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.) BIOTECHNOLOGY

(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) Biotechnology by the Board of Studies
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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 (HSBS)

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

GOALS AND OBJECTIVES:

1. GOAL

B.Sc. (H) Biotechnology program endeavors to instill in students the skills related to basic and applied aspects of biotechnological approaches. The knowledge of biotechnology 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. Attain a deep understanding and practical proficiency in the various domains of biotechnology, while recognizing the interconnectedness with other life science disciplines.
2. Utilize biotechnological approaches in addressing challenges concerning the environment, bio-energy, health, medicine, and industries while incorporating ethical considerations
3. Demonstrate competence and skills that enable pursuing further education, as well as establishing successful careers in industries, laboratories, and related fields, all while upholding strong ethical value.
4. Inculcate life-long learning ability along with competent communication and professional skills.

b) Skills:

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

1. Plan and interpret laboratory investigations for the animals, plants and microbes.
2. Identify the common laboratory procedures to study the molecular aspects of animals, 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.
5. Practical Skills: Develop proficiency in essential laboratory techniques used in biotechnology, including DNA manipulation, protein analysis, genetic engineering, cell culture, and microbiological technique. Problem Solving and Application: Apply

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Swami Rama Himalayan University

biotechnological tools and methods to address real-world challenges in healthcare, agriculture, environmental science, and industrial processes

c) Integration:

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 life science

Attain the qualification and competence necessary to not only pursue advanced studies after obtaining Bachelor degree in biotechnology but also to excel in competitive examinations. Additionally, gain eligibility for a variety of career opportunities across industries, organizations, startups, and other professional domains.

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

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

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

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

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

.....
(Dr. Vikash S. Jadon)
Member

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

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

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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) Biotechnology was held on 12th August, 2023 at 10:00 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) Biotechnology and found it to be a good and relevant and believe that the curriculum will make a student to deal with various biotechnological 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. Vikash S. Jadon)
Member

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

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

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Swami Rama Himalayan University

Swami Rama Himalayan University
Himalayan School of Biosciences (HSBS)
Board of Studies August 2023
Attendance

Date: 12/08/2023

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

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

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

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

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

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

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

Registrar
Swami Rama Himalayan University

SWAMI RAMA HIMALYAN UNIVERSITY, DEHRADUN

Swami Rama Nagar, Jollygrant, Dehradun

HIMALAYAN SCHOOL OF BIOSCIENCES

B.Sc. (Hons.) Biotechnology

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

B. Sc. Biotechnology (three full academic years), B.Sc. (Hons.) Biotechnology (four full academic years) and B.Sc. (Hons.) Biotechnology 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. Biotechnology)

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

120 (For three years B. Sc. Microbiology) + 12 (DSC) + 14 (Research Project) + 14 (Dissertation) =160 (For four years B. Sc. (Hons.) Biotechnology 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 programmes 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) programme of study or a bachelor's degree with research after a 4-year (eight semesters) programme of study if the student completes a rigorous research project in their major area(s) of study.

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❖ Program Educational Outcomes (PEOs)

PEO 1. Attain a deep understanding and practical proficiency in the various domains of biotechnology, while recognizing the interconnectedness with other life science disciplines.

PEO 2. Utilize biotechnological approaches in addressing challenges concerning the environment, bio-energy, health, medicine, and industries while incorporating ethical considerations

PEO 3. Demonstrate competence and skills that enable pursuing further education, as well as establishing successful careers in industries, laboratories, and related fields, all while upholding strong ethical value.

PEO 4. Inculcate life-long learning ability along with competent communication and professional skills.

❖ PSO of B.Sc. (H) Biotechnology

Program Specific Outcome 1 (PSO1):

Develop a strong foundation in both theoretical and practical aspects of biotechnology and related disciplines, gaining expertise in a wide range of bio-analytical techniques encompassing molecular and cell biology, biochemistry, bioinformatics, plant and animal biotechnology, as well as environmental and industrial biotechnology.

Program Specific Outcome 2 (PSO2):

Demonstrate proficiency in conceiving and executing laboratory-based experiments, coupled with the capability to meticulously analyze and interpret data. Simultaneously refine communication, presentation, and writing skills to effectively communicate research findings.

Program Specific Outcome 3 (PSO3):

Apply biotechnology and life sciences knowledge to discern and address intricate challenges spanning diverse sectors such as environmental conservation, biodiversity preservation, healthcare, agriculture, animal and plant sciences, societal well-being, and industrial applications.

Program Specific Outcome 4 (PSO4):

Attain the qualification and competence necessary to not only pursue advanced studies after obtaining Bachelor degree in biotechnology but also to excel in competitive examinations. Additionally, gain eligibility for a variety of career opportunities across industries, organizations, startups, and other professional domains.

❖ 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.

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Swami Rama Himalayan University

PO1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning.
PO2	Comprehensive Knowledge: Acquire a solid understanding of the fundamental principles and concepts in biotechnology, encompassing molecular biology, genetics, biochemistry, and cell biology.
PO3	Practical Skills: Develop proficiency in essential laboratory techniques used in biotechnology, including DNA manipulation, protein analysis, genetic engineering, cell culture, and microbiological technique. Problem Solving and Application: Apply biotechnological tools and methods to address real-world challenges in healthcare, agriculture, environmental science, and industrial processes.
PO4	Ethical and Professional Conduct: Demonstrate ethical awareness and professional behavior in biotechnological research, considering societal, environmental, and legal implications.
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.)
Biotechnology
(With multiple entry & exit option)
UNDERGRADUATE CERTIFICATE IN BIOTECHNOLOGY

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	BBTC 111	Biochemistry and Metabolism	3	0	0	3	25	25	50	100	200
Major Core	BBTC 112	Cell Biology	3	0	0	3	25	25	50	100	200
Minor Core	BMBC 111	General Microbiology	3	0	0	3	25	25	50	100	200
Open Elective **(Multidisciplinary)**	*	To be opted from the list	3	0	0	3	25	25	50	100	200
Skill Enhancement	BBTSE 111	Public Health & Hygiene	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	BBTPC 111	Lab course based on course BBTC 111	0	0	2	1	25	25	50	100	200
Major Core	BBTPC 112	Lab course based on course BBTC 112	0	0	2	1	25	25	50	100	200
Minor Core	BBTPC 113	Lab course based on course BMBC 111	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 BIOTECHNOLOGY

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	BBTC 121	Human Physiology	3	0	0	3	25	25	50	100	200
Major Core	BBTC 122	Plant Physiology	3	0	0	3	25	25	50	100	200
Minor Core	BMBC 121	Microbial Physiology & Metabolism	3	0	0	3	25	25	50	100	200
Open Elective **(Multidisciplinary)**	*		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 Communicatio n	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BBTPC 121	Lab course based on course BBTC 121	0	0	2	1	25	25	50	100	200
Major Core	BBTPC 122	Lab course basedon course BBTC 122	0	0	2	1	25	25	50	100	200
Minor Core	BBTPC 123	Lab course based on course BMBC 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 Biotechnology) 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 Elective- to be offered by another Department

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 BIOTECHNOLOGY

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	BBTC 232	Developmental Biology	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	*		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-I I	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BBTPC 231	Lab course based on course BBTC 231	0	0	2	1	25	25	50	100	200
Major Core	BBPTC 232	Lab course based on course BBTC 232	0	0	2	1	25	25	50	100	200
Minor Core	BBPTC 232	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 Elective- to be offered by another Department

Open Electives:

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

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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	BBTC 241	Genetics	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	BBTPC 241	Lab course based on course BBTC 241	0	0	2	1	25	25	50	100	200
Major Core	BBTPC 242	Lab course based On courseBBTC 242	0	0	2	1	25	25	50	100	200
Minor Core	BBTPC 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 Biotechnology) 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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UNDER GRADUATE DEGREE IN BIOTECHNOLOGY

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	BBTC 351	Bioprocess Technology	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 353	Food Processing &Preservation	3	0	0	3	25	25	50	100	200
Discipline Specific Elective (Any one)	BBTDE 351/ BBTDE 352/ BBTDE 353	Animal Diversity I/ Plant Diversity I/Plant Biotechnology	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	BBTC 351	Project/ Educational Tour Report I	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BBTPC 351	Lab course based on course BBTC 351	0	0	2	1	25	25	50	100	200
Major Core	BBTPC 352	Lab course based on course BBTC 352	0	0	2	1	25	25	50	100	200
Minor Core	BBTPC 353	Lab course based on course BBTC 353	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 BIOTECHNOLOGY

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	BBTC 361	Bio Analytical Tools	3	0	0	3	25	25	50	100	200
MajorCore	BBTC 362	Genomics & Proteomics	3	0	0	3	25	25	50	100	200
Minor Core	BMBC 361	Environment Microbiology	3	0	0	3	25	25	50	100	200
Discipline Specific Elective (Any one	BBTDE 361/ BBTDE 362/ BBTDE 363	Plant diversity-II/Animal Diversity-II/ Animal Biotechnology	3	0	0	3	25	25	50	100	200
Value Addition course	BTVAC 361	Medical Biotechnology	3	0	0	3	25	25	50	100	200
Project 2	BTPR 361	Project/EducationalTour Report II	2	0	0	2	25	25	50	100	200
Practical											
Major Core	BBTPC 361	Lab course based oncourse BBTC 361	0	0	2	1	25	25	50	100	200
Major Core	BBTPC 362	Lab course based oncourse BBTC 362	0	0	2	1	25	25	50	100	200
Minor Core	BBTPC 363	Lab course based on course BBTC 363	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 Biotechnology)" 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).

