Manonmaniam Sundaranar University

Reaccredited with 'A' Grade (CGPA 3.13 out of 4.0) by NAAC in the Third Cycle

Tirunelveli - 627012, Tamil Nadu, India

Department of Biotechnology

Learning Outcome Based Curriculum Framework

MSc Biotechnology (Integrated)

2022 - 2023 onwards

Programme code
2549

MANONMANIAM SUNDARANAR UNIVERSITY

Vision of the University : To provide quality education to reach the unreached

Mission of the University :

- To conduct research, teaching, and outreach programmes to improve conditions of human living.
- To create an academic environment that honours women and men of all races, caste, creeds, cultures and an atmosphere that values intellectual curiosity, the pursuit of knowledge, academic freedom, and integrity.
- To offer a wide variety of off-campus educational and training programmes, including the use of information technology, to individuals and groups.
- To develop a partnership with industries and government to improve the quality of the workplace and serve as a catalyst for economic and cultural development.
- To provide quality / inclusive education, especially for the rural and unreached segments of economically downtrodden students, including women, socially oppressed, and differently-abled.

Department of Biotechnology

Vision of the department

Originating process development scientists, entrepreneurs, and professionals in the field of biotechnology.

Mission of the department

- Developing intellectuals with a remarkable capability, creativity, and sincerity for uplifting society through innovative biotechnological products and ideas.
- Nurturing and conserving the environment through sustainable biotechnological concepts.

1. **Name of the programme**: MSc. Biotechnology (Integrated)
2. **Preamble of the programme**:

MSc. Biotechnology (Integrated) is a ten-semester programme that includes theory and practicals in different areas of biotechnology. In addition, it contains two research projects (a Short research/ mini group project in the 6th semester and an individual dissertation project in the 10th semester) to enhance knowledge and research skills in biotechnology during the course.

I. Objectives of the programme

- To impart theoretical and practical knowledge and skills that underpin the various branches of biotechnology.
- To enable the students to have a thorough understanding and knowledge of different branches of biotechnology.
- To make the students develop the ability to think analytically in solving problems concerned with biotechnology.

2. Eligibility for admission

The minimum eligibility conditions for admission to the MSc. Biotechnology (Integrated) programme are below.

The candidates seeking admission into the first semester of this course will be required to have passed the Higher Secondary Examination conducted by the Board of Higher Secondary Education, Government of Tamil Nadu/ CBSE/ ICS within the following science subject groups:

1. Physics, Chemistry, Botany/Zoology
2. Physics, Chemistry, Biology

Or any other examination as equivalent to that in a science subject. Admission will be based on the total marks obtained in the Higher Secondary examination (Physics, Chemistry, Biology/ Botany/Zoology, or relevant subjects by following the govt. norms of reservation.

3. Duration, mark statement and certificates of the programme

The students shall undergo the prescribed course of study for a period, not less than five academic years (Ten semesters) consisting of six semesters (I – VI) for studying fundamentals of biotechnology (similar to undergraduate biotechnology) and four semesters (VII – X) for studying advanced biotechnology (post-graduate biotechnology). Each semester would contains 90 working days or as prescribed by the university.

The mark statements, provisional certificate, and degree certificate shall be awarded in the programme name. i.e., MSc. Biotechnology (Integrated).

I. The mark statements shall be awarded as per the following norms.

a. Cumulative mark statements shall be awarded from semester I – VI with the footnote Declaration: "A candidate is declared to have completed the BSc. Biotechnology (VI semester) programme successfully only when the cumulative credits earned is a minimum of 140".

b. Cumulative mark statements from VII semester to IX semester shall be issued separately. The X semester consolidated mark statement comprising I semesters to X semesters shall be issued

II. The students who are willing to exit the MSc. Biotechnology (Integrated) programme shall be permitted after completion of the VI semester; such students are instructed to inform their exit options at the end of the V semester. They will be allowed to exit the integrated programme with a special request and its due approval by the Vice-Chancellor through the Controller of Examinations.

III. For the students who opted exit option upon completion of the VI semester, their provisional and degree certificate shall be awarded in the name of BSc. Biotechnology. Such students shall not be considered for the university ranking and shall not be allowed to re-join the same programme.

IV. Those exiting after the VI semester shall be issued with the consolidated statement of a mark with the class classification as per the integrated programme (UG level) of our university departments.

V. For those exiting after the VI semester, the consolidated mark statement for the VI semester will be issued with the controller of examination office seal 'Eligible for the award of BSc. Biotechnology.'

VI. Those availing exit option after VI semesters shall be issued a course completion certificate by the Controller of Examination as per the given format.

This is to certify that the student bearing the name ---------- Reg. no----------joined the MSc. Biotechnology (Integrated) programme during academic year ---------- who opted exit option and earned 143 credits at the end of VI semesters shall be eligible for the award of BSc. Biotechnology.

VII. All other students except those who opted for the exit option at the end of the VI semester shall be permitted to continue the MSc. Biotechnology (Integrated) programme in the VII semester.

VIII. Since this programme is 5 years integrated programme, the university ranking shall be awarded only at the entire end of the MSc. Biotechnology (Integrated) programme, i.e., I – X semester. Besides, the university ranking for languages for the I – IV semester shall not be considered.

IX. The students who are unable to continue MSc. Biotechnology (Integrated) programme during the VII – X semester shall be considered for the BSc. Biotechnology degree award after collecting the processing fee as fixed by the university.

X. The students who are continuing MSc. Biotechnology (Integrated) programme in the VII semester with arrears in previous semesters shall be permitted to continue MSc. Biotechnology (Integrated) programme.

XI. The exited student Transfer certificate in serial no.7. The reason for leaving the university shall be noted as completed BSc. Biotechnology by exit option from MSc. Biotechnology (Integrated). The course in which the students were studying at the time of leaving shall be noted as MSc. Biotechnology (Integrated) in the serial no.10.

3. Programme structure

Semester	Course code	Course	Course nature	Credits	Contact hours per week	Continuous internal assessment (CIA)	End semester exam (ESE)
FIRST		Tamil/other language	Language	4	4	25	75
		English	Language	4	4	25	75
		Biodiversity	Core – I	4	5	25	75
		Biodiversity	Practical – I	2	4	50	50
		Biochemistry	Allied – I	3	3	25	75
		Biochemistry	Allied Practical – I	2	4	50	50
		Professional English for Life Science – I	Core – II	4	4	25	75
		Environmental Studies	Common – I	2	2	25	75
Sub Total				25	30		
SECOND		Tamil/other language	Language	4	4	25	75
		English	Language	4	4	25	75
		Cell & molecular biology	Core – III	4	5	25	75
		Cell & molecular biology	Practical – II	2	4	50	50
		Biochemistry II	Allied – I	3	3	25	75
		Biochemistry II	Allied Practical – I	2	4	50	50
		Professional english for life science - II	Core – IV	4	4	25	75
		Value based education/Social harmony	Common – II	2	2	25	75
Sub Total				25	30		
THIRD		Tamil/other language	Language	4	4	25	75
		English	Language	4	4	25	75
		Microbiology	Core – V	4	5	25	75
		Microbiology	Practical – III	2	3	50	50
		Biophysics I	Allied – II	3	3	25	75
		Biophysics I	Allied	2	3	50	50

			Practical – II				
		Bioprospecting	Skill based Core – I	4	4	25	75
		Biotechnology & human health	NME – I	2	2	25	75
		Yoga	Common – III	2	2	25	75
Sub Total				27	30		
FOURTH		Tamil/other language	Language	4	4	25	75
		English	Language	4	4	25	75
		Genetics	Core – VI	4	5	25	75
		Genetics	Practical – IV	2	3	50	50
		Biophysics II	Allied – II	3	3	25	75
		Biophysics II	Allied Practical – II	2	3	50	50
		Food Processing	Skill based core – II	4	4	25	75
		Biostatistics	NME – II	2	2	25	75
		Computer for digital era	Common – IV	2	2	25	75
		NCC,NSS, YRC,YWF	Extension Activity	1	-	25	75
Sub Total				28	30		
FIFTH		Animal & plant physiology	Core - VII	4	5	25	75
		Immunology	Core - VIII	4	5	25	75
		Molecular diagnostics	Major elective - I	4	4	25	75
		Animal & plant physiology	Practical - V	2	4	50	50
		Immunology	Practical - VI	2	4	50	50
		Personality development/Effective communication/ Youth leadership	Skill based common	2	2	25	75
		Seminar / Group discussion	Skill development course	-	3		
		Career guidance		-	3		
Sub Total				18	30		
SIXTH		Bioanalytical techniques	Core - IX	4	5	25	75
		Developmental biology	Core - X	4	5	25	75
		Medical biotechnology	Core - XI	4	5	25	75
		Drug designing	Major Elective – II	4	4	25	75
		Short research project	Project	5	10	50	50
		Seminar / Group discussion/ Career guidance/ Entrepreneurship training	Skill development course	-	1		
Sub Total				20	30		
SEVENTH		Advanced cell & molecular biology	Core – XII	4	4	25	75
		Enzymology	Core - XIII	4	4	25	75
		Genetic engineering & rDNA	Core - XIV	4	4	25	75

