SYLLABUS FOR

B. Sc. Biotechnology
(Three Year Course- Semester System)
OR
B. Sc. (Hons./Hons. with Research) Biotechnology
(Four Year Course-Semester System)

(Effective from Academic Session 2026-2027 Onward)

School of Applied Sciences

Suresh Gyan Vihar University, Jaipur

Rajasthan-302017

OUTCOME BASED EDUCATION

Programme outcomes (POs)

Students will be able to

PO 1	Foundational Knowledge in Sciences: Students will possess a solid grasp of Biotechnology, Biochemistry, Microbiology, Plant Biotechnology, Environmental Science, Chemistry, and Biology, applying this understanding to practical contexts.
PO2	Problem Identification and Analysis: Students will skillfully recognize, articulate, and assess issues within Applied and Natural Sciences, particularly in Biotechnology.
PO3	Solution Design and Development: Students will proficiently devise solutions for prevalent challenges in Applied Sciences, emphasizing Biotechnology, to enhance the well-being of the public and the environment.
PO4	Utilization of Contemporary Tools: Students will adeptly employ modern techniques and resources to comprehend Biotechnology concepts effectively.
PO5	Sustainability in the Environment: Students will evaluate how Biotechnology and Applied Sciences impact environmental health, promoting awareness of sustainable development principles.
PO6	Project Management and Communication Skills: Students will acquire competency in laboratory procedures, project planning, and clear communication within the scientific community and broader society.
PO7	Future Opportunities and Collaborative Endeavors: Students will explore avenues for advanced studies, research, and interdisciplinary cooperation, utilizing their Biotechnology expertise for societal benefit.
PO8	Lifelong Learning and Cross-Disciplinary Approach: Students will grasp the interconnectedness of Biotechnological progress with other scientific fields, fostering a commitment to continuous learning and interdisciplinary cooperation.
PO9	Proficiency in Writing: Students will develop writing skills suited for scientific literature and social media platforms, particularly in the realm of life sciences.
PO10	Effective Communication Abilities: Students will demonstrate clarity in verbal and written communication, in English and one Indian language, facilitating meaningful exchanges between individuals and ideas.
PO11	Social Engagement and Ethical Awareness: Students will engage in respectful discourse, mediate conflicts, and navigate ethical dilemmas, recognizing diverse perspectives and assuming responsibility for their choices.
PO12	Practical Learning through Interdisciplinary Approaches: Students will analyze the interconnectedness of animals, plants, microbes, and industry, while also conducting laboratory experiments in various Biotechnological domains, adhering to established standards.

Program Specific Outcomes (PSOs)

PSO 1	Students will acquire comprehensive knowledge of fundamental and advanced concepts in biotechnology, including molecular biology, genetics, immunology, bioinformatics, synthetic biology, genomics, proteomics, and emerging interdisciplinary areas.
PSO2	Students will develop technical and analytical skills in modern biotechnological tools and techniques such as recombinant DNA technology, molecular diagnostics, computational biology, data science, artificial intelligence, genome editing, molecular modeling, and bioanalytical methods.
PSO3	Students will acquire practical laboratory and computational proficiency through hands-on training in microbiology, biochemistry, cell biology, bioinformatics, bioprocess engineering, omics technologies, and AI-enabled biological data analysis.
PSO4	Students will be capable of applying biotechnology knowledge for solving real-world problems in healthcare, agriculture, food technology, environmental sustainability, industrial biotechnology, precision medicine, and emerging technology-driven sectors.
PSO5	Students will demonstrate critical thinking, innovation, research aptitude, entrepreneurship, ethical awareness, and interdisciplinary problem-solving abilities to pursue higher education, research, startups, and careers in academia, biotechnology industries, healthcare, and allied sectors.

B. Sc Biotechnology OR B. Sc (Hons. / Hons. with Research) Biotechnology (3 year OR 4 Year course)

Certification and Duration of Study with Multiple Entry Multiple Exit (MEME)

The undergraduate degree will have a flexible duration of either three or four years, with multiple exit options during this period. The table below outlines the various certifications a student can earn at different stages of their undergraduate study (Table 1).

Duration of Study	Semesters Completed	Certification Earned
4 years	Eight Semester	Bachelor's Degree (Honours)
		Bachelor's Degree (Honours with Research)
3 years	Six semesters	Bachelor's Degree
2 years	Four semesters	Undergraduate Diploma
1 year	Two Semester	Undergraduate Certificate

Table 1: Certification (and duration) on MEME

In consonance with the National Education Policy (NEP) 2020 and the guidelines of the University Grants Commission (UGC), Multiple Entry and Multiple Exit (MEME) scheme in undergraduate programme of Biotechnology has been implemented. This structure provides students with the flexibility to enter, exit, and re-enter the programme at various stages, each with its corresponding certification as demonstrated in Table 2.

Programme Exit	Credits Required	Additional Requirement	Awarded Qualification	Re-entry to Degree Programme
After Year 1	51	Completion of one 4-credit vocational course / internship/ apprenticeship (in addition to 4 credits from Skill based course) during summer vacation of Year 1	UG Certificate	Within three years of exit
After Year 2	99	Completion of one 4- credit vocational course during summer vacation of Year 2	UG Diploma	Within three years of exit
After Year 3	149	Compliance with minimum credit requirements specified in regulations	3-year UG Degree	Within three years of exit
After Year 4 (Honours)	190	Compliance with credit requirements as specified in regulations	4-year UG Honours Degree	NA
After Year 4 (Honours with Research)	190	75% marks and above in the first six semesters, completion of a research project/dissertation under faculty guidance in the major discipline	4-year UG Honours Degree with Research	NA

The maximum time in which a student will be allowed to complete the Degree is Seven Years

The undergraduate curriculum will include credit-based courses and projects centred around community engagement, environmental education, and value-based education. Additionally, students will have opportunities for internships with local industries, businesses, artists, craftspeople, as well as research internships with faculty and researchers at their own or other Higher Education Institutions (HEIs)/research institutions. These practical experiences are integral to enhancing students' learning and employability.

B. Sc Biotechnology OR B. Sc (Hons. / Research) Biotechnology (3 year OR 4 Year course)

Type of Course	**No. of courses in the proposed scheme**						**Minimum Requirement of no. of courses for B.Sc Degree**	**Minimum Requirement of credits and no. of courses for B.Sc (Hons.) Degree**
	B. Sc Biotech (3 yr course)		**B. Sc (Hons.) Biotech- 4 yr course**		**B. Sc (research) Biotech) 4 yr course**			
	No. of course	Credits	No. of course	Credits	No. of course	Credits		
DCC	17 (Th + Lab)	79	20	94	19	89	12 courses (4 core papers in three disciplines)	14 courses
DSE	6	18	9	27	8	24	2 courses	4 courses
GEC	5	14	8	23	7	20	2 courses	4 courses
AECC	10	18	11	20	11	20	2 courses	2 courses
SEC	10	14	11	14	11	14	4 courses	2 courses
DPR	1	6	2	12	2	23	As per norms	As per norms
Total Credits		**149**		**190**		**190**	**140**	**160**

SURESH GYAN VIHAR UNIVERSITY

School of Applied Science

Teaching and Examination Scheme for

B. Sc Biotechnology/B. Sc (Hons. /Hons. with Research) Biotechnology

SESSION 2026-27

Year: I **Semester: I (AUTUMN/PAVAS)**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-I	Social Outreach, Discipline & Extra Curriculum Activities -I	AECC	2	0	0	0	0	100	-
2	UC1002	Human Values and Professional Ethics	SEC	Non-Credit	1	0	0	3	100	-
3	UC1003	English Language	AECC	2	2	0	0	3	40	60
4	UC1004	Yoga Education & Practices	SEC	2	0	0	2	-	100	-
5	UC1005	Elementary Computers	SEC	2	2	0	0	3	40	60
B	**Program Core**									
1	BT1001	Cell Biology	DCC	3	3	0	0	3	40	60
2	BT1002	General Microbiology	DCC	3	3	0	0	3	40	60
3	BT1003	Biochemistry & Metabolism	DCC	3	3	0	0	3	40	60
4	BT1004	Introduction to Artificial intelligence	SEC	2	2	0	0	3	40	60
5	BT1101	Cell Biology Lab	DCC	2	0	0	3	3	60	40
6	BT1102	General Microbiology Lab	DCC	2	0	0	3	3	60	40
7	BT1103	Biochemistry & Metabolism lab	DCC	2	0	0	3	3	60	40
		TOTAL		**25**						

NOTE: Non-credit courses (e.g., IKS, Human Values & Professional Ethics, Group Discussion, Aptitude & Reasoning etc.) require minimum 40% passing marks to qualify.

The University Electives are apart from minimum credits required for award of degree.

L= Lecture **T=Tutorial** **CIE=Continuous Internal Evaluation**

S= Seminar **P= Practical** **ESE= End Semester Examination**

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

School of Applied Science

Teaching and Examination Scheme for

B. Sc Biotechnology/B. Sc (Hons. /Hons. with Research) Biotechnology

SESSION 2026-27

Year: I **Semester: II (SPRING/BASANT)**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-II	Social Outreach, Discipline & Extra Curriculum Activities-II	AECC	2	0	0	0	0	100	-
2	UC2001	Indian Knowledge System	AECC	Non-credit	2	0	0	-	100	-
3	UC2002	English Communication	AECC	2	2	0	0	3	40	60
4	UC2004	Environmental Studies	AECC	2	2	0	0	3	40	60
5	UCFV	Field Visit-I	SEC	2	0	0	2	-	100	-
B	**Program Core**									
1	BT2001	Basics of Immunology	DCC	3	3	0	0	3	40	60
2	BT2002	Biotechnology and Human Welfare	DSE	3	3	0	0	3	40	60
3	BT2003	Biotechnology skills and Analytical techniques	DSE	3	0	0	3	3	100	-
4	BT2004	Genetics and Molecular Biology	DCC	3	3	0	0	3	40	60
5	BT2101	Basic Immunology Lab	DCC	2	0	0	3	3	60	40
6	BT2102	Genetics and Molecular Biology Lab	DCC	2	0	0	3	3	60	40
7	BT2103	Biotech Innovation Lab-I	DCC	2	0	0	3	3	60	40
C	**Program Electives (Any one)**									
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**26**						

NOTE: Non-credit courses (e.g., IKS, Human Values & Professional Ethics, Group Discussion, Aptitude & Reasoning etc.) require minimum 40% passing marks to qualify.

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School of Applied Science

Teaching and Examination Scheme for

B. Sc Biotechnology/B. Sc (Hons. /Hons. with Research) Biotechnology

SESSION 2026-27

Year: II **Semester: III (AUTUMN/PAVAS)**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-III	Social Outreach, Discipline & Extra Curriculum Activities-III	AECC	2	0	0	0	0	100	-
2	UCEEPI	Election and Electoral Processes in India	SEC	Non-Credit	1	0	0	0	100	-
3	UCFV	Field Visit-II	SEC	2	0	0	2	-	100	-
B	**Program Core**									
1	BT3001	Bioanalytical Techniques	DCC	3	3	0	0	3	40	60
2	BT3002	Environmental Biotechnology	DCC	3	3	0	0	3	40	60
3	BT3003	Biosafety and Bioethics	GE	3	3	0	0	3	40	60
4	BT3004	Chemistry-I	DCC	3	3	0	0	3	40	60
5	BT3101	Bioanalytical Techniques Lab	DCC	2	0	0	3	3	60	40
6	BT3102	Environmental Biotechnology Lab	DCC	2	0	0	3	3	60	40
7	BT3103	Chemistry I Lab	DCC	2	0	0	3	3	60	40
C	**Program Electives (Any one)**									
1	BT3005	Molecular diagnostics	DSE	3	3			3	40	60
2	BT3006	Biofertilizers and biopesticides	DSE	3	3			3	40	60
3	BT3007	AI in Healthcare and Biotechnology	DSE	3	3	0	0	3	40	60
4	BT3008	MOOC (through SWAYAM/NPTEL etc) *Under Credit Transfer Scheme*	DSE/GE	3	3			3	40	60
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**25**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

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School of Applied Science

Teaching and Examination Scheme for

B. Sc Biotechnology/B. Sc (Hons. /Hons. with Research) Biotechnology

SESSION 2026-27

Year: II **Semester: IV (SPRING/BASANT)**

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage(in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-IV	Social Outreach, Discipline & Extra Curriculum Activities-IV	AECC	2	0	0	0	0	100	-
B	**Program Core**									
1	BT4001	Chemistry II	DCC	3	3	0	0	3	40	60
2	BT4002	Genetic Engineering	DCC	3	3	0	0	3	40	60
3	BT4003	Biostatistics and Data Analysis	GE	3	3	0	0	3	40	60
4	BT4004	IPR, Bio-entrepreneurship and Bio-business Management	GE	3	3	0	0	3	40	60
5	BT4101	Chemistry II Lab	DCC	2	0	0	3	3	60	40
6	BT4102	Genetic Engineering Lab	DCC	2	0	0	3	3	60	40
7	BT4103	Biotech Innovation Lab-II	DCC	2	0	0	3	3	60	40
C	**Program Electives (Any one)**									
1	BT4005	Food Biotechnology	DSE	3	3	0	0	3	40	60
2	BT4006	Molecular modeling and drug designing	DSE	3	3	0	0	3	40	60
3	BT4007	Structural Biology	DSE	3	3	0	0	3	40	60
4	BT4008	MOOC (through SWAYAM/NPTEL etc) *Under Credit Transfer Scheme*	DSE/GE	3	3	0	0	3	40	60
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**23**						

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Teaching and Examination Scheme for

B. Sc Biotechnology/B. Sc (Hons. /Hons. with Research) Biotechnology

SESSION 2026-27

Year: III **Semester: V (AUTUMN/PAVAS)**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-V	Social Outreach, Discipline & Extra Curriculum Activities-V	AECC	2	0	0	0	0	100	-
2	UCFV	Field Visit-III	SEC	2	0	0	2	-	100	-
3	UC5001	Group Discussion, Aptitude & Reasoning-I	SEC	Non-Credit	0	2	0	3	100	-
B	**Program Core**									
1	BT5001	Bioprocess Engineering	DCC	3	3	0	0	3	40	60
2	BT5002	Bioinformatics	DCC	3	3	0	0	3	40	60
3	BT5003	Plant Biotechnology	DCC	3	3	0	0	3	40	60
4	BT5007	Data Science for Life Sciences	GE	3	3	0	0	3	40	60
5	BT5101	Bioinformatics Lab	DCC	2	0	0	3	3	60	40
6	BT5102	Bioprocess Engineering Lab	DCC	2	0	0	3	3	60	40
7	BT5103	Plant Biotechnology Lab	DCC	2	0	0	3	3	60	40
C	**Program Electives (Any one)**									
1	BT5004	Nanobiotechnology	DSE	3	3	0	0	3	40	60
2	BT5005	Biophysics	DSE/GE	3	3	0	0	3	40	60
3	BT5006	MOOC (through SWAYAM/NPTEL etc) *Under Credit Transfer Scheme*	DSE/GE	3	3	0	0	3	40	60
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**25**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

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Signature of Concerned Teacher **Signature of Convener-BOS**

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SURESH GYAN VIHAR UNIVERSITY

School of Applied Science

Teaching and Examination Scheme for

B. Sc Biotechnology/B. Sc (Hons. /Hons. with Research) Biotechnology

SESSION 2026-27

Year: III **Semester: VI (SPRING/BASANT)**

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage(in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-VI	Social Outreach, Discipline & Extra Curriculum Activities-VI	AECC	2	0	0	0	0	100	-
2	UCFV	Field Visit-IV	SEC	2	0	0	2	-	100	-
B	**Program Core**									
1	BT6001	Animal Biotechnology	DCC	3	3	0	0	3	40	60
2	BT6002	Genomics and Proteomics	DCC	3	3	0	0	3	40	60
3	BT6101	Animal Biotechnology Lab	DCC	2	0	0	3	3	60	40
4	BT6102	Genomics and Proteomics Lab	DCC	2	0	0	3	3	60	40
5	BT6103	Medical Microbiology Lab	GE	2	0	0	3	3	60	40
6	BT6104	Minor Project	DPR	6	0	0	3	3	40	60
C	**Program Electives (Any one)**									
1	BT6003	Basics of Forensic Science	GE	3	3	0	0	3	40	60
2	BT6004	Medical Biotechnology	DSE	3	3	0	0	3	40	60
3	BT6005	AI in Agriculture	DSE	3	3	0	0	3	40	60
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**25**						

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Total Credits: 79(C) +18(AECC) + 14(SEC) + 14(GEC) + 18(DSE) + 6(DPR) =149
C= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GEC= Generic Elective, DSE= Discipline Specific Elective

School of Applied Science

Teaching and Examination Scheme for

B. Sc (Hons. /Hons. with Research) Biotechnology

SESSION 2026-27

Year: IV **Semester: VII (Autumn/Pavas)**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-VII	Social Outreach, Discipline & Extra Curriculum Activities-VII	AECC	2					100	-
2	UC7001	Group Discussion, Aptitude & Reasoning-II	SEC	Non-Credit	0	2	0	3	100	-
B	**Program Core**									
1	BT7001	Enzyme Biotechnology	DCC	3	3	-	-	3	40	60
2	BT7002	Environmental Toxicology	DCC	3	3	-	-	3	40	60
3	BT7003	Research Methodology and Scientific Communication skills	GE	3	3	-	-	3	40	60
4	BT7101	Enzyme Biotechnology Lab	DCC	2	-	-	3	3	60	40
5	BT7102	Environmental Toxicology Lab	DCC	2	-	-	3	3	60	40
6	BT7103	Project Proposal Preparation and Presentation	GE	3	-	-	3	3	100	-
C	**Program Electives (any one)**									
1	BT7004	Nutrition and Health	GE/DSE	3	3	-	-	3	40	60
2	BT7005	Epidemiology	GE/DSE	3	3	-	-	3	40	60
3	BT7006	Synthetic Biology and Genome Editing	GE/DSE	3	3	-	-	3	40	60
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**21**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

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SURESH GYAN VIHAR UNIVERSITY

School of Applied Science

Teaching and Examination Scheme for

B. Sc (Hons.) Biotechnology (4 Year Course)

SESSION 2026-27

Year: IV **Semester: VIII (SPRING/BASANT)**

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage(in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
B	**Program Core**									
1	BT8001	Computer aided Drug Design	DCC	3	3	0	0	3	40	60
2	BT8002	Entrepreneurship Development	GE	3	3	0	0	3	40	60
3	BT8101	Research Project/Internship	DPR	6	0	0	18	3	40	60
4	BT8102	Seminar and Review Paper Writing in Immunotherapy/Sustainable development/Waste Management	DSE	3	0	0	12	3	100	-
5	BT8104	CADD Lab	DCC	2	0	0	3	3	60	40
C	**Program Electives (any one)**									
1	BT8003	Cell Signaling and Cancer Biology	DSE	3	3	0	0	3	40	60
2	BT8004	Functional Food and Nutraceuticals	DSE/GE	3	3	0	0	3	40	60
3	BT8005	Quantum Biotechnology	DSE	3	3	0	0	3	40	60
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**20**						

***For B. Sc (Hons.) Biotechnology, in lieu of Research project, Internship of two months in Industry/research laboratory in the biotechnology field may be carried out**

NOTE: The University Electives are apart from minimum credits required for award of degree.