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Swami Rama Himalayan University

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

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	BBTC 471	Biostatistics, and Computers	3	0	0	3	25	25	50	100	200
Major Core	BBTC 472	Biomedical Technology	4	0	0	4	25	25	50	100	200
Minor Core	BMBC 471	Microbial Genetics	3	0	0	3	25	25	50	100	200
Discipline Specific Elective (Any one)	BBTDE 471/ BBTDE 472/	Advance Molecular Biology & Genetics/ **MOOC**	3	0	0	3	25	25	50	100	200
Value Addition course	BTVAC 471	Food and Fermentation Techniques	3	0	0	3	25	25	50	100	200
Project/Seminar	BTPR 471		-	-	-	2					
Practical											
Major Core	BBTPC 471	Lab Course based on courseBBTC 471	0	0	2	1	25	25	50	100	200
Minor Core	BBTPC 472	Lab Course based on courseBMBC 471	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 COURSE IN HONOURS BIOTECHNOLOGY
(B.SC. HONS. BIOTECHNOLOGY)

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	BBTC 481	Protein Engineering	4	0	0	4	25	25	50	100	200
Major Core	BBTC 482	Advances in Genetic Engineering	3	0	0	3	25	25	50	100	200
Minor Core	BBTC 483	Molecular Diagnostics	4	0	0	4	25	25	50	100	200
Discipline Specific Elective (Any one)	BBTDE 481/ BBTDE 482/	Pharmaceutical Biotechnology & Drug Designing/ Advance Biochemistry/ Online	3	0	0	3	25	25	50	100	200
Open Elective	BBTOE 481/ BBTOE 482	Epigenetics and Cancer Biology/Enzymology/ MOOC	3	0	0	3	25	25	50	100	200
Value Addition course	BTVAC 481	Industrial Waste Management	3	0	0	3	25	25	50	100	200
Practical											
Major Core	BBPC 481	Lab Course based on course BBTC 482	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 BIOTECHNOLOGY 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	BBTRM 473	Review of literature/ Minor Project	0	0	0	10	25	25	50	100	200
Research 2	BBTRS 474	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	BBTRD 481	Major Project/ Internship	0	0	0	14	25	25	50	100	200
Research 3	BBTRD 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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Under Graduate Certificate Course in Biotechnology

B. Sc. Biotechnology
SEMESTER I

Program Name	B.Sc. Biotechnology	Program Code	15301
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.

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Suggested Reading and Text Books

1. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
2. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WHFreeman and Company, New York, USA
3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 111	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
BBTPC 111 CO 1	1	1	3	-	1	2	1	2	1
BBTPC 111 CO 2	-	1	3	1	-	-	2	2	-
BBTPC 111 CO 3	-	1	3	-	-	1	-	1	-
BBTPC 111 CO 4	-	-	1	1	-	-	-	-	3
Average CO (BBTPC 111)	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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 112	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Cell Biology (Major 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, ultrastructure 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.
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 112	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

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 112 CO 1	1	1	2	1	-	3	2	1	1
BBTPC 112 CO 2	-	2	3	1	-	-	2	1	-
BBTPC 112 CO 3	-	-	2	2	-	2	3	1	-
BBTPC 112 CO 4	-	-	2	1	1	-	-	2	2
Average CO (BBTPC 112)	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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BMBC 111	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	General Microbiology (Minor 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,

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Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

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. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein'sMicrobiology. 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 113	Credit	1
Year/Semester	Semester III	L-T-P	0-0-2
Course Title	Lab Course based on BMBC 111(Minor 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
BBTPC 113 CO 1	1	3	2	-	-	3	2	-	-
BBTPC 113 CO 2	-	-	3	1	-	2	2	2	1
BBTPC 113 CO 3	-	-	3	2	1	2	-	2	1
BBTPC 113 CO 4	-	2	-	2	-	2	2	-	-
Average CO (BBTPC 113)	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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTSE 111	Credit	3
Year/Semester	Semester I	L-T-P	3-0-0
Course Title	Public Health and Hygiene (Skill Enhancement)		

COURSE OBJECTIVES: The Public Health and Hygiene course aims to provide students with a comprehensive understanding of key concepts and practices in public health. Through an exploration of epidemiology, disease prevention, health promotion, hygiene, and sanitation, students will gain valuable insights into the prevention and management of communicable and non-communicable diseases at both individual and community levels. The course emphasizes the importance of global health considerations, public health policy development, ethical decision-making, emergency preparedness, and environmental health awareness.

UNIT I

Introduction to Public Health and Hygiene: Introduction to Public Health and Hygiene, Relationship between health and hygiene. Physical fitness of human body and WHO definition of health. Washing habits and hygiene. Factors affecting public health. Community health and medicine.

UNIT II

Personal heath and balanced diet: Personal health and balanced diet, Food safety quality control and hygiene, Personal and Domestic hygiene, clean food and water, Ill effects of addictive substances. Yoga the way of living and regular exercise.

UNIT III

Public health and balanced diet: Public Health and nutrition. Classification and Nutritional profiles of various foods and drinks. Balanced diet, nutritional problems, Demography and family planning.

UNIT IV

An overview of metabolic conditions: Epidemiology and history of epidemiological diseases. In India. Route of transmission of disease. Communicable and non-communicable diseases. Common community diseases like. Chikungunya, Dengue, Malaria, Cholera, Tuberculosis,

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HIV/AIDS, Hepatitis: their prevention and control.

Suggested Reading and Text Books:

1. K.D. Chanergy, (2015), Parasitology, CBS Publishers.
2. Andrew Proctor (2011), Alternatives to conventional food processing, RSC Pub.
3. Willey J. Sherwood L.&WoolvertonC (2014) ,Prescott's Microbiology, 9th edition McGrawHill.

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

CO	Description
CO1	Demonstrate a comprehensive understanding of key principles and concepts in public health, including disease prevention, health promotion, and the role of community-based approaches in enhancing population health.
CO2	Apply epidemiological methods and data analysis techniques to assess public health issues, identify risk factors, and design evidence-based strategies for disease prevention and control.
CO3	Implement effective hygiene and sanitation practices, emphasizing the significance of personal and environmental cleanliness in preventing the spread of infectious diseases and promoting public health.
CO4	Evaluate the impact of global health challenges, disparities, and health policies, and advocate for equitable access to quality healthcare services, emphasizing the importance of health education and community engagement in promoting well-being.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTSE 111 CO 1	1	-	-	2	-	3	-	2	2
BBTSE 111 CO 2	2	2	3	-	2	3	2	2	2
BBTSE 111 CO 3	2	2	-	3	2	2	3	2	-
BBTSE 111 CO 4	-	-	2	2	2	-	2	3	2
Average CO (BBTSE 111)	1.75	2	2.5	2.3	2	2.67	2.3	2.25	2

3: High, 2: Medium, 1: Low

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B.Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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

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vehicles in Delhi).

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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, RNAand 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.

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.

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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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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

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concept and theories – Maslow, Herzberg, McClelland, Vrooms' Expectancy.

Transaction Methodology – PPTs, Quiz, Case Study, and Critical Thinking exercises.

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 121	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Human Physiology (Major 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. Johnwiley & 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 121	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
BBTPC 121 CO 1	-	1	3	2	1	3	-	2	-
BBTPC 121 CO 2	1	2	3	-	1	3	1	3	-
BBTPC 121 CO 3	-	2	2	-	2	1	-	2	1
BBTPC 121 CO 4	1	-	2	2	-	-	3	2	1
Average CO (BBTPC 121)	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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 122	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Plant Physiology (Major Core)		

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

1. To provide detailed information about the basic principles of plant function
2. To teach the plant-water relationships
3. To teach principles of plant cell physiology and plant growth and development
4. To teach carbon and nitrogen metabolism
5. To provide information about plant secondary metabolites and their role in plant stress physiology

UNIT I: Anatomy

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT II: Plant water relations and micro & macro nutrients

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT III: Carbon and nitrogen metabolism

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV: Growth and development

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

Suggested Reading and Text Books

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.