		technology (e-PG Pathshala)					
		Microbial biotechnology	Core - XV	4	4	25	75
		Advanced cell & molecular biology and Enzymology	Practical – VII	2	4	50	50
		Genetic engineering & rDNA technology and Microbial biotechnology	Practical - VIII	2	4	50	50
		Electives: any one	Optional elective - I	3	3	25	75
		1. Aquaculture biotechnology					
		2. Basics of forensic science					
		3. Cancer biology					
		Seminar / Group discussion/ Career guidance/ Entrepreneurship training	Skill development course	-	3		
Sub Total				23	30		
EIGHTH		Agricultural biotechnology	Core – XVI	4	4	25	75
		Food biotechnology	Core – XVII	4	4	25	75
		Genomics & proteomics	Core – XVIII	4	4	25	75
		Nano biotechnology	Core – XIX	4	4	25	75
		Agricultural biotechnology and Food biotechnology	Practical – IX	2	4	50	50
		Genomics & proteomics and Nano biotechnology	Practical - X	2	4	50	50
		Electives: any one	Optional elective - II	3	3	25	75
		1. Bioethics and biosafety					
		2. Pharmaceutical biotechnology					
		Extra departmental course (NPTEL online course)	Supportive - I	3	3	25	75
		Internship / Industrial / Institutional visit / In plant training * (Extra credits course)	Skill development course	7*	-	50	50
Sub Total				31	30		
NINETH		Animal biotechnology	Core – XX	4	4	25	75
		Industrial biotechnology	Core – XXI	4	4	25	75
		Plant biotechnology	Core – XXII	4	4	25	75
		Research methodology & biostatistics	Core – XXIII	4	4	25	75
		Animal biotechnology & Industrial biotechnology	Practical – XI	2	4	50	50
		Plant biotechnology and Research methodology & biostatistics	Practical – XII	2	4	50	50
		Electives: any one	Optional elective - III	3	3	25	75
		1. Management in biotechnology					
		2. Molecular diagnostic tools					
		3. Stem cells & regenerative biology					
		Extra departmental course (NPTEL online course)	Supportive - II	3	3	25	75
Sub Total				26	30		

TENTH		Environmental biotechnology (e-PG Pathshala)	Core – XXIV	4	4	25	75
		IPR and bioentrepreneurship	Core – XXV	4	4	25	75
		Dissertation	Project	8	22	50	50
Sub Total				18	30		
Total				241	300		

* Extra credits will be given to the students who have submitted the internship report/ Industrial visit report / Institutional visit report / In plant training report with an internship/ In plant training completion certificate from their respective internship / In plant training supervisor/faculty guide of the host institute.

Scheme of evaluation

For evaluation of theory papers (core, allied, elective), the continuous internal assessment (CIA) will be 25 marks and the end semester external examination (ESE) for 75 marks. Core practicals and allied practicals carry 100 marks with 50 marks internal and 50 marks external. Short research/Mini project and Dissertation/project carry 100 marks with 50 marks as internal and 50 as external.

i. Core, Allied and Elective Papers:

a. Continuous Internal Assessment:

- The CIA component for a theory course may include tests/seminar/assignment parts.
- There is no passing minimum for the CIA components and the CIA in total.
- There shall be no provision for improvement of CIA components.
- There shall be three compulsory periodical tests in a semester.
- Each test shall be conducted for about one and a half units of the syllabus in each course.
- The duration of each test will be one hour
- The question paper pattern for the internal test is given below:
- Each test carries 25 marks and shall be converted as required.

Section	Type of questions	Max. Marks
Part A	Objective type - 5 questions	5 x 1 = 05
Part B	2 out of 3 Descriptive or analytical questions	2 x 5 = 10
Part C	1 out of 2 Descriptive or analytical questions	1x 10 = 10
	Total marks	25

The CIA 25 marks would be divided as 20 marks for the internal written test (average of the marks from the best two tests out of three tests), 2.5 marks for the seminar, and 2.5 marks for the assignment activities.

b. External examinations:

The duration of the University examination for each theory course is 3 hours. The question paper pattern for the end-semester examination of each theory paper is given below:

Section	Type of questions	Max. marks
Part A	Objective type / descriptive - 10 questions (2 from each units)	10 x 1 = 10
Part B	Unit-wise choice - either (a) or (b) type - 5 questions	5 x 5 = 25
Part C	Unit-wise choice - either (a) or (b) type - 5 descriptive questions	5 x 8 = 40
	Total Marks	75

- There is a passing minimum of 50% in the university examination in each theory course and there is a passing minimum of 50% in the overall component, i.e., out of the total marks in the CIA component and university examination for each theory course.
- There will be a special supplementary examination for those candidates who have failed only one subject in the last semester.

Model question:

MANONMANIAM SUNDARANAR UNIVERSITY – NOVEMBER 2022

First semester

MSc., Biotechnology (Integrated)

Biodiversity **Subject code:**

Time: 3 hours **Total marks: 75**

Part A **1X1O=10 marks**

Answer ALL questions

1	Define the term biodiversity	CO1	R
2	Classify the different sources of genetic diversity	CO4	A
3	State the principal objective of TEEB.	CO3	R
4	Give an example of the indirect value of biodiversity	CO2	U
5	How will you define the population?	CO2	R
6	List out the significance of the ecological niche	CO3	
7	Enumerate the effects of overexploitation	CO4	R
8	Name two invasive plant species	CO4	R
9	Identify any two Indian famous wildlife sanctuaries	CO6	R
10	Quote any two important features of the bio-park.	CO5	R

Part B 5X5= 25 marks

Answer ALL questions. Each question carries equal marks

11a	Assess the effects of urbanization on biodiversity	CO4	E
	(Or)		
11b	Compile the possible benefits of agrobiodiversity to human beings	CO5	C
12a	Compare and contrast instrumental and intrinsic values of biodiversity	CO2	UA
	(Or)		
12b	What is the difference between the utilitarian and nonutilitarian reasons for conserving biodiversity?		
13a	Explain ecological natality	CO1	U
	(Or)		
13b	How will you predict the stability of an ecosystem?	CO4	E

14a	Propose ways to stop poaching.	CO5	C
	(Or)		
14b	Illustrate the predicted biological impacts of climate change	CO2	A
15a	Prepare the list Indian tiger reserves launched through project tiger. Add a note on tiger reserve located near to you	CO3	A
	(Or)		
15b	Appraise the purpose of botanical gardens. Add your views on entrance fee collection.	CO6	E

Part C 5X8= 40 marks

Answer ALL questions. Each question carries equal marks

16a	Justify the statement "India's biodiversity is greater than any other nation". Add a note on the importance of ecosystem diversity	CO1	C
	(Or)		
16b	Evaluate the role of centers of biodiversity and their importance in maintaining biodiversity.	CO2	A
17a	Explain in detail the direct values and non-consumptive value of biodiversity	CO5	U
	(Or)		
17b	What is a biodiversity hotspot? "India is one of the mega biodiversity hotspots"-Justify the statement	CO4	RE
18a	Explain the important characteristic features of the population. Add a note on the implications of change in population characteristics.	CO2	UE
	(Or)		
18b	How will you estimate the ecological diversity? Add a note on the index used and the importance of diversity measurement.	CO2	AE
19a	Categorize the main threats to biodiversity. Add a report on the steps taken by the Indian government to mitigate them.	CO3	AU
	(Or)		
19b	Compile the main natural causes of climate change. Discuss its biological impacts.	CO3	CU
20a	Predict the consequences of biodiversity loss. How will you contribute to Western ghat biodiversity conservation	CO6	AA
	(Or)		

20b Explain in detail the various *In-situ* methods followed for conserving Indian biodiversity CO4 A

Practical

Maximum marks	100
Passing minimum marks	50

Phase of Examination	Marks	Evaluation
Phase I: Internal - Continuous assessment	Total – 50 Shall be given based on the internal exams score, practicals attended and submission of observation	"N" number of practicals be conducted based on the practicals prescribed in the syllabus and the marks should be distributed equally for each practicals. There is no passing minimum for continuous assessment
Phase II: External - Practical examination	Total – 50 Marks awarded by the Examiner – 25 marks (10 for practicals + 10 for viva + 5 for records) Marks awarded by the External examiner – 25 marks (10 for practicals + 10 for viva + 5 for records)	Only one practical examination be conducted at the end of the semester for the students on a lot basis by appointing two examiners from the same department / one from the other institution. Passing minimum: 50% (25 marks) in the external