L= Lecture **T=Tutorial** **CIE=Continuous Internal Evaluation**
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Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

<u>For Award of B. Sc (Hons.) Biotechnology- four year course</u>

Total Credits: 94(C) + 20(AECC) + 14(SEC) + 23(GEC) + 27(DSE) + 12(DPR) =190

C= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GEC= Generic Elective, DSE= Discipline Specific Elective

SURESH GYAN VIHAR UNIVERSITY

School of Applied Science

Teaching and Examination Scheme for

B. Sc (Hons. with Research) Biotechnology (4 Year Course)

SESSION 2026-27

Year: IV **Semester: VIII (SPRING/BASANT)**

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
B	**Program Core**									
1	BT8103	Research Project	DPR	17	-	-	45	3	40	60
2	BT8102	Seminar and Review Paper Writing in Immunotherapy/Sustainable development/Waste Management	DSE	3	-	-	12	3	100	-
C	**Program Electives (any one)**									
D	**University Elective**									
		Opt from the list of University Electives								
		TOTAL		**20**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

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Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

<u>For Award of B. Sc (Research) Biotechnology- four year course</u>

Total Credits: 89(C) + 20(AECC) + 14(SEC) + 20(GEC) + 24(DSE) + 23(DPR) =190

C= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GEC= Generic Elective, DSE= Discipline Specific Elective

Abbreviations: DCC-Discipline Core Courses; DSE-Discipline Specific Electives; GEC-Generic Elective Courses; DPR-Dissertation/Project/Field Study; IOJ-Internship/On-Job Experience; CEE-Community Engagement Experience; SEM-Seminar; RCC-Research Credit Courses; AECC-Ability Enhancement Compulsory Courses; SEC- Skill Enhancement Courses

Type	Level	Sem.	BoS	Course Code	Course Name	Credits			
						L	T/S	P	Total
AECC	5	1	SOA	SODECA-I	Social Outreach, Discipline & Extra Curriculum Activities -I	0	0	0	2
SEC	5	1	SOA	UC1002	Human Values and Professional Ethics	1	0	0	Non-Credit
AECC	5	1	SOA	UC1003	English Language	2	0	0	2
SEC	5	1	SOA	UC1004	Yoga Education & Practices	0	0	2	2
SEC	5	1	SOA	UC1005	Elementary Computers	2	0	0	2
DCC	5	1	SOA	BT1001	Cell Biology	3	0	0	3
DCC	5	1	SOA	BT1002	General Microbiology	3	0	0	3
DCC	5	1	SOA	BT1003	Biochemistry & Metabolism	3	0	3	3
SEC	5	1	SOA	BT1004	Introduction to Artificial intelligence	3	0	0	2
DCC	5	1	SOA	BT1101	Cell Biology Lab	0	0	3	2
DCC	5	1	SOA	BT1102	General Microbiology Lab	0	0	3	2
DCC	5	1	SOA	BT1103	Biochemistry & Metabolism lab	0	0	3	2
AECC	5	2	SOA	SODECA -II	Social Outreach, Discipline & Extra Curriculum Activities-II	0	0	0	2
AECC	5	2	SOA	UC2001	Indian Knowledge System	2	0	0	Non-credit
AECC	5	2	SOA	UC2002	English Communication	2	0	0	2
AECC	5	2	SOA	UC2003	Environmental Studies	2	0	0	2
SEC	5	2	SOA	UCFV	Field Visit-I	0	0	2	2
DCC	5	2	SOA	BT2001	Basics of Immunology	3	0	0	3
DSE	5	2	SOA	BT2002	Biotechnology and Human Welfare	3	0	0	3
DSE	5	2	SOA	BT2003	Biotechnology Skills and Analytical Techniques	3	0	0	3
DCC	5	2	SOA	BT2004	Genetics and Molecular Biology	2	0	3	2
DCC	5	2	SOA	BT2101	Basic Immunology Lab	2	0	3	2
DCC	5	2	SOA	BT2102	Genetics and Molecular Biology Lab	2	0	3	2
DCC	5	2	SOA	BT2103	Biotech Innovation Lab-I	2	0	3	2
AECC	6	3	SOA	SODECA-III	Social Outreach, Discipline & Extra Curriculum Activities-III	0	0	0	2
SEC	6	3	SOA	UCEEPI	Election and Electoral Processes in India	1	0	0	Non-Credit
SEC	6	3	SOA	UCFV	Field Visit-II	0	0	2	2
DCC	6	3	SOA	BT3001	Bioanalytical Techniques	3	0	0	3

DCC	6	3	SOA	BT3002	Environmental Biotechnology	3	0	0	3
GE	6	3	SOA	BT3003	Biosafety and Bioethics	3	0	0	3
DCC	6	3	SOA	BT3004	Chemistry-I	3	0	0	3
DCC	6	3	SOA	BT3101	Bioanalytical Techniques Lab	0	0	3	2
DCC	6	3	SOA	BT3102	Environmental Biotechnology Lab	0	0	3	2
DCC	6	3	SOA	BT3103	Chemistry I Lab	0	0	3	2
DSE	6	3	SOA	BT3005	Molecular diagnostics	3	0	0	3
DSE	6	3	SOA	BT3006	Biofertilizers and biopesticides	3	0	0	3
DSE	6	3	SOA	BT3007	AI in Healthcare and Biotechnology	3	0	0	3
DSE	6	3	SOA	BT3008	MOOC (through SWAYAM/NPTEL etc) Under Credit Transfer Scheme	3	0	0	3
AECC	6	4	SOA	SODECA-IV	Social Outreach, Discipline & Extra Curriculum Activities-IV				
DCC	6	4	SOA	BT4001	Chemistry II	3	0	0	3
DCC	6	4	SOA	BT4002	Genetic Engineering	3	0	0	3
GE	6	4	SOA	BT4003	Biostatistics and Data Analysis	3	0	0	3
GE	6	4	SOA	BT4004	IPR, Bio-entrepreneurship and Bio-business Management	3	0	0	3
DCC	6	4	SOA	BT4101	Chemistry II Lab	0	0	3	2
DCC	6	4	SOA	BT4102	Genetic Engineering Lab	0	0	3	2
DCC	6	4	SOA	BT4103	Biotech Innovation Lab-II	0	0	3	2
DSE	6	4	SOA	BT4005	Food Biotechnology	3	0	0	3
DSE	6	4	SOA	BT4006	Molecular modeling and drug designing	3	0	0	3
DSE	6	4	SOA	BT4007	Structural Biology	3	0	0	3
DSE	6	4	SOA	BT4008	MOOC (through SWAYAM/NPTEL etc) Under Credit Transfer Scheme	3	0	0	3
AECC	7	5	SOA	SODECA-V	Social Outreach, Discipline & Extra Curriculum Activities- V	0	0	0	2
SEC	7	5	SOA	UCFV	Field Visit-III	0	0	2	2
SEC	7	5	SOA	UC5001	Group Discussion, Aptitude & Reasoning-I	0	2	0	Non-credit
DCC	7	5	SOA	BT5001	Bioprocess Engineering	3	0	0	3
DCC	7	5	SOA	BT5002	Bioinformatics	3	0	0	3
DCC	7	5	SOA	BT5003	Plant Biotechnology	3	0	0	3
GE	7	5	SOA	BT5007	Data Science for Life Sciences	3	0	0	3
DCC	7	5	SOA	BT5101	Bioinformatics Lab	0	0	3	2
DCC	7	5	SOA	BT5102	Bioprocess Engineering Lab	0	0	3	2
DCC	7	5	SOA	BT5103	Plant Biotechnology Lab	0	0	3	2
DSE	7	5	SOA	BT5004	Nanobiotechnology	3	0	0	3
DSE	7	5	SOA	BT5005	Biophysics	3	0	0	3
DSE/GEC	7	5	SOA	BT5006	MOOC (through SWAYAM/NPTEL etc)	3	0	0	3

					Under Credit Transfer Scheme				
AECC	7	6	SOA	SODECA-VI	Social Outreach, Discipline & Extra Curriculum Activities-VI	0	0	0	2
SEC	7	6	SOA	UCFV	Field Visit-IV	0	0	2	2
DCC	7	6	SOA	BT6001	Animal Biotechnology	3	0	0	3
DCC	7	6	SOA	BT6002	Genomics and Proteomics	3	0	0	3
DCC	7	6	SOA	BT6101	Animal Biotechnology Lab	0	0	3	2
DCC	7	6	SOA	BT6102	Genomics and Proteomics Lab	0	0	3	2
GEC	7	6	SOA	BT6103	Medical Microbiology Lab	0	0	3	2
DPR	7	6	SOA	BT6104	Minor Project	0	0	3	6
GE	7	6	SOA	BT6003	Basics of Forensic Science	3	0	0	3
DSE	7	6	SOA	BT6004	Medical Biotechnology	3	0	0	3
DSE	7	6	SOA	BT6005	AI in Agriculture	3	0	0	3
B. Sc (Hons./Hons. with Research) Biotechnology									
AECC	8	7	SOA	SODECA-VII	Social Outreach, Discipline & Extra Curriculum Activities-VII	0	0	0	2
SEC	8	7	SOA	UC7001	Group Discussion, Aptitude & Reasoning-I	0	2	0	Non-credit
DCC	8	7	SOA	BT7001	Enzyme Biotechnology	3	-	-	3
DCC	8	7	SOA	BT7002	Environmental Toxicology	3	-	-	3
GEC	8	7	SOA	BT7003	Research Methodology and Scientific Communication skills	-	-	3	3
DCC	8	7	SOA	BT7101	Enzyme Biotechnology Lab	-	-	3	2
DCC	8	7	SOA	BT7102	Environmental Toxicology Lab	-	-	3	2
GEC	8	7	SOA	BT7103	Project Proposal Preparation and Presentation	-	-	3	3
DSE	8	7	SOA	BT7004	Nutrition and Health	3	-	-	3
DSE	8	7	SOA	BT7005	Epidemiology	3	-	-	3
DSE	8	7	SOA	BT7006	Synthetic Biology and Genome Editing	3	-	-	3
DCC	8	8	SOA	BT8001	Computer aided Drug Design	3	-	-	3
GE	8	8	SOA	BT8002	Entrepreneurship Development	3	-	-	3
DPR	8	8	SOA	BT8101	Research Project/Internship	-	-	18	6
DSE	8	8	SOA	BT8102	Seminar and Review Paper Writing in Immunotherapy/Sustainable development/Waste Management	-	-	12	4
DCC	8	8	SOA	BT8104	CADD Lab	0	0	3	2
DSE	8	8	SOA	BT8003	Cell Signaling and Cancer Biology	3	0	0	3
DSE	8	8	SOA	BT8004	Functional Food and Nutraceuticals	3	0	0	3
DSE	8	8	SOA	BT8005	Quantum Biotechnology	3	0	0	3
8th sem For B. Sc (Hons. with Research) Biotechnology									
DPR	8	8	SOA	BT8103	Research Project	-	-	45	15
DSE	8	8	SOA	BT8102	Seminar and Review Paper Writing in Immunotherapy/Sustainable development/Waste Management	-	-	12	4

Programme Structure for B. Sc Biotech or B. Sc (Hons./Hons. with Research) Biotechnology

Semester	Discipline Core Courses (Credits) (T+P=3+2; T=3)	Generic Elective Course/Discipline specific Elective (3)	University Core courses	Ability Enhancement compulsory Courses	Skill Enhancement Courses		Total Credits
					Skill based	Value added (Credits) L+T+P	
I	**1.**BT1001- Cell Biology (3) **2.**BT1002-General Microbiology (3) **3.**BT1003-Biochemistry & Metabolism (3) **4.**BT1101- Cell Biology Lab (2) **5.**BT1102-Biochemistry & Metabolism lab (2) **6.**BT1003- General Microbiology Lab (2)	-	SODECA-I Social Outreach, Discipline & Extra Curriculum Activities - I (2)	**1.** Human Values and Professional Ethics (Non-credit) **2.** English Language (2)	**1.** Yoga Education & Practices (2) **2.** Elementary Computers (2) **3.** Introduction to Artificial Intelligence (3)	Sports (1)	27
II	**1.** BT2001-Basics of Immunology (3) **2.** BT2004-Genetics and Molecular Biology (3) **3.** BT2101-Basic Immunology Lab (2) **4.** BT2102-Genetics and Molecular Biology Lab (2) **5.** BT2103-Biotech Innovation Lab-I (2)	BT2002-Biotechnology and Human Welfare (3) BT2003- Biotechnology Skills and Analytical Techniques (3)	SODECA-II Social Outreach, Discipline & Extra Curriculum Activities - II (2)	**1.** UC2001- Indian Knowledge System (Non-credit) **2.** UC2002-English Communication (2) **3.** UC2004-Environmental Studies (2)	**1.** UCFV- Field Visit-I (2)	Health and Wellness (1)	28
Exit option with Certificate in Biotechnology (with completion of courses equal to a minimum of 51 credits)							

III	**1.** BT3001-Bioanalytical Techniques (3) **2.** BT3002-Environmental Biotechnology (3) **3.** BT3004-Chemistry-I (3) **4.** BT3101-Bioanalytical Techniques Lab (2) **5.** BT3102-Environmental Biotechnology Lab (2) **6.** BT3103-Chemistry I Lab (2)	BT3003-Biosafety and Bioethics (3) **DSE Course (any one)- 3 credits:** **1.** BT3005-Molecular diagnostics **2.** BT3006-Biofertilizers and biopesticides **3.** BT3007- AI in healthcare and Biotechnology **4.** BT3008- MOOC (through SWAYAM/ NPTEL etc) Under Credit Transfer Scheme	SODECA-III Social Outreach, Discipline & Extra Curriculum Activities-III (2)		1. UCEEPI-Election and Electoral Processes in India (Non-credit) 2. UCFV- Field Visit-II (2)	-	25
IV	**1.** BT4001-Chemistry II (3) **2.** BT4002-Genetic Engineering (3) **3.** BT4101-Chemistry II Lab (2) **4.** BT4102-Genetic Engineering Lab (2) **5.** BT4103- Biotech Innovation Lab-2 (2)	**1.** BT4003-Biostatistics and Data analysis (3) **2.** BT4004-IPR, Bio-entrepreneurship and Bio-business Management (3) **DSE Course (any one)- 3 credits:** **1.** BT4005-Food Biotechnology **2.** BT4006-Molecular modeling and drug designing **3.** BT4007- Structural Biology **4.** BT4008-MOOC (through SWAYAM/ NPTEL etc) Under Credit Transfer Scheme	SODECA-IV Social Outreach, Discipline & Extra Curriculum Activities-IV (2)			Sports (1)	24
Exit option with Diploma in Biotechnology (with completion of courses equal to a minimum of 99 credits OR continue with degre)							

V	**1.** BT50001-Bioprocess Engineering (3) **2.** BT5002-Bioinformatics (3) **3.** BT5003-Plant Biotechnology (3) **4.** BT5101-Bioinformatics Lab (2) **5.** BT5102-Bioprocess Engineering Lab (2) **6.** BT5103-Plant Biotechnology Lab (2)	**GE** 1. BT5007- Data Science for Life Sciences (3) **DSE Course (any one)- 3 credits:** **1.** BT5004-Nanobiotechnology **2.** BT5005-Biophysics **3.** BT5006-MOOC (through SWAYAM/ NPTEL etc) under Credit Transfer Scheme	SODECA-V Social Outreach, Discipline & Extra Curriculum Activities-V (2)	-	1. UCFV- Field Visit-III (2) 2. UC5001- Group Discussion, Aptitude & Reasoning-I (Non-credit)	-	25
VI	**1.** BT6001-Animal Biotechnology (3) **2.** BT6002-Genomics and Proteomics (3) **3.** BT6101-Animal Biotechnology Lab (2) **4.** BT6102-Genomics and Proteomics Lab (2)	**DSE Course (any one)- 3 credits:** 1. BT6004- Medical Biotechnology 2. BT6003- Basics of Forensic science 3. BT6005-AI in Agriculture BT6103-Medical Microbiology Lab (2) BT6104-Minor Project (6)	SODECA-VI Social Outreach, Discipline & Extra Curriculum Activities-VI	-	UCFV- Field Visit-IV (2)	-	25
Exit option with BSc in Biotechnology (with completion of courses equal to a minimum of 149 credits OR continue for Hons/Research)							
VII	**1.** BT7001-Enzyme Biotechnology (3) **2.** BT7002-Environmental Toxicology (3) **3.** BT7101-Enzyme Biotechnology Lab (2) **4.** BT7102-Environmental	BT7003-Research Methodology and Scientific Communication skills (3) BT7103- Project Proposal preparation and Presentation (3) **Open Elective (3 credits):** **1.** BT7004-Nutrition and Health	SODECA-VII-Social Outreach, Discipline & Extra Curriculum Activities-VII (2)	-	UC7001-Group Discussion, Aptitude & Reasoning-I (Non-Credit)	-	21

	Toxicology Lab (2)	**2.** BT7005-Epidemiology **3.** BT7006-Synthetic Biology and Genome Editing					
VIII (for Hons.)	**1.** BT8001-Computer aided Drug Design (3) **2.** BT8002-Entrepreneurship Development (3) **3.** BT8101- Research Project//Internship (6 Credits) **4.** BT8104-CADD Lab (2)	**1.** BT8102-Seminar and Review Paper Writing in Immunotherapy/ Sustainable development/Waste Management (4) **DSE Course (any one)- 3 credits:** **1.** BT8003- Cell Signalling and Cancer Biology **2.** BT8004-Functional Food and Nutraceuticals **3.** BT8005- Quantum Biotechnology				-	20
VIII (for Hons. with Research.)	BT8103- Research Project (15 Credits)	BT8102- Seminar and Review Paper Writing in Immunotherapy/Sustainable development/Waste Management (4)				-	20
Award of B.Sc (Hons./ Hons. with Research) Degree in Biotechnology (with completion of courses equal to a minimum of 190 credits)							

SEMESTER-I

BT1001	**Cell Biology**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of Basic biology.
Learning objective	The learning objective of course are: To create an understanding regarding the cells and its organelles. To gain knowledge about cytoplasm and its components.
Course outcome	**CO1:** Remember the terms and basic concepts of cell biology and their different roles in biological systems **CO2:** Understand and remember the principle, mechanism of cellular reaction like cell membrane functions, membrane vacuolar system, intracellular compartmentalization and extracellular complexes. **CO3:** Applying, understanding and remembering the detailed processes of structure and function of Cell membrane, cytoplasmic organelles and different components of cells. **CO4:** Analyzing, Applying, remembering, Understanding the detailed processes of structure and function of Membrane carbohydrates, lipids and proteins, cytoplasmic organelles and different components of cells. **CO5:** Evaluating, Analyzing, Applying, remembering, and understanding the principle, methods, properties, functions and isolation of Biochemical cell's components and organelles and Constructing (Creating), the cell biology and cancer biology.
Unit-I	**Cell and Organelles** **8 hours**
	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.
Unit-II	**Structure of Cell organelles** **7 hours**
	Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.
Unit-III	**Functions of cell organelles** **7 hours**
	Lysosomes: Vacuoles and micro bodies: Structure and functions, Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis. Nucleus: Structure and function, chromosomes and their structure.
Unit-IV	**Extracellular Matrix and cancer** **7 hours**
	Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.
Unit-V	**Interactions between cell & environment** **7 hours**

	Interactions between cell & environment: - cell functions, cells adhesions, cell junction and extracellular matrix, cell signaling through G-protein linked receptors. Cellular regulation. cell cycle and its regulation. Mitosis and Meiosis. cell apoptosis.
Reference 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. 8thedition.Lippincott Williams and Wilkins, Philadelphia. 3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & 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.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	1	1	1	1	3	1	1	2	3	2	2	2	3
CO2	3	3	2	1	1	1	2	2	3	1	1	2	3	2	1	2	2
CO3	3	3	3	3	3	3	2	2	3	2	2	2	3	2	2	2	3
CO4	3	2	3	3	3	3	1	1	3	1	1	2	3	3	3	2	2
CO5	3	2	3	2	1	1	2	2	3	3	2	1	3	2	2	2	2

3: High, 2: Medium, 1: Low

BT1002	**General Microbiology**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of microbiology.
Learning objective	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
Course outcome	**CO1:** Understand the core principles, history, and diversity of microbiology, as well as techniques for cultivating and maintaining microorganisms, microbial growth, metabolism, reproduction, and control. **CO2:** Grasp the fundamentals, historical context, and diversity of microbiology, along with methods for cultivating and maintaining microorganisms, microbial growth, metabolism, reproduction, and control. **CO3:** Apply detailed knowledge of microbiology processes, techniques, genetic recombination, microbial diversity and metabolism, pathogen control, and microbiology in water and food contexts. **CO4:** Analyze and apply comprehensive understanding of microbiology concepts, genetic recombination, diversity, metabolism, pathogen control, and their applications in water and food microbiology. **CO5:** Evaluate and analyze the principles, methods, and functions of microbiology techniques, genetic recombination, diversity, metabolism, pathogen control, and their relevance to water and food microbiology.
Unit-I	**Fundamentals of microbiology** **8 hours**
	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. Viruses: SARS CoV2
Unit-II	**Cultivation and Maintenance of microorganisms** **7 hours**
	Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.
Unit-III	**Microbial growth** **7 hours**
	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** **7 hours**
	Control of Microorganisms: By physical, chemical and chemotherapeutic Agents Water

	Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.
Unit-V	**Food Microbiology** **7 hours**
	Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.
Reference 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. 4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings. 5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company. 6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan. 7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education. 8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	2	1	2	1	3	1	1	2	3	2	2	2	3
CO2	3	2	2	2	1	1	2	2	3	1	1	2	3	2	1	2	2
CO3	3	3	3	3	3	3	2	2	3	2	2	2	3	2	2	2	3
CO4	3	2	3	3	3	3	1	2	3	1	1	2	3	3	3	2	2
CO5	3	2	3	2	1	1	2	2	3	3	2	1	3	2	2	2	2

3: High, 2: Medium, 1: Low

BT1003	**Biochemistry & Metabolism**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of Basic biology.
Learning objective	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.
Course outcome	**CO1:** Understand and recall the properties of amino acids and proteins, classify protein types, and explain purification techniques and protein structural changes. **CO2:** Comprehend lipid classification and nucleic acid properties, including DNA's double helical model. **CO3**: Apply enzyme classification and structure knowledge, and analyze enzyme kinetics. **CO4:** Analyze enzyme specificity and evaluate the roles of various coenzymes in enzymatic reactions. **CO5:** Evaluate carbohydrate metabolism processes and analyze energy metabolism pathways.
Unit-I	**Amino acids, Proteins and Carbohydrates** **8 hours**
	Amino acids & Proteins: Structure and properties of Amino acids, Types of proteins and their classification, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Urea cycle, Deamination and transamination. **Carbohydrates**: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Glycoprotein's and their biological functions.
Unit-II	**Lipids and Nucleic acids** **7 hours**
	Lipids:Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. β-oxidation of fatty acids. **Nucleic acids**: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA.
Unit-III	**Enzymes** **7 hours**
	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	**Enzyme specificity and co-enzymes** **7 hours**
	Enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions
Unit-V	**Carbohydrates Metabolism** **7 hours**
	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.
Bibliography	1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co. 2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of