3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4 edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4 edition, Sinauer Associates Inc .MA, USA

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

CO	Description
CO1	Impart an insight into the various plant water relations and mineral nutrition in plants.
CO2	Acquire fundamental and scientific knowledge related to plant physiology and its significance in agriculture research.
CO3	Understand the mechanism of various metabolic processes in plants and access role of seed germination and dormancy.
CO4	Equip students with skills and techniques related to plant physiology so that they can design their own experiments, gain knowledge and make good career in this field.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 122 CO 1	2	1	-	-	2	2	2	-	1
BBTC 122 CO 2	1	1	2	1	-	2	2	1	1
BBTC 122 CO 3	-	2	-	1	-	3	2	-	2
BBTC 122 CO 4	-	1	3	-	1	-	2	2	2
Average CO (BBTC 122)	1.5	1.25	2.5	1	1.5	2.3	2	1.5	1.5

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 122	Credit	1
Year/Semester	Semester II	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 122 (Major Core)		

PRACTICALS

1. Demonstration of plasmolysis in *Tradescantia* leaves.
2. Determination of water potential of plant tissue.
3. Study stomatal distribution on leaf surfaces and calculation of stomatal index.
4. Study of ascent of sap in plants.
5. Study aerobic respiration in germinating seeds.
6. Separation of photosynthetic pigments by paper chromatography.
7. Chlorophyll and carotenoid quantification via spectrophotometric analysis.
8. Demonstration of photosynthesis in aquatic plant.
9. Determine the presence of starch and sucrose in plants.
10. Determination of transpiration from foliar surface.

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

CO	Description
CO1	Acquire skills about techniques related to plant physiology to prepare for higher studies and employment.
CO2	Depict ability to identify and estimate various photosynthetic pigments found in leaf and its application in botanical studies.
CO3	Identify ad appraise concept and mechanism of photosynthesis in plants.
CO4	Comprehend different process of scarification, role of different plant hormone in growth and development of the plants and application of same in agriculture.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 122 CO 1	-	3	3	2	2	3	-	2	3
BBTPC 122 CO 2	2	2	3	-	2	3	2	-	-
BBTPC 122 CO 3	-	2	2	1	2	2	-	2	-
BBTPC 122 CO 4	1	2	2	-	-	2	-	2	2
Average CO (BBTPC 122)	1.5	2.25	2.5	1.5	2	2.5	2	2	2.5

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BMBC 121	Credit	3
Year/Semester	Semester II	L-T-P	3-0-0
Course Title	Microbial Physiology and Metabolism (Minor 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.SherwoodL.M.andWoolverton,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.

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	2	-	-	1	1	1	-	1
BMBC 121 CO 2	1	2	3	1	-	1	2	2	1
BMBC 121 CO 3	-	-	3	2	1	2	1	2	-
BMBC 121 CO 4	-	-	2	2	1	-	2	2	1
Average CO (BMBC 121)	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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 123	Credit	1
Year/Semester	Semester II	L-T-P	0-0-2
Course Title	Lab course based on BMBC 121 (Minor Core)		

COURSE OBJECTIVES: The objectives of this lab course are

1. To get awareness about how to check the effect to temperature and pH on the growth of bacteria and how to plot the growth curve.
2. To understand and how to calculate generation time and specific growth rate of Bacteria.

PRACTICALS

1. Study and plot the growth curve of E. coli by turbidimetric 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.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 123 CO 1	2	2	3	2	1	3	1	2	1
BBTPC 123 CO 2	1	2	3	1	2	3	2	2	1
BBTPC 123 CO 3	-	-	3	2	1	2	1	2	2
BBTPC 123 CO 4	-	2	2	2	1	-	2	2	1
Average CO (BBTPC 123)	1.5	2	2.75	1.75	1.25	2.67	1.5	2	1.25

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.

*The nuances of grammar [Parts of Speech, Forms of Verb, Subject Verb Agreement,

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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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.
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.

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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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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 followingobjectives:

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 BIOTECHNOLOGY

B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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:

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 232	Credit	3
Year/Semester	Semester III	L-T-P	3-0-0
Course Title	Developmental Biology (Major Core)		

COURSE OBJECTIVES: The course aims to teach the principles and molecular biology of eukaryotic development, from zygote to embryo development and differentiation. The specific objectives of the course are:

1. To understand the history and basic concepts of embryology
2. To become familiar with the process of fertilization, spermatogenesis and oogenesis
3. To understand the process of organogenesis.
4. To understand the molecular basis of development.

UNIT I: Gametogenesis and Fertilization

Definition, scope & historical perspective of development Biology, Gametogenesis– Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early Embryonic Development

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

Suggested Reading and Text Books

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

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

CO	Description
CO1	Comprehensive understanding of the animal embryonic development and concepts of developmental biology, genetic models to provide insight into cellular and molecular mechanisms of development.
CO2	Perceptive of the animal development biology, evolutionary mechanisms and relevant diseases and genetic disorder concepts.
CO3	Study the epigenetic and environmental impact on growth and development, and the application of these technologies in different R&D sectors and industries.
CO4	Rationalization of the genetic studies, gene expression and cell-to-cell interactions of animal models in embryonic development.

Mapping of COs with POs & PSOs

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

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 232	Credit	1
Year/Semester	Semester III	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 232		

PRACTICALS

1. Identification of developmental stages of chick/ frog embryo using permanent mounts
2. Study of permanent mount of section of Insect Gonads.
3. Study of permanent mount of section of Ovary & Testis
4. Study of Oogenesis in Chick/Frog
5. Study of Spermatogenesis in Chick/Frog
6. Study of the developmental stages of Drosophila from permanent mounts.
7. Study of permanent mount of Human Karyotype
8. Study of permanent mount of different types of placenta
9. Enlist the genes involved in Embyogenesis.
10. To Study the developmental stages of chick embryo.

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

CO	Description
CO1	Knowledge of cell growth, division, differentiation and embryonic development and significance of same in biological research.
CO2	Practical understanding of cell division, formation of gamete and embryonic development.
CO3	Perfection in handling and preparation of biological samples such as cells culture, developing embryos.
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
BBTPC 232 CO 1	2	2	3	-	-	2	-	2	-
BBTPC 232 CO 2	-	-	3	2	-	-	1	2	-
BBTPC 232 CO 3	-	-	3	2	-	-	-	2	2
BBTPC 232 CO 4	-	-	3	-	1	-	-	2	2
Average CO (BBTPC 232)	2	2	3	2	1	2	1	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.

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Oxidation Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate Introduction and reactions of Alcohols, Aldehydes, Ketones and Nitro compounds

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.

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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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	AECC 231	Credit	2
Year/Semester	Semester III	L-T-P	2-0-0
Course Title	Environmental Sciences II		

COURSE OBJECTIVES:

1. To define and explain various techniques of word formation and develop skill so 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 error ecommitted by users of English and solve exercises to develop their understanding of grammatically correct sentence.
4. To organize language and work develop oral communication skills

UNIT I: Pollution

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

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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 internationalpublishers.

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 241	Credit	3
Year/Semester	Semester IV	L-T-P	3-0-0
Course Title	Genetics (Major Core)		

COURSE OBJECTIVES: Molecular biology has witnessed a paradigm shift after the discovery of double helical structure of DNA. This course on molecular biology aims to teach the fundamental role of DNA molecule as a blueprint of life. The specific objectives of the course are as follows:

1. To familiarize students with the structure and function of biological system at the molecularlevel.
2. To impart knowledge about the key components participating in the replication of geneticmaterial.
3. To teach the processes and pathways which replicate, transcribe and translate DNA.
4. To make students understand the different methods of DNA damage, repair and recombination.
5. To teach the fundamental principles of gene expression regulation.

UNIT I

Mendelian laws of inheritance, Lethality and interaction of Genes. Multiple Alleles and isoalleles.

Linkage and crossing- over: Mapping of gene-interference, coincidence in pro- and eukaryotes

UNIT II

Sex determination in plants and animals: Sex-linkage; non-disjunction as a proof of chromosomal theory of inheritance. Basic microbial genetics: Conjugation, transformation, transduction and their use in genetic mapping.

UNIT III

Concept of Gene: Classical and modern gene concepts; pseudo- allelism, position effect, intergenic crossing over and complementation (Cistron, recon and muton).