Internship

The internship course will provide the interns to gain knowledge. Internships are off-campus experiential learning activities designed to provide students with opportunities to make connections between the theory and practical of academic study. Internships are completed under the guidance of an internship supervisor and a faculty guide, who in combination with the interns will create a framework for learning. The interns will append, to their internship contract, from the internship supervisor, which lists responsibilities and how their performance will be evaluated.

a. The interns will be evaluated by research internship supervisor based on their sincerity, and research output.
b. At MSU, the intern will be evaluated through a seminar on his work, by a duly constituted faculty/ expert committee, on the following:

Criteria for evaluation of internship

S.No.	Criteria	Internal (50 Marks)		External (50 marks)
		Internship supervisor	Dept. faculty	
1	Organisation profile / Internship module	5	5	10
2	Activity logbook and evaluation report	5	5	5
3	Skill acquisition	-	5	5
4	Originality and innovation	-	5	5
5	Significance of research outcomes	5	-	5
6	Report writing	5	-	10
7	Presentation/Demonstration	5	5	10
Total (100 Marks)		25	25	50

Short research project (6th Semester)

Maximum marks	Internal	External
100	50	50

Mode of mini project : Group project

Guide : Students shall be allotted as a group (3 to 5 per group) under the guidance of a department faculty member by the Head of the Department

Nature of mini project : Each group of students shall undertake a unique project which shall be implemented using available lab facilities in the department approved by his/her guide.

Phase of examinations	**Marks**	**Assessment**
Phase I – Internal	Total – 50 marks	Periodical reviews by the guide/ faculty There is no passing minimum for assessment

Phase II – External	Total – 50 marks Marks awarded by the examiner – 25 marks (10 for Project + 5 for Viva-voce+ 10 for dissertation) Marks awarded by the external examiner – 25 marks (10 for Project + 5 for Viva- voce+ 10 for dissertation)	Examination shall be conducted at the end of the sixth semester by appointing either two examiners from the same department or at least one from the other department/ institution. Passing minimum: 50% (25 marks) in the external

Dissertation (10th Semester)

Mode of project : Individual project

Guide : Each student shall be allotted under the guidance of a department faculty member by the Head of the Department

Nature of project : Every student shall undertake a unique project, which shall be implemented using available lab facilities in the University/ other institution as approved by the guide and Head.

Phase of examination	**Marks**	**Assessment**
Phase I – Internal	Total – 50 marks	Periodical reviews by the guide/ faculty There is no passing minimum for assessment
Phase II – External	Total – 50 marks Marks awarded by the examiner – 25 marks (10 for Project + 5 for Viva-voce+ 10 for dissertation) Marks awarded by the external examiner – 25 marks (10 for Project + 5 for Viva-voce+ 10 for dissertation)	Examination shall be conducted at the end of the tenth semester by appointing either two examiners from the same department or at least one from the other department/ institution. Passing minimum: 50% (25 marks) in the external

Programme outcomes (POs)

PO 1: Learn to apply the biotechnology knowledge and meet the skilled manpower needed for the exploration of inclusive and sustainable development of agro-food, medical, pharmaceutical industries, and healthcare service organizations.

PO 2: Understand the applications of biotechnology and advances in the diverse fields like medical, microbial, food, environmental, agricultural, plant, animal, aquaculture, nano, and forensic sciences.

PO 3: Idealize the concept and applications of biotechnological tools in response to various infectious and non-infectious diseases. Interpret the usage of mammalian, plant, and microbial cells to produce therapeutically and other commercially important products.

PO 4: Explain the significance of genetically modified organisms and their products and general principles underlying the generation of transgenic plants, animals, and microbes.

PO 5: Appraise the interdisciplinary nature of the bioinformatics course with a substantial understanding of biological, physical, and chemical sciences.

PO 6: Analyze the current applications of biotechnology to environmental quality evaluation, monitoring, and contaminated environment remediation.

PO 7: Nurture necessary hands-on technical skills to support biotechnology research activity and innovative product development.

PO 8: Enable to avail the employment opportunities in various government and non-government research laboratories, institutes, bio-industries, and start-ups establishment.

Programme specific outcome (PSOs)

Upon successful completion of the MSc. Biotechnology (Integrated) 5 years programme, the candidate should be able to:

PSO 1: Develop the adequate skill to explore and document local biodiversity using molecular tools and knowledge needed for identifying, formulating, and solving the issues of Biotech, Pharma, Medical, Food industries and Healthcare service organizations, statutory and regulatory agencies, and academia.

PSO 2: Understand comprehensively the conceptual developments of the biotechnological principles and products and their future course.

PSO 3: Develop the ability to process, analyze and interpret the practical projects and internship generated data into evidence supporting scientific ideas, arguments, and hypotheses.

PSO 4: Know the appropriate use of modern analytical/biological software/ online tools and equipment for quick and accurate study, diagnose, and solve biotech and related problems.

PSO 5: Explore all the different career paths as biotechnologists through appropriate skill-based courses and execute their professional role in society.

PSO 6: Identify the nature and extent of the community-oriented service and/or outreach programmes, and ethical values and implement the same.

PSO 7: Ability to design, and develop innovative products in the field of biological sciences for social welfare.

PSO 8: Develop empirical knowledge to develop new techniques and products into commercial products, start-ups and entrepreneurship.

Semester I

BIODIVERSITY

L	T	P	C
4	1	0	4

a. Course code:

b. Course objectives:

1. Understanding the critical and conceptual values of biodiversity.
2. Identification of the interdisciplinary perspectives of biodiversity management.

c. Course prerequisites:

- Basic knowledge on taxonomic principles used for the identification of flora and fauna.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive Level
CO1	Knowledge of the types, hot spots, bio resources and economic values of Indian biodiversity.	K1, K2 & K4
CO2	Understand the relationship between organisms and their habitat with a particular reference to human beings.	K2 &K3
CO3	Analyze critically and address the ecological challenges of the 21st century with special emphasis on the Indian scenario.	K4
CO4	Apply scientifically generated information analysis and its usage to address conservation and biodiversity issues.	K3, K5 & K6
CO5	Evaluate the role of ethics, values, and norms in biodiversity conservation interventions.	K5
CO6	Develop conservation strategies to protect the local natural environment and habitats	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I: 12 hrs

Concepts and definitions: Biodiversity - Definition: Scope and Constraints of Biodiversity study, Genetic diversity, Species/Organismal Diversity, Ecosystem diversity, Landscape/Pattern Diversity, Agrobiodiversity, Bicultural Diversity, and Urban Biodiversity, Current Centers of Biodiversity

Unit II: **12 hrs**

Values of biodiversity: Value of Biodiversity: Instrumental/Utilitarian value and their categories, Direct use-value; Indirect/ Non-consumptive use-value, Introduction to Ecological Economics; Monetizing the value of Biodiversity; Intrinsic value; Ethical and aesthetic values, India as a Mega Diversity, National Hotspots of Biodiversity.

Unit III: **12 hrs**

Population concepts and diversity measurement: Population: Basic concepts, population characteristics – density, natality, mortality, age structure, population growth. Ecological niche and habitat, measuring diversity: Alfa, Beta, and Gamma diversity, relative importance, and analysis.

Unit IV: **12 hrs**

Threats, climate change, and its biological impacts: Threats to biodiversity: habitat loss, pollution, species introduction, global climate change, overexploitation, poaching of wildlife. Extinction: mass extinction, extinction process, ecosystem degradation, exploitation, invasive species. Nature of Climate Change, Predicted Biological impacts, Observed Biological impacts on Species and Ecosystems.