	Plants.American Society of Plant Biologists. 3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA. 4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons. 5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2	1	2	1	3	1	2	2	3	2	2	2	3
CO2	3	2	2	2	1	1	2	2	3	2	1	2	3	2	1	2	2
CO3	3	3	3	3	3	3	2	2	3	2	2	2	3	2	2	2	3
CO4	3	2	3	3	3	3	1	2	3	1	1	2	3	3	3	2	2
CO5	3	2	3	2	2	1	2	2	3	3	2	1	3	2	2	2	2

3: High, 2: Medium, 1: Low

BT1004	Introduction to Artificial Intelligence
Version	1.0
Prerequisite	Basic knowledge of computer fundamentals, mathematics, and biological sciences.
Learning objective	The course is designed to introduce the fundamental concepts, techniques, and applications of Artificial Intelligence with emphasis on biological and industrial applications. The specific objectives are: 1. To familiarize students with the principles, history, and importance of Artificial Intelligence. 2. To introduce intelligent systems, problem-solving approaches, and knowledge representation techniques. 3. To provide foundational understanding of machine learning methods and AI algorithms. 4. To highlight emerging trends and industrial applications of AI. 5. To expose students to AI applications in biotechnology, healthcare, and life sciences.
Course outcome	**CO1:** Understand the concepts, evolution, types, and applications of Artificial Intelligence. **CO2:** Analyze intelligent systems, search strategies, and AI-based problem-solving approaches. **CO3**: Evaluate knowledge representation methods, logical reasoning, and expert systems. **CO4:** Apply basic machine learning concepts and computational approaches used in AI systems. **CO5:** Analyze recent trends and real-world applications of AI in industries, healthcare, and biotechnology.
Unit-I	**Fundamentals of Artificial Intelligence 8 hours**
	Introduction to Artificial Intelligence, History and evolution of AI, Goals, scope, and importance of AI, Types of AI: Narrow AI, General AI, AI vs Machine Learning vs Deep Learning, Applications of AI in daily life and biological sciences
Unit-II	**Intelligent Systems and Problem Solving 7 hours**
	Concept of intelligent agents, Problem formulation in AI, State space representation, Introduction to search techniques: Breadth First Search (BFS), Depth First Search (DFS), Heuristic search (basic idea). Applications in biological problem solving
Unit-III	**Knowledge Representation and Expert Systems 7 hours**
	Knowledge representation concepts, Logical Agents– Propositional and first order Predicate logic-–inference– Knowledge representation and Automated Planning– Uncertain Knowledge and Reasoning: Quantifying uncertainty– probabilistic reasoning
Unit-IV	**Introduction to Machine Learning 7 hours**
	Introduction to machine learning, Supervised and unsupervised learning, Classification and regression (conceptual overview), Clustering and pattern recognition (basic idea), Neural networks and deep learning (introductory concepts), Machine Learning Model, Regression Analysis in Machine Learning, Classification Techniques, Clustering Techniques, Naïve Bayes Classification, Neural Network, Support Vector Machine (SVM).
Unit-V	**Trends in AI and its applications in Industries 7 hours**
	AI and Ethical Concerns, AI as a Service (AIaaS), Recent trends in AI, Expert System, Internet of Things, Artificial Intelligence of Things (AIoT), AI applications in-genomics, drug discovery, healthcare, diagnostics, precision medicine
Bibliography	1. Artificial Intelligence: A Modern Approach, Third Edition, Stuart Russell and Peter Norvig, Pearson Education. 6. Ajantha Devi Vairamani and Anand Nayyar, Prompt Engineering: Empowering

	Communication, 1st Edition, CRC Press, Taylor & Francis Group, 2024. 7. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (4th Edition), Pearson Education, 2023. 8. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, Artificial Intelligence, McGraw Hill Education.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	1	1	1	2	-	1	1	1	2	2	1	2	2
CO2	3	3	2	2	1	1	1	2	-	1	1	1	2	3	2	2	2
CO3	2	3	2	2	1	1	1	2	-	1	2	1	2	3	1	2	2
CO4	3	3	3	3	2	2	2	2	1	1	1	2	3	3	3	2	3
CO5	3	3	3	3	3	2	2	3	1	2	2	2	3	3	2	3	3

3: High, 2: Medium, 1: Low

SEMESTER-II

BT2001	**Basics of Immunology**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of circulatory system.
Learning objective	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.
Course outcome	**CO1:** Understand the mammalian immune system components, including antibodies, and differentiate between humoral and cellular immune responses. Analyze the roles of T-lymphocytes in immune response. **CO2**: Analyze genetic rearrangements during B-lymphocyte differentiation and the assembly of T-cell receptor genes. Evaluate the role of adjuvants, cytokines, and the complement system in immunity. **CO3:** Evaluate the major histocompatibility complexes and their role in antigen processing. Analyze immunity to different pathogens and pathogen defense strategies. **CO4:** Analyze the regulation of immunoglobulin gene expression and the genetic basis of antibody diversity. Evaluate theories related to antibody diversity and immunologic memory. **CO5**: Assess immune-techniques such as blood grouping and antigen-antibody reactions. Analyze autoimmune diseases, factors contributing to their development, and mechanisms involved in immunodeficiency diseases like AIDS.
Unit-I	**Immune Response** **7 hours**
	Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T lymphocytes& immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, T cell and B cell activation.
Unit-II	**Genetic Rearrangement** **7 hours**
	Genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination. Adjuvants, cytokine and signaling, Complement system.
Unit-III	**Major Histocompatibility complexes** **7 hours**
	Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition.
Unit-IV	**Regulation of Ig** **7 hours**
	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-V	**Immunotechniques and Autoimmune disease** **8 hours**

	Blood grouping, Antigen-Antibody reactions: agglutination, precipitation, immuno-electrophoresis, Coomb's test, ELISA, RIA. Vaccines & Vaccination Autoimmunity & auto-immune diseases, factors contributing development of auto-immune diseases, mechanism of development, breakdown of self-tolerance, rejection of transplants, molecular mimicry, nature of auto-antigens, immunodeficiency, AIDS
Reference 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-Blackwell Scientific Publication, Oxford. 3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York. 4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York. 5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg. 6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	2	2	1	3	1	2	2	3	3	2	2	3
CO2	3	3	2	3	1	2	2	2	3	2	1	2	3	2	2	2	2
CO3	3	3	3	3	3	3	2	2	3	2	2	2	3	2	2	2	3
CO4	3	2	3	3	3	3	1	2	3	1	1	2	3	3	3	2	2
CO5	3	2	3	2	2	1	2	2	3	3	2	1	3	3	2	2	2

3: High, 2: Medium, 1: Low

BT2002	Biotechnology and human welfare
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of biotechnology
Learning objective	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.
Course outcome	**CO1:** Understand the principles of protein engineering, enzyme synthesis, and the production of alcohol and antibiotics in industrial settings. **CO2:** Evaluate the role of nitrogen fixation, pest resistance gene transfer, and plant-microbe interactions in agricultural practices. **CO3:** Analyze processes involved in environmental pollutant degradation, stress management, and the development of biodegradable polymers. **CO4:** Assess forensic methods for solving crimes and disputes, including DNA fingerprinting techniques for identifying individuals and resolving legal cases. **CO5:** Evaluate advancements in health-related fields, such as the development of therapeutic agents, vaccines, gene therapy, diagnostics, and contributions from projects like the Human Genome Project.
Unit-I	**Industry** **8 hours**
	Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion,alcohol and antibiotic formation.
Unit-II	**Agriculture** **7 hours**
	Agriculture: N_2 fixation: transfer of pest resistance genes to plants; interaction between plantsand microbes; qualitative improvement of livestock.
Unit-III	**Environment** **7 hours**
	Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation ofhydrocarbons and agricultural wastes, stress management, development of biodegradablepolymers such as PHB.
Unit-IV	**Forensic science** **7 hours**
	Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternityand theft etc. using various methods of DNA finger printing.
Unit-V	**Health** **7 hours**
	Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, genetherapy, diagnostics, monoclonal in E.coli, human genome project.
Reference 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 internationalpublishers
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by	

academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2	2	2	2	3	1	2	2	3	3	3	2	3
CO2	3	2	2	2	1	1	2	2	3	2	1	2	3	2	2	2	2
CO3	3	3	3	3	3	3	2	2	3	2	2	2	3	2	2	2	2
CO4	3	2	3	3	3	3	1	3	3	1	1	2	3	3	3	2	2
CO5	3	2	3	2	2	1	2	3	3	3	2	2	3	2	2	2	2

3: High, 2: Medium, 1: Low

BT2003	Genetics and Molecular Biology
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Genetics
Learning objective	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.
Course outcome	**CO1:** Understand genetic history, Mendelian principles, and allelic interactions, including dominance and various genetic inheritance patterns. **CO2:** Analyze non-allelic genetic interactions and chromosome organization in eukaryotes, focusing on unique and repetitive DNA sequences. **CO3:** Evaluate genetic organization, mutations, and chromosome variations, including deletions, duplications, inversions, and translocations. **CO4:** Analyze DNA replication mechanisms, including replication fidelity, and mechanisms of DNA damage and repair. **CO5:** Evaluate transcription and translation processes, including gene regulation mechanisms, genetic code characteristics, translation fidelity, and protein post-translational modifications.
Unit-I	**Introduction and Mendelian genetics** **8 hours**
	Introduction: Historical developments in the field of genetics. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.
Unit-II	**Non allelic interactions** **7 hours**
	Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences - SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.
Unit-III	**Genetic organization and mutation** **7 hours**
	Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function. Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.
Unit-IV	**Replication and DNA damage** **7 hours**
	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. DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair, Homologous recombination.
Unit-V	**Transcription and translation** **7 hours**
	RNA structure and types of RNA, Transcription in prokaryotes, Transcription in eukaryotes, Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation, Fidelity of translation, Inhibitors of translation. Posttranslational modifications of proteins.
Reference books	1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons. 2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc. 3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings. 4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings. 5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co. 6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc. 7. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	1	2	2	2	2	3	2	3	3	3	3	3	3
CO2	3	2	3	2	1	3	2	2	3	3	1	3	3	3	3	3	2
CO3	3	3	2	2	1	3	2	2	2	3	2	2	3	3	3	2	3
CO4	3	2	3	3	0	3	3	2	2	2	3	3	3	3	3	3	2
CO5	3	3	3	3	0	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT2004	Biotechnology skills and Analytical techniques
Version	1.0
Prerequisite	Basic understanding of biology and laboratory procedures.
Learning objective	To equip students with the necessary industry-specific, interpersonal, digital, and laboratory skills required for successful careers in the biotechnology sector.
Course outcome	**CO 1.** Knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety (EHS), good laboratory practices (GLP), standard operating procedures (SOP) and GMP as per the industry standards. **CO 2.** Acquire essential interpersonal and digital skills, including effective communication, conflict resolution, data interpretation, and basic computer proficiency, crucial for success in a laboratory or workplace setting. **CO 3.** Skill enhancement as per National Occupational Standards (NOS) of "Lab Technician/ Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council – LFS/Q0509, Level 3. **CO4:** Soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking, and documentation. **CO5**: Demonstrate competence in laboratory analytical skills, including solution preparation, cleaning and maintenance of lab equipment, handling of chemicals, and adherence to safety protocols, essential for efficient laboratory operations and research outcomes.
Unit-I	**Insights into biotechnology industry and Industrial professional skills** **8 hours**
Biotechnology Industry in Indian and Global context – organization in context of large /medium/ small enterprises, their structure and benefits. Industry professional skills: Planning and organizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, risk assessment.	
Unit-II	**Interpersonal and Digital skills** **7 hours**
Interpersonal skills: Writing skills, reading skills, oral communication, conflict-resolution techniques, interpretation of research data, trouble shooting in work place Digital skills: Basic Computer Skills (MS Office, Excel, Power point, Internet) for Workplace. Professional Email drafting skills and PowerPoint presentation skills	
Unit-III	**Analytical Skills in laboratory** **7 hours**
Solutions: Molarity, Molality, Normality, Mass percent % (w/w), Percent by volume (% v/v), parts per million (ppm), parts per billion (ppb), Dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottle label reading and precautions **Methods and practices of cleaning and management of lab:** Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirements for cleaning specific area, equipment, ventilation area, personal protective requirements **Procedure of cleaning and storage of Labware:** Methodology for storage area, Cleaning procedure and materials to be used for various surfaces. Sign boards, labelling do's & don'ts, Knowledge about standard procedures of cleaning or glass ware, plastic ware. Maintenance of inventory; **Best practices of usage and storage of chemicals:** Knowledge and practice in handling of chemicals, labelling and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labelling, storage, and disposal.	
Unit-IV	**Usage and maintenance of basic equipment of biotechnology lab** **7 hours**
Principles, calibrations, and SOPs of weighing balances, pH meters, autoclaves, laminar flows and biosafety cabinets, basic microscopes, homogenizers, stirrers, colorimeters, UV, and Visible spectrophotometers. Properties and uses of	

chemicals commonly used in life sciences laboratories. Maintaining safety standards for handling various solutions and chemicals. Preparation of test reagents and buffers,	
Unit-V	**Principles and practices of lab safety and Laboratory Record writing 7 hours**
Knowledge about safety symbols and hazard signs. Personal safety gears, utility, and disposal. Equipment safety protocols, chemical safety protocols. Documentation of chemical and equipment usage records. Handling hazardous chemicals. **Record maintenance as per SOP's:** Labelling of samples and reagents as per SOP's. Recording detail of work done for research experiments. Importance of study of manuals, health, and safety instructions Method of record writing, data collection and recording, reporting of result, discussion of result, summary writing, effective PowerPoint presentation taking any experiment as example	
Reference books	1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons. 2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc. 3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings. 4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings. 5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co. 6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc. 7. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3	3	2	2	2	2	3	3	2	2	3	2	3
CO2	2	2	2	3	2	3	2	3	3	3	2	2	1	2	2	2	3
CO3	3	3	3	3	2	3	2	2	2	2	2	3	2	3	3	2	3
CO4	2	3	3	2	2	3	2	3	3	3	3	2	1	2	2	2	3
CO5	3	3	3	3	3	3	2	2	2	2	3	3	2	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER-III

BT3001	**Bioanalytical Techniques**
Version	2.0
Prerequisite	All students are expected to have a basic knowledge of techniques
Learning objective	The broad objective of the course is to make students aware about the importance and significance of the diverse tools and techniques used to study and understand the biological world. The specific objectives of the course are as follows: 1. To introduce the basic principle, types and application of microscopy. 2. To study concepts applications and types of centrifugation. 3. To acquaint students with chromatography and spectroscopy techniques. 4. To makes students understand the techniques of electrophoresis and blotting
Course outcome	**CO1:** Understand the principles and applications of various microscopy techniques including light, phase contrast, fluorescence, confocal, scanning, and transmission electron microscopy. **CO2:** Analyze the principles and applications of UV-visible, IR, NMR spectroscopy, and X-ray crystallography. **CO3:** Evaluate the principles and applications of centrifugation techniques, including sedimentation rate, types of centrifuges, and different types of centrifugation methods. **CO4:** Understand the principles and applications of various chromatography techniques, including adsorption chromatography, gas chromatography, liquid chromatography, and HPLC. **CO5:** Analyze the principles and applications of electrophoresis techniques, including paper electrophoresis, agarose and polyacrylamide gel electrophoresis, Western blotting, and isoelectric focusing.
Unit-I	**Microscopy** **7 hours**
	Basic knowledge of the principles and applications of Microscopy: Light, phase contrast, Fluorescence and Confocal microscopy, Scanning and Transmission Electron microscopy.
Unit-II	**Spectroscopy** **7 hours**
	Spectroscopic methods: principle and applications of UV-visible, IR, NMR. Spectroscopy. Principle & application of X-ray crystallography.
Unit-III	**Centrifugation** **7 hours**
	Centrifugation: Basic principles. Common centrifuges used in laboratory (clinical, high speed &ultra centrifuges). Sedimentation rate, Sedimentation coefficient, Zonal centrifugation, Equilibrium density gradient centrifugation Types of rotors (fixed angle, swing bucket), Types of centrifugation: Preparative, differential & density gradient
Unit-IV	**Analytical separation methods** **8 hours**
	Chromatography - General principle and application Adsorption chromatography, Partition chromatography, Gas chromatography, liquid chromatography, Paper chromatography, Thin layer chromatography, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, HPLC (High Performance/Pressure Liquid chromatography).
Unit-V	**Electrophoresis** **7 hours**
	Electrophoresis - General principle and application, Paper electrophoresis, Agarose and Polyacrylamide Gel electrophoresis (Native, Denaturing & Reducing), Western Blotting, Disc Gel electrophoresis, Slab Gel electrophoresis, Isoelectrofocussing (IEF)

Reference books	1. Sharma, V.K.: Techniques in Microscopy and Cell Biology Tata McGraw Hill, 1991. 2. Alberts et al.: Molecular Biology of the cell (2nd ed.), Garland, 1989. 3. Biochemical Technique: Theory & Practical J.F. Robyt& B.J. White $ 30.95. Waveland Press, Inc. 4. Wilson & Walker: Practical Biochemistry (4th ed) University of Hertfordshire Cambridge University Press 5. Jayraman: Laboratory Manual in Biochemistry 6. Arnold L. Demain& Julian E. Davies: Manual of Industrial Microbio. & Biotech. 2nd ed
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	1	2	2	2	2	2	2	3	3	3	3	3	3
CO2	3	3	3	2	1	3	2	2	2	3	1	3	3	3	3	3	2
CO3	3	3	2	2	2	3	2	2	2	3	2	2	2	3	2	2	2
CO4	3	3	3	3	2	3	3	2	1	2	3	3	3	3	3	3	2
CO5	3	2	3	2	1	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT3002	Environmental Biotechnology
Version	2.0
Prerequisite	All students are expected to have a basic knowledge of Environmental Sciences.
Learning objective	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 learn its applications. 4. To give students an overview of various applications of biotechnology in pollution control and biotransformation of pollutants.
Course outcome	**CO1:** Understand the environmental impact of conventional and modern fuels, including firewood, coal, biogas, and gasohol, and analyze their implications on the environment. **CO2:** Analyze different types of environmental pollutants from natural and anthropogenic sources, and evaluate their impact on society and nature. **CO3:** Evaluate wastewater treatment processes and the utilization of biomass-derived biomaterials for treating municipal and industrial effluents. **CO4:** Understand the role of nitrogen-fixing bacteria and biofertilizers in soil enrichment, and analyze the process of bioleaching for ore enrichment. Evaluate the environmental significance of genetically modified organisms. **CO5:** Evaluate bioremediation and biodegradation processes for soil and water contamination, including oil spills, heavy metals, and xenobiotics, and analyze techniques for analyzing pollutant transformation.
Unit-I	**Conventional fuels and their environmental impact** **8 hours**
	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	**Pollutants and their environmental impact** **7 hours**
	Environmental Pollutants and their types from natural and anthropogenic sources: Metals, Solvents, Radiations, Carcinogen, Poisons. Impact on pollutants on society and Nature
Unit-III	**Waste Treatment** **7 hours**
	Wastewater: Primary, Secondary, Tertiary treatment processes, Treatment of municipal waste and Industrial effluents: utilizing biomass derived biomaterials
Unit-IV	**Biofertilizer and Bioleaching** **7 hours**
	Bio-fertilizers, Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM), Bioleaching: Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.
Unit-V	**Bioremediation and Biodegradation** **7 hours**
	An overview of process of Bioremediation and Biodegradation, Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents, Degradation of lignin and cellulose using microbes, Degradation of Basic Structures found in Hydrocarbons & Xenobiotics,

	Biodegradation of Xenobiotics, PCBs (Poly Chlorinated Biphenyls), DDT, Nitrobenzene, Biomagnifiction, Phyto-remediation. Techniques to analyze biotransformation of pollutants.
Reference 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
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3	2	2	2	2	3	2	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	2	2	3	2	3	2	3	3	3	2
CO3	3	3	2	2	3	3	2	2	2	3	2	2	2	3	2	2	2
CO4	3	3	3	3	3	3	3	2	1	2	3	3	3	3	3	3	2
CO5	3	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT3003	Bioethics and Biosafety
Version	1.0
Prerequisite	All students are expected to have a basic concept of general biology.
Learning objective	The learning objective of course are to introduce safety and ethical aspects of applied biology. The student will be able to conceptualize about Govt guidelines of Biosafety, Relevance of Bioethics, Ethics in Health Care, Biosafety Management
Expected Outcome	**CO1:** Understand biosafety historical background, principles of biological safety cabinets, and biosafety levels for specific microorganisms. Analyze universal biosafety guidelines. **CO2:** Analyze Indian government regulations on GMOs and LMOs. Evaluate roles of biosafety committees and regulatory bodies in assessing GMO applications. Assess biosafety of biotech foods and pharmaceutical products. **CO3:** Evaluate risk analysis, assessment, and management in biosafety. Analyze national regulations and international agreements on biosafety. Assess ethical implications of biotechnology and biological weapons. **CO4:** Define bioethics and its relevance to various professions. Analyze moral and ethical norms relevant to bioethics. **CO5:** Evaluate ethical issues in healthcare, including prenatal screening, clinical trials, and women's health. Analyze ethical issues in HIV medicine and research ethics related to HIV.
Unit-I	**Introduction** **7 hours**
Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Definition, historic evolution, codes and guidelines, universal principles.	
Unit-II	**Biosafety guidelines** **8 hours**
Government of India definition of genetic modified organism (GMOs) and living modified organisms (LMOs), roles of institutional biosafety committee, review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMOs. The GM-food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.	
Unit-III	**Biosafety management** **7 hours**
Risk analysis, risk assessment, risk management and communication, overview of national regulations and relevant international agreements including Cartagena Protocol.Key to the environmentally responsible use of biotechnology, ethical implications of biotechnological products and techniques, social and ethical implications of biological weapons.	
Unit-IV	**Bioethics** **7 hours**
Define the term “Bioethics” in relation to profession, society, and biomedicine, learn about gradation of moral and ethical norms from simpler to higher levels for initiating right actions to „first do no harm“ and learn about prayers, oaths, covenants, declarations, guidelines and codes which have relevance to bioethics.	
Unit-V	**Health ethics** **7 hours**
Describe the sanctity of human life and the need to preserve human life, explain about issues related to prenatal screening, **Preclinical studies**, clinical trials (Phase I/II/III/IV) studies. Vulnerability of women with respect to health care, examination and screening of women for disease, social issues like domestic violence and female genital mutilation and abortion.identify ethical issues in clinical practice of HIV medicine and its prevention, research ethics related to HIV.	