Mutation- spontaneous and induced; chemical and physical mutagens; induced mutation in plants, animals and microbes for economic benefit of man.

UNIT IV

Structural and numerical aberrations involving chromosomes; Evolution of wheat, cotton and rice; heredity defects- Kleinefelter, Turner, Cri-du-chat and Down syndromes.

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UNIT V

Extrachromosomal inheritance: Cytoplasmic inheritance; Mitochondrial and Chloroplast genetic systems. Population Genetics: Hardy-Weinberg equilibrium, gene and genotypic frequencies

Suggested Readings and Text Books:

1. Lewin B (1998) Genes VII Oxford, Inded.
2. Snustad et al (1997), Principles of Genetics, John Wiley & Sons.
3. De Robertis & Robertis (1987), Cell & Molecular Biology, Lee & Fabiger Philadelphia.
4. Strickberger (1996), Genetics, Prentice Hall.

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

CO	Description
CO1	Comprehensive understanding of the heredity, heritable traits and genetic methodology or laws.
CO2	Provides insight into cellular and molecular mechanisms of the inheritance of traits.
CO3	Proficiency to design, implement and analyze the results at statistically of animal and plant model systems
CO4	Perceptive of the genetic concepts on societal, environmental issues and genetic technologies in different R&D sectors and industries.

Mapping of COs with POs & PSOs

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

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 241	Credit	1
Year/Semester	Semester IV	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 241 (Major Core)		

PRACTICALS

1. To Demonstrate Mendel's work on Garden pea.
2. To demonstrate the law of segregation.
3. To demonstrate the law of independent assortment.
4. Demonstration of blood group by RBO system.
5. To determine the Rh-factor of blood

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

CO	Description
CO1	Practical Knowledge of cell division and formation of gametic cells, mendelian cross, genetic material and transfer of genes
CO2	Practical knowledge of the methods for measurement and their quantitative as well as qualitative estimation and their application in research.
CO3	Expertise in instrument and sample handling for the preparation and analysis of samples.
CO4	Proficiency in data analysis and perception of biological samples such as cells, genome to study the heredity.

Mapping of COs with POs & PSOs

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

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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. 6 th 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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, RIA) 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
BBTPC 242 CO 1	1	3	3	2	3	3	3	3	2
BBTPC 242 CO 2	2	3	3	1	2	3	2	2	2
BBTPC 242 CO 3	2	3	3	1	2	3	2	2	2
BBTPC 242 CO 4		3	3	2	2	3	2	2	2
Average CO (BBTPC 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBPME 241	Credit	1
Year/Semester	Semester IV	L-T-P	0-0-1
Course Title	Lab Course based on BBTME 241a		

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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 "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.

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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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.
2. Nafsaneh; Robert B. Denhardt; Janet V. Den Robbins, S.P. and Judge, T.A. (2018) Essentials of Organizational Behavpior. 14th Edition, Pearson

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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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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
BACHELOR DEGREE IN BIOTECHNOLOGY

B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 351	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Bioprocess Technology (Major 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 351	Credit	1
Year/Semester	Semester V	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 351 (Major 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.

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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 352	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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BMBC 352	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Food processing and Preservation (Minor Core)		

COURSE OBJECTIVES: The objectives of this course are

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.

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	Define food Microorganism., food hygienic and sanitization.
CO2	Generalize the concept of food born illness, food beverage and disease.
CO3	Illustrate diagrammatically different types of food spoilage.
CO4	Explain and Differentiate between the types of contamination of food products and its prevention.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 352 CO 1	2	2	3	1	-	2	2	-	-
BMBC 352 CO 2	-	2	3	-	-	2	2	-	-
BMBC 352 CO 3	-	-	3	2	2	1	-	2	3
BMBC 352 CO 4	-	-	3	2	2	1		3	3
Average CO (BMBC 352)	2	2	3	1.66	2	1.5	2	2.5	3

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 352	Credit	1
Year/Semester	Semester V	L-T-P	0-0-2
Course Title	Lab Course Based on BMBC 352 (Minor 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 hands-on proficiency in various food processing techniques, including cleaning, sorting, cutting, blanching, and cooking, enhancing your ability to handle and prepare raw food materials.
CO2	Acquire practical experience in applying different food preservation methods such as canning, drying, refrigeration, and freezing. Understand the principles behind each method and their impact on food safety and shelf life.
CO3	Learn how to assess food quality using sensory analysis and instrumental methods, including texture analysis, color measurement, and taste evaluation, ensuring that processed and preserved foods meet desired standards.
CO4	Gain a strong foundation in food safety and hygiene protocols during processing and preservation. Understand the importance of maintaining clean working environments, proper sanitation, and safe handling practices to prevent contamination.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BMBC 352 CO 1	2	2	3	1	-	2	2	-	-
BMBC 352 CO 2	-	2	3	-	-	2	2	-	-
BMBC 352 CO 3	-	-	3	2	2	1	-	2	3
BMBC 352 CO 4	-	-	3	2	2	1		3	3
Average CO (BMBC 352)	2	2	3	1.66	2	1.5	2	2.5	3

3: High, 2: Medium, 1: Low

Registrar
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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 351	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Animal Diversity- I (Open Elective)		

COURSE OBJECTIVES: This course presents an overview of invertebrates, ranging from protozoa to hemichordata. The specific objectives of the course are as follows:

1. To make the student understand the classification invertebrates of animal kingdom.
2. To make the student understand the characteristics of invertebrates.
3. To make the student learn the diversity of protozoa to hemichordata.
4. To impart the knowledge about parasitic adaptation of roundworms.

UNIT I

Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata,Symmetries, Deutrostomes, Protostomes.

Protozoa: Locomotion, Reproduction, evolution of Sex, General features of Paramoecium and Plasmodium. Pathogenic protozoans

Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II

Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.

Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.

Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT III

Annelida: - General features, Outline of classification, Coelom: Metameric segmentation,General features of Earthworm, Vermicomposting.

Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT IV

Mollusca : general features, Outline of classification, Shell Diversity; Torsion ingastropoda.

Echinodermata: General features, Outline of Classification Larval forms

Hemichordata: Phylogeny: Affinities of Balanoglossus

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Suggested Reading and Text Books

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) TheInvertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.

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

CO	Description
CO1	Develop a comprehensive understanding of the classification and diversity of animal species, including their evolutionary relationships and characteristics.
CO2	Acquire skills in observing and identifying animal morphological features and behaviors to distinguish between different animal groups.
CO3	Analyze the ecological roles of different animal species and their adaptations to various habitats and environmental conditions.
CO4	Recognize the importance of animal diversity in ecosystem functioning and understand the significance of conservation efforts to preserve endangered animal species and maintain biodiversity.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTDE 351 CO 1	2	3	2	2	2	3	3	3	2
BBTDE 351 CO 2		2	3		2	3		2	2
BBTDE 351 CO 3		2	3		1	3			1
BBTDE 351 CO 4	2	3	3	2	2	3	2	2	2
Average CO (BBTDE 351)	2	2.5	2.75	2	1.75	3	2.5	2.3	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 352	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Plant Diversity-I (Open Elective)		

COURSE OBJECTIVES: This course presents an overview of lower plants, ranging from algae to pteridophytes. The specific objectives of the course are as follows:

1. To make students understand the organization of plant kingdom.
2. To teach the characteristics of lower plant genera.
3. To make students learn the economic importance of lower plants.
4. To impart the knowledge about diseases caused by plant pathogens.

UNIT I: Algae

General character, classification and economic importance. Life histories of algae belonging to various classes:

Chlorophyceae – Volvox, Oedogonium Xantho phyceae –Vaucheria Phaeophyceae – Ectocarpus Rhodophyceae-Polysiphonia

UNIT II: Fungi

General characters, classification & economic importance. Life histories of Fungi: Mastigomycontina- Phytophthora

Zygomycotina-Mucor Ascomycotina- Saccharomyces Basidomycotina-Agaricus Deutromycotina-Colletotrichum

UNIT III: Lichens

Classification, general structure, reproduction and economic importance. Plant diseases: 4 of 36 Casual organism, symptoms and control of following plant diseases.

Rust & Smut of Wheat. White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

UNIT IV: Bryophytes

General characters, classification & economic impotence. Life histories of following:

Marchantia, Funaria.