Unit V: **12 hrs**

Protection and conservation: Conservation of Biodiversity: Strategies for conservation: In-situ and ex-situ conservation environmental assessment, protected areas-biosphere reserves, national parks, sanctuaries, tiger reserves project tiger. Ex-situ conservation-Managed ecosystems, biological resources, gene banks, botanical gardens, bio-parks, simulated ex situ conservation strategies, valuing biological resources, ecotourism, Role of IUCN.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M	M	L	M	M
CO2	H	M	H	H	L	M	M	M
CO3	M	M	M	M	L	M	M	M
CO4	H	M	M	L	L	M	M	H
CO5	M	M	M	H	M	H	H	M
CO6	M	H	M	L	L	M	M	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	M	M	M	L	M	M
CO2	M	H	M	M	M	M	M	M
CO3	H	M	M	H	M	M	M	M
CO4	H	M	H	H	M	H	M	M
CO5	M	M	H	M	M	H	H	M
CO6	M	M	H	M	M	M	M	M

(L – Low, M – Medium, H – High)

g. Text Books/ References

1) Benson E, 1999. Plant Conservation Biotechnology. Taylor & Francis, NY, USA.
2) Stuart C, Spalding M, Jenkins, M, 2008. The world's Protected Areas: Status, Values and prospects in 21st century, University of California Press, Berkeley.
3) Trivedy RK, Goel PK, Trisal CL, 1998. Practical methods in ecology and environmental science. Enviro Media publishers, Karad Maharashtra.
4) Van Dyke F, 2008.Conservation Biology Foundations, Concepts, Applications 2nd Edition, Springer
5) Wickens GE, 2004 Economic Botany: Principles and Practices, Springer. Kluwer Publishers, Dordrecht, The Netherlands

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://onlinecourses.swayam2.ac.in/cec21_ge31/preview
2) https://soe.environment.gov.au/theme/biodiversity/topic/2016/importance-biodiversity
3) https://www.askiitians.com/biology/biodiversity-and-conservation/
4) https://www.nationalgeographic.org/encyclopedia/biodiversity/
5) https://www.researchgate.net/publication/304523269_Sample_Course_Material_for_Biodiversity_and_Sustainable_Education

Practical I: BIODIVERSITY

a. Course code:

L	T	P	C
0	0	4	2

b. Course objectives:

The core objectives of this course are:

1. To understand the ecological diversity of the local area
2. To estimate the plant and animal species diversity of a specific region

c. Course prerequisites:

- Basic knowledge of species identification

d. Course outcomes (COs):

At the end of the course a students will be able to:

Course outcome	Expected outcome	Cognitive Level
CO1	Discuss the types, hot spots, bioresources, and economic values of biodiversity.	K1, K2 & K4
CO2	Understand the significance of preservation methods in rare and endangered species	K2 &K3
CO3	Illustrate the importance of population density in a specific region	K3
CO4	Categorize and explain the conservation method to protect sacred groves	K3 & K4
CO5	Justify the need for flora conservation to manage the green ecosystem	K5
CO6	Design and develop modern conservation strategies to secure the local natural environment	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Study the community structure and assess the density and abundance of the species
2. Familiarity with local flora and herbarium techniques.
3. Determination of population density in a terrestrial community or hypothetical community by quadrate method and calculation of the Simpson's and Shannon-Weiner diversity index for the same community.
4. Biodiversity of a selected sacred grove.
5. Fieldwork to the nearby biodiversity-rich area to study the flora of that region.
6. Preparation of field report and submission of the herbarium in groups of 4-5, field-based viva –voce.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	H	M	M	L	H	M	M
CO2	L	H	H	H	L	M	H	M
CO3	L	M	M	L	L	M	M	M
CO4	L	H	H	M	L	M	M	M
CO5	L	H	H	M	L	M	M	M
CO6	L	H	H	M	L	M	M	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	M	M	M	M	M	M
CO2	H	H	M	M	M	L	M	M
CO3	H	M	M	M	M	L	M	M
CO4	H	M	M	M	M	M	M	M
CO5	H	M	M	M	M	M	M	M
CO6	H	M	M	M	M	M	M	M

(L – Low, M – Medium, H – High)

g. Laboratory manuals / Reference:

1) Darrell S. Vodopich, 2009. Ecology Lab Manual (Botany, Zoology, Ecology and Evolution) Lab Manual edition, McGraw Hill.
2) Donald R Thomas, 2018. Biodiversity: A Lab Manual for General Biology II, Second edition Kendall/Hunt Publishing Co ,U.S.
3) Geri Mayer, 2011. Laboratory Manual for Biodiversity, 2nd edition Dawn Earl, Paul Raymond.
4) Jones, R.C., et al. 2020. Lab Manual: EVPP 301: Environmental Science: Biological Diversity and Ecosystems.
5) Vinesh Practical Botany (Biodiversity-Microbes, Algae, Fungi & Archegoniates) (Including Lab Manual) B.Sc. I (BOTA101PR), S. Vinesh & Co

BIOCHEMISTRY I

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

1. Provide students with a learning experience that helps stimulate a deep interest in learning Biochemistry
2. Develop broad and balanced knowledge on the understanding of biomolecules, key biochemical concepts, principles, and theories related to biochemistry
3. Provide students with the right analytical tools, acquire theoretical, technical and analytical skills to address questions, and problems in biochemistry.

c. Course prerequisites:

- Higher Secondary level chemistry basic knowledge

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Describe the basic structure of atoms, molecules, and chemical bonds	K1
CO2	Understand and explain the process of Metabolism and its significance	K2, K3
CO3	Develop knowledge on various metabolic processes of carbohydrates, electron transport chain, and its importance.	K3
CO4	Illustrate the lipid metabolic processes, the structure of amino acids, and their significance.	K4
CO5	Compare the difference between DNA & RNA and distinguish their roles in biological functions	K2, K5
CO6	Integrate the acquired knowledge and enhance the capability to compete in competitive examinations	K3, K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **9hrs**

Biomolecules and their interaction: Structure of atoms, atomic theory, valency, atomic weight. Periodic table: periodic law, arrangement of atoms, in the periodic table, and group number. Vertical, horizontal, and diagonal relationships among atoms in the

periodic table. Biomolecules, molecular weight, molarity, molality, normality & percentage solutions. Chemical bonding - electrostatic, covalent, ionic, and Vander Waals and electrostatic forces, Structure of water molecules, properties and ionization of water, pH and buffers, hydrogen bonding, hydrophobic interaction.

Unit II **9hrs**

Metabolism: Anabolism and catabolism. Carbohydrates- Introduction and classification, properties of mono, oligo, and polysaccharides and glycosidic bonds. Reducing & non-reducing Sugars, Constitution of glucose & fructose, Osazone formation, pyranose & furanose forms, determination of ring size, Inter-conversion of monosaccharides. Glycogen metabolism - Gluconeogenesis, glycogenolysis, glycogen synthesis. Glycolysis, energetic of glycolysis. Electron transport chain. Cori cycle. Citric acid cycle and its energetics. Pentose phosphate pathway and its significance.

Unit III **9hrs**

Lipids- Structure and classification of lipids, Distribution, and biological importance of fats and fatty acids. Properties of lipid aggregates. Lipoproteins. Metabolism of lipids: Oxidation of fatty acid - α, β, and ω types. β-oxidation of even number saturated fatty acids. Energetics of β-oxidation. Oxidative phosphorylation. Schematic representation of biosynthesis of even number saturated fatty acids and cholesterol biosynthesis. Formation of ketone bodies.

Unit IV **9hrs**

Proteins: Structure and properties of amino acids, classification, and properties of proteins, conformation, and structure of proteins-primary, secondary, tertiary, and quaternary structure, coagulation, and denaturation of proteins. General reaction of amino acid degradation - Transamination, deamination, and decarboxylation. Ketogenic and glucogenic amino acids. Urea cycle and its significance.

Unit V **9hrs**

M- Structure of purines, pyrimidines, nucleosides, and nucleotides. Structure, types, and biological role of RNA and DNA. Biosynthesis and degradation of purine and pyrimidines nucleotides, uricotelic and ureotelic system, inhibitors of nucleotides biosynthesis. Diseases associated with purine and pyrimidine metabolism.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	H	L	H	M	L	H
CO2	H	H	M	H	L	H	H	M
CO3	M	H	H	M	H	M	H	H
CO4	H	M	H	H	M	H	M	H
CO5	M	H	H	M	H	H	H	M
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	L	M	H	L	H	H
CO2	M	H	M	H	M	M	M	M
CO3	H	M	H	L	H	H	L	H
CO4	H	H	M	H	M	M	M	L
CO5	M	L	H	M	M	M	H	M
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text Books/ References

1) Berg JM, Tymoczko JL, Stryer L, 2006. Biochemistry. VI Edition. W.H Freeman and Co.
2) Donald Voet, Judith G. Voet, 2011. Biochemistry, 4th Edition (International Student Version), John Wiley & Sons (Asia) Pvt Ltd
3) Jeoffrey Zubay, 1995. Principles of Biochemistry Wm C. Brown Publications.
4) Lubert Stryer, Jeremy Berg, John Tymoczko, Gregory Gatto, 2019. Biochemistry, 9th Edition, New York, Freeman
5) Nelson DL, Cox MM, 2004. Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://onlinecourses.nptel.ac.in/noc22_bt22/preview
2) https://study.com/academy/topic/biochemistry-study-guide.html
3) https://www.brainkart.com/subject/Biochemistry_302/
4) https://www.brainkart.com/subject/Biochemistry_302/
5) https://www.easybiologyclass.com/topic-biochemistry/
6) https://www.easybiologyclass.com/topic-biochemistry/

Allied practical I: BIOCHEMISTRY I

a. Course code:

L	T	P	C
0	0	3	3

b. Course objectives:

The main objectives of this course are to:

1. To develop laboratory skills in preparing chemicals and handling instruments
2. To understand various biochemical assays and their significance
3. To offer students with analytical skills to qualitatively and quantitatively estimate different biochemical parameters

c. Course prerequisites:

- Fundamental knowledge of biomolecules

d. Course outcomes (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Observe the instruments, types of equipment, and chemicals present in the lab and follow good lab practices (GLP)	K1
CO2	Differentiate normal, molar, and percentage solutions.	K2
CO3	Prepare stock solutions, working solutions, and buffers.	K3
Analyze	Analyse the presence of saccharides, urea, and cholesterol.	K4
CO5	Estimate the quantity of carbohydrate, lipid, DNA, RNA, and proteins	K5
CO6	Create opportunities to compete for positions in the pharma and biotech industries	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Use of analytical balance and weighing.
2. Calculation and preparation of normal, molar, and percentage solutions.