Reference books	1. Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703. 2. The Cambridge Textbook of Bioethics, 1st edition (2008), Peter A. Singer and A. M. Viens; Cambridge University Press, ISBN-13: 978-0511545566. 3. Foundation of Bioethics, 2nd edition (1996), E. H Tristram; Oxford University Press, ISBN-13: 9780195057362. 4. Social science: An introduction to the study of society, 14th edition (2010), Hunt, E. F.,and Colander, D. C. ; Peason/Allyn and Bacon, Boston, ISBN-13: 978-020570271. 5. Principles of Biomedical Ethics, 6th edition (2011), Beauchamp Tl, Childress JF; Oxford University Press, 2001. ISBN-13: 978-0195143317. 6. A Companion to Bioethics, 2nd edition (2012), Helga Kuhse, Peter Singer; John Wiley and Sons, ISBN-13: 978-1444350845.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	2	2	2	2	3	2	3	2	2	3	3	3
CO2	3	2	3	2	2	3	2	2	2	3	2	3	2	3	3	3	2
CO3	2	3	2	2	2	3	2	2	2	3	2	2	2	3	2	2	2
CO4	2	2	3	3	2	3	3	2	1	2	3	3	2	2	3	3	2
CO5	3	3	3	2	2	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT3004	**Chemistry I**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of chemistry
Learning objective	The specific objectives of the course is to teach students the basic concepts of chemistry and the importance of chemistry in sustainable development, and fundamental principles of biocatalysis, photochemistry & electrochemistry.
Course outcome	**CO1:** Understand Fischer, Newman, Sawhorse projections & wedge formulas. Analyze interconversion of structural representations, different conformations of ethane, butane, and cyclohexane. **CO2:** Analyze requirements for geometrical isomerism and optical activity. Understand Cis-Trans, E/Z notation, and CIP rules. **CO3:** Analyze reactions of alkenes and alkynes, including hydrogenation, hydration, and ozonolysis. Evaluate reactions of aldehydes and ketones, including addition-elimination reactions and name reactions. **CO4:** Understand free radical substitution reactions of alkanes and nucleophilic substitution reactions. Analyze mechanisms of SN1 and SN2 reactions. Evaluate substitution reactions of alcohols, amines, and phenols. **CO5:** Analyze hydrolysis of carboxylic acid derivatives and cleavage reactions of ethers. Understand electrophilic substitution reactions of aromatic compounds and elimination reactions of alkyl halides and quaternary ammonium salts.
Unit-I	**Stereochemistry-I** **8 hours**
	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.
Unit-II	**Stereochemistry-II** **7 hours**
	Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, Cis-Trans and E/ Z notation along with CIP rules for geometrical isomers. Optical Isomerism: Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. R and S configuration (upto two chiral centers).
Unit-III	**Unsaturated and carbonyl compounds** **7 hours**
	Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercuration demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes. **Aldehydes and ketones:** (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition- elimination reactions with ammonia and its derivatives Name reactions: Aldol, cross Aldol, Claisen, Knoeven gel, Cannizzaro, cross Cannizzaro
Unit-IV	**Free radical and nucleophilic Substitution reactions** **7 hours**

	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) **Benzene diazonium chloride:** Replacement of diazo group Alcohols, amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols (using PCl5, SOCl2 and HI)
Unit-V	**Aromatic Electrophilic substitution and Elimination reaction 7 hours**
	Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents. **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.
Reference books	1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5 th 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. 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.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	0	2	2	2	1	2	2	3	3	2	2	2	2
CO2	3	3	3	2	0	3	2	2	1	2	1	3	2	2	2	3	2
CO3	3	3	2	2	0	3	2	2	1	2	2	2	2	2	2	2	2
CO4	2	3	3	3	0	3	3	2	1	2	3	3	3	2	2	3	2
CO5	3	2	3	2	0	3	3	2	1	2	2	3	3	3	2	3	3

3: High, 2: Medium, 1: Low

BT3005	Molecular Diagnostics
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Microbiology and Immunology
Learning objective	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.
Course outcome	**CO1:** Understand enzyme immunoassays, including enzyme comparison, conjugation, and solid phases. Analyze their applications in diagnostic microbiology. **CO2:** Evaluate molecular methods such as PCR, RFLP, and nuclear hybridization in clinical microbiology. **CO3:** Analyze laboratory tests for chemotherapy, including susceptibility tests and automated procedures for antimicrobial susceptibility. **CO4**: Understand automation in microbial diagnosis and rapid diagnostic approaches, including antigen and antibody standardization. **CO5:** Evaluate concepts and methods in idiotyping, including epitope design and applications in immunodiagnostic tests.
Unit-I	**Enzyme Immunoassays** **8 hours**
	Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solidphases used in enzyme immunoassays. Homogeneous and heterogeneous enzymeimmunoassays. Enzyme immunoassays after immunoblotting. Enzyme immuno-histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immunoassays. Applications of enzyme immunoassays in diagnostic microbiology
Unit-II	**Molecular methods in clinical microbiology** **7 hours**
	Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphismand plasmid finger printing in clinical microbiology
Unit-III	**Laboratory tests in chemotherapy** **7 hours**
	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-IV	**Automation in diagnostics** **7 hours**
	Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies.
Unit-V	**Idiotyping** **7 hours**
	Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immunofluorescence. Radioimmunoassay.
Reference books	1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker 2. Bioinstrumentation, Webster 3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic 4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker

	CKJ). University Press Publication. 5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication. 6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition. Elsevier. 7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication. 8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education. 9. Microscopic Techniques in Biotechnology, Michael Hoppert
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	1	2	2	2	1	3	2	3	3	3	3	2	3
CO2	3	3	3	2	1	3	2	2	2	3	1	3	3	3	3	3	3
CO3	3	3	2	2	2	3	2	2	2	3	2	2	3	3	2	2	2
CO4	3	3	3	3	2	3	3	2	1	2	3	3	3	3	3	3	3
CO5	3	2	3	2	1	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT3006	Bio-fertilizers and Biopesticides
Version	1.0
Prerequisite	Basic understanding of agriculture, microbiology, and environmental science.
Learning objective	The students will be able to 1. Classify different types of biopesticides and analyze their effectiveness in pest management. 2. Evaluate the environmental benefits of using biopesticides in organic farming practices. 3. Understand the production techniques and scaling up processes involved in biopesticide
Course Outcome	**CO1:** Understand the concept and classification of insect pathogens and biopesticides. Analyze their importance in eco-friendly agriculture and the virulence of entomopathogenic organisms. **CO2:** Evaluate different types of biopesticides and their role in organic farming. Assess production methods, application techniques, and quality control measures for biopesticides. **CO3:** Analyze the scope and classification of biofertilizers, including nitrogen-fixing microbes. Understand their production, application methods, and benefits in sustainable agriculture. **CO4:** Evaluate phosphate-solubilizing microbes and their role in plant growth promotion. Understand production techniques and the significance of plant growth-promoting biofertilizers. **CO5:** Assess quality control measures and applications of biofertilizers. Understand the role of beneficial microbes in waste recycling and composting. Analyze application technologies and storage considerations for biofertilizers.
Unit-I	**Introduction** **7 hours**
History and concept of Insect pathogens and Bio Pesticides. Introduction, importance, scope and potential of Bio Pesticides. Definitions, concepts and classification of Bio Pesticides viz. pathogens, botanical pesticides, and bio rational. Microbial Bio Pesticides viz. Viruses, Bacteria, Fungi etc. Virulence, pathogenicity and symptoms of entomopathogenic organisms.	
Unit-II	**Biopesticides** **8 hours**
Botanicals & other bio rational pesticides and their uses. Role of Bio Pesticides in Organic farming and ecofriendly agriculture. Mass production and scaling up of production of different categories of Bio Pesticides. Methods of applications of Bio Pesticides. Precautionary approaches in application and usage of Bio Pesticides. Methods of quality control and Techniques of Bio Pesticides. Constraints & possible solutions in production and use of Bio Pesticides	
Unit-III	**Biofertilizers** **7 hours**
Different Agriculturally important beneficial Microorganisms. Introduction and scope of Biofertilizers Types and classification of Biofertilizers. Total Biofertilizer production in India. Different Nitrogen Biofertilizers. Symbiotic & Non-Symbiotic Nitrogen fixation. Nodule formation, Competitiveness, Quantification of Nitrogen fixed. Associative and Free-living Nitrogen fixation. Cyanobacterial Biofertilizers.	
Unit-IV	**Plant Growth Promoting Biofertilizers** **7 hours**
Phosphate solubilizing Bacteria and Fungi. Mechanism and solubilization of Phosphorus. Phosphate mobilizing microorganisms. VAM in detail. Potassium and Zinc Biofertilizers. Plant Growth Promoting Biofertilizers (PGPR). Production technology; Strain selection, Sterilization, Growth and Fermentation. Mass scale production of different carrier and liquid based biofertilizers.	
Unit-V	**Applications** **7 hours**
FCO specifications and quality control of biofertilizers. Microbes beneficial for recycling of Organic wastes & Composting. Bio remediators and its related Microbes. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers – Storage, shelf lifeand marketing. Factors influencing the efficacy of Biofertilizers.	

Reference books	1. Leo, M.L. Nollet, Hamirsingh Rathore. Bio Pesticide Handbook. CRC Press Tayler & Francisgroup, Newyork. 1-29 pp. 2. Md. Arshad Anwer. 2017. Bio Pesticides and Bio Agents e book CRC Press Taylor & Francisgroup Newyork. 1-365 pp. 3. Dwijendra Singh.2014. Advances in Plant Bio Pesticides. Publisher Springer 1-401 pp. 4. GhayurAlam. 2000. A Study of Bio Pesticides and Bio Fertilisers in Haryana, India. International Institute for Environment and Development 3 Endsleigh Street London 1-24 pp. 5. Vibrant Gujarath. 2017. Setting up a Bio-Fertilizers and Bio-Pesticides Unit Biotechnology Government of Gujarat. Gujarat State Biotechnology Mission. 1-23 pp. 199 6. Salma Mazid, Ratul Ch. Rajkhowa, Jogen Ch. Kalita (2011). A review on the use of Bio Pesticides in Insect Pest Management. International Journal of Science and Advanced Technology, Volume 1 No 7, 169-178 pp
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	3	2	3	2	2	3	2	3	3	3	2	2	3
CO2	2	3	3	2	2	3	2	2	2	3	2	3	3	3	2	3	2
CO3	2	3	2	2	2	3	2	2	2	3	2	2	2	3	2	2	2
CO4	2	3	3	3	2	3	3	2	1	2	3	3	3	3	3	2	2
CO5	2	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT3007	AI in Healthcare and Biotechnology
Version	1.0
Prerequisite	Basic knowledge of biotechnology, molecular biology, bioinformatics, statistics, and fundamentals of artificial intelligence/machine learning.
Learning objective	1. To understand advanced applications of Artificial Intelligence in biotechnology and healthcare 2. To develop knowledge of AI-driven approaches in omics sciences, diagnostics, drug discovery, and industrial biotechnology 3. To familiarize students with computational tools and case studies in modern biotechnology 4. To understand ethical, regulatory, and societal aspects of AI in biotechnology
Course Outcome	**CO1:** Understand AI methodologies and their relevance in biotechnology and healthcare. **CO2:** Apply machine learning approaches for analysis of biological and healthcare datasets. **CO3:** Utilize AI tools and computational platforms for omics and biomedical applications. **CO4:** Analyze AI-driven solutions in drug discovery, diagnostics, agriculture, and industrial biotechnology. **CO5:** Evaluate ethical, regulatory, and future aspects of AI applications in biotechnology and healthcare.
Unit-I	**Foundations of AI in Biotechnology and Healthcare** **7 hours**
Overview of Artificial Intelligence in life sciences, Evolution of AI in biotechnology and healthcare, Role of AI in biological research and healthcare systems, AI workflow in biotechnology:data acquisition, preprocessing, model development, prediction and validation, Biological and healthcare datasets: genomic. Proteomic, clinical imaging data Case studies: AI-based disease prediction, AI-assisted biological data analysis	
Unit-II	**Machine Learning Approaches in Biotechnology** **8 hours**
Machine learning techniques in biological science, Supervised and unsupervised learning applications, Classification algorithms:Decision Trees, Support Vector Machines (SVM), Random Forest (introductory idea), Regression techniques in biological data analysis, Clustering approaches: K-means clustering, Hierarchical clustering, Feature selection and dimensionality reduction, Applications in: biomarker discovery, disease classification, gene expression analysis	
Unit-III	**AI Tools, Programming and Omics Applications** **7 hours**
AI computational tools and software platforms, Introduction to Python libraries for AI:NumPy, Pandas, Scikit-learn, Introduction to TensorFlow and Keras, AI applications in:genomics, transcriptomics, proteomics, metabolomics, Protein structure prediction and protein–protein interaction analysis, Big data analytics in biotechnology, Data mining techniques in biological sciences	
Unit-IV	**AI Applications in Modern Biotechnology** **7 hours**
AI in drug discovery and development: target identification, virtual screening, lead optimization, AI in precision medicine and personalized therapeutics, AI-assisted diagnostics and predictive modeling, AI in medical imaging and digital pathology, Agricultural biotechnology: crop genomics, stress and pest resistance prediction, Environmental biotechnology: bioremediation, environmental monitoring, Industrial biotechnology: bioprocess optimization, biofuel production, Food biotechnology: food safety monitoring, quality prediction systems	
Unit-V	**Ethical Issues, Case Studies and Future Perspectives** **7 hours**
Ethical issues in AI and biotechnology: data privacy, bias and fairness, transparency and accountability, Regulatory frameworks and biosafety considerations, Challenges in implementation of AI in healthcare and biotechnology, Case studies: AI in cancer diagnostics, epidemic prediction, protein structure prediction, AI-assisted drug repurposing, Future prospects of AI in biotechnology and healthcare, Emerging trends:generative AI, digital twins in healthcare	

Reference books	1. Baldi, P., & Brunak, S. Bioinformatics: The Machine Learning Approach, MIT Press. 2. Bishop, C. M. Pattern Recognition and Machine Learning, Springer. 3. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning, MIT Press. 4. Charniak, E. Introduction to Artificial Intelligence, Pearson. 5. Lesk, A. M. Introduction to Bioinformatics, Oxford University Press. 6. Zou, J., Huss, M., Abid, A., Mohammadi, P., Torkamani, A., & Telenti, A. A Primer on Deep Learning in Genomics, Nature Genetics
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	1	1	1	2	1	1	1	1	3	3	2	2	2
CO2	3	3	3	3	2	2	2	2	1	1	1	2	3	3	3	3	3
CO3	3	3	3	3	2	2	2	2	1	1	1	2	3	3	3	3	3
CO4	3	3	3	3	3	2	2	2	1	1	2	2	3	3	2	3	3
CO5	2	3	2	2	3	2	3	3	2	2	3	2	2	2	1	3	3

3: High, 2: Medium, 1: Low

SEMESTER-IV

BT4001	**Genetic Engineering**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Molecular Biology and genetics
Learning objective	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.
Course outcome	**CO1:** Gain a comprehensive understanding of the principles and techniques of genetic engineering, including the utilization of molecular tools, gene recombination, and transfer methods. **CO2:** Develop proficiency in performing essential molecular techniques for genetic manipulation and analysis. **CO3:** Apply genetic engineering methods to design and execute experiments in various biotechnological applications, including the production of transgenic organisms and recombinant proteins. **CO4:** Analyze and interpret genetic data obtained from experiments to draw conclusions about gene structure and function. **CO5:** Evaluate the ethical, social, and environmental implications of genetic engineering technologies, including the debate over genetically modified crops, and assess their impact on modern society.
Unit-I	**Molecular tools and applications** **7 hours**
	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** **7 hours**
	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 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** **7 hours**
	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** **7 hours**
	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.
Unit-V	**Recombinant protein Technology** **8 hours**
	Recombinant protein Technology: Design and use of expression vectors, selection of suitable promoter sequences, ribosome binding sites, transcription terminator, plasmid copy number. Processing of Recombinant proteins- Stabilization of proteins. Phage Display, Inclusion Bodies, solubilization of insoluble proteins. Codon optimization, Fusion Proteins, Gene therapy, Gene silencing.
Reference 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, 7thedition. Blackwell Publishing, Oxford, U.K. 5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rdedition. Cold Spring Harbor Laboratory Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	1	2	2	3	2	3	3	3	3	3	3	3	3
CO2	3	3	3	2	1	3	2	2	2	3	2	3	3	3	3	3	2
CO3	3	3	3	2	2	3	2	2	2	3	2	2	3	3	3	2	2
CO4	3	3	3	3	2	3	3	3	1	2	3	3	3	3	3	3	2
CO5	3	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT4002	**Chemistry II**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of Chemistry
Learning objective	The course aims to teach the principles of green chemistry. The specific objectives of the course are: 1. To teach students the basic concepts of green chemistry and its importance in sustainable development. 2. To teach students the fundamental principles of biocatalysis, photochemistry and electrochemistry.
Course outcome	CO1: Remember, understand and analyze the classification, properties, and structures of carbohydrates, including reducing and non-reducing sugars, glucose, and fructose, and explain the concepts of epimers, mutarotation, and anomers. CO2: Evaluate the structures and properties of amino acids, peptides, and proteins, and demonstrate methods for determining primary structure and synthesizing simple peptides. CO3: Apply knowledge of enzyme mechanisms, factors affecting enzyme action, and enzyme inhibition to understand drug action and the structure-activity relationships of drug molecules. CO4: Understand the principles and goals of green chemistry, and calculate atom economy to evaluate the sustainability of chemical reactions. CO5: Evaluate various green chemistry techniques and their industrial applications, including the use of green solvents, catalysis, and biocatalysis for more sustainable chemical processes.
Unit-I	**Carbohydrates** **8 hours**
	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. Linkage between monosachharides, structure of isachharides (sucrose, maltose, lactose) and polysachharides (starch and cellulose) excluding their structure elucidation.
Unit-II	**Amino Acids, Peptides and Proteins** **7 hours**
	Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.
Unit-III	**Enzymes and correlation with drug action** **7 hours**
	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 allosteric inhibition). Drug action – receptor theory. Structure - activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring.
Unit-IV	**Green chemistry I** **7 hours**

	Introduction to green chemistry, requirement of green chemistry: goals and basic principles of green chemistry, evaluation of types of chemical reactions, calculation of atom economy in a chemical/biochemical transformation, examples of green chemical transformation or modification.
Unit-V	**Green Chemistry II** **7 hours**
	Green chemistry and synthesis/biosynthesis, green solvents: aqueous medium, ionic liquids and supercritical fluids, solvent free reactions, green catalysis, heterogenous catalysis, redox reagents and biocatalysis, factors affecting biocatalysis, industrial applications of green chemistry e.g. Vitamin C synthesis using enzymes, production of healthier fats and oils by green chemistry, different tools for green chemistry and their advantages, ultrasound/microwave assisted transformations.
Reference books	1. Clark, J and Macquarrie, D 2002. Handbook of Green Chemistry and Technology, 1st ed. Blackwell Science Ltd. 2. Lancaster, M 2010. Green Chemistry: An Introductory Text, 1st ed. Royal Society of Chemistry. 3. Sharma, SK and Mudhoo, A 2010. Green Chemistry for Environmental Sustainability, 1st ed. CRC Press, Boca Raton. 4. Torok, B and Dransfield, T 2017. Green Chemistry: An Inclusive Approach, 1st ed. Elsevier
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	2	2	2	2	3	2	3	3	3	3	2	3
CO2	3	3	3	2	2	3	2	2	2	3	1	3	3	3	2	3	2
CO3	3	3	2	2	3	3	2	2	2	3	2	2	2	3	2	2	2
CO4	3	3	3	3	3	3	3	2	1	2	3	3	3	3	2	3	2
CO5	3	2	3	2	2	3	3	2	2	2	2	3	3	3	2	3	3