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Suggested Reading and Text Books

1. Agrios, G.N. 1997 Plant Pathology, 4 th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4 Th edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2 nd Ed.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

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

CO	Description
CO1	Develop a comprehensive understanding of the classification and diversity of plant species, including their evolutionary relationships and distinguishing characteristics.
CO2	Acquire proficiency in identifying and differentiating various plant species through hands-on observation and examination of morphological features.
CO3	Recognize the importance of plant diversity in ecosystem functioning and understand the significance of conservation efforts to preserve endangered plant species and maintain biodiversity.
CO4	Analyze the ecological roles of different plant species in various ecosystems and understand their distribution patterns in different geographical regions.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTDE 352 CO 1	2	3	2	2	3	3	3	3	2
BBTDE 352 CO 2	1	3	3	2	1	3	1	2	2
BBTDE 352 CO 3	-	3	-	-	1	3	1	2	1
BBTDE 352 CO 4	2	3	2	-	1	3	2	2	2
Average CO (BBTDE 352)	1.67	3	2.3	2	1.5	3	1.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 353	Credit	3
Year/Semester	Semester V	L-T-P	3-0-0
Course Title	Plant Biotechnology (Open Elective)		

COURSE OBJECTIVES: This course presents an overview of the techniques and underlying theory of plant tissue culture, and plant genetic engineering, and their applications. The specific objectives of the course are as follows:

1. To enable students acquire knowledge of the fundamental principles of plant tissue culture.
2. To learn about different kinds of plant culture techniques.
3. To make students understand the principles of Agrobacterium tumefaciens biology and Ti-plasmid.
4. To impart knowledge about the diverse applications of plant biotechnology and genetically-modified crops.

UNIT I

Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT II

In vitro haploid production: Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination

techniques for production of haploids in cereals.

UNIT III

Protoplast Isolation and fusion: Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclature, methods, applications basis and disadvantages.

UNIT IV

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

Suggested Reading and Text Books

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)

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

CO	Description
CO1	Understand the concept and principle of micropropagation technique and identify designing of culture medium types of culture and application in agriculture and biological research with emphasis on conservation studies.
CO2	Identify the potential of micropropagation to produce haploids and significance of involved techniques such as chromosome elimination with utility of such plants in agriculture.
CO3	Demonstrate understanding of principle involved and technique adopted for protoplast isolation and fusion and applicability to produce hybrid plants.
CO4	Exhibit knowledge about plant growth promoting bacteria free living bacteria their impact on plants and environment and interpret applicability of hydroponics in tissue culture studies.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTDE 353 CO 1	2	3	2	2	3	3	3	3	2
BBTDE 353 CO 2	1	3	3	2	2	3	2	2	2
BBTDE 353 CO 3	1	3	2	2	2	3	2	2	1
BBTDE 353 CO 4		3	3	2	2	3	2	2	2
Average CO (BBTDE 353)	1.3	3	2.5	2	2.25	3	2.25	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BTPR 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Bio Analytical Techniques (Major 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 Readings 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. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 361	Credit	1
Year/Semester	Semester VI	L-T-P	0-0-2
Course Title	Lab Course Based on BBTC 361 (Major 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
BBTPC 361 CO 1	2	3	3	2	-	3	2	2	2
BBTPC 361 CO 2	-	2	3	2	2	2	3	2	2
BBTPC 361 CO 3	2	2	3	3	2	2	3	3	2
BBTPC 361 CO 4	-	2	3	3	2	2	2	2	2
Average CO (BBTPC 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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Swami Rama Himalayan University

B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 362	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Genomics & Proteomics (Major Core)		

COURSE OBJECTIVES: The broad objective of the course is to make students aware about the importance of the modern methods of genome and proteome analysis and the significance of these on the changing paradigm in genetics, medicine and agriculture. The specific objectives of the course are as follows:

1. To introduce the basic concepts of genomics and next generation sequencing.
2. To acquaint students with various genome databases and their applications.
3. To make students aware about the applications of genomics in various industries.
4. To makes students understand the techniques of proteome analysis diverse applications and benefits of genome and proteome analysis.

UNIT I

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

Suggested Reading and Text Books

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
8. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
9. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
10. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

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

CO	Description
CO1	Punitive knowledge of the biological systems information and the explanation of the key concepts Omics technologies-genomics, transcriptomics and proteomics.
CO2	Comprehend the range of molecular biology techniques for DNA or genome profiling, sequencing, assembly, annotation, summaries and interpretation of the outcome.
CO3	Knowledge of bioinformatics tools for the genomic data storage and analysis of the outgoing research in the area of genomic and proteomic studies.
CO4	Erudition skills on software for data analysis relevant to forensic, conservation, quantitative and evolutionary genetics.

Mapping of COs with POs & PSOs

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

3: High, 2: Medium, 1: Low

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Swami Rama Himalayan University

B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 362	Credit	1
Year/Semester	Semester VI	L-T-P	0-0-2
Course Title	Lab Course Based on BBTC 362 (Major Core)		

PRACTICALS

1. Identification of unknown sequence by BLAST and its functional annotation.
2. SNP analysis using SNP database of NCBI.
3. Comparison of genomes of two organisms using SynMap of CoGe.
4. Demonstration of microarray applications and analysis of microarray data.
5. Computation of pI and molecular weight of a protein using ExPASy ProtParam tool.
6. Demonstration of 2D PAGE and data analysis.
7. Generation of protein interaction networks using STRING software.
8. Subcellular protein localization study using CELLO tool.
9. Protein motif identification using MEME software.
10. Conserved domain analysis using NCBI batch-CD research.

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

CO	Description
CO1	Practical knowledge of molecular techniques for genome collection and data analysis.
CO2	Expertise in instrument handling and bio-informatics software for the analysis of biological samples.
CO3	Expand proficiency in data analysis and perception of samples to solve problems (multidisciplinary) contexts related to the field of study.
CO4	Design of experiments and manage bibliography and IT resources related to biochemistry, molecular biology or biomedicine about the scientific or business context.

Mapping of COs with POs & PSOs

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

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 363	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Environmental Biotechnology (Minor Core)		

COURSE OBJECTIVES: The course is aimed to introduce basics of environmental biotechnology and focuses on the utilization of different biotechnological methods to protect environment. The course is designed to meet the following specific objectives:

1. To impart the basic knowledge about environmental biotechnology.
2. To make students understand the concepts and applications of biofuels and bioremediation.
3. To make the student understand the process of formation of biofertilizers and leran its applications.
4. To give students an overview of various applications of biotechnology in pollution control and biotransformation of pollutants.

UNIT I

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

UNIT II

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms. Treatment of municipal waste and Industrial effluents.

UNIT III

Bio-fertilizers. Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers VAM)

UNIT IV

Bioleaching. Environmental significance of genetically modified microbes, plants and animals

Suggested Reading and Text Books

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

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

CO	Description
CO1	Prior acquaintance and introduction of environmental science and apply these concepts within a coherent engineering-based framework to the broad areas of environmental biotechnology.
CO2	Edification of the environmental guidelines, agencies and acts, and awareness about the environmental impact assessment by natural causes, GMO's, man-made activities.
CO3	Proficiency to design, implement and analyze data and the technology to overcome them- energy production and reduction of pollution.
CO4	Implication of scientific principles to design new models concerning modern biotechnology trends, benefit-cost analysis, better management of biotechnologies and environmental control of the biotechnology industry.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBPME 362b CO 1	2	3	1	-	-	3	2	-	-
BBPME 362b CO 2	-	2	-	2	2	2	2	3	-
BBPME 362b CO 3	-	2	3	-	-	-	-	2	3
BBPME 362b CO 4	-	1	2	2	3	-	3	3	2
Average CO (BBPME 362b)	2	2	2	2	2.5	2.5	2.3	2.67	2.5

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 363	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
BBPME 362b CO 1	1	2	3	-	-	3	3	-	-
BBPME 362b CO 2	-	2	3	-	-	3	-	2	-
BBPME 362b CO 3	-	-	3	2	2	-	-	2	2
BBPME 362b CO 4	-	-	3	-	2	-	-	2	2
Average CO (BBPME 362b)	1	2	3	2	2	3	3	2	2

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Plant Diversity- II (Discipline Specific Elective)		

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

1. To make students understand the general features and classification of pteridophytes.
2. To impart knowledge about the features of gymnosperms and process of fossil formation.
3. To make students learn about general characters of angiosperms.
4. To remember the origin, evolution of flowering plants and their economic importance.

UNIT I: Pteridophytes

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – Rhynia.

UNIT II: Pteridophytes: Type studies

Life histories of Selaginella- (Heterospory and seed habit), Equisetum, Pteris, Lycopodium.

UNIT III: Gymnosperms

General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- Williamsonia & Glossopteris, telome and stele concept.

UNIT IV: Gymnosperms: Type studies

Life histories of Cycas & Pinus, economic importance of gymnosperms.

Suggested Reading and Text Books

1. Bhatnager, S.P. and Moitra, A. 1996 Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi.
2. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
3. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany.

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IK International Publishers.

4. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

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

CO	Description
CO1	Develop the ability to identify and classify diverse plant species using taxonomic keys and morphological features, understanding their evolutionary relationships.
CO2	Analyze the ecological roles of different plant species in various ecosystems, exploring their interactions with other organisms and their contributions to ecosystem stability.
CO3	Recognize the importance of plant diversity in maintaining ecosystem health and biodiversity, and explore conservation strategies to protect endangered plant species and their habitats.
CO4	Understand the diverse adaptations of plants to different environmental conditions, including physiological, morphological, and reproductive strategies that contribute to their survival and success in specific habitats.

Mapping of COs with POs & PSOs

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

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 362	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Animal Diversity-II (Discipline Specific Elective)		

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

1. To make the student understand the classification and characteristics of Proto- chordates and the Origin of Chordates
2. To make the student understand the characteristics and classifications of Pisces and Ambhibia
3. To make the student learn the diversity of different classes of Reptilia and Aves and Mammalia
4. To impart the knowledge about the Comparative anatomy of vertebrates.

UNIT I: Proto-chordates, Pisces and Amphibia

Proto-chordates: Outline of classification, General features and important characters of Herdmania, Branchiostoma. Origin of Chordates. Pisces: Migration in Pisces, Outline of classification. Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT II: Reptilia, Aves and Mammalia

Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration. Mammalia: Classification, Origin, dentition

UNIT III: Comparative anatomy of Vertebrates I

Comparative anatomy of various systems of vertebrates: Integumentary, digestive, respiratory systems.

UNIT IV: Comparative anatomy of Vertebrates II

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear. Autonomic Nervous system in Mammals.

Suggested Reading and Text Books

1. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and

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2. Bartlett Publishers Inc.
3. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
4. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
5. Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
6. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.

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

CO	Description
CO1	Develop advanced taxonomic skills to identify and classify diverse animal species, including lesser-known groups and specialized taxa.
CO2	Understand the evolutionary relationships and phylogenetic patterns among different animal groups, interpreting their shared ancestry and divergent characteristics.
CO3	Behavioral and Ecological Adaptations: Analyze complex animal behaviors and ecological adaptations within specific taxonomic groups, linking their traits to ecological niches and survival strategies.
CO4	Explore the conservation status and threats to various animal species, understanding the importance of preserving biodiversity and contributing to conservation efforts.

Mapping of COs with POs & PSOs

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

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 363	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Animal Biotechnology (Discipline Specific Elective)		

COURSE OBJECTIVES: The course aims to make students gain knowledge in the current trends and techniques in animal biotechnology. The specific objectives of the course are as follows:

1. To develop an understanding about animal cell culture and gene delivery methods in animals.
2. To provide an overview of in-vitro fertilization, embryo transfer methods and other related techniques.
3. To gain knowledge about the stem cells and their various applications
4. To learn about the production of transgenic animal and gene therapy and their applications.

UNIT I

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Suggested Reading and Text Books

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

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

CO	Description
CO1	Understand the knowledge related to basic concept of animal biotechnology for academics and higher research.
CO2	Identify different types of animal cell culture, methods of gene transfer.
CO3	Comprehend aspects related to basic principles and techniques in genetic manipulation and genetic engineering in respects of animal model system.
CO4	Acquire knowledge about animal genome applications, gene therapy, human genetic engineering, stem cell technology, associated ethical issues and application for human welfare.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTME 351b CO 1	2	3	2	2	3	3	3	3	2
BBTME 351b CO 2	1	3	2	2	2	3	3	2	2
BBTME 351b CO 3	1	3	3	2	2	3	3	2	1
BBTME 351b CO 4	2	3	3	2	2	3	2	2	2
Average CO (BBTME 351b)	1.5	3	2.5	2	2.25	3	2.75	2.25	1.75

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BTVAC 361	Credit	3
Year/Semester	Semester VI	L-T-P	3-0-0
Course Title	Medical Biotechnology (Value Addition Course)		

COURSE OBJECTIVES: To enlighten the knowledge of the students on different areas of Medical Biotechnology. To train the students in a hospital based setup and familiarize them with the clinical diagnostics

UNIT I

Introduction: History and scope of medical biotechnology, current status and future prospects. Classification of genetic diseases: Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, mitochondrial disorders.

UNIT II

Molecular basis of human diseases: Pathogenic mutations Gain of function mutations: Oncogenes, Huntington's disease, Pittsburg variant of alpha1antitrypsin. Loss of function - Tumor Suppressor. Genomic. E.g. Sickle Cell AnemiaDynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases

UNIT III

Gene therapy: Ex-vivo, In vivo, In situ gene therapy, Strategies of gene therapy: gene augmentation Vectors used in gene therapy. Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, and receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumors.

UNIT IV

Nucleic acid based Therapy: Gene silencing technology, siRNA, Aptamers, antisense oligodeoxynucleotides (AS-ODN), Ribozymes, Peptide Nucleic Acids.

UNIT V

Recombinant & Immunotherapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and Urokinase in thrombosis; Recombinant coagulation factors.

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Suggested Readings and Text Books

1. Owen JA, Punt J, Strandfold SA, Jones PP, Kuby J (2013)- Immunology W.H. Freeman & Company, 7 th ed. 92nd Senate approved Courses Scheme & Syllabus for B.Tech. (Biotechnology).
2. Allen LV, Popovich NG & Ansel HC (2005). Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins.4. Walsh G (1998). Biopharmaceuticals: Biochemistry and Biotechnology, Wiley.
3. Delves PJ, Martin JS, Burton RD, Roitt MI (2011). Roitt's Essential Immunology, Wiley Blackwell, 12th Ed.
4. Gennaro AR, Remington (2005). The Science and Practice of Pharmacy. Lippincott Williams and Wilkins.
5. Tripathi KD (2008), Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers.

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

CO	Description
CO1	Students will be able to explain insights about genetic diseases and also about the molecular aspects related to human disease
CO2	Students will be able to gain new insights into molecular mechanisms of nucleic acid and gene therapy
CO3	Students will be able to gain knowledge about therapeutic recombinant proteins and immunotherapy for the treatment of different diseases
CO4	Explore the diverse applications of medical biotechnology, including gene therapy, personalized medicine, vaccine development, regenerative medicine, and diagnostic imaging.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BTVAC 361 CO 1	2	3				3	2		
BTVAC 361 CO 2	2	3				3	2	2	
BTVAC 361 CO 3		3	2	2		2	2	2	
BTVAC 361 CO 4			3	1	1	3	2	2	
Average CO (BTVAC 361)	2	3	2.5	1.5	1	2.75	2	2	

3: High, 2: Medium, 1: Low

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B. Sc. Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BTPR 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 Biotechnology [B.Sc. (Hons.) Biotechnology]

B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.

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.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 472	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Biomedical Technology		

COURSE OBJECTIVES: The objectives of this course are

1.To understand various types of cancer, tumor invasion, markers in cancer research and diagnosis

2. To acquire knowledge related to genetic disease, gene diagnosis, gene tracking & other diagnostic application of biomedical technology.

3. To understand the concept and types of mutations in Molecular biology.

4. To acquire knowledge related to cellular and molecular mechanisms in biomedical technology.

UNIT I

Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnostic application of RDT) Molecular diagnostic- direct gene diagnosis, Linkage analysis. Nucleic acid sequences as diagnostic tools, SNPs, VNTRs, Non-invasive methodology. MRI, CT-SCAN.

UNIT II

Types and grading of cancer. Introduction to molecular diagnosis of cancer. (Southern & Northern blot analysis, PCR based diagnosis). Gene therapy, Immunotherapy and chemotherapy of cancer cells.

UNIT III

Chemical mutagens. Carcinogenic agents and their cellular interactions. Radiation as health hazard. (Types, measurements, effects & protective measures). Immunological basis of diseases: Hypersensitivity (I – IV) Autoimmune diseases, Preparation of polyclonal antisera: characterization of antisera, Immunodiagnostic – RIA, ELISA.

Suggested Reading and Text Books

1. Biomedical Technology and Devices Handbook, James E Moore, George Zouridakis, CRC Press (2004).
2. Introduction to Biomedical Engineering. John Enderle, Susan Blanchard, Joseph Bronzino, Academic Press (2011).