3. Preparation of buffers (acidic, neutral, and alkaline) and determination of pH.
4. Qualitative tests
    a. Estimation of glucose – O T Method
    b. Estimation of fructose –Seliwanoff's Method
    c. Estimation of Pentose – Bial's Method
    d. Estimation of Protein – Biuret Method
    e. Estimation of Urea – DAM Method
    f. Estimation of Cholesterol – Zak's Method
5. Quantitative tests
    a. Estimation of Carbohydrate by anthrone Method.
    b. Quantitative determination of lipids
    c. Estimation of proteins by Bradford method.
    d. Estimation of DNA by Diphenylamine method
    e. Estimation of RNA by orcinol method

f. Mapping of Course Outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	H	H	H	H	M	H	L
CO2	H	H	M	H	M	H	H	H
CO3	M	M	H	M	H	H	M	H
CO4	H	H	H	H	M	M	H	M
CO5	M	L	M	M	H	H	M	H
CO6	H	H	H	M	H	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	H	H	L	H	L
CO2	H	H	M	M	H	H	M	H
CO3	M	M	H	H	H	M	L	H
CO4	H	H	M	H	H	H	H	M
CO5	H	M	H	L	H	M	M	H
CO6	H	H	M	H	M	H	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manuals / Reference:

1) David L Nelson, Michael M. Cox, 2017. Lehninger Principles of Biochemistry, 7th edition, NJ, W.H. Freeman.
2) Donald Voet, Judith G. Voet, 2011. Biochemistry, 4th Edition (International Student Version), John Wiley & Sons (Asia) Pte Ltd.
3) Rodney Boyer, 2000. Modern experimental biochemistry, 3rd edition, Prentice Hall Publisher, USA.
4) Victor Rodwell, David Bender, Kathleen Botham, Peter Kennelly, P. Anthony Weil, 2018. Harper's Illustrated Biochemistry Thirty-First Edition, McGraw Hill
5) Wilson KM, Walker JM, 2010. Principles and Techniques of Biochemistry and Molecular Biology,7th edition, Cambridge University Press, UK

SEMESTER II

CELL & MOLECULAR BIOLOGY

a. Course code:

L	T	P	C
4	1	0	4

b. Course objectives:

The core objectives of this course are:

1) To understand the scientific pieces of evidence of the origin of life on earth
2) To study the types of cell organelles and their structural organizations.
3) To strengthen the student's basic knowledge of DNA as genetic material and the molecular mechanism of DNA repair
4) To understand the synthesis of protein and its regulation.

c. Course prerequisites:

- Elementary knowledge about cells and DNA.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Understand the basic principles and concepts of theories of the origin of life on earth.	K1 & K2
CO2	Enhance the basic knowledge of cell theory, types of cells, and cellular organization	K2 & K4
CO3	Understanding and remembering the functions, biogenesis, and structural properties of cellular organelles.	K3 & K5

CO4	Understand the basics of DNA, structure, and its functions	K2
CO5	Appraise the features of the genetic code and the mutation involved.	K4 & K5
CO6	Describe the mechanism of protein synthesis & regulation and create an idea about the basic principles in molecular biology	K2 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **12 hrs**

Cell and their origin: The theory of extraterrestrial contact – import of life through meteorites. Theory of chemical evolution, Primitive earth conditions – anoxic reductive atmosphere, relatively high temperature, volcanic eruption, radioactivity, high-frequency UV radiation. Abiotic formation of sugars, amino acids, organic acids, purines, pyrimidines, glycerol and formation of nucleotides and their polymerization to RNA on reactive Surfaces, polymerization of amino acids to polypeptides and proteins. Ribozymes and RNA world. Formation of DNA, Formation of nucleoproteins, Prions, Natural selection of self-replicating polymers.

Unit II **12 hrs**

Cellular Components: Discovery of cell and cell theory; Types of cells, cell size, and shape, specialized cells; Comparison between prokaryotic and eukaryotic cells & plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome, and microbodies; Ribosome; Centriole; Nucleus; Chemical components of a cell; Catalysis and use of energy by cells. Protein synthesis and folding in the cytoplasm; Degradation of cellular components.

Unit III **12 hrs**

DNA as Genetic Material: Griffith's Transformation, Forms of DNA and RNA, Introduction to Molecular Biology: Chromosome-Number, size, Molecular organization of chromosome (Nucleosome model). Chemistry of Genetic material (Chargaff's rule of DNA composition and Watson-Crick Model), physical and chemical properties of DNA: Denaturation and Melting point, C-Value Paradox, DNA conformation. Mechanism of DNA Replication. Enzymes and accessory proteins involved in DNA replication. DNA proofreading. Extrachromosomal DNA.

Unit IV **12 hrs**

Replication and mutation: Prokaryotic and Eukaryotic DNA replication, Experiments of Meselson and Stahl, Okazaki fragments, Enzymes and accessory proteins involved in DNA replication, C-value paradox. Molecular basis of Recombination: Concept, General and Site-specific recombination, Transposons, Significance of mobile DNA. DNA Repair Mechanism: Direct, Mismatch, Base excision repair.

Unit V **12 hrs**

Genetic Code: Characteristic features of the Genetic Code, Transcription and translation in prokaryotes and eukaryotes, Mutations in genetic code. Regulation of Gene Expression: Positive and Negative control, Operon concept, TVP, Operon control and catabolic repression Molecular events of protein synthesis in prokaryotes and eukaryotes, regulation of protein synthesis, gene pool, and gene library.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	M	H	M	M	M	M	M
CO2	H	M	H	M	L	M	H	M
CO3	H	M	M	M	L	L	M	M
CO4	M	M	M	M	M	L	M	M
CO5	H	M	H	M	L	L	M	M
CO6	M	M	H	M	M	M	M	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	H	H	M	M	M	M
CO2	M	M	M	M	H	M	M	M
CO3	M	H	M	M	M	M	M	M
CO4	M	H	M	M	M	L	M	M
CO5	M	M	M	M	H	M	H	H
CO6	M	H	M	M	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text Books/ References

1) Bruce Alberts et al., 2014. Essential Cell Biology, Taylor and Francis Group.
2) Geoffrey M Cooper, Robert E Hausman, 2016. The cell: A molecular approach. ASM press
3) George Plopper, 2016. Principles Cell Biology, Jones & Bartlett Publishers.
4) John K. Young, 2010. Introduction to Cell Biology, World Scientific.
5) Lodish, H., Baltimore, D; Fesk, A., Zipursky S.L., Matsudaride, P. and Darnel. 2018. Molecular Cell Biology, American Scientific Books. W.H. Freeman, New York

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/102106025
2) https://www.britannica.com/science/cell-biology
3) https://www.bu.edu/gk12/nishant/cellbioarticle.htm
4) https://www.slideshare.net/MichaelHo6/lecture-notes-cell-biology
5) https://www.uou.ac.in/sites/default/files/slm/BSCBO-301.pdf

Practical I: CELL & MOLECULAR BIOLOGY

L	T	P	C
0	0	4	2

a. Course code:

b. Course objectives:

The main objectives of this course are to:

1. Gain the required laboratory skills to perform, interpret and analyze widely used molecular biology techniques.
2. Explain the basic molecular processes of mitosis and meiosis.
3. Provide practical experience for those pursuing careers in biological research.

c. Course prerequisites:

- Essential knowledge about cells.
- Knowledge about chemicals and buffer preparation.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Identify and explain the different stages in cell divisions	K1, K2
CO2	Develop knowledge to perform and apply histochemical techniques.	K3