3: High, 2: Medium, 1: Low

BT4003	Biostatistics and Data Analysis
Version	2.0
Prerequisite	All students are expected to have a basic knowledge of mathematics
Learning objective	The learning objective of course are: ➢ To introduce statistical methods used in biological sciences. ➢ To develop skills in organization, analysis, and interpretation of biological data ➢ To familiarize students with basic computational tools for data analysis
Course outcome	**CO1:** Gain a comprehensive understanding of statistics, including its definition, functions, and limitations, as well as the methods for collecting, classifying, tabulating, and representing data graphically. **CO2:** Develop proficiency in calculating and interpreting measures of central tendency and dispersion along with understanding their merits and demerits. **CO3:** Apply correlation analysis techniques to analyze relationships between variables, and utilize regression analysis to model and predict these relationships. **CO4:** Understand the basics of probability theory and various distributions in probability calculations and apply them to biological sciences **CO5:** Develop proficiency in hypothesis testing techniques, small sample tests like Student's t-test, and understand the basic concepts of analysis of variance (ANOVA).
Unit-I	**Basics of Statistics** **8 hours**
	Statistics – Definition, functions and its limitations. Types of Biological Data, Collection, Classification, Tabulation of data, Diagrammatic and Graphical representation of data. Introduction to data analysis in biological sciences
Unit-II	**Measures of Central Tendency** **7 hours**
	Measures of Central Tendency – Mean, Median, Mode, Geometric mean, Harmonic mean – Merits and demerits of these measures, Measures of Dispersion – Range, Quartile deviation, Mean deviation, Standard deviation, Variance, Skewness, Kurtosis.
Unit-III	**Correlation** **7 hours**
	Correlation – Types, scatter diagram – Karl Pearson's coefficient of correlation, Spearman's Rank Correlation, Regression – Formation of Regression lines, Uses of Regression lines. Applications in biological sciences
Unit-IV	**Basics of Probability Theory** **7 hours**
	Basics of Probability Theory – Addition & Multiplication Rule – Binomial, Poisson and Normal Distribution and their uses in biological sciences.
Unit-V	**Introduction to Computational Data Analysis** **7 hours**
	Hypothesis testing and significance levels, Test for Mean, Test for the difference between two means, Test for proportion, Test for the difference between two proportions, Small sample Tests: Student's t-test, F-test – Analysis of variance (one-way and two-way – Basic Ideas only). Introduction to statistical software/tools for biological data analysis
Reference books	1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA 2. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA 3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press. 4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

	5. S.P. Gupta (2011), Statistical methods, Sultan Chand & Sons,4th Edition. 6. Jerold H. Zar (2009): Bio-statistical Analysis, 4th Edition, Pearson Education Inc., 7. Dorling Kindersley (India) Pvt. Ltd., New Delhi. 8. Antonisamy.B, Solomon Christopher and Prasanna Samuel.P, (2010): 9. Bio-Statistics Principles and Practice, 1st Reprint 2011, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	1	2	2	2	1	3	2	3	3	3	3	2	3
CO2	2	3	3	2	1	3	2	2	2	3	1	3	2	3	3	3	2
CO3	2	3	2	2	2	3	2	2	2	3	2	2	2	3	2	2	2
CO4	2	3	3	3	2	3	3	2	1	2	3	3	3	3	3	3	2
CO5	2	2	3	2	1	3	3	2	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT4004	IPR, Bio-entrepreneurship and Bio-business Management
Version	1.0
Prerequisite	Basic understanding of business concepts and intellectual property rights.
Learning objective	1. Classify different types of intellectual property and analyze their significance in research and development. 2. Evaluate the impact of international agreements and treaties on intellectual property rights in biotechnology. 3. Assess the role of entrepreneurship in fostering innovation and economic development in the biotechnology sector. 4. Analyze the process of establishing and managing a biotechnology enterprise, including project identification and feasibility assessment.
Course outcome	**CO1:** Classify different types of intellectual property and assess their relevance to the biotechnology industry. **CO2:** Analyze the legal frameworks and international agreements governing intellectual property rights in biotechnology. **CO3:** Evaluate the role of entrepreneurship in driving innovation and commercialization in the biotechnology sector. **CO4:** Assess the process of establishing and managing a biotechnology enterprise, including project feasibility and business planning. **CO5:** Analyze the global market landscape of biotechnology-based businesses and develop strategies for effective bio-business management.
Unit-I	**Intellectual Property** **8 hours**
	Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D;
Unit-II	**Agreement and Treaties** **7 hours**
	IPs of relevance to Biotechnology and few. Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent Amendments. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.
Unit-III	**Entrepreneurship** **7 hours**
	Meaning, Needs and Importance of Entrepreneurship, Entrepreneurs and Innovators, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful 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.
Unit-IV	**Establishing and enterprise** **7 hours**
	Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility. Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.
Unit-V	**Bio-business Management** **7 hours**

	Worldwide market scenario of biotechnology based business, Bio-business prospective in India. Management Process & organization, General analysis of Indian Bio-business, Project formulation Business Plan, technological assessment, Cost estimation, feasibility and commercial viability of project.
Reference 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. 4. P. Narayan: Patent Law. 5. S. L Rao: Economic reforms and Indian markets.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	1	2	2	2	1	1	2	3	3	3	3	2	3
CO2	2	3	3	2	1	2	2	2	2	1	1	3	2	2	2	3	2
CO3	2	3	2	2	2	3	2	2	2	2	2	2	3	2	2	2	2
CO4	2	3	3	2	2	3	3	2	2	1	3	3	3	3	3	3	3
CO5	2	2	3	2	1	3	3	2	2	2	2	3	3	3	3	3	2

3: High, 2: Medium, 1: Low

BT4005	Food Biotechnology
Version	1.0
Prerequisite	Basic understanding of biology and chemistry.
Learning objective	Students can undergo this course to get basic knowledge in the application of Biotechnology in food processing, food spoilage, food preservation and dairy industry
Course outcome	**CO1:** Understand the historical development and scope of food biotechnology, including traditional food processing methods and biochemical pathways. **CO2:** Analyze the role of microorganisms in food spoilage and preservation, and the factors influencing their growth in various food products. **CO3:** Explore the diverse range of food fermentations and their significance in food technology and production. **CO4:** Evaluate the use of enzymes in the food industry, including their types, applications, and biotechnological advancements for food modification. **CO5**: Examine value addition products in food technology, such as high fructose syrup, single-cell proteins, and flavor enhancers, and their potential contributions to food products.
Unit-I	**Introduction of Food technology and Food preservation 7 hours**
	Introduction, History and scope of food Biotechnology, development and prospects of biotechnology in animal products, ancient and traditional food processing techniques; Biochemical and metabolic pathways of biological systems used in food production. Principles of preservation of foods, methods of food preservation, Physical, & Chemical Methods, Osmotic pressure – preserving foods in sugar and salt, chemical preservatives, Radiation as preservation methods
Unit-II	**Role of Microorganism in Food Biotechnology 7 hours**
	Spoilage of foods, Microorganism in food spoilage, chemical changes, microbes in the spoilage of canned foods, meat, fish; Factors affecting growth of spoilage organisms
Unit-III	**Food Fermentations 7 hours**
	Common fermented foods - Cheese, Butter, Yoghurt, fermented/condensed milk and kefir, Alcoholic beverages (Beer, Wine, Whisky), Sauerkraut, Pickles, Soy products, Tea, coffee etc.
Unit-IV	**Enzymes in Food Industry 8 hours**
	Use of biotechnology improved enzymes in food processing industry, Carbohydrases, Proteases Lipases, Modification of food using enzymes, Role of endogenous enzymes in food quality, Enzymes use as processing aid and ingredients.
Unit-V	**Value addition products 7 hours**
	Value addition products like High Fructose Syrup, Invert Sugars etc. SCPs (e.g. Spirulina, Yeast etc.) as food supplements, Edible fungus: Mushrooms. Potential of Probiotics. Flavour enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products.
Reference books	1. HD Kumar (2023) Modern Concept of Biotechnology- Vikas Publishing House Pvt. Ltd., New Delhi. 2. SS Marwaha & JK Arora (2015) Food Processing – Biotechnological Applications-, Asiatech Publishers Inc., New Delhi 3. M R Adamas & M O Moss (2008) Food Microbiology-; Panima Publishing Corporation, New Delhi.

	4. A. J. Nair (2008) Introduction to Genetic Engineering & Biotechnology- Jones & Bartlett Publishers, Boston, USA.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	2	2	2	1	1	2	3	3	3	3	2	3
CO2	3	3	3	2	1	2	2	2	2	1	1	3	3	3	3	3	2
CO3	3	3	2	3	2	3	2	2	2	2	2	2	3	3	2	2	2
CO4	3	3	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO5	3	2	3	2	1	2	3	2	2	2	2	3	3	3	3	3	3
CO6	3	2	3	2	3	2	3	2	1	1	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT4006	Molecular Modeling and Drug Designing
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Bioinformatics and drugs
Learning objective	The course is designed to give an overview of the process of drug design and development. The specific objectives of the course are as follows: 1. To teach the criteria used for drug development as a process involving target selection and lead discovery. 2. To impart the knowledge about computer aided drug design. 3. To give students an overview of drug delivery system, pre-clinical and clinical testing.
Course Outcomes	**CO1:** Understand the stability profile and barriers to protein and peptide delivery. Analyze methods for delivery of protein and peptide drugs, including lymphatic transportation and site-specific protein modification. **CO2:** Evaluate drug targeting and delivery systems, including ligands, carrier systems, and vesicular systems for targeting. Analyze cellular-level events in targeting and blood cell receptors. **CO3:** Analyze various types of vaccines, including multivalent subunit vaccines, synthetic peptide vaccines, and vector vaccines. Evaluate new generation vaccines and novel vaccine delivery systems. **CO4:** Understand the drug design cycle and principles of structure-activity relationship (SAR). Analyze rational drug design methods, pharmacophoric patterns, and quantitative structure-activity relationship (QSAR). **CO5:** Evaluate molecular modeling techniques, including quantum mechanical methods and molecular orbital methods. Analyze docking and modeling of substrate-receptor interactions using software tools for computer-aided drug design (CADD).
Unit-I	**Biotechnological products** **8 hours**
	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	**Basic principles of molecular dynamics** **7 hours**
	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** **7 hours**
	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	**Drug Design** **7 hours**
	Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) &Hans equation
Unit-V	**Molecular Modelling** **7 hours**
	Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction tosemiempirical, molecular mechanics and ab initio techniques. Potential energy

	surface, Docking andmodeling substrate – receptor interactions. Introduction to s/w tools for CADD.
Reference books	1. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition),Addison Wesley Longman, Essex, England, 1996. 2. Alan Hinchliffe, Modelling Molecular Structures, 2nd Edition, John-Wiley, 2000. 3. Alan Hinchliffe, Molecular Modelling for Beginners, John-Wiley, 2003. 4. N. Cohen (Ed.), Guide Book on Molecular Modeling in Drug Design, AcademicPress, San Diego, 1996. 5. D. Frenkel and B. Smith, Understanding Molecular Simulations. FromAlgorithms to Applications, Academic Press, San Diego, California, 1996. 6. C. Rauter and K. Horn, X-ray crystallography and drug design, Elsevier, 1984. 7. M. Kalos and P. A. Whitlock, Monte Carlo Methods. John Wiley & Sons, NewYork, 1986. 8. J.A. McCammon and S.C. Harvey. Dynamics of Proteins and Nucleic Acids.Cambridge University Press, Cambridge, 1987. 9. D.C. Rapaport. The Art of Molecular Dynamics Simulation.Cambridge UniversityPress, Cambridge, England., 1995
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	1	2	2	3	1	1	2	3	3	3	3	2	3
CO2	3	3	3	3	2	2	2	2	2	1	1	3	3	3	3	3	2
CO3	3	3	2	2	1	2	2	2	2	2	2	2	3	3	3	2	2
CO4	3	3	3	3	1	2	3	3	1	1	3	3	3	3	3	2	2
CO5	3	3	3	3	1	2	3	3	2	2	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT4007	**Structural Biology**
Version	1.0
Prerequisite	Basic knowledge of cell biology, biochemistry, and biomolecules.
Learning objective	The course is designed to provide understanding of the structural organization of biological macromolecules and modern approaches used to study biomolecular structures. The specific objectives are: 1. To introduce principles of structural organization of proteins and nucleic acids. 2. To familiarize students with experimental techniques used in structural biology. 3. To understand structure-function relationships in biological systems. 4. To introduce structural databases and visualization tools. 5. To highlight applications of structural biology in biotechnology and biomedical sciences.
Course Outcomes	**CO1:** Understand the structural organization and conformational properties of biological macromolecules. **CO2:** Analyze structural motifs, domains, and macromolecular assemblies in biological systems. **CO3:** Evaluate experimental techniques used for biomolecular structure determination. **CO4:** Apply structural databases and molecular visualization tools for biomolecular analysis. **CO5:** Analyze applications of structural biology in biotechnology, disease biology, and modern biomedical research.
Unit-I	**Fundamentals of Structural Biology** **8 hours**
	Introduction and scope of structural biology, Levels of structural organization in biomolecules, Structural hierarchy in proteins and nucleic acids, Biomolecular interactions, Conformational stability of biomolecules, Structural dynamics and conformational changes
Unit-II	**Structural Organization of Biological Macromolecules** **7 hours**
	Structural motifs and domains, α-helices, β-sheets, turns, and loops, Membrane proteins and transport proteins, Structural organization of ribosomes and chromatin, Macromolecular assemblies and molecular machines, Protein misfolding and conformational disorders
Unit-III	**Experimental Techniques in Structural Biology** **7 hours**
	Principles of biomolecular structure determination, X-ray crystallography: crystallization principles, diffraction basics, Nuclear Magnetic Resonance (NMR) spectroscopy, Cryo-electron microscopy (Cryo-EM), Circular dichroism and fluorescence spectroscopy, Comparative applications and limitations of structural techniques
Unit-IV	**Structural Bioinformatics and Visualization** **7 hours**
	Structural databases: Protein Data Bank (PDB), SCOP, CATH. Structure visualization tools: PyMOL, UCSF Chimera, Sequence-structure relationships, Structural alignment and comparative analysis, Introduction to protein structure prediction, AI-based protein structure prediction (AlphaFold overview)
Unit-V	**Applications of Structural Biology** **7 hours**
	Structure-function relationships in enzymes and receptors, Structural basis of antigen-antibody interactions, Structural biology in drug target identification, Structural biology in genomics and proteomics. Case studies: Hemoglobinopathies, SARS-CoV-2 spike protein, Amyloid diseases. Recent advances and future perspectives in structural biology
Reference books	1. Branden, C., & Tooze, J. Introduction to Protein Structure, Garland Science. 2. Liljas, A. et al. Textbook of Structural Biology, World Scientific Publishing.

	3. Rhodes, G. Crystallography Made Crystal Clear, Academic Press. 4. Petsko, G., & Ringe, D. Protein Structure and Function, Oxford University Press. 5. Bourne, P. E., & Weissig, H. Structural Bioinformatics, Wiley-Liss. 6. Lesk, A. M. Introduction to Bioinformatics, Oxford University Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	1	1	1	2	-	1	1	2	3	2	2	1	2
CO2	3	3	2	2	1	1	1	2	-	1	1	2	3	2	2	2	2
CO3	3	3	2	3	2	2	1	2	1	1	1	3	3	3	3	2	3
CO4	3	3	3	3	2	2	2	2	1	1	1	3	3	3	3	2	3
CO5	3	3	3	3	2	2	2	3	1	1	2	3	3	3	2	3	3

3: High, 2: Medium, 1: Low

SEMESTER-V

BT5001	Bioprocess Engineering
Version	1.0
Prerequisite	All students are expected to have basic understanding of microbiology, biochemistry, and chemical engineering principles.
Learning objective	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.
Course outcome	**CO1:** Explain the fundamental principles of bioprocess engineering, including various types of fermentation design and bioreactor design and operation modes **CO2:** Interpret and illustrate the relationship between bioprocess variables and their impact on the microbial growth kinetics, mass transfer and efficiency of biotechnological production processes. **CO3:** Apply bioprocess engineering principles to solve problems related to scaling up, product recovery and purification in biotechnological processes from laboratory to industrial scale **CO5:** Analyze and assess different strategies for optimizing bioprocess parameters to maximize yield and productivity of industrially important biochemicals and therapeutic products while ensuring product quality and Waste management. **CO6:** Develop and propose novel bioprocess strategies incorporating innovative technologies to address challenges in bio-production and sustainability
Unit-I	**Introduction to bioprocess technology** **7 hours**
	Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetic parameters– Batch, Fed-batch and Continuous culture.
Unit-II	**Designing of Bioreactor** **8 hours**
	Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.
Unit-III	**Downstream processing** **7 hours**
	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. Introduction to downstream processing, product recovery and purification. Effluent treatment.
Unit-IV	**Production of industrial chemicals** **7 hours**
	Production of biochemicals and chemotherapeutic products- Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, hydrogen, biodiesel; starch conversion processes; anti-cancer agents, amino acids. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.
Unit-V	**Microbial products of pharmacological interest** **7 hours**
	Microbial products of pharmacological interest, steroid fermentations and transformations.

	Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzymes in food technology/organic synthesis- proteolytic enzymes, hydrolytic enzymes, glucose isomerase; Enzyme and cell immobilization techniques in industrial processing
Reference 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. 2ndedition, Elsevier Science Ltd. 5. Salisbury, Whitaker and Hall. Principles of fermentation Technology,
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	2	2	2	1	1	2	3	3	3	3	2	3
CO2	3	3	3	2	1	2	2	2	2	1	1	3	3	3	3	3	2
CO3	3	3	2	3	2	3	2	2	2	2	2	2	3	3	2	2	2
CO4	3	3	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO5	3	2	3	2	1	2	3	2	2	2	2	3	3	3	3	3	3
CO6	3	2	3	2	3	2	3	2	1	1	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT5002	**Bioinformatics**
Version	2.0
Prerequisite	All students are expected to have a basic knowledge of Computer Sciences and Biotechnology.
Learning objective	The aim of the course is to introduce students to the basic tenets of bioinformatics. The course provides a strong foundation for developing skills in using biological sequence databases, and tools for biological sequence analysis. The specific objectives of the course are as follows: 1. To teach students about biological sequence data storage. 2. To make students understand about various bioinformatics tools used for DNA, RNA and protein sequence analysis. 3. To impart knowledge about biological sequence alignment. 4. To teach the fundamental principles of molecular phylogeny.
Course outcome	**CO 1:** Understand fundamental bioinformatics principles and applications. **CO 2:** Use major biological databases and handle various biomolecular sequence file formats. **CO 3:** Perform phylogenetic analysis and genome annotation, and construct phylogenetic trees using ClustalW and MEGA6 **CO 4:** Access and utilize protein databases such as PDB and SWISSPROT, and understand data-generating techniques. **CO 5:** Apply methods for protein structure prediction, including primary, secondary, and tertiary structures using homology modeling and threading methods.
Unit-I	**Introduction to Bioinformatics** **7 hours**
	Databases: Primary and Secondary. Biological databases: Nucleotide databases, Protein databases, Specialized databases. Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA etc.;
Unit-II	**Sequence analysis and Alignment** **7 hours**
	Sequence analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Multiple Sequence Alignment, Introduction to BLAST, using it on the web, Interpreting results, Sequence Similarity Searches-BLAST, FASTA.
Unit-III	**Phylogenetic Analysis** **7 hours**
	Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny definition and description of Phylogenetic trees and various types of trees Phylogenetic Analysis. Searching Databases: Data Submission. Phylogenetic tree building methods, ClustalW and MEGA6.
Unit-IV	**Protein Identification and Information Sources** **7hours**
	Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.
Unit-V	**Protein Structure prediction** **8 hours**
	Production of Protein Structure & Modeling Protein Primary & Secondary Structure, Prediction Methods – Introduction to various methods. Tertiary structure prediction (Homology & Threading Methods) Profiles.