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

CO	Description
CO1	Develop a comprehensive understanding of the principles and applications of biomedical technology, including medical devices, imaging modalities, and diagnostic tools used in healthcare.
CO2	Acquire knowledge and practical skills in operating and calibrating various biomedical instruments and devices used for patient monitoring and medical research.
CO3	Understand the integration of biomedical technology with healthcare systems, electronic health records, and telemedicine, improving patient care and medical outcomes.
CO4	Recognize the ethical, legal, and regulatory aspects related to biomedical technology, including patient privacy, data security, and compliance with healthcare standards.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 472 CO 1	3	3	-	-	-	3	2	2	-
BBTC 472 CO 2	-	2	3	2	-	2	-	3	-
BBTC 472 CO 3	-	-	2	3	2	-	-	3	3
BBTC 472 CO 4	-	-	2	3	-	-	3	2	3
Average CO (BBTC 472)	3	2.5	2.3	2.67	2	2.5	2.5	2.5	3

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BMBC 471	Credit	3
Year/Semester	Semester VII	L-T-P	3-0-0
Course Title	Microbial Genetics (Minor 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.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 472	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.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 471	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Advance Molecular Biology & Genetics		

COURSE OBJECTIVES: The objectives of this course are

1. To provide fundamental aspects of molecular biology with detailed basics of cellular organization and biochemical molecules present in the cell.
2. To understand the basic knowledge molecular events like replication, transcription and translation that is important for cell.
3. To provide basic knowledge and understanding of principle and mechanism of inheritance.
4. To provide students basic knowledge of gene expression ant its regulation in prokaryotes and eukaryotes.

UNIT I

Advanced Gene Regulation Mechanisms. Transcriptional Regulation: Explore complex mechanisms of transcriptional regulation, including enhancers, silencers, insulators, and long non-coding RNAs. Study transcription factors, chromatin remodeling, and epigenetic modifications affecting gene expression. Post-Transcriptional Regulation: Delve into microRNAs, small interfering RNAs, and other non-coding RNAs involved in post-transcriptional gene silencing. Understand mechanisms like RNA interference and translational regulation

UNIT II

Comparative Genomics: Study evolutionary relationships among genomes, synteny analysis, and identification of conserved elements. Explore the role of comparative genomics in understanding gene function, genome evolution, and speciation.

UNIT III

CRISPR-Cas Systems and Genome Editing: Learn about CRISPR-Cas9 and advanced genome editing techniques. Study applications in gene therapy, functional genomics, and creating genetically modified organisms.

UNIT IV

Synthetic Biology Applications: Explore the principles of synthetic biology, designing genetic circuits, and building artificial biological systems. Understand applications in biomedicine, biofuels, and bioremediation.

Suggested Reading and Text Books

1. Lewin: Genes, Vol. VII Oxford, 1998, Inded.
2. Straehan & Read: Human Molecular Genetics 1999, John Wiley & Sons Pte. Ltd.

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3. Snustad et al: Principles of Genetics 1997, John Wiley & Sons.
4. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelplna.
5. Strickberger: Genetics, 1996, Prentice Hall.
6. Friefelder: Molecular Biology (2nd ed.), 1996 Narosa Publ. House.
7. Alberts et al: Molecular biology of the cell (4th ed.) 1994, Garland Publ. New York.

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

CO	Description
CO1	Develop a deep understanding of advanced genetic principles.
CO2	Develop a deep understanding of molecular mechanisms, including gene regulation, epigenetics, and genome organization.
CO3	Explore the application of molecular biology tools in genetic engineering, including the creation of genetically modified organisms (GMOs) and gene therapy for medical interventions.
CO4	Stay updated with the latest advancements and research trends in molecular biology and genetics, including breakthroughs in genomics and personalized medicine.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTDE 471 CO 1	3	3	2	-	-	3	-	-	-
BBTDE 471 CO 2	-	3	-	-	-	3	-	3	1
BBTDE 471 CO 3	-	-	3	2	-	2	3	3	-
BBTDE 471 CO 4	-	2	3	-	2	-	3	3	1
Average CO (BBTDE 471)	3	2.67	2.67	2	2	2.67	3	3	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BTVAC 471	Credit	4
Year/Semester	Semester VII	L-T-P	4-0-0
Course Title	Food and Fermentation Techniques		

COURSE OBJECTIVES

1. To understand the relationship between food, nutrition, and health.
2. To understand digestion, absorption, functions and food sources of various nutrients.
3. To appreciate the concept of balanced and healthy diets.
4. To know the different methods of cooking and ways to prevent nutrient losses.
5. To be able to plan and prepare meals and nutritious dishes for various age groups.
6. To be able to assess nutritional status of adults.

UNIT I

Fermented Foods; Definition, types, advantages and health benefits of fermented foods; Probiotics.

UNIT II

Milk Based Fermented Foods; Preparation of inoculums, microorganisms and production process: Dahi, Yogurt, Buttermilk, Cheese.

UNIT III

Grain Based Fermented Foods; Microorganisms and production process: Soy sauce, Bread, Idli, Dosa.

UNIT IV

Vegetable Based Fermented Foods; Microorganisms and production process: Pickle, Sauerkraut.

UNIT V

Fermented Meat and Fish Products; Microorganisms and production process: Sausages and sauces.

Suggested Readings and Text Books

1. Bamji MS, Krishnaswamy K, Brahmam GNV (2016). Textbook of Human Nutrition, 4th edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Chadha R & Mathur P (2015). Nutrition: A Lifecycle Approach. Hyderabad: Orient Blackswan.
3. Longvah T, Ananthan R, Bhaskarachary K & Venkaiah K. (2017). Indian Food Composition Tables. National Institute of Nutrition, Indian Council of Medical Research, Department of Health Research, Ministry of Health and Family Welfare, Government of India, Hyderabad.
4. Seth V, Singh K & Mathur P (2018). Diet Planning Through the Lifecycle Part I: Normal Nutrition- A Practical Manual. 6th Edition. Delhi: Elite Publishing House.
5. Srilakshmi B (2017). Nutrition Science. 6th edition. Delhi: New Age International Publishers.

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

CO	Description
CO1	Students will be able to appreciate the relationship between food, nutrition and health.
CO2	Students will be able to explain digestion, absorption, functions and food sources of various nutrients. Students will be able to understand the concept of balanced diets and menu planning.
CO3	Students will be able to describe different methods of cooking and ways to prevent nutrient losses. Students will be able to plan and prepare meals and nutritious dishes for various age groups.
CO4	Students will be able to assess nutritional status of adults.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BTVAC 471 CO 1	3	2	1	-	-	3	2	-	1
BTVAC 471 CO 2	2	3	2	-	-	2	3	2	-
BTVAC 471 CO 3	-	-	3	3	2	2	2	-	2
BTVAC 471 CO 4	-	-	3	2	2	-	2	-	2
Average CO (BTVAC 471)	2.5	2.5	2.25	2.5	2	2.3	2.25	2	1.67

3: High, 2: Medium, 1: Low

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SEMESTER VIII

B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 481	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Protein Engineering (Major 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 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, data bases.

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.
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.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 482	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Advance Genetic Engineering (Major Core)		

COURSE OBJECTIVES

1. Develop expertise in utilizing advanced gene editing tools such as CRISPR-Cas systems, understanding their mechanisms and applications for precise genetic modifications.
2. Explore the use of advanced genetic engineering for therapeutic applications, focusing on gene therapy, personalized medicine, and the treatment of genetic disorders.
3. Understand the ethical considerations and societal impact of advanced genetic engineering techniques, fostering a thoughtful approach to their application and implications.

UNIT I

Enzymes and vectors used in Gene Cloning, Restriction enzymes, DNA polymerases, reverse transcriptase, terminal transferase, alkaline phosphatase, polynucleotide kinase, ligase, DNases, RNases, and topoisomerase. Plasmid vectors, phage vectors, BAC vectors and plasmid incompatibility, and vectors for cloning in yeast, and mammalian cells.

UNIT II

Polymerase Chain Reaction: PCR, factors affecting PCR, design of gene-specific and degenerate primers, semi quantitative Reverse transcriptase-PCR, real-time PCR with SYBR and TaqMan probe, site directed mutagenesis by PCR, LAMP-PCR

UNIT III

Gene Cloning Methods: Cohesive end cloning, blunt end cloning, checking the direction of cloning by PCR and restriction digestion, cloning using adapters, and cloning adding restriction site by PCR. TA cloning, TOPO-TA cloning. Ligation independent cloning and single step cloning of multiple fragments by Gibson Assembly

UNIT IV

Gene & Promoter Isolation: Construction of cDNA library, genomic DNA library, screening the libraries using heterologous probes, functional screening, screening by complementation. Constitutive and inducible promoters, tissue specific promoters, promoter identification from gene expression data, reporter genes for promoter deletion studies, promoter deletion studies

UNIT V

Expression of Recombinant Proteins: Components of an expression plasmid vector, strategies for cloning in proper reading frame, codon optimization, optimization of induction of protein

expression, factors affecting inclusion body formation, factors affecting protein folding, solubilizing recombinant protein in inclusion bodies, purification of recombinant proteins with and without purification ligands. Immobilization of recombinant proteins.