CO3	Demonstrate the handing techniques of microscopes and use them to observe histochemical specimens.	K4
CO4	Perform karyotyping to distinguish chromosome complement within the cells.	K4, K5
CO5	Describe the experimental procedures for polythene chromosome and chloroplast isolation	K3, K6
CO6	Facilitate the ways of applying novel molecular biology techniques for the welfare of society.	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Study the working principle of the microscope
2. Micrometry - stage and ocular micrometer.
3. Cell Counting – Haemocytometer
4. Demonstration of dialysis
5. Mounting epithelium cells using vital staining.
6. Mitosis in onion root tip squash
7. Preparation of permanent slides of transverse sections (TS) of stem, root, and leaf
8. Isolation of chloroplast from spinach leaves.
9. Microtomy (Demo)
10. To measure the concentration of DNA & RNA by UV spectrophotometry
11. SDS, Electrophoresis apparatus, structure, function.
12. PCR principles, reaction electrophoresis, observation. (Demo)

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	L	H	M	M	M	H
CO2	M	M	M	H	M	M	H	H
CO3	H	H	M	H	L	M	M	M
CO4	H	H	M	H	M	L	M	M
CO5	H	M	M	M	M	H	M	H
CO6	H	H	H	M	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	M	M	M	H	H
CO2	L	H	H	M	M	L	M	M
CO3	M	M	H	M	H	M	H	H
CO4	H	M	L	H	M	M	H	L
CO5	M	H	H	M	M	M	M	M
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manuals / Reference:

1) Carson S, Miller HB, Srougi MC, Witherow DS, 2019. Molecular biology techniques: a classroom laboratory manual. Academic Press.
2) Chaitanya KV, 2013. Cell and Molecular biology: A lab manual, Prentice Hall India Learning Private Limited
3) Rajan. S, Selvi Christy R, 2018. Experimental procedures in life sciences, CBS Publishers & Distributors Pvt Ltd, India.
4) Sharma RK, 2013. Basic techniques in biochemistry and molecular biology. IK International Pvt Ltd.
5) Surzycki S, 2012. Basic techniques in molecular biology. Springer Science & Business Media.

BIOCHEMISTRY II

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The main objectives of this course are:

1) Developing skills in performing basic biochemical tests important in clinical investigation.
2) Knowing familiar with the biochemical laboratory techniques in disease diagnosis.
3) Introducing the students to various practical aspects of enzymology and its correlation to diseases.

c. Course prerequisites:

- Primitive knowledge about chemistry and biology.

d. Course outcome (COs):

At the end of the Course, the student will be able to -

Course outcome	Expected outcome	Cognitive Level
CO1	Summarize the knowledge of biological samples, and their collection procedures, and perform biochemical laboratory analysis.	K2, K4
CO2	Evaluate blood glucose levels and understand disorders of lipid metabolism.	K2, K5
CO3	Distinguish serum, plasma, and whole blood emphasizing the role of anticoagulants and inborn errors in metabolism.	K4, K5
CO4	Evaluate the organ function, hormonal disturbances like tests and their use in the diagnosis, and monitoring of diseases.	K2, K5
CO5	Determine the activity of enzymes such as SOD, catalase, GPx, creatine kinase, LDH, Na KATPase, SGOT, and SGPT.	K3
CO6	Create awareness of different lifestyle diseases increasingly found in the present day.	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I: 9 hrs

Introduction to Clinical Biochemistry: Definition and scope of clinical biochemistry in diagnosis, collection, and preservation of biological fluids (blood, urine & CSF), normal values of important constituents of blood, CSF, and urine. Requirements of setting up of clinical laboratory, collection preparation, preservation, and handling of clinical samples, quality control, safety measures in the clinical laboratory.

Unit II: 9 hrs

Clinical Importance of biomolecules: Carbohydrates - Estimation of glucose, glycosuria, hyper & hypoglycemia, blood glucose regulation and role of hormones, diabetic coma. Lipids- lipid profile estimation, Disorders of lipid metabolism, Sphingolipidosis, hypercholesterolemia, and atherosclerosis. Lipoproteins and hyperlipoproteinemia, LCAT deficiency, gall stones, gout, tropical sprue.

Unit III: **9 hrs**

Metabolic diseases: Inborn errors in metabolism, rheumatoid factors, multiple myeloma, glutathioneurea, Hartnup disease, hyperuricemia and gout, adenosine deaminase, oratic aciduria, Lesch Nyhen syndrome. Disorders of blood - Blood Agranulocytosis, Thrombocytopenia, β Thalassemias, anemias, hemoglobinopathies, disorders of blood clotting mechanism, laboratory test to measure coagulation and thrombolysis.

Unit IV: **9 hrs**

Biochemical and clinical tests: Organ function tests - Liver function test with special reference to hepatitis and jaundice, renal function test and gastric function test, Diagnostic significance of serum enzymes, Routine urine analysis, and stone analysis. Hormonal disturbances: Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. Disturbances in thyroid function. hCG screen (pregnancy test) and quantitative hCG. Insulin tolerance test; growth hormone stimulation test; Adrenocorticotropin, congenital adrenal hyperplasia or hirsutism, Bolus Tests. cAMP, cGMP, prostaglandins.

Unit V: **9 hrs**

Free radicals and antioxidants: chemistry of free radicals and reactive oxygen species-superoxide, hydroxyl peroxyl, alkoxyl, non-radicals - hydrogen peroxide, reactive nitrogen species, the role of nitric oxide, role of metals, generation of free radicals bone-electron reduction, Detection of free radicals, trapping and fingerprinting methods: Lipid peroxidation, protein damage by ROS/RNS, DNA damage by ROS/RNS and repair mechanisms. Anti-oxidant defense enzymes-Superoxide dismutase, catalases, glutathione peroxidase, Glutathione reductase, glutathione-S-transferases. Free radical scavengers-Vitamins C, E, carotenoids, reduced glutathione, uric acid.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	L	M	H	M	H
CO2	M	H	H	L	M	M	H	H
CO3	H	H	L	M	M	H	H	H
CO4	M	H	M	H	H	L	H	M
CO5	H	H	H	M	L	M	H	H
CO6	H	H	H	M	M	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	H	H	M	M	M	H
CO2	H	M	H	L	M	H	M	H
CO3	M	H	H	H	H	M	H	M
CO4	M	M	H	H	L	M	H	M
CO5	H	M	M	H	L	M	H	H
CO6	H	M	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

g. Text Books/ References

1. Allan Gaw, Micheal Murphy, Robert Cowan, Denis O Reilly, Micheal Stewart, James Shepherd, 2013. Clinical Biochemistry: An illustrated color text 3rd Churchill Livingtons.
2. Dawn B, Marks, Allam D. Smith M, 1996. Basic Medical Biochemistry: A Clinical Approach, Lippincott Williams & Wilkins.
3. John K. Joseph, 2006. Biochemistry Campus Books International.
4. Lehninger, Nelson AL, & Cox MM, 2008. Lehninger Principles of Biochemistry 5th Edition, W. H. Freeman and, Company, New York.
5. William J. Marshall, Stephan K. Bangert, Elizabeth SM, (Ed.), 2008. Clinical Biochemistry: Metabolic And Clinical Aspects, Marshall Publisher: Elsevier Science Health Science Division.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://microbenotes.com/category/biochemistry/
2) https://study.com/academy/topic/biochemistry-study-guide.html
3) https://nptel.ac.in/courses/102106087
4) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQlU+6LM40KjY1Q==
5) https://microbenotes.com/category/biochemistry/
6) https://nptel.ac.in/courses/102106087

Allied practical I: BIOCHEMISTRY II

a. Course code:

L	T	P	C
0	0	4	2

b. Course objectives:

The main objectives of this course are:

1. To develop laboratory skills in preparing chemicals and handling instruments, related to biochemistry
2. To understand various biochemical assays and their significance
3. To offer students with analytical skills to address questions and problems in biochemistry

c. Course prerequisites:

- Necessary know-how about chemicals and buffer preparation

d. Course outcomes (COs):

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Observe the functioning of instruments and relate their use in biochemical analysis.	K1, K2
CO2	Know the ways to estimate important parameters including the blood glucose level	K2
CO3	Determine the concentration of carbohydrates, lipids, and proteins present in any biological sample.	K3
CO4	Illustrate the importance of SGOT/ SGPT assay	K4
CO5	Estimate the concentration of serum cholesterol	K5
CO6	Integrate the acquired skills and develop the capability to perform independent research	K3, K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Analysis of Biological Samples
2. Hematological analysis-RBC, WBC-TC/DC,
3. Hemoglobin content and ESR.
4. Total Platelet count.
5. Estimation of Blood Glucose
6. Estimation of calcium and Vitamins-A & E.
7. Assay of SGOT/SGPT.
8. Estimation of Serum Bilirubin.
9. Estimation of A: G ratio in serum.
10. Estimation of serum Cholesterol.