Reference books	1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press. 2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell. 3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	1	2	2	2	1	1	1	3	3	3	3	2	3
CO2	3	3	3	2	1	2	2	2	2	1	1	3	3	3	3	3	2
CO3	3	3	3	3	1	3	2	2	2	1	2	2	3	3	2	2	2
CO4	3	2	3	3	0	3	3	2	1	1	1	3	3	3	3	3	3
CO5	3	2	3	2	1	3	3	2	1	1	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT5003	Plant Biotechnology
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of plant science
Learning objective	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.
Course Outcomes	**CO1:** Comprehend the principles and techniques involved in plant tissue culture, including micropropagation, callus induction, and somatic embryogenesis. **CO2:** Evaluate the various types of plant tissue culture methods, such as seed culture, embryo culture, and cell culture, along with their advantages and disadvantages. **CO3:** Analyze the production of polyploid plants through in vitro haploid production, androgenic methods, and gynogenic haploids, considering factors influencing chromosome doubling. **CO4:** Investigate protoplast isolation and fusion techniques, including somatic hybridization and cybrid formation, as well as the generation and applications of somaclonal variation. **CO5:** Explore the role of Plant Growth Promoting Bacteria (PGPR) in nitrogen fixation, nodulation, biocontrol of pathogens, and promoting plant growth, emphasizing their significance in agriculture.
Unit-I	**Plant tissue culture** **8 hours**
	Plant tissue culture – basis, plant hormones in PTC – micropropagation - callus induction, organogenesis, embryogenesis, somatic embryogenesis, somaclonal variation, artificial seeds and embryo rescue, plant cell suspension culture. Protoplast culture.
Unit-II	**Plant tissue culture** **7 hours**
	Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus,Organs, Cell and Protoplast culture. Micropropagation Axillary bud proliferation, Meristem andshoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages ofmicropropagation.
Unit-III	**Polyploid plant production** **7 hours**
	In vitro haploid production Androgenic methods: Anther culture, Microspore culture and oogenesis Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome eliminationtechniques for production of haploids in cereals.
Unit-IV	**Protoplast and somaclonal production** **7 hours**
	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-V	**PGPR** **7 hours**

	Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.
Reference 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) 8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	1	2	2	2	1	1	1	3	3	3	3	2	3
CO2	3	3	3	2	1	2	2	2	1	0	1	3	3	3	3	3	3
CO3	3	3	3	3	2	3	2	2	2	0	2	2	3	2	3	2	2
CO4	3	2	3	3	2	3	3	2	1	1	1	3	3	3	3	3	3
CO5	3	2	3	2	3	2	3	2	2	1	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT5007	**Data Science for Life sciences**
Version	1.0
Prerequisite	Basic knowledge of biology, biostatistics, computer fundamentals, and introductory artificial intelligence.
Learning objective	The course is designed to introduce computational and data-driven approaches used in modern biological sciences. The specific objectives are: 1. To familiarize students with different types of biological datasets and data science workflows. 2. To develop understanding of computational tools for biological data handling and visualization. 3. To introduce data analytics approaches used in genomics, proteomics, and healthcare. 4. To provide basic exposure to machine learning applications in life sciences. 5. To highlight applications of data science in biotechnology, healthcare, and precision medicine.
Course Outcomes	**CO1:** Understand the principles of data science and different types of biological datasets. **CO2:** Apply computational tools for handling, preprocessing, and visualization of biological data. **CO3:** Analyze omics and healthcare datasets using basic data science approaches. **CO4:** Evaluate applications of machine learning and data analytics in biotechnology and healthcare. **CO5:** Analyze challenges, ethical issues, and future perspectives of data-driven biological research.
Unit-I	**Introduction to Data science for Life-science** **8 hours**
	Introduction to data science and computational biology, Biological data types: genomic data, transcriptomic data, proteomic data, metabolomic data, clinical data. Structured and unstructured biological data, Biological databases and repositories, Big data concepts in life sciences and healthcare, Data science workflow in biological research
Unit-II	**Data Collection, Preprocessing and Management** **7 hours**
	Data acquisition and data formats, Data cleaning and preprocessing, Missing data handling and normalization, Data integration and transformation, Introduction to spreadsheets and computational data handling, Introduction to Python/R for biological data analysis, Handling CSV and biological data files
Unit-III	**Biological Data Visualization and Analysis** **7 hours**
	Principles of biological data visualization, Visualization techniques:bar plots, scatter plots, box plots, heat maps, volcano plots, Correlation and trend analysis in biological datasets, Gene expression data visualization, Interpretation of omics and healthcare datasets
Unit-IV	**Omics Data Analysis and Computational Biology** **7 hours**
	Introduction to omics technologies: genomics, transcriptomics, proteomics, metabolomics, Gene expression data analysis (basic concepts), Biological sequence data analysis, Introduction to biological network analysis, Pathway analysis and systems biology (overview), Data integration in multi-omics studies, Computational challenges in biological data analysis
Unit-V	**Biological Data Mining and Applications** **7 hours**
	Introduction to data mining in biological sciences, Pattern discovery in biological datasets, Clustering and association analysis (conceptual overview), Biological database mining and retrieval, Applications of data science in: biodiversity analysis, epidemiological studies, agricultural biotechnology, environmental biotechnology, Data sharing, reproducibility, and FAIR data principles, Challenges and future perspectives in biological data science

Reference books	1. VanderPlas, J. Python Data Science Handbook, O'Reilly Publications. 2. James, G., Witten, D., Hastie, T., & Tibshirani, R. An Introduction to Statistical Learning, Springer. 3. Baldi, P., & Brunak, S. Bioinformatics: The Machine Learning Approach, MIT Press. 4. Lesk, A. M. Introduction to Bioinformatics, Oxford University Press. 5. Han, J., Kamber, M., & Pei, J. Data Mining: Concepts and Techniques, Elsevier. 6. Field, A., Miles, J., & Field, Z. Discovering Statistics Using R, Sage Publications.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	1	1	1	2	-	1	1	1	3	2	1	2	2
CO2	3	3	2	3	2	2	1	2	1	1	1	2	3	3	3	2	2
CO3	3	3	3	3	2	2	2	2	1	1	1	2	3	3	3	3	3
CO4	3	3	3	3	3	2	2	3	1	1	2	2	3	3	2	3	3
CO5	2	3	2	2	3	2	3	3	2	2	3	2	2	2	1	3	3

3: High, 2: Medium, 1: Low

BT5004	Nanobiotechnology
Version	1.0
Prerequisite	A basic understanding of biology, chemistry, and nanotechnology concepts would be helpful for this course.
Learning Objectives	1. Understand the historical development and progress of nanobiotechnology. 2. Learn the synthesis methods and characterization techniques of nanomaterials for biotechnological applications. 3. Explore various detection systems and transducing elements used in nanobiotechnology. 4. Investigate the applications of nanobiotechnology in treating chronic and infectious diseases. 5. Examine the role of nanobiotechnology in environmental monitoring and food sciences.
Course Outcome	**CO1:** Gain knowledge of the historical background and timeline of nanobiotechnology. **CO2:** Acquire skills in synthesizing and characterizing nanomaterials suitable for biotechnological applications. **CO3:** Demonstrate an understanding of various nanobiotechnology detection systems and their applications. **CO4:** Analyze the potential of nanobiotechnology in addressing chronic diseases and infectious diseases. **CO5:** Evaluate the impact of nanobiotechnology on environmental monitoring and food safety.
UNIT-I	**Introduction of nanobiotechnology** **8 hours**
	Introduction, history and Timeline of Nanobiotechnology, Development of nanobiotechnology – timelines and progress, overview.
UNIT-II	**Synthesis and Characterization of nanomaterials** **7 hours**
	Nanomaterials for Biotechnological Applications, Carbon Nanotubes, Nanowires, synthesizing nanoparticles, Green synthesis of nanoparticles, characterization of nanoparticles.
UNIT –III	**Nanobiotechnology detection system** **7 hours**
	Various types of transducing elements and their applicationsin Bio-Nanotechnology, Electrochemical transducer, optical transducer, biosensors in nanotechnology, Quantum dots, gold nanoparticle as biosensors, DNA detection, small scale system for drug delivery.
UNIT-IV	**Nanobiotechnology in chronic and infectious disease** **7 hours**
	Application of Nanobiotechnology in the treatment of Infectious Diseases, Nanotechnology Applications in Cancer Diagnosis and Therapy
UNIT-V	**Nanobiotechnology in environment and food sciences** **7 hours**
	Nanobiotechnology in environment, detection of food contaminants, food industry, Food preservation, waste water treatment.
Text Book	*Bio nanotechnology* by David S. Goodsell, 2004, Wiley Publications
Reference Books	1. Rolf E. Hummel, *Electronic Properties of materials*, Narosa Publishing House 2. Raghavan.V., *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India 3. Khanna. O. P., *A Text Book of Material Science & Metallurgy*, Revised edition, Dhanpat Rai Publications
Mode of Evaluation:	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended by BOS on :	
Adopted by Faculty on:	

Approved by Academic Council on	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	2	3	1	1	1	3	3	3	2	2	3
CO2	3	3	3	2	2	3	3	3	2	0	1	3	3	2	3	3	3
CO3	3	3	2	3	2	3	2	3	2	1	2	2	3	3	3	3	3
CO4	3	2	3	3	2	3	3	3	1	1	1	3	3	3	3	3	3
CO5	3	2	3	2	3	3	3	3	1	1	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT5005	Biophysics
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of basic physics and chemistry
Learning objective	The course aims to provide information to make students- 1. Understand the principles and applications of spectroscopy, radioactivity, and bioinstrumentation in biological research. 2. Gain proficiency in using microscopy techniques for visualizing biological samples and analyzing biomolecules. 3. Explore the principles of bioenergy production and the conversion of biomass into renewable energy sources.
Course outcome	**CO1:** Demonstrate proficiency in using spectroscopic techniques for analyzing biomolecules. **CO2:** Apply knowledge of radioactivity principles to assess and handle radioactive materials safely. **CO3:** Describe thermoregulatory mechanisms and apply microscopy techniques for biological research. **CO4:** Operate bio instruments effectively for the analysis of biomolecules and biological samples. **CO5:** Evaluate the potential of different bioenergy sources and understand the processes involved in bioenergy production.
Unit-I	**Spectroscopy** **8 hours**
	Spectroscopy: Definition. Electromagnetic wave. Electromagnetic spectrum. Applications of each region of electromagnetic spectrum for spectroscopy. Introduction to molecular energy levels. Excitation. Absorption. Emission. Rotational spectra. Energy levels of rigid diatomic molecules. Electron spectroscopy. UV-visible spectroscopy. Principle, construction and working of colorimeter, Spectrophotometer, Fluorometer. Application to biomolecules (proteins, DNA, Hb, chlorophyll).
Unit-II	**Radioactivity** **7 hours**
	Radioactivity: Nucleus. Properties. Nuclear forces. Nuclear models (liquid drop and shell model). Radioactive nucleus. Revision of nuclear radiations and their properties - alpha, beta and gamma. Half-life, physical and biological handling and standardization of alpha and beta emitting isotopes. Radioimmunoassay. Radiopharmaceuticals and their uptake. Production of radionuclides. Measurement of radiation - Dosimetry and detectors. Principle, construction and working of – GM counter. Scintillation Counter (Solid and liquid).
Unit-III	**Thermoregulation and microscopy** **7 hours**
	Thermoregulation: Thermometric properties and types of thermometers (clinical, thermocouple, bimetallic, platinum resistance, thermistor - thermometers). Microscopes: Concepts - Resolving power. Chromatic and achromatic aberrations. Construction and working principles of the following microscopes– Stereozoom (Dissecting), Compound, bright and Dark field, Inverted, Phase contrast, Fluorescence. Electron microscopes: TEM and SEM.
Unit-IV	**Bioinstrumentation** **7 hours**
	Bio instruments: Concepts- Analytical techniques, analyte, method, procedure and protocol. Principle construction, working and applications for analysis of biomolecules of following instruments. pH meter, weighing balance, Ultrasonicator, Centrifuge (RCF, sedimentation concept), different types of centrifuges. Mass spectroscopy (Bainbridge mass spectrometer). Atomic absorption spectrometer (AAS), HPLC, GC-MS

Unit-V	**Bioenergy** **7 hours**
	Forms of renewable bioenergy; Biomass conversion; Biocatalysts; Biochemical engineering; Algal biofuels; Bio-electricity; Microbial fuel cell; Bioenergy system and technology; Bioreactor design and engineering; Consolidated bioprocessing; Organic waste to fuels
Reference books	1. Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and Sons Ltd., USA 2. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer Academic Publisher, USA. 3. Textbook of optics and atomic physics, 8th edition (1989) P.P. Khandelwal, Himlaya Publishing House, India. 4. Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata Mc Graw Hill, India. 5. Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Anshan Publication, India
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	2	2	2	1	1	1	3	3	3	3	2	3
CO2	3	3	3	2	3	2	2	2	2	1	2	3	3	3	3	3	2
CO3	3	3	2	3	1	2	2	2	1	1	2	2	3	3	2	2	2
CO4	3	2	2	3	2	2	3	2	1	1	1	3	3	3	3	3	3
CO5	2	2	3	2	3	2	3	2	1	1	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER-VI

BT6001	Animal Biotechnology
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of animal sciences.
Learning objective	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.
Course outcome	**CO1:** Understand gene transfer methods in animals, including microinjection, embryonic stem cell manipulation, and retroviral-mediated gene transfer. **CO2:** Explore transgenesis concepts and applications in various animal species, along with the role of biotechnology in combating animal diseases. **CO3:** Examine animal propagation techniques such as artificial insemination, cloning, and embryo transfer, highlighting their significance in conservation biology. **CO4:** Analyze the principles and applications of genetic modification in medicine, focusing on gene therapy, vectors, molecular engineering, and ethical considerations. **CO5:** Introduce the fundamentals of cloning, including cell cloning techniques, micromanipulation, and the application of animal cell culture in stem cell research and tissue engineering.
Unit-I	**Gene transfer methods in Animals** **7 hours**
	Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.
Unit-II	**Introduction to transgenesis** **7 hours**
	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** **7 hours**
	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** **7 hours**
	Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.
Unit-V	**Introduction of cloning** **8 hours**
	Cell cloning, micromanipulation and types of cloning. Cell transformation. Application of animal cellculture, limitations of animal cell cultures.Stem cell culture, embryonic stem cells and their applications. Organ and histotypic cultures. Three dimensional culture and tissue engineering
Reference 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 DNA genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	2	2	1	1	1	3	3	3	3	2	3
CO2	3	3	3	2	1	2	2	2	2	1	1	3	3	3	3	3	2
CO3	3	3	2	3	2	3	2	2	1	1	2	2	3	3	2	2	2
CO4	3	2	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO5	3	2	3	2	1	2	3	2	1	1	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT6002	**Genomics and Proteomics**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Molecular Biology and genetics
Learning objective	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.
Course outcome	**CO1:** Understand genomics basics, including DNA sequencing methods like Maxam & Gilbert and Sanger's method, and advanced techniques such as pyrosequencing and genome sequencing methods. **CO2:** Explore genome data management and distribution using web-based servers and tools like ENSEMBL, VISTA, UCSC Genome Browser, and NCBI genome, focusing on selected model organisms' genomes and databases. **CO3:** Grasp protein structure fundamentals, covering chemical properties, physical interactions, and forces determining protein properties like electrostatic forces, Vander Waals interactions, hydrogen bonds, and hydrophobic interactions. **CO4:** Learn methods for determining protein sizes, including sedimentation analysis, gel filtration, SDS-PAGE, Native PAGE, and covalent structure determination using techniques like Edman degradation. **CO5:** Gain an introduction to proteomics, covering proteome analysis techniques like 2D-PAGE, sample preparation, resolution, reproducibility, and mass spectrometry-based methods for protein identification, including de novo sequencing.
Unit-I	**Introduction to Genomics** **8 hours**
	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	**Genome Data** **7 hours**
	Managing and Distributing Genome Data: Web based servers and software's for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.
Unit-III	**Introduction to protein structure** **7 hours**
	Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, Vander Waal interactions, hydrogen bonds, Hydrophobic interactions.
Unit-IV	**Determination of sizes** **7 hours**
	Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.
Unit-V	**Introduction to Proteomics** **7 hours**
	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.
Reference 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. Glick, J.J. Pasternak and C.L. Patten, 2010. 5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989. 6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001. 7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc. 3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings. 4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings. 5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington. 6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	2	2	2	1	1	2	3	3	3	3	3
CO2	3	3	3	2	1	2	2	2	2	1	1	2	3	3	3	3	2
CO3	3	3	2	3	1	3	2	2	1	1	2	2	3	2	2	2	2
CO4	3	2	3	3	1	3	1	2	0	1	0	3	3	3	2	3	3
CO5	3	2	3	2	1	2	2	2	1	1	0	2	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT6004	**Medical Biotechnology**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of basic biology
Learning objective	The learning objective of course are: 1. To create an understanding of reproductive and cellular biotechnology 2. Evaluate diagnostic methods and gene therapy models 3. Understand synthetic therapy and tissue engineering 4. Comprehend gene therapy principles and methods
Course outcome	CO1: Explain the principles and applications of assisted reproductive technology, pregnancy diagnosis, and animal cell culture. CO2: Evaluate various prenatal diagnostic techniques, both invasive and non-invasive, and modern methods for diagnosing pathogenic microbes CO3: Analyze gene therapy models for various diseases (liver, lung, hematopoietic, cancer, autoimmune) and discuss the development and application of vaccines. CO4: Describe synthetic therapy techniques involving synthetic DNAs, therapeutic ribozymes, and synthetic drugs, as well as tissue engineering for organs CO5: Understand the background, types, targets, vectors, and delivery methods of gene therapy, including viral and non-viral methods
Unit-I	**Advanced Techniques in Reproductive and Cellular Biotechnology 8 hours**
	Assisted reproductive technology- Pregnancy diagnosis - Animal cell culture-media, maintenance and culture of primary, secondary and continuous cell lines- organ culture- applications- cancer cell lines- apoptosis.
Unit-II	**Diagnostics methods 7 hours**
	Prenatal diagnosis - Invasive techniques and Non-invasive techniques – Diagnosis of pathogenic microbes: Classical and modern methods- Diagnosis using protein and enzyme markers, DNA/RNA based diagnosis - Molecular markers - Microarray technology - genomic and cDNA arrays.
Unit-III	**Gene therapy Models 7 hours**
	Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases, Circulated gene products, Cancer & Auto-immune diseases. Vaccines – Vaccine vectors, nucleic acid vaccines, immuno-enhancing technology.
Unit-IV	**Synthetic therapy 7 hours**
	Synthetic therapy – synthetic DNAs, therapeutic Ribozymes, synthetic drugs. Tissue Engineering – Skin, Liver, Pancreas. Xenotransplantation – terminology, technology behind it, organ donors, social & ethical issues.
Unit-V	**Gene therapy 7 hours**
	Gene therapy – background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics. Gene Delivery methods – Viral delivery (through Retroviral vectors, through Adenoviral vectors), Non-viral delivery, Antibody engineering. Cell Adhesion-based therapy – integrins, inflammation, cancer & metastasis. Drug delivery – conventional & new approaches to drug

	delivery.
Reference books	1. Jogdand, S. N.. Medical Biotechnology, Himalaya Publishing house, Mumbai, 2005. 2. Click, B. R. and Pasternak.. Molecular Biotechnology: Principle and applications of recombinant DNA. ASM Press, 2010. 3. Ramasamy, P.. "Trends in Biotechnology", University of Madras, Pearl press, 2002. 4. Trevan.. "Biotechnology". Tata McGraw-Hill, 2005.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	2	2	2	1	1	2	3	3	3	3	3
CO2	3	3	3	2	1	2	2	2	2	1	1	2	3	3	3	3	2
CO3	3	3	2	3	1	3	2	2	1	1	2	2	3	2	2	2	2
CO4	3	2	3	3	1	3	1	2	0	1	0	3	3	3	2	3	3
CO5	3	2	3	2	1	2	2	2	1	1	0	2	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT6003	Basics of Forensic Science
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Basic biology and chemistry knowledge.
Learning objective	To understand forensic science fundamentals, analyze crime and forensic investigation, assess crime causes, injury classifications, and death assessment methods, apply toxicological principles, utilize genetic engineering in forensics
Course outcome	**CO1:** Describe the foundational principles of forensic science and the organization and services of forensic science laboratories. **CO2:** Analyze the causes of crime, classify injuries and assess their medico-legal aspects, and evaluate methods of determining various types of deaths. **CO3:** Differentiate between various types of firearms and explosives, explain the principles of ballistics, and assess the general and individual characteristics of handwriting. **CO4:** Discuss the role of toxicologists in forensic investigations, apply principles of fingerprinting for personal identification, and classify different fingerprint patterns. **CO5:** Explain the principles of DNA fingerprinting and its application in forensic medicine, and implement techniques for evidence preservation, search and seizure of computers, and cyber security.
Unit-I	**Basics of Forensic Science** **8 hours**
	Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science
Unit-II	**Crime Forensic** **7 hours**
	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-III	**Fire Arm Forensic** **7 hours**
	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-IV	**Toxicology Forensic** **7 hours**
	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-V	**Genetic Engineering Forensic** **7 hours**
	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.
Reference books	1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press,Washington. 2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty FirstCentury, Select Publishers, New Delhi (2001). 3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, Universityof Delhi, Delhi (2002). 4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific andInvestigative

	Techniques, 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). 7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime SceneInvestigation, CRC Press, Boca Raton (2013).
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	2	2	2	1	1	2	3	3	3	3	3
CO2	3	3	3	2	1	2	2	2	2	1	1	2	3	3	3	3	2
CO3	3	3	2	3	1	3	2	2	1	1	2	2	3	2	2	2	2
CO4	3	2	3	3	1	3	1	2	0	1	0	3	3	3	2	3	3
CO5	3	2	3	2	1	2	2	2	1	1	0	2	3	3	3	3	3

3: High, 2: Medium, 1: Low

BT6003	**AI in Agriculture**
Version	1.0
Prerequisite	Basic knowledge of biotechnology, plant biology, data science, and artificial intelligence.
Learning objective	The course is designed to introduce applications of Artificial Intelligence in modern agriculture and agri-biotechnology. The specific objectives are: 1. To understand the role of AI in smart and sustainable agriculture. 2. To familiarize students with AI-based agricultural data analysis and decision-making systems. 3. To introduce AI applications in crop improvement, disease detection, and precision farming. 4. To develop understanding of computational tools used in agricultural biotechnology. 5. To highlight challenges, ethics, and future prospects of AI-driven agriculture.
Course outcome	**CO1:** Understand the concepts and importance of AI in modern agriculture and agri-biotechnology. **CO2: A**nalyze agricultural datasets using computational and AI-driven approaches. **CO3:** Evaluate AI applications in crop monitoring, disease prediction, and precision farming. **CO4:** Apply AI concepts in agricultural biotechnology, genomics, and environmental sustainability. **CO5:** Assess ethical, environmental, and societal implications of AI in agriculture.
Unit-I	**Introduction to AI in Agriculture 8 hours**
	Introduction to smart agriculture and digital farming, Evolution of AI in agriculture, Need for AI in sustainable agriculture, Agricultural data types:crop data, soil data, weather data, remote sensing data, Role of AI in agricultural decision-making, Challenges in modern agriculture and AI-based solutions
Unit-II	**Precision Agriculture and Smart Farming 7 hours**
	Precision agriculture: concepts and significance, Sensors and IoT in agriculture, AI-based irrigation and nutrient management, Smart greenhouse systems, Drone technology and remote sensing applications, GIS applications in agriculture, Automated monitoring systems in farming
Unit-III	**AI Applications in Crop Improvement and Plant Biotechnology 7 hours**
	AI in plant breeding and crop genomics, Prediction of crop yield and productivity, I-based identification of plant diseases and pests, Image analysis in plant phenotyping, AI applications in stress tolerance studies, Data-driven approaches in agricultural biotechnology
Unit-IV	**Machine Learning and Data Analytics in Agriculture 7 hours**
	Agricultural data preprocessing and analysis, Machine learning approaches in agriculture (overview), Classification and prediction models in crop science, Weather forecasting and climate analytics, Decision support systems for agriculture, Big data applications in agri-biotechnology
Unit-V	**Sustainability, Ethics and Future Perspectives 7 hours**
	AI for sustainable agriculture and food security, AI in environmental monitoring and resource management, Ethical and social issues in AI-driven agriculture, Data privacy and digital agriculture challenges, Case studies:AI-based crop disease prediction, precision farming systems smart irrigation systems, Future prospects of AI in agriculture and agri-biotechnology
Reference books	1. Liakos, K. G. et al. Machine Learning in Agriculture: A Review, Sensors Journal. 2. Balasundram, S. K., & Shamshiri, R. Digital Agriculture for Food Security. 3. Lesk, A. M. Introduction to Bioinformatics, Oxford University Press. 4. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach, Pearson.