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. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

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.
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 482 CO 1	2	3	-	-	-	3	2	-	-
BBTC 482 CO 2	-	3	3	1	-	2	2	2	1
BBTC 482 CO 3	2	-	3	2	2	2	-	2	1
BBTC 482 CO 4	-	2	-	2	-	2	2	-	-
Average CO (BBTC 482)	2	2.67	3	1.67	2	2.25	2	2	1

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTPC 482	Credit	1
Year/Semester	Semester VIII	L-T-P	0-0-2
Course Title	Lab Course based on BBTC 482		

PRACTICALS

1. Molecular weight determination of isolated DNA samples.
2. Molecular weight determination of isolated protein samples.
3. Restriction digestion of DNA
4. To study about preparation of competent cells
5. Transformation of competent cells.
6. Demonstration of PCR.
7. Demonstration of mutagenesis

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. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

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

CO	Description
CO1	Develop expertise in the latest gene editing techniques, including CRISPR-Cas systems, enabling precise and targeted genetic modifications.
CO2	Gain proficiency in designing and constructing complex genetic circuits for synthetic biology applications, showcasing creativity in engineering biological systems.
CO3	Apply advanced genetic engineering tools for innovative biomedical solutions, demonstrating the ability to design gene therapies and personalized medicine approaches
CO4	Understand the ethical and societal considerations surrounding advanced genetic engineering, demonstrating responsible decision-making in research and applications.

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Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTPC 481 CO 1	2	3	3	-	-	3	2	3	-
BBTPC 481 CO 2	-	3	3	1	1	2	2	2	1
BBTPC 481 CO 3	2	-	3	2	2	2	1	2	1
BBTPC 481 CO 4	-	2	-	2	1	2	2	2	-
Average CO (BBTPC 481)	2	2.67	3	1.67	1.3	2.25	1.75	2.25	1

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTC 483	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Molecular Diagnostics (Minor Core)		

COURSE OBJECTIVES: The course is designed to give an overview and applications of different molecular biology techniques used in disease diagnosis. The specific objectives of the course are:

1. To teach students different molecular techniques used for disease diagnosis.
2. To make students understand the utilization of these techniques in disease diagnosis.
3. To teach the use of different enzyme immunoassay based diagnostic methods.
4. To impart the knowledge about the molecular diagnostic of different human diseases.

UNIT I

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology.

UNIT II

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

Suggested Reading and Text Books

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

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2. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
3. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
4. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's
5. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
6. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton- Centuary-Crofts publication.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's
8. Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert.

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

CO	Description
CO1	Inculcate ability to design and assess theoretical skills such as the use of molecular techniques in the diagnostics labs, academic, higher research and clinical industries
CO2	Fundamental aspects of Immunodiagnostics and assays for biomarkers, enzyme assays, and antibody-based detection.
CO3	Provide basic and advanced diagnostic techniques that explore research and training in higher education and applicable to the modern medicinal treatment system..
CO4	Apply the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory such as nucleic acid extraction, resolution and detection, analysis and characterization of nucleic acids and proteins, nucleic acid amplification and DNA sequencing for contribution in modern science.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTC 483 CO 1	3	3	3	2	3	3	3	3	2
BBTC 483 CO 2	2	3	2	-	-	3	2	2	-
BBTC 483 CO 3	3	3	3	2	3	3	2	2	2
BBTC 483 CO 4	-	3	3	2	2	3	2	2	2
Average CO (BBTC 483)	2.67	3	2.75	2	2.67	3	2.25	2.25	2

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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 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.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.

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.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
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.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 481	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Pharmaceutical Biotechnology & Drug Designing		

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, Anti-idiotype vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.

UNIT IV

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

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	Develop a comprehensive understanding of how biotechnological tools and techniques are employed in the pharmaceutical industry for drug discovery, production, and development.
CO2	Acquire knowledge of the principles and strategies involved in drug design, including rational drug design, structure-based drug design, and computer-aided drug design (CADD).
CO3	Learn about the production of biopharmaceuticals, including recombinant proteins, monoclonal antibodies, and vaccines, and their applications in treating various diseases.
CO4	Understand the regulatory framework and ethical aspects related to pharmaceutical biotechnology, including drug approval processes, clinical trials, and patient safety.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTDE 481 CO 1	3	3	3	-	-	3	-	3	-
BBTDE 481 CO 2	2	3	3	-	-	-	3	-	-
BBTDE 481 CO 3	-	-	3	-	2	-	2	2	1
BBTDE 481 CO 4	-	-	3	3	2	-	2	3	-
Average CO (BBTDE 481)	2.5	3	3	3	2	3	2.3	2.67	1

3: High, 2: Medium, 1: Low

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B. Sc. (Hons.) Biotechnology

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTDE 482	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
Course Title	Advance Biochemistry		

COURSE OBJECTIVES: The objectives of this course are

1. Understand the principles of enzyme kinetics and catalysis, including mechanisms of enzyme action and factors affecting enzyme activity.
2. Analyze the structure and function of biomolecules at an advanced level, including proteins, nucleic acids, carbohydrates, and lipids.
3. Understand the interdisciplinary nature of biochemistry and its applications in various fields, including medicine, biotechnology, and environmental science.

UNIT I

Enzymes: Classification, overview and specific example Zymogens and their activation (protease and Prothrombin) Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Lock and Key Hypothesis, Induced –Fit Hypothesis, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax . Enzyme inhibition: types of inhibition, suicide Inhibitor. Carbohydrate – Classification, structure and functions.

UNIT II

Protein: Classification, structure and functions. Urea cycle and its regulation. Conversion of nitrogen to ammonia by microorganisms, overview of amino-acid biosynthesis. N2 fixation. Fatty Acids - Classification and structure, Fatty Acid Metabolism. Nucleic Acid - structure and functions. Nucleic Acid Metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis and its regulation.

Suggested Reading and Text Books

1. Lehninger: Principles of Biochemistry, 4th ed., Nelson & Cox, WH Freeman and Company,
2. 2007
3. Voet & Voet: Biochemistry, 2nd ed., Wiley & Sons.
4. Berg, Tymoczko, Stryer: Biochemistry, 5th ed., WH Freeman and Company, 2003.
5. Garett & Grisham: Biochemistry, 4th ed., Brooks/Cole Cengage learning, 2010.

6. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 27th ed. McGraw Hill, 2006.
7. Conn & Stumpf: Outlines of Biochemistry, 5th ed., Willey India, 2007.

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

CO	Description
CO1	Develop a thorough understanding of advanced biochemical concepts, including enzyme kinetics, metabolic pathways, signal transduction, and macromolecular structure and function.
CO2	Explore the integration of biochemical principles in various biological processes, such as metabolism, cellular signaling, and gene expression, to comprehend the molecular basis of cellular functions.
CO3	Develop research skills and critical thinking abilities to analyze scientific literature, design experiments, and interpret biochemical data, contributing to advancements in the field of biochemistry.
CO4	Apply advanced biochemical principles and techniques to solve real-world problems in various fields, such as medicine, biotechnology, agriculture, and environmental science.

Mapping of COs with POs & PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
BBTDE 482 CO 1	3	2	1	-	-	3	2	-	1
BBTDE 482 CO 2	2	3	2	-	2	2	3	2	-
BBTDE 482 CO 3	-	-	3	3	2	2	3	2	2
BBTDE 482 CO 4	-	2	3	2	2	-	3	-	2
Average CO (BBTDE 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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Degree Course in Biotechnology with Research

B. Sc. (Hons) Biotechnology with Research

Program Name	B.Sc. Biotechnology	Program Code	15301
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

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UNIT V: Statistical Techniques and Tools –II

Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard 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) Biotechnology with Research

Program Name	B.Sc. Biotechnology	Program Code	15301
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) Biotechnology with Research

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTRM 473	Credit	10
Year/Semester	Semester VII	L-T-P	0-0-24
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) Biotechnology with Research

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTRS 474	Credit	2
Year/Semester	Semester VII	L-T-P	2-0-0
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) Biotechnology with Research

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTRC 481	Credit	4
Year/Semester	Semester VIII	L-T-P	4-0-0
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

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) Biotechnology with Research

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTRD 481	Credit	14
Year/Semester	Semester VIII	L-T-P	0-0-40
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) Biotechnology with Research

Program Name	B.Sc. Biotechnology	Program Code	15301
Course Code	BBTRD 482	Credit	2
Year/Semester	Semester VIII	L-T-P	2-0-0
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.) Biotechnology**
(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.) Biotechnology

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.

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