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	H	M	M	H	H	H	L
CO2	H	H	H	H	M	H	M	H
CO3	H	M	M	H	H	H	H	H
CO4	M	H	H	M	M	H	H	M
CO5	H	H	M	H	H	M	M	H
CO6	M	H	H	L	H	L	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	M	H	M	H	L
CO2	H	H	H	H	L	H	M	H
CO3	H	M	H	L	H	M	H	H
CO4	L	H	M	H	H	H	M	H
CO5	H	H	M	H	M	H	H	H
CO6	H	M	H	H	H	H	M	H

(L – Low, M – Medium, H – High)

g. Laboratory manuals/ Reference

1) David L Nelson, Michael M. Cox, 2017. Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman
2) Donald Voet, Judith G. Voet, 2011. Biochemistry, 4th Edition (International Student Version), John Wiley & Sons (Asia) Pte Ltd.
3) Lubert Stryer, Jeremy Berg, John Tymoczko, Gregory Gatto, 2019. Biochemistry, 9th Edition, New York, Freeman.
4) Rodney Boyer, 2000. Modern experimental biochemistry. 3rd edition, Prentice Hall Publisher, USA.
5) Wilson KM, Walker JM, 2010. Principles and Techniques of Biochemistry and Molecular Biology,7th edition, Cambridge University Press, UK

Semester III

MICROBIOLOGY

L	T	P	C
4	1	0	4

a. Course code:

b. Course objectives:

The core objectives of this course are:

1. To create a thorough knowledge of microorganisms,
2. To understand their morphology, mode of multiplication, metabolism, diagnosis, and treatment.

c. Course prerequisites:

- Simple understanding about microbes

d. Course Outcome

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Ability to acquire, articulate, retain and apply specialized skills and knowledge relevant to Microbiology	K3
CO2	Comprehend the diversity of microorganisms and microbial communities inhabiting a multitude of habitats	K1 & K4
CO3	Understand the pathogenesis as well as the significance of microbes to mankind.	K2 & K5
CO4	Define and appraise the concepts of invisible organisms	K1, K4 & K5
CO5	Understand the mycological concepts and their application	K2, K4 & K5
CO6	Justify the significance of microorganisms in human life	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **12 hrs**

General microbiology - History and scope of microbiology - Sterilization and disinfection -different culture media - Cultivation of bacteria - Identification of bacteria - Principle, operation and maintenance of microbiology instruments

Unit II **12 hrs**

Bacterial anatomy - Structure and functions of cellular components of bacteria. Physiology of bacteria - Growth and nutrition of bacteria and their requirement

Unit III **12 hrs**

Medical Bacteriology: Morphology, cultural characteristics, pathogenicity, laboratory diagnosis and treatment of Gram-Positive and Gram-negative organisms.

Gram-Positive - *Staphylococcus, Streptococcus, Bacillus*. Gram Negative - *Neisseria, E. coli, Klebsiella*

Unit IV **12 hrs**

Medical Virology: Classification and nomenclature of viruses, the morphology of viruses - Properties of viruses - Viral multiplication, Viral Genetics, Common viral diseases.

Unit V **12 hrs**

Medical Mycology - Features, laboratory diagnosis, treatment of pathogenic fungi- Superficial mycoses - Subcutaneous mycoses - Systemic mycoses - Opportunistic mycoses. Parasitology - *Entamoeba histolytica, Giardia*, *Taxoplasma, Plasmodium* - life cycle, diagnosis and treatment

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	M	L	M	M	H	M
CO2	M	M	H	M	L	L	H	M
CO3	H	M	H	M	L	M	M	M
CO4	M	M	M	L	M	M	H	H
CO5	H	H	M	H	L	M	H	H
CO6	H	H	H	M	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	M	M	M	M	H	M
CO2	M	H	M	M	M	M	L	M
CO3	H	H	M	H	H	M	H	H
CO4	M	M	M	M	H	L	M	M
CO5	H	H	M	M	M	L	H	H
CO6	H	H	H	H	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text Books/ References:

1) Brock, Madigan, MT, Martinko JM, Parker J, 2018. Biology of Microorganisms, Prentice-Hall.
2) Cappucino JG, Sherman N, Addison Wesley, 2011, Microbiology - A Laboratory Manual, Pearson.
3) Pelczar MJ Jr, Chan ECS, Kreig NR, 2013. Microbiology, Tata McGraw-Hill.
4) Rose AH, Butterworth, 2021. Chemical Microbiology-An introduction to Microbial Physiology 2nd edition, Butterworth, London.
5) Stanier RY, Ingram JLK, Wheelis ML, Painter PR, 2003. General Microbiology, Macmillan Press Ltd.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) http://ecoursesonline.iasri.res.in/course/view.php?id=108
2) https://alison.com/course/foundational-microbiology
3) https://nptel.ac.in/courses/102103015
4) https://nptel.ac.in/courses/105107173
5) https://www.mooc-list.com/tags/microbiology
6) https://www.pdfdrive.com/microbiology-books.html

Practical III: MICROBIOLOGY

L	T	P	C
0	0	3	2

a. Course code:

b. Course objectives:

The core objectives of this course are:

1. To identify the microbes through staining and microscopic methods
2. Characterize the microorganisms by biochemical methods
3. To examine the antibacterial activity of various discs through agar disc diffusion method

c. Course prerequisites:

- Fundamental understanding on microbial classification and sterilization techniques.

d. Course outcomes (COs):

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the importance of sterilization techniques	K1
CO2	Understand the significance of media preparation for microbes	K2
CO3	Illustrate the concept of staining techniques to identify the microbes	K3
CO4	Differentiate the bacterial culture by Gram staining	K4
CO5	Analyze and evaluate the antibiotic susceptibility	K4 & K5
CO6	Invent and develop the drugs against the diverse antibiotic-resistant microorganism	K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Sterilization Techniques
2. Preparation of Culture Media
3. Isolation of bacteria using the spread plate and streak plate method from soil and water
4. Gram staining
5. Motility by Hanging drop method
6. Fungal identification by lacto phenol cotton blue staining
7. Identification of bacteria by IMViC tests
8. Determination of antibiotic susceptibility by Kirby-Bauer method.
9. Microbial examination of food and detection of Pathogenic Bacteria from Food Samples.
10. Isolation of organisms causing Food Spoilage.
11. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination.

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M	M	H	M	M
CO2	M	H	H	M	L	L	M	M
CO3	M	H	H	M	L	L	M	M
CO4	M	M	M	M	L	L	M	M
CO5	M	H	H	H	L	H	H	H
CO6	M	H	H	M	H	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	M	M	M	M	M	M
CO2	M	H	H	M	H	M	H	H
CO3	M	H	M	M	H	M	M	H
CO4	M	H	M	M	H	M	M	M
CO5	H	H	H	H	H	M	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manuals/Reference

1) Aneja KR, 2002. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Production technology, Third edition. New age International Publishers.
2) Atlas RM, Brown AE, Parks LC, 1995. Laboratory Manual of Experimental Microbiology, Mosby, St. Louis.
3) Cappuccino JG, Sherman N, 2002. Microbiology: A Laboratory Manual, Addison– Wesley.
4) Holt JG, Krieg NR, 2000. Bergey's Manual of Determinative Bacteriology, Ninth edition Lippincott Williams & Wilkin Publishers.
5) Kannan K, 2002. Laboratory Manual in General Microbiology, Panima Publishers.

BIOPHYSICS I

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The core objectives of this course are:

1. To deal with the structure and function of molecules of life along with their mechanics.
2. To strengthen the students' knowledge of the essential biophysical techniques instrumental in the characterization of biomolecules and understanding their functional roles.
3. To explain the operation skill and optimization of fundamental and advanced analytical instruments.

c. Course prerequisites:

- Simple knowledge in cell biology and/ or biochemistry and thermodynamics.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Remember and understand the basic knowledge about the nature of chemical bonds.	K1 & K2
CO2	Describe and understand the concepts of thermodynamics	K2 & K3
CO3	Illustrate and appraise the biophysical method	K2,K3 & K5
CO4	Understand and explain the concept of enzymes	K2 & K4
CO5	Discuss and evaluate the complete knowledge of the cooperativity of bio-macromolecular interactions.	K2 & K5
CO6	Develop the basic knowledge in biophysics	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

UNIT I **9 hrs**

Nature of chemical bonds: Forces responsible for molecular conformation, chemical bonds: ionic, covalent, coordinate, hydrogen bonds, and Van der Waal forces. Structure, function, and properties of water; Water as a universal solvent, stereo-chemical factors.

UNIT II: **9 hrs**

Thermodynamics: thermodynamic system, equilibrium, thermodynamic laws, and their applications. Different types of processes of heat transfer; thermodynamic variable; entropy, enthalpy, free energy, thermodynamic potentials and relations, Maxwell equation, Fundamental equation of heat flow.

Unit III: **9 hrs**

Biophysical methods: General biophysical methods, Measurement of pH, Radioactive labelling and counting, Autoradiography, diffusion, sedimentation, osmosis, viscosity- definition, factors influencing it, and its application in biology. Bragg`s equation, Reciprocal lattice, Miller indices, Unit cell, Concept of different crystal structures, determination of crystal structure

Unit IV: **9 hrs**

Enzymes: Enzymes, structure, classification and function- active site, energy of activation, Transition state hypothesis, Lock and key hypothesis, Induced fit hypothesis; Concept of Km – Michaelis Menten equation. Various types of enzyme inhibition and identification using double reciprocal plot. Introduction to allosteric enzymes. Definition of holozyme, apoenzyme, coenzyme, cofactor, prosthetic groups and their examples. Concept of ribozyme, multiple forms, isozymes and abzymes

UNIT V: **9 hrs**

Bio-macromolecular interactions: Cooperativity in bio-macromolecular interactions: the phenomenon of cooperativity, DNA and protein melting, allosteric enzymes, other examples of cooperativity in biology. Non-equilibrium thermodynamics in biology: Information and entropy, Nonequilibrium processes, coupling of fluxes, coupling of chemical reactions, far-from-equilibrium molecular processes.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	L	L	M	M
CO2	M	H	M	M	L	H	H	M
CO3	H	M	M	L	L	M	M	M
CO4	H	M	M	M	M	L	M	M
CO5	H	M	M	M	M	L	M	M
CO6	H	M	M	M	M	M	M	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	M	L	M	L	M	M
CO2	M	H	M	L	M	M	M	M
CO3	H	H	M	H	M	L	M	H
CO4	M	H	H	M	M	L	H	M
CO5	M	M	H	M	H	L	H	M
CO6	M	M	M	M	M	M	H	M

(L – Low, M – Medium, H – High)

g. Text Books/ References:

1) Hopper W, Lohmann W, Markl H, Ziegler H, 1983. Biophysics, Springer.
2) Michel Daune, 1999. Molecular Biophysics: Structures and Dynamics, Oxford Univ. Press.
3) Rodney Cotterill, 2014. Biophysics - An Introduction, Wiley.
4) Thomas E. Creighton, 2011. The Biophysical Chemistry of Nucleic Acids & Proteins, Helvetian Press.
5) Volkenstein MV, 2012. Molecular Biophysics, Academic press.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) http://www.freebookcentre.net/Physics/BioPhysics-Books-Download.html
2) https://nptel.ac.in/courses/115101121
3) https://www.jaypeedigital.com/eReader/chapter/9789350251225/ch1
4) https://www.pdfdrive.com/biophysics-books.html

Allied practical II : BIOPHYSICS I

a. Course code:

L	T	P	C
0	0	3	2

b. Course outline:

1. To develop laboratory skills in preparing chemicals and handling instruments
2. To understand the effect of pH
3. To understand the preparation of buffers

c. Course prerequisites:

- Elemental understanding on the optical characteristics of chemicals and solutions.

d. Course outcomes (COs):

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the significance solution's pH and its application.	K1, K2
CO2	Estimate the pKa value for any given solution and the proton donating nature of the experimental solution	K2
CO3	Determine the amino acid's identity through titration curve-like experiments.	K3
CO4	Analyze the crystal structure of a molecule by X-ray diffraction	K4
CO5	Justify the significance of isoenzymes	K5
CO6	Develop immobilized enzymes for the bioprocess and engineering applications	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Determination of acidic and alkalinity of a solution
2. Preparation of acidic and basic buffers
3. Determine the titration curve of aminoacids and calculate the pKa values
4. Identification of C –terminal amino acids of a protein.
5. Autoradiography of acrylamide gels
6. X – ray diffraction analysis (Demo)
7. Separation of isoenzymes from lactate dehydrogenase by PAGE
8. Immobilization of enzymes on solid support.
9. Effect of pH on enzyme activity.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	M	M	L	M	M	M
CO2	L	H	H	M	L	M	M	M
CO3	H	H	H	M	L	L	M	M
CO4	M	M	M	L	M	L	H	M
CO5	H	H	H	H	L	L	M	M
CO6	H	H	H	H	L	M	H	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	M	M	L	M	M
CO2	M	M	H	H	M	M	M	M
CO3	M	H	H	H	M	M	M	M
CO4	M	M	M	H	H	L	M	M
CO5	H	M	M	M	M	L	H	H
CO6	H	H	M	M	M	L	H	H

(L – Low, M – Medium, H – High)

g. Text Books/ References:

1) Wilson KM, Walker JM, 2010. Principles and Techniques of Biochemistry and Molecular Biology,7th edition, Cambridge University Press, UK
2) Rodney Boyer, 2000. Modern experimental biochemistry. 3rd edition, Prentice Hall Publisher, USA.
3) Donald Voet, Judith G. Voet, 2011. Biochemistry, 4th Edition (International Student Version), John Wiley & Sons (Asia) Pte Ltd.
4) David L Nelson, Michael M. Cox, 2017. Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman
5) David Holmes, Peck H, 1998. Analytical Biochemistry, 3rd edition, Prentice-Hall UK.

BIOPROSPECTING (Skill paper)

L	T	P	C
4	0	0	4

a. Course code:

b. Course objectives:

The main objectives of this course are:

1. To teach students in-depth knowledge and make them competent in the field of bioprospecting.
2. To impart sufficient information and scientific knowledge about useful products derived from bioresources including plants, microorganisms, animals, etc.
3. To facilitate the students to understand the bioprospecting aspects related to product production and their regulations.

c. Course prerequisites:

- Rudimentary knowledge on bioresource origin bioactive compounds.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive Level
CO1	Explain to the students about major areas of bioprospecting and its acts	K2, K3
CO2	Obtain a complete knowledge about natural products from plants.	K3
CO3	Assess the bioprospecting aspects related to microorganisms and marine resources.	K5
CO4	Gain information on drug discovery, product development, and modern tools involved in drug discovery.	K2, K3, K6
CO5	Anticipate with regulatory legislation and convention in bioprospecting for commercialization.	K6
CO6	Create an innovative idea about the discovery of novel products from an existing source.	K2, K3, K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I: 12 hrs

Bioprospecting concepts and benefits: Definition, introduction, current practices in bioprospecting for conservation of biodiversity and genetic resources. Bioprospecting act: Introduction, phases of bioprospecting, Exemption to act. Fields of bioprospecting.

Unit II: 12 hrs

Natural Products from plants: Drugs derived from plants. Antitumor agent - Etoposide, Colchicine, Taxol, Vinblastine, Vincristine. Cardiotonic - Convallatoxin, Acetyldigoxin, Adoniside. Anti-inflammatory - Aescin, Bromelain. Choleretic - Curcumin. Antimalarial - Quinine from Cinchona. Plant analgesic - Morphine-Opium. Laxatives, Volatiles, Pigments, Terpenes, Phenols, and Flavonoids.

Unit III: 12 hrs

Bioprospecting of microbial products: Products of microbial origin: Antimicrobials - pharmacologically active agents of microbial origin - Bioprospecting for industrial enzymes - Plant growth-promoting agents – biotreatment - bioprospecting novel antifoulants and anti-biofilm agents from microbes. Bioprospecting of marine organisms. Sources of marine planktons and their bioprospecting, Marine Yeast and its industrial applications, bioactive chemicals from seaweeds and their applications.

Unit IV: 12 hrs

Drug discovery from natural resources: Drug discovery and product development: Discovery from traditional medicine. Modern tools in drug discovery. Role of chromatography in drug analysis including HPLC, GC, LC, and GC Mass spectrometry, FT IR, NMR – principles, and applications.

Unit V: 12 hrs

Regulations for bioprospected products: Regulatory legislation and convention in bioprospecting: rules and regulations in patenting of products and process development. Various conventions pertaining to bioprospecting of products from microorganisms, plants, and animals. Bioprospecting policies. Approval and IPR, protection policies of bioprospecting.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs and PSOs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	L	M	L	M	M	M
CO2	H	M	H	L	M	M	H	M
CO3	L	H	H	L	L	M	M	M
CO4	L	M	H	L	L	M	H	M
CO5	L	H	M	L	L	M	M	M
CO6	M	M	H	M	M	M	H	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	L	M	L	M	L	M	M	M
CO2	