	5. Aggarwal, C. C. Data Mining: The Textbook, Springer. 6. Patricio, D. I., & Rieder, R. Computer Vision and Artificial Intelligence in Precision Agriculture, Computers and Electronics in Agriculture.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2	1	1	2	-	1	1	2	3	2	1	3	2
CO2	3	3	3	3	2	2	1	2	1	1	1	2	3	3	2	3	3
CO3	3	3	3	3	3	2	2	2	1	1	2	3	3	3	2	3	3
CO4	3	3	3	3	3	2	2	3	1	1	2	3	3	3	2	3	3
CO5	2	3	2	2	3	2	3	3	2	2	3	2	2	2	1	3	3

3: High, 2: Medium, 1: Low

SEMESTER-VII (For B.Sc (Hons./Hons. with Research)

BT7001	**Enzyme Biotechnology**
Version	1.0
Prerequisite	Basic understanding of biochemistry, molecular biology, and cell biology, with a focus on enzyme kinetics and microbial processes.
Learning objective	To provide a detailed knowledge about enzymes, their chemical nature, kinetics, catalysis, classifications, factors affecting the velocity of enzymes, theories of enzyme action, enzyme regulation, inhibitions, clinical enzymes, industrial enzymes, non-protein enzymes, coenzymes and cofactors.
Course outcome	**CO1:** Define and classify enzymes, including metalloenzymes, holoenzymes, and isozymes, to comprehend their diverse biological functions and structures. **CO2:** Apply enzyme kinetics principles, including Michaelis-Menten equation and Lineweaver-Burk plot, to analyze catalytic efficiency and substrate binding in enzymatic reactions. **CO3:** Evaluate enzyme immobilization techniques, such as adsorption and covalent binding, to enhance enzyme stability and reusability in industrial applications. **CO4:** Analyze the industrial and clinical applications of enzymes, elucidating their roles in pharmaceuticals, food processing, and medical diagnostics. **CO5:** Synthesize the structure-activity relationship of enzymes for drug discovery, employing techniques like combinatorial chemistry and high-throughput screening to identify lead compounds.
Unit-I	**Enzymes as Catalysts** **7 hours**
	Proteins as catalysts (Historical background); Enzyme nomenclature & classification; EC number of enzymes, Enzyme characteristics and properties; Factors affecting Enzyme Activity-Concentration, pH and temperature, Co-enzyme; Co-factors and their role in enzyme activity; Structure and function of coenzymes - TPP, pyrodoxal phosphate, Nicotinamide, flavin nucleotide, coenzyme A and biotin, Catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site). Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis.
Unit-II	**Enzyme Kinetics and Regulation** **7 hours**
	Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, Lineweaver Burk Plot, Turnover number, $K_{cat.}$ Kinetics of Enzyme Inhibition. Allosteric enzymes. Numerical problems in enzyme kinetics and enzyme inhibition. Feedback Regulation, Allosteric Regulation, Reversible, Covalent Modification and Proteolytic Activation. Enzyme processing. Enzymes in post translational modifications.
Unit-III	**Isolation, purification and immobilization of enzymes** **7 hours**
	Localization of proteins in various organelles/Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation, Cross linking, covalent binding and their examples. Enzyme stabilization & protein engineering; Catalytic antibodies
Unit-IV	**Industrial and Clinical Applications of Enzymes** **8 hours**

	Applications in leather industry, food processing industry, Dairy industry, pharmaceutical industry. Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflammatory agents, streptokinase, asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphatases. Enzyme Engineering and site directed mutagenesis
Unit-V	**Enzyme Structure activity Relationship (SAR) and Drug Discovery 7 hours**
	Lead Compound, Structure based drug design, combinatorial chemistry, High-throughput screening, Case study of DHFR etc.
Reference books	1. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition. 2016. 2. Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals" 2nd edition, McGraw–Hill, 1988 2. Michael L. Shuler and Fikret Kargi, "Bioprocess Engineering Basic Concepts", 3rd edition, Prentice Hall, 2017. 3. Trevor Palmer and P L Bonner, Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 2nd Edition, 2007. 4. Gary walsh, Proteins, 2nd Edition, 2015.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	2	1	1	2	2	2	1	1	2	3	2	1	1	3
CO2	3	3	2	1	1	1	2	2	2	1	1	2	3	2	1	1	2
CO3	3	3	3	3	1	3	2	2	1	1	2	2	3	2	2	1	2
CO4	3	2	3	3	1	3	1	1	0	1	0	3	3	3	2	1	3
CO5	3	2	3	2	1	2	2	2	1	2	2	2	3	2	1	1	3

3: High, 2: Medium, 1: Low

BT7002	Environmental Toxicology
Version	1.0
Prerequisite	Basic knowledge of biology, chemistry, and environmental science, including concepts of toxicity, ecology, and human health.
Learning objective	1. Understand fundamental concepts in environmental toxicology, including dose-response relationships and ADME processes. 2. Analyze the movement and distribution of toxicants in various environmental compartments. 3. Apply ecotoxicological principles to assess risks to ecosystems, evaluate the impact on human health, and implement strategies for pollution prevention and regulatory compliance.
Course outcome	**CO1**: Define and categorize environmental toxicants, such as carcinogens and teratogens, to comprehend their diverse effects on biological systems and the environment. **CO2**: Apply environmental fate and transport principles to assess the movement and distribution of toxicants in different environmental compartments, and analyze their potential for bioaccumulation and biomagnification. **CO3**: Evaluate methods for environmental risk assessment, including hazard identification and dose-response analysis, to quantify the potential adverse effects of toxicants on human health and ecosystems. **CO4:** Analyze the mechanisms of toxicity of environmental pollutants, elucidating their impacts on cellular processes and ecological communities, to develop effective mitigation strategies. **CO5:** Synthesize strategies for environmental management and pollution control, including prevention, remediation, and regulatory compliance, to minimize the impact of toxicants on ecosystems and human health.
Unit-I	**Introduction to Environmental Toxicology** **7 hours**
	Principles of Environmental Toxicology and the Dose-Response Relationship, Toxicity Testing, and ADME I (Absorption, Distribution, Metabolism and Excretion) ADME II (Toxicokinetics and Metabolism), and Classes of Environmental Chemicals, Biochemical Effects and Mechanisms of Toxicity of Pollutants
Unit-II	**Environmental Fate and Transport of Toxicants** **7 hours**
	Environmental Fate and Sources of Pollutants, Transport and Distribution of toxicants in air, water, soil, and biota; Carcinogenic & Genotoxicity Pollutants and Their Effects, Bioaccumulation and biomagnification of toxicants in food chains and ecosystems.
Unit-III	**Ecotoxicology and Environmental Risk Assessment** **7 hours**
	Principles of ecotoxicology and its application in assessing the effects of toxicants on ecosystems and biodiversity, Methods for environmental risk assessments-Hazard identification, dose-response assessment, exposure assessment, and risk characterization, Biomarkers and Biomonitoring, Developmental Origins of Disease and Endocrine Disruption
Unit-IV	**Toxicological impact on human health** **7 hours**
	Routes of exposure to environmental toxicants, Effect of common environmental pollutants on human health, Neurotoxicological Effects of Environmental Pollutants Epidemiological studies and risk assessment approaches for implications over human health,
Unit-V	**Biological Control of Toxicity & Environment regulation** **8 hours**

	Strategies for pollution prevention, remediation, and sustainable management of contaminated sites. Biomonitoring - Bioassays, Biosensors, Biochips, Biological indicators; Bio restoration of waste land, Bioleaching – microbes involved, Thuringiensis toxin as a natural pesticide. Biological control of other insects swarming the agricultural fields. Regulatory frameworks and policies governing the management and control of environmental toxicants at local, national, and international levels.
Reference books	1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press. 2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication. 3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House 4. Joseph, B., Environmental studies, Tata Mc Graw Hill. 5. Michael Allabay, Basics of environmental science, Routledge Press 6. Casarett & Doull's Essentials of Toxicology. 3rd edition. Klaassen CD, Watkins JB. McGraw 7. Hill, 2015. Also available on libraries.rutgers.edu (via accespharm) at https://bit.ly/3o0TasX 8. Principles of Ecotoxicology. 2nd edition. Walker CH, Hopkin SP, Sibly RM, Peakall DB. Taylor & Francis Group, 2001.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	2	2	2	1	0	1	3	3	3	2	2	3
CO2	2	3	2	2	3	2	2	2	3	3	1	1	3	2	3	2	3
CO3	2	3	3	2	3	2	2	2	2	2	0	1	3	2	2	3	3
CO4	2	2	2	1	3	3	1	1	3	3	1	1	3	3	2	3	2
CO5	2	2	2	2	3	3	2	2	3	3	1	1	3	3	2	1	2

3: High, 2: Medium, 1: Low

BT7003	RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
Version	I
Prerequisite	All students are expected to have a basic knowledge of life sciences and their applications in research.
Learning objective	The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.
Course Outcome	**CO1:** Understand research methodologies, literature search techniques, and bibliometric analysis in life sciences. **CO2:** Develop research hypotheses, distinguish between hypothesis-driven and hypothesis-generating research, and apply them effectively in scientific projects. **CO3:** Design experiments, analyze data using statistical software, and present findings with clarity and precision. **CO4:** Enhance formal presentation skills, defend research findings, and participate in group discussions effectively. **CO5:** Master technical writing skills, navigate the scientific publication process, and adhere to ethical standards in scientific communication.
Unit-I	**Introduction to Research Methodology** **7 hours**
	Fundamentals of Research Methodology, Applications in life sciences, Literature Search: Use of databases, framing query with examples, Bibliometric: Citation, Impact factor, Eigen factor.
Unit- II	**Formulating Research Hypothesis and Experimental Design** **7 hours**
	Hypothesis Testing: Hypothesis as a framework for scientific projects, Alternatives of hypothesis driven research and hypothesis generating research.
Unit-III	**Experimental Design and Data Analysis** **8 hours**
	Different types of experimental designs, Controls, Taking measurements, Data Analysis: Between-individual variation, replication and sampling. Data collection, presentation and analysis by using Excel and other statistical software's.
Unit-IV	**Presentation skills** **7 hours**
	Presentation skills - formal presentation skills, preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.
Unit-V	**Scientific communication** **7 hours**
	Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Reference Books	1. Experimental Design for Biologists. David J. Glass. Cold Spring Harbor Laboratory. 2. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press. 3. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558. 4. Research Methods for the Biosciences. Holmes, Moody & Dine. Oxford University Press. 5. C.R. Kotari, Research Methodology Methods and Techniques, Second Revised Edition, New Age International (P) Limited, Publishers.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	1	1	1	2	3	2	1	2	3	3	2	2	3
CO2	2	2	2	1	1	2	1	2	3	3	1	1	3	2	2	2	3
CO3	2	2	3	2	1	2	2	2	2	2	0	1	2	2	2	2	3
CO4	2	1	2	1	1	3	1	1	3	3	1	1	2	2	1	1	2
CO5	2	2	2	2	2	3	2	2	3	3	1	1	2	2	2	1	2

3: High, 2: Medium, 1: Low

BT7004	Nutrition and Health
Version	I
Prerequisite	Basic understanding of human biology and physiology, including knowledge of macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins, minerals).
Learning objective	Learn the basics of nutrition and dietary planning, along with the importance of functional foods and antioxidants for health. Recognize essential nutrients, their sources, and deficiencies, and assess the impact of cooking methods on nutritional quality.
Course Outcome	**CO1:** Understand nutrition concepts, including food, diet, and balanced meals, and their impact on health. **CO2:** Differentiate functional foods, prebiotics, probiotics, and antioxidants, and grasp their roles in promoting gut health and combating oxidative stress. **CO3:** Recognize macro and micronutrients, their sources, functions, and deficiencies, alongside recommended dietary allowances and metabolic indicators. **CO4:** Evaluate cooking methods' effects on nutritional value, considering advantages and disadvantages of boiling, steaming, frying, baking, and air frying. **CO5:** Explore nutritional needs across life stages, and understand dietary guidelines for adulthood, pregnancy, infancy, and geriatric years. Examine management strategies for metabolic disorders like diabetes and cardiovascular disease.
Unit-I	**Introduction** **7 hours**
	Concepts of nutrition and health. Definition of Food, Diet and nutrition, Food groups. Food pyramids. Functions of food. Balanced diet. Meal planning. Eat right concept
Unit- II	**Functional Foods and Probiotics** **7 hours**
	Functional foods- types, and characteristics; Prebiotics- Sources, importance and their impact on gut health, Probiotics- Definition, types and Mechanisms of action and Sources of probiotics in foods and supplements, Antioxidants- types, sources, their role in combating oxidative stress and health benefits
Unit-III	**Nutrients** **8 hours**
	Macro and Micronutrients - Sources, functions and deficiency. Carbohydrates, Proteins, Fats – Sources and calories. Minerals –Calcium, Iron, Iodine. Vitamins – Fat soluble vitamins –A, D, E & K. Water soluble vitamins – vitamin C Thiamine, Riboflavin, Niacin. Water–Functions and water balance. Fiber –Functions and sources. Recommended Dietary Allowance, Body Mass Index and Basal Metabolic Rate
Unit-IV	**Methods of Cooking and Nutritional Value** **7 hours**
	Methods of cooking affecting nutritional value. Advantages and disadvantages. Boiling, steaming, pressure cooking. Oil/Fat – Shallow frying, deep frying. Baking, air frying
Unit-V	**Nutrition through lifecycle and metabolic disorders** **7 hours**
	Nutrition through lifecycle. Nutritional requirement, dietary guidelines: Adulthood, Pregnancy, Lactation, Infancy- Complementary feeding, Pre-school, Adolescence, geriatric. Nutrition related metabolic disorders- diabetes and cardiovascular disease.

Reference Books	**1.** Experimental Design for Biologists. David J. Glass. Cold Spring Harbor Laboratory. **2.** On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press. **3.** Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558. **4.** Research Methods for the Biosciences. Holmes, Moody & Dine. Oxford University Press. **5.** C.R. Kotari, Research Methodology Methods and Techniques, Second Revised Edition, New Age International (P) Limited, Publishers.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	1	2	1	2	2	1	2	1	2	2	2	1	2
CO2	3	2	2	1	1	1	1	2	2	1	2	2	3	2	1	2	2
CO3	3	2	3	2	1	2	2	2	2	1	2	2	3	2	2	1	2
CO4	2	1	3	2	2	3	1	2	2	1	2	1	3	3	2	1	1
CO5	3	2	3	2	1	2	2	2	2	2	0	1	3	2	2	1	2

3: High, 2: Medium, 1: Low

BT7005	Epidemiology
Version	I
Prerequisite	Basic understanding of public health concepts and familiarity with statistical analysis methods.
Learning objective	Understand epidemiological concepts and methods, and apply them to analyze disease patterns and outbreaks. Evaluate the effectiveness of public health interventions in preventing and controlling diseases, and address global health challenges.
Course Outcome	**CO1:** Understand the fundamentals of epidemiology in public health, including its definition, historical development, and the principles and methods of disease surveillance. **CO2:** Identify and differentiate between various epidemiological study designs, including observational and experimental studies, and evaluate their strengths and limitations in establishing causality. **CO3**: Analyse epidemiological data using measures of disease frequency and association, interpret findings using statistical tools, and recognize and address biases, confounding factors, and effect modification in study design. **CO4**: Explore the role of epidemiologists in detecting, monitoring, and controlling outbreaks of infectious and non-communicable diseases, and analyse case studies to understand real-life epidemiological outbreaks. **CO5**: Evaluate strategies for disease prevention and control, including primary, secondary, and tertiary prevention measures, and understand the significance of public health interventions in addressing global health challenges, including emerging infectious diseases and global health disparities.
Unit-I	**Introduction to Epidemiology and Disease surveillance** **7 hours**
	Epidemiology in public health- Definition and importance; Historical development in epidemiological research. Principles and methods of disease surveillance. Steps in outbreak investigation: Identification, confirmation, descriptive epidemiology, hypothesis generation, analytical studies, and control measures.
Unit- II	**Epidemiological Study Designs** **7 hours**
	Observational studies: Cross-sectional, case-control, and cohort studies; Experimental studies: Randomized controlled trials and community trials. Strengths and limitations of different study designs in establishing causality and informing public health interventions.
Unit-III	**Analyzing Epidemiological Data** **8 hours**
	Measures of disease frequency and association: Incidence, prevalence, Odds ratio, relative risk, and attributable risk. Interpretation of epidemiological data using tables, graphs, and statistical software. Bias, confounding, and effect modification: Identification and control in epidemiological studies.
Unit-IV	**Disease prevention and control** **7 hours**
	Role of epidemiologists in detecting, monitoring, and controlling outbreaks of infectious and non-communicable diseases. Case studies of real-life epidemiological outbreaks
Unit-V	**Public Health Interventions and Global Health** **7 hours**
	Strategies for disease prevention and control: Primary, secondary, and tertiary prevention. Public health interventions: Vaccination programs, health promotion campaigns, and environmental interventions. Epidemiology in global health: Emerging infectious diseases, pandemic preparedness, and global health disparities.

