethics and identify the predatory
CO3.	Analyzing, Applying, remembering, understanding the detailed and complete study related tothe use plagiarism software tools, citation databases and research metrics.
CO4.	Evaluating, analyzing, applying, remembering, and understanding the properties of mechanism of Research Publication and Ethics.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTRC 472 CO 1	1	3	3	2	2	3	2	3	1
BBTRC 472 CO 2	1	2	3	2	3	3	2	2	2
BBTRC 472 CO 3	1	2	3	1	2	3	2	3	2
BBTRC 472 CO 4	1	1	3	2	1	3	2	3	2
Average CO (BBTRC 472)	1	2	3	1.75	2	3	2	2.75	1.75

3: High, 2: Medium, 1: Low

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B. Sc. (Hons) Microbiology with Research

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBRM 471	Credit	10
Year/Semester	Semester VII	L-T-P	
Course Title	Review of literature/ Minor Project		

COURSE OBJECTIVES: The objectives of this course are

1. The intention of this course is to expose the student to new dimensions of research & development.
2. The course enhances different aspects of scientific reading and writing.
3. The course also ensures the student to learn practical based scientific skills.

In the beginning of 4th year (7th semester), students are required to undertake review of literature as a part of their minor project. Its progress will be assessed at the end of 7th semester. Title of the project work may be extended in the 8th semester as a major project. At the end of the 8th semester the dissertation is to be submitted in the department. If a student opts to carry out his/her project (major/minor) from industry or research organization/Institute then he/she may be allowed for the same but the dissertation copy is to be submitted in the department and the internal supervisor will be required from the university

Suggested Readings and Text Books:

1. Dutta, Sumanta, Research and Publication Ethics, Bharti Publications.
2. Yadav S.K., Research and Publication Ethics, Anne Publications.

COURSE OUTCOMES (COs)

CO1.	Enhance his/her presentation skills in a creative manner
CO2.	Analyzing, Applying, remembering, understanding the detailed and complete study related to grade up their problem-solving ability
CO3.	Evaluating, analyzing, applying, remembering, and understanding the properties of mechanism of Review of literature/ Minor Project.
CO4.	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Review of literature/ Minor Project.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTRM 473 CO 1	1	3	-	2	2	3	2	3	1
BBTRM 473 CO 2	1	2	2	2	3	3	2	2	2
BBTRM 473 CO 3	1	2	1	1	2	3	2	3	2
BBTRM 473 CO 4	1	1	-	2	1	3	2	3	2
Average CO (BBTRM 473)	1	2	1.5	1.75	2	3	2	2.75	1.75

3: High, 2: Medium, 1: Low

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B. Sc. (Hons) Microbiology with Research

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBRM 472	Credit	2
Year/Semester	Semester VII	L-T-P	
Course Title	Research Seminar Presentation-I		

COURSE OBJECTIVES: The objectives of this course are

1. To demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
2. To exhibit good communication and presentation skills.
3. To acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.

Each student has to participate in any one of the following mentioned academic activity. A power point presentation will be presented by each student pertaining to the activity in which the student has participated. A hard copy of the presentation will be submitted in the department. Evaluation will be done based upon the presentation and report submitted.

Activities:

(i) Participation in seminar / conference / workshop

Poster presentation/ oral presentation in any other academic event (beside seminar / conference) organized by departmental clubs / College / University / research institute.

Suggested Readings: NA

COURSE OUTCOMES (COs)

CO1.	Demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities
CO2.	Acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc
CO3.	Analyzing, Applying, remembering, understanding the detailed and complete study related to Research Seminar Presentation.
CO4.	Evaluating, analyzing, applying, remembering, and understanding the properties of mechanism of Research Seminar Presentation.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTRS 474 CO 1	1	3	-	2	2	3	2	3	1
BBTRS 474 CO 2	1	2	2	2	3	3	2	2	2
BBTRS 474 CO 3	1	2	1	1	2	3	2	3	2
BBTRS 474 CO 4	1	1	-	2	1	3	2	3	2
Average CO (BBTRS 474)	1	2	1.5	1.75	2	3	2	2.75	1.75

3: High, 2: Medium, 1: Low

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SEMESTER VIII
B. Sc. (Hons) Microbiology with Research

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BBTRC 481	Credit	4
Year/Semester	Semester VIII	L-T-P	
Course Title	Research-IPR		

COURSE OBJECTIVES: The objectives of this course are

1. To explain about Intellectual Property and Copyrights
2. To explain about software patents and their importance.
3. To gain knowledge about trade marks
4. To layout design of integrated circuits and Industrial Designs
5. To Illustrate layout design and Different International Agreements

UNIT I

Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP. Copyrights: Introduction, how to obtain, Differences from Patents.

UNIT II

Trade Marks: Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs. Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

UNIT III

Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India. Industrial Designs: Definition, how to obtain, features, international design registration. Layout design of integrated circuits: Circuit Boards, Integrated Chips, Importance for electronic industry.

UNIT IV

Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. Word Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS), (iii) Madrid Protocol (iv) Berne Convention, (v) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement-Role of Judiciary, Role of law enforcement Agencies-Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and

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technology transfer.

Suggested Readings and Text Books:

1. Acharya, N.K.: Textbook on intellectual property rights, Asia Law House.
2. Guru, M,&Rao, M.B., Understanding Trips: Managing Knowledge in Developing Countries,Sage Publications.
3. Ganguli, P., Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
4. Miller,A, R,Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in aNutshell, West Group Publishers.
5. Watal, J., Intellectual property rights in the WTO and developing countries, Oxford UniversityPress, Oxford

COURSE OUTCOMES (COs):

CO1.	Acquire knowledge about Intellectual property rights, copyrights, trademarks and patents. Appraise about geographical indications, industrial designs, trade secrets and different international agreements including Paris convention, Budapest treaty etc
CO2.	**Analyzing,** Applying, remembering, understanding the detailed and complete study relatedto Research-IPR. Assess introduction and historical perspectives of trade secrets, working of WTO, Madrid protocol, different type of IPs, trademarks, copyrights etc.
CO3.	**Evaluating,** analyzing, applying, remembering, and understanding the properties of mechanism of Research-IPR.
CO4.	**Constructing (Creating),** Evaluating, Analyzing, demonstrating, remembering, and understanding the Research-IPR.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTRC 481 CO 1	1	3	-	2	2	3	2	3	1
BBTRC 481 CO 2	1	2	2	2	3	3	2	2	2
BBTRC 481 CO 3	1	2	1	1	2	3	2	3	2
BBTRC 481 CO 4	1	1	2	2	1	3	2	3	2
Average CO (BBTRC 481)	1	2	1.67	1.75	2	3	2	2.75	1.75

3: High, 2: Medium, 1: Low

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B. Sc. (Hons) Microbiology with Research

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBRD 481	Credit	14
Year/Semester	Semester VIII	L-T-P	
Course Title	Major Project/ Internship		

COURSE OBJECTIVES: The objectives of this course are

1. To make the students industry deployable.
2. To provide an opportunity to students to gain practical knowledge.
3. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/dissertation under the guidance of faculty member/supervisor from industry/research organizations. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

COURSE OUTCOMES (COs):

CO1.	Demonstrate analytical and practical training. Interpretation and organization of data and develop thesis writing skills.
CO2.	Analyzing, Applying, remembering, understanding the detailed and complete study related to Major Project/ Internship.
CO3.	Evaluating, analyzing, applying, remembering, and understanding the properties of mechanism of Major Project/ Internship.
CO4.	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Major Project/ Internship.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTRD 481 CO 1	1	3	-	2	2	3	2	3	1
BBTRD 481 CO 2	-	2	2	2	3	3	2	2	2
BBTRD 481 CO 3	-	2	1	1	2	3	2	3	2
BBTRD 481 CO 4	1	1	2	2	1	3	2	3	2
Average CO (BBTRD 481)	1	2	1.67	1.75	2	3	2	2.75	1.75

3: High, 2: Medium, 1: Low

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B. Sc. (Hons) Microbiology with Research

Program Name	B.Sc. Microbiology	Program Code	15302
Course Code	BMBRD 482	Credit	2
Year/Semester	Semester VIII	L-T-P	
Course Title	Research Seminar Presentation-II		

COURSE OBJECTIVES: The objectives of this course are

1. To demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
2. To exhibit good communication and presentation skills.
3. To acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.

Each student has to participate in any one of the following mentioned academic activity. A power point presentation will be presented by each student pertaining to the activity in which the student has participated. A hard copy of the presentation will be submitted in the department. Evaluation will be done based upon the presentation and report submitted.

Activities:

Participation in seminar / conference / workshop

Poster presentation/ oral presentation in any other academic event (beside seminar / conference) organized by departmental clubs / College / University / research institute.

OR

If student opts internship, it is compulsory to complete 4 weeks internship between 7th and 8th semester in any industry/ research institute/ various agencies/ other organizations and to submit internship report in department will be evaluate in department through presentation and internship report.

Suggested Readings: NA

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COURSE OUTCOMES (COs):

CO1.	Demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities. Exhibit good communication and presentation skills.
CO2.	Analyzing, Applying, remembering, understanding the detailed and complete study related to Major Project/ Research Seminar Presentation
CO3.	Evaluating, analyzing, applying, remembering, and understanding the properties of mechanism of Major Project/ Major Project/ Research Seminar Presentation.
CO4.	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering and understanding the Major Project/ Major Project/ Research Seminar Presentation.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTRD 482 CO 1	1	3	-	2	2	3	2	3	1
BBTRD 482 CO 2	-	2	2	2	3	3	2	2	2
BBTRD 482 CO 3	-	2	1	1	2	3	2	3	2
BBTRD 482 CO 4	1	1	2	2	1	3	2	3	2
Average CO (BBTRD 482)	1	2	1.67	1.75	2	3	2	2.75	1.75

3: High, 2: Medium, 1: Low

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***Question Paper Pattern for* B.Sc. (Hons.) Microbiology**
(Effective from academic year 2023-2024 onwards)
END SEMESTER/ YEAR END EXAMINATIONS (Month/ Year)

Programme..... **Semester/ year.....**
Subject/Course Name: **Subject / Course Code:**

Time allotted: 3 Hours **Max Marks: 100**
NOTE – Read all the instructions carefully.

Q.1. Objectives Type (Very short/ Short Answer, MCQ, One-liners, Fill in the Blank, True/ False) Attempt all. (10×2=20)

a.	
b.	
c.	
d.	
e.	
f.	
g.	
h.	
i.	
j.	

Q.2. Short notes / Short Answer Type (Attempt any five out of Seven) **(5×4=20)**

a.	
b.	
c.	
d.	
e.	
f.	
g.	

Q.3. Structured Question (Attempt any three out of four) **(3×10=30)**

a.	(i), (ii), (iii)
b.	(i), (ii), (iii)
c.	(i), (ii), (iii)
d.	(i), (ii), (iii)

Q.4. Long Answer / Essay type (Attempt any two out of three) **(2×15=30)**

a.	(i), (ii)
b.	(i), (ii)
c.	(i), (ii)

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INSTRUCTIONS FOR THE END TERM PRACTICAL EXAM

Note:

1. End Semester Practical Examination for B.Sc. (Hons) Program will carry Maximum Marks of 100.
2. Question No. 1: Practical I (Major Experiment)- 35 Marks
   The student will perform an experiment and evaluation shall be based on the steps conducted and results obtained.
3. Question No. 2: Practical II (Minor Experiment)- 30 Marks
   It may be experiment performance / spot identification / writing protocol of an experiment / answering logical questions related to practical's conducted.
4. Practical record: 15 marks.
5. Viva-voce: 20 marks.

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ASSESSMENT

B.Sc. (Hons.) Microbiology

Internal Assessment and End Semester Examinations shall have the following weightages for the theory and practical courses.

Sr. No.	Name of the evaluation component	Weightage (%)
1	Internal Assessment	30%
2	End Semester Examination	70%

Grading of the students shall be carried-out course-wise for theory and practical courses separately. Marks obtained by the students in each evaluation component shall be normalized on the scale of 100 (Hundred) Marks. The final composite score in a course shall be calculated by the adding normalized marks in the following proportion in the weightages so that the total percentage of the components taken together in hundred.

Theory Components

Sr. No.	Continuous Internal Assessment	Weightage (%)
1	Sessional Examination I	25%
2	Sessional Examination II	25%
3	Day to Day Assessment	50%

Practical Components

Internal Assessment and End Semester Examinations for a practical course shall be conducted with the following weightages

Sr. No.	Continuous Internal Assessment	Weightage (%)
1	Sessional Examination I	25%
2	Sessional Examination II	25%
3	Day to Day Assessment	50%

Subsequently, the absolute grading method, based on composite score, shall be used on normalized marks obtained by all the registered students in a course and accordingly graded shall be awarded.