Reference Books	1. "Epidemiology: Beyond the Basics" by Moyses Szklo and Javier Nieto (2014) 2. "Epidemiology: An Introduction" by Kenneth J. Rothman (2021) 3. "Modern Epidemiology" by Kenneth J. Rothman, Sander Greenland, and Timothy L. Lash (2008) 4. "Principles of Epidemiology in Public Health Practice" by Richard Dicker, Daniel E. Smith, and William R. Teutsch (2020) 5. "Introduction to Epidemiology" by Ray M. Merrill (2010)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	1	1	1	2	3	1	1	1	3	2	1	1	2
CO2	3	3	2	1	1	1	1	2	2	1	1	1	3	2	1	1	2
CO3	2	2	3	2	2	2	2	2	2	2	2	2	3	2	2	1	2
CO4	3	1	3	2	2	3	1	2	2	1	2	1	3	3	2	1	1
CO5	3	2	3	1	2	3	2	2	3	2	0	1	3	2	2	1	2

3: High, 2: Medium, 1: Low

BT7006	Synthetic Biology and Genome Editing
Version	I
Prerequisite	Basic knowledge of molecular biology, genetics, recombinant DNA technology, and biotechnology.
Learning objective	The course is designed to introduce principles and applications of synthetic biology and modern genome editing technologies. The specific objectives are: 1. To understand the fundamentals and design principles of synthetic biology. 2. To familiarize students with genome editing tools and molecular engineering strategies. 3. To introduce synthetic circuits, pathway engineering, and chassis organisms. 4. To understand applications of synthetic biology in healthcare, agriculture, and industrial biotechnology. 5. To highlight ethical, biosafety, and regulatory concerns associated with genome editing technologies
Course Outcome	**CO1:** Understand the concepts, principles, and components of synthetic biology. **CO2:** Analyze various genome editing technologies and their mechanisms. **CO3**: Evaluate synthetic genetic circuits and metabolic engineering approaches. **CO4**: Apply synthetic biology concepts in healthcare, agriculture, and industrial biotechnology. **CO5**: Assess ethical, biosafety, and societal implications of synthetic biology and genome editing.
Unit-I	**Introduction to Synthetic Biology** **7 hours**
	Introduction and scope of synthetic biology, History and evolution of synthetic biology, Principles of biological engineering, Standardization and modularity in biology, Biological parts, devices, and systems Chassis organisms:E. coli, yeast, mammalian cells, Synthetic biology workflow and design principles
Unit- II	**Genome Editing Technologies** **7 hours**
	Introduction to genome engineering, DNA repair mechanisms: homologous recombination, non-homologous end joining, Zinc Finger Nucleases (ZFNs), TALEN technology, CRISPR-Cas systems: CRISPR-Cas9, guide RNA design, genome targeting, Base editing and prime editing (overview)
Unit-III	**Synthetic Genetic Circuits and Metabolic Engineering** **8 hours**
	Gene circuits and regulatory networks, Toggle switches and oscillators, Promoters, repressors, and regulatory elements, Synthetic pathways and metabolic engineering, Pathway optimization strategies, Engineering microbes for production of: biofuels, pharmaceuticals, industrial enzymes, Introduction to computational tools in synthetic biology
Unit-IV	**Applications of Synthetic Biology and Genome Editing** **7 hours**
	Applications in medical biotechnology: gene therapy, engineered vaccines, CAR-T cell technology (basic overview), Applications in agricultural biotechnology: stress-tolerant crops, disease-resistant plants Applications in environmental biotechnology: biosensors, bioremediation, Industrial biotechnology applications, Synthetic biology in personalized medicine
Unit-V	**Biosafety, Bioethics and Future Perspectives** **7 hours**
	Biosafety considerations in synthetic biology, Ethical and societal issues in genome editing, Regulatory guidelines and risk assessment, Dual-use concerns in synthetic biology, Intellectual property issues in synthetic biology, Case studies: CRISPR applications, synthetic insulin production, engineered microbes Future prospects and emerging trends in synthetic biology

Reference Books	1. Brown, T. A. *Gene Cloning and DNA Analysis*, Wiley-Blackwell. 2. Cox, M. M., & Doudna, J. A. *Genome Editing and Engineering*, Academic Press. 3. Voigt, C. *Synthetic Biology: Methods for Engineering Biological Systems*, Academic Press. 4. Glick, B. R., Pasternak, J. J., & Patten, C. L. *Molecular Biotechnology*, ASM Press. 5. Primrose, S., & Twyman, R. *Principles of Gene Manipulation and Genomics*, Wiley-Blackwell. 6. Smolke, C. D. *The Metabolic Pathway Engineering Handbook*, CRC Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	1	1	1	2	-	1	1	2	3	2	1	2	2
CO2	3	3	2	3	2	2	1	2	1	1	1	3	3	3	2	3	3
CO3	3	3	3	3	2	2	2	2	1	1	1	3	3	3	3	3	3
CO4	3	3	3	3	3	2	2	3	1	1	2	3	3	3	2	3	3
CO5	2	3	2	2	3	2	3	3	2	2	3	2	2	2	1	3	3

3: High, 2: Medium, 1: Low

SEMESTER-VIII [For B.Sc (Hons.) Biotechnology]

BT8001	**Computer Aided Drug Designing (CADD)**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Computer Sciences and Biotechnology.
Course objective	This subject is designed to provide detailed knowledge of rational drug design process and various techniques used in rational drug design process.
Course outcome	Upon completion of the course, the student shall be able to understand **CO1:** Understand various rational approaches to lead discovery in drug design, including traditional medicine-based, random screening, and serendipitous discovery methods. **CO2:** Familiarize with bioinformatics and chemoinformatics tools, including ADME databases, and comprehend their role in drug design and discovery. **CO3:** Identify and analyze different types of drug targets, including proteins/enzymes, receptor proteins, and nucleic acids, along with understanding the intermolecular binding forces between drugs and targets. **CO4:** Gain proficiency in molecular modeling and virtual screening techniques, such as pharmacophore mapping, molecular docking, and de novo drug design, for lead optimization and compound screening. **CO5:** Understand the principles and applications of Quantitative Structure-Activity Relationship (QSAR) in drug design, including the history, types of physicochemical parameters, and experimental/theoretical approaches for parameter determination.
Unit-I	**Lead discovery and Analog Based Drug Design** **7 hours**
	Rational approaches to lead discovery based on traditional medicine, Random screening, Non-random screening, serendipitous drug discovery, lead discovery based on drug metabolism, lead discovery based on clinical observation
Unit-II	**Informatics & Methods in drug design** **7 hours**
	Introduction to Bioinformatics, chemoinformatics. ADME databases, chemical, biochemical and pharmaceutical databases.
Unit-III	**Drug Targets** **7 hours**
	Molecular Concept of Disease, Disease Pathway (example of inflammation pathway), Drug-Targets; Types of Drug targets: Proteins/Enzymes, Receptor Proteins, Nucleic Acids & other drug targets, Active sites and pharmacophores, allosteric sites, Intermolecular binding force of drugs with targets: electrostatic or ionic bonds, Hydrogen bonds, Vander Waals forces, Dipole- dipole and ion dipole interaction, Repulsive interaction and Pi-Pi interaction
Unit-IV	**Molecular Modeling and virtual screening techniques** **8 hours**
	Virtual Screening techniques: Drug likeness screening, Concept of pharmacophore mapping and pharmacophore-based Screening, Molecular docking: Rigid docking, flexible docking, manual docking, Docking based screening. De novo drug design.
Unit-V	**Quantitative Structure Activity Relationship (QSAR)** **7 hours**
	History and development of QSAR, Types of physicochemical parameters, experimental and theoretical approaches for the determination of physicochemical parameters such as Partition coefficient, Hammet's substituent constant and Tafts steric constant.

Reference books	1. Textbook: Molecular Modelling: Principles and Applications (Paperback), by Andrew R. Leach, Pearson Higher Education, USA, 2001 (ISBN 0582382106). b) Handouts and notes for the computer labs 2. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases, and Analytical Tools by Supratim Choudhuri (2019) 3. Principles of Drug Design by Hansch, C., et al. (2010)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	1	1	2	2	1	1	1	2	3	2	2	2	2
CO2	3	2	3	2	1	1	1	2	2	1	1	1	3	2	2	2	2
CO3	2	2	2	1	2	2	2	2	2	1	1	2	3	2	2	2	3
CO4	3	2	3	2	1	0	3	1	2	1	0	2	3	3	2	1	2
CO5	3	2	2	2	1	1	2	2	3	1	0	2	3	2	3	3	3

3: High, 2: Medium, 1: Low

BT8002	Entrepreneurship Development
Version	1.0
Prerequisite	Basic understanding of business concepts and principles, including organizational structures and financial management.
Course objective	1. To understand the meaning and importance of Entrepreneurship. 2. To understand the various forms of business organization. 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.
Course outcome	**CO1**: Remember and define the terms and basic concepts of entrepreneurship development and their different roles to influencing entrepreneurship, features of a successful Entrepreneurship **CO2:** Understand and remember the introduction and principle, mechanism of entrepreneurship, features, financing the enterprise, marketing management and entrepreneurship and international business. **CO3**: Applying, understanding and remembering the detailed processes of mechanism of entrepreneurship, features, financing the enterprise, marketing management and entrepreneurship and international business. **CO4:** Analyzing, Applying, remembering, understanding the detailed and complete study related to Biotechnological entrepreneurship features for the growth or individual person and society **CO5**: Evaluating, analyzing, applying, remembering, and understanding the properties of mechanism of entrepreneurship, features, financing the enterprise, marketing management and entrepreneurship and international business. **CO6:** Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the entrepreneurship and the awareness, appreciation and applicability in environment, and their diverse functions.
Unit-I	**INTRODUCTION TO ENTREPRENEURSHIP** **7 hours**
	Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.
Unit-II	**ESTABLISHING AN ENTERPRISE** **7 hours**
	Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.
Unit-III	**FINANCING THE ENTERPRISE** **7 hours**
	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** **8 hours**
	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.
Unit-V	**ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS** **7 hours**
	Meaning of International business, Selection of a product, Selection of a market for

	international business, Export financing, Institutional support for exports
Reference books	1. Holt DH. Entrepreneurship: New Venture Creation. (2019) 2. Kaplan JM Patterns of Entrepreneurship. (2017) 3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons. (2018)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	2	2	2	2	1	2	2	2	1	3	2	1	3	2
CO2	1	2	1	2	2	2	3	3	2	2	2	1	1	2	2	3	3
CO3	1	2	2	2	2	1	2	2	1	2	3	0	3	3	2	2	2
CO4	2	1	2	2	2	3	2	1	2	2	3	2	2	3	3	2	2
CO5	1	2	2	2	2	2	3	2	1	2	2	1	3	2	1	2	2
CO6	2	1	2	2	3	2	2	1	2	2	2	1	2	1	2	2	2

3: High, 2: Medium, 1: Low

BT8003	**Cell Signaling and Cancer Biology**
Version	1.0
Prerequisite	It focuses on the mechanisms that underlie fundamental processes such as cell growth, the transformation of normal cells to cancer cells, and the spread (metastasis) of cancer cells. How the disturbance in cell signalling results in initiation and progression of cancer in the body.
Course objective	To understand how intracellular signaling networks function in normal cells, and how they are altered in cancer cells.
Course outcome	**CO1**: Understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location **CO2:** Apply the knowledge of signaling pathway in the cell and understand the cell receptors and signal transduction. **CO3**: Analyze the signaling pathways that control gene expression **CO4:** Evaluate and understand the role of cell signaling pathways in cancer **CO5**: Apply the molecular level of understanding of cell signaling in cancer biology **CO6:** Understand and apply the knowledge of cell signaling in the cancer biology
Unit-I	**Cell signaling** **7 hours**
	Signal Transduction and G Protein– Coupled Receptors- Signaling Molecules Can Act Locally or at a Distance. Receptors Bind Only a Single Type of Hormone or a Group of Closely Related Hormones. Protein Kinases and Phosphatases Are Employed in Many Signaling Pathways. GTP-Binding Proteins Are Frequently Used in Signal Transduction Pathways as on/Off Switches, Intracellular “Second Messengers” Transmit Signals from Many Receptors Signal Transduction Pathways Can Amplify the Effects of Extracellular Signals
Unit-II	**Studying Cell-Surface Receptors and Signal Transduction Proteins** **7 hours**
	G Protein–Coupled Receptors: Structure and Mechanism, Protein–Coupled Receptors That Regulate Ion Channels, G Protein–Coupled Receptors That Activate or Inhibit Adenylyl Cyclase, G Protein–Coupled Receptors That Trigger Elevations in Cytosolic and Mitochondrial Calcium
Unit-III	**Signaling Pathways That Control Gene Expression** **7 hours**
	Receptor Serine Kinases That Activate Smads, Cytokine Receptors and the JAK/STAT Signaling Pathway, Receptor Tyrosine Kinases, The Ras/MAP Kinase Pathway; Phosphoinositide Signaling Pathways, Signaling Pathways Controlled by Ubiquitinoylation and Protein Degradation: Wnt, Hedgehog, and NF-κB
Unit-IV	**Cancer- Fundamentals of cancer biology** **8 hours**
	Introduction to Cancer Biology; Modulation of cell cycle in cancer Different forms of cancers, Cancer screening and early Detection, action using biochemical assays tumor markers molecular tools for early diagnosis of cancer, Principles of carcinogenesis-Theory of Carcinogenesis, Chemical carcinogenesis; Principles of physical carcinogenesis, Mechanisms of radiation carcinogenesis, Nutrition and cancer,
Unit-V	**Principles of molecular cell biology of cancer** **7 hours**

	Signal targets and cancer Activation of kinases Proto oncogenes and oncogenes activity Identification of oncogenes, Retroviruses and oncogenes, Detection of oncogenes, Growth factors related to transformation, Telomerases Tumour suppressor genes Single Nucleotide; Polymorphism (SNP) in cancer Molecular tools for identifying cancer genes
Reference books	1. Becker JM, Cold Well GA & Zachgo EA. 2007. Biotechnology a Laboratory Course. Academic Press. 2. Brown CM, Campbell I & Priest FG. 2005. Introduction to Biotechnology. Panima. 3. Singh BD. 2006. Biotechnology Expanding Horizon. Kalyani
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	2	2	2	2	1	2	2	2	1	3	2	2	3	2
CO2	3	2	3	2	2	2	3	3	2	2	2	1	3	2	2	3	3
CO3	3	2	2	2	2	1	2	2	1	2	3	0	3	3	2	2	3
CO4	3	2	2	2	2	3	2	1	2	2	3	2	3	3	3	2	2
CO5	3	2	2	2	2	2	3	2	1	2	2	1	3	2	2	2	2
CO6	3	2	2	2	3	2	2	1	2	2	2	1	3	3	2	2	2

3: High, 2: Medium, 1: Low

BT8004	Functional Foods and Nutraceuticals
Version	1.0
Prerequisite	This course comprises of the structure, function, properties and significance of functional and nutraceutical food. Sources and health benefits will be studied in details.
Course objective	➢ To understand the interrelationship between nutraceuticals and health maintenance. ➢ Understanding the traditional system of medicine as well as the need for changing trends in the nutraceutical Functional Food Industry. ➢ To learn the efficacy and safety of nutraceutical and functional food products. ➢ To learn the packaging and labelling strategies of remedial food.
Course outcome	**CO1**: Recall the basic principles and concepts of functional food and nutraceuticals **CO2:** Describe and understand the properties, structure, and functions of nutraceuticals **CO3**: Apply the principles of formulation and development of functional food and nutraceutical products for specific health conditions or populations **CO4:** Analyze about the different sources of functional food and nutraceuticals, there application and packaging and labelling requirements **CO5**: Assess the potential risks and benefits associated with the consumption of specific functional food and nutraceutical products and Safety regulations in USA, EU and India. **CO6:** Understand the basic concepts of nutraceuticals and functional food and use those concepts to development of food products and Evaluate the impact of functional food and nutraceutical interventions on the overall health and well-being of individuals
Unit-I	**Introduction to Nutraceuticals and Functional Food 7 hours**
	Definition, national and international status, scope & prospects of nutraceuticals and functional food, Applied aspects of the Nutraceutical and Functional Food Science. Sources of Nutraceuticals. Relation of functional foods & Nutraceutical to foods, Formulation considerations and challenges, new product development
Unit-II	**Properties and Functions of Nutraceuticals and Functional Foods 7 hours**
	Nutraceuticals: Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha-ketoglutarate, pro-anthocyanidins, grape products, flaxseed oil and others, Functional Foods: Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols, Polyunsaturated fatty acids, sphingolipids, lecithin, choline, Terpenoids, Vegetables, Cereals, milk and dairy products as Functional foods and others
Unit-III	**Role of Functional Foods as Remedial Foods and Disease Prevention 7 hours**
	Nutraceuticals bridge the gap between food and drug, Nutraceuticals – garlic, grape, wine, tea, soy proteins and soy isoflavones, dietary fibre, omega-3 fatty acids, antioxidants and phytochemicals, single-cell proteins, and marine-derived nutraceuticals, Nutraceutical remedies for common disorders like circulatory problems, hypo-glycemia, nephrological disorders, liver disorders, osteoporosis, gastrointestinal disorders, and cardiovascular diseases
Unit-IV	**Nutraceutical Sources and Packaging & Labelling Requirements for Functional Food Products 8 hours**
	Plant secondary metabolites: Role of Plant Sterols and Phytoestrogens in Functional Foods, Phenolics in Herbal and Nutraceutical Products, Animal metabolites: Fat-rich functional food and their applications - Functional Fats and Spreads, modified fats and oils. Functional Meat

	as Functional Foods, Functional Confectionery and other functional Products, Packaging and labelling requirements: Packaging and packaging materials, an overview of dietary supplements labelling, nutrition labelling requirements.
Unit-V	**Claims, Marketing and Regulations for Functional Food Products 7 hours**
	Nutritional content claims, health claims and exemption from FDA requirements, Dietary supplements labelling issues, regulatory agencies views on label claims, The market for Functional Food Products: Market scenario, Functional foods and consumers, The role of health in food choice; Functional foods market; Regulations and laws for functional food. Regulations in USA, EU and India
Reference books	1. A. E. Bender, "Nutrition and Dietetic Foods", Chem. Pub. Co. New York, 2ndEdition, 2004. 2. P. S. Howe, "Basic Nutrition in Health and Disease",2ndEdition,W. B. Saunders Company, London, 2003. 3. Kramer, "Nutraceuticals in Health and Disease Prevention", Hoppe and Packer, Marcel Dekker, Inc., NY 2001. 4. Bao and Fenwick, "Phytochemicals in Health and Disease", Marcel Decker, Inc. NY 2004. 5. Rotimi E.Aluko. Functional Foods and Nutraceuticals. Springer
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	2	2	2	2	1	2	2	2	1	2	1	2	2	2
CO2	3	1	1	2	2	2	3	3	2	2	2	1	2	2	1	2	2
CO3	1	1	2	2	2	1	2	2	1	2	2	0	1	2	2	1	3
CO4	1	1	2	2	2	2	2	1	2	2	3	2	1	2	3	2	2
CO5	3	1	2	2	2	2	3	2	1	2	2	1	2	2	2	2	2
CO6	3	1	2	2	3	2	2	1	2	2	2	1	2	3	2	2	2

3: High, 2: Medium, 1: Low

BT8005	Quantum Biotechnology
Version	1.0
Prerequisite	Basic knowledge of biotechnology, biophysics, molecular biology, and nanotechnology.
Course objective	The course is designed to introduce emerging concepts of quantum science in biological systems and biotechnology. The specific objectives are: 1. To familiarize students with basic principles of quantum biology and quantum biotechnology. 2. To understand quantum phenomena occurring in biological systems. 3. To introduce applications of quantum technologies in biosensing, imaging, and healthcare. 4. To explore interdisciplinary applications of quantum science in biotechnology and medicine. 5. To highlight future prospects and challenges in quantum biotechnology.
Course outcome	**CO1**: Understand the basic principles of quantum mechanics relevant to biological systems. **CO2:** Analyze quantum phenomena involved in biological processes. **CO3**: Evaluate quantum-based technologies used in biosensing, imaging, and diagnostics **CO4:** Apply concepts of quantum biotechnology in healthcare, nanobiotechnology, and biomedical research. **CO5**: Assess emerging trends, challenges, and future prospects of quantum biotechnology.
Unit-I	**Introduction to Quantum Biotechnology 7 hours**
	Introduction and scope of quantum biotechnology, Basics of quantum mechanics:wave-particle duality, quantum states, superposition, quantum tunneling; Quantum concepts relevant to biological systems, Quantum biology: overview and significance, Interdisciplinary nature of quantum biotechnology
Unit-II	**Quantum Phenomena in Biological Systems 7 hours**
	Quantum effects in photosynthesis, Quantum coherence in biological systems, Enzyme catalysis and quantum tunneling, Electron transfer in biomolecules, Quantum aspects of olfaction and magnetoreception, Biomolecular interactions at quantum scale, Limitations and challenges in studying quantum biology
Unit-III	**Quantum Tools and Technologies in Biotechnology 7 hours**
	Quantum dots and nanobiotechnology, Quantum sensors and biosensors, Quantum imaging techniques, Quantum microscopy and spectroscopy, Applications of quantum technologies in diagnostics, Quantum computing basics for biological data analysis, Introduction to quantum algorithms in biotechnology
Unit-IV	**Applications of Quantum Biotechnology 8 hours**
	Quantum biotechnology in healthcare and medicine, Drug discovery and molecular simulations, Quantum approaches in genomics and proteomics, Quantum-enabled medical imaging, Applications in nanomedicine and targeted drug delivery, Quantum biosensing in environmental monitoring, Industrial and agricultural applications of quantum biotechnology
Unit-V	**Case Studies, Challenges and Future Perspectives 7 hours**
	Technical challenges in quantum biotechnology, Limitations of current quantum technologies in biological systems, Integration of quantum science with biotechnology and medicine. Case studies: quantum dots in biomedical imaging, quantum biosensors in diagnostics, quantum-inspired drug discovery, quantum effects in photosynthesis. Emerging trends: quantum

	computing in biological data analysis, quantum nanomedicine, quantum-enabled precision diagnostics. Industrial and healthcare prospects of quantum biotechnology, Future perspectives and interdisciplinary research opportunities
Reference books	1. McFadden, J., & Al-Khalili, J. Life on the Edge: The Coming of Age of Quantum Biology, Crown Publishing. 2. Abbott, D., Davies, P. C. W., & Pati, A. K. Quantum Aspects of Life, Imperial College Press. 3. Mohseni, M., Omar, Y., Engel, G., & Plenio, M. Quantum Effects in Biology, Cambridge University Press. 4. Nielsen, M., & Chuang, I. Quantum Computation and Quantum Information, Cambridge University Press. 5. Vo-Dinh, T. Nanotechnology in Biology and Medicine, CRC Press. 6. Kulzer, F., & Orrit, M. Single-Molecule Optics and Spectroscopy, Springer.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	1	1	1	2	-	1	1	1	3	2	1	1	2
CO2	3	3	2	2	2	1	1	2	-	1	1	2	3	2	2	2	2
CO3	3	3	3	3	2	2	1	2	1	1	1	3	3	3	2	2	3
CO4	3	3	3	3	2	2	2	3	1	1	1	3	3	3	2	3	3
CO5	2	3	2	2	3	2	3	3	2	2	3	2	2	2	1	3	3

3: High, 2: Medium, 1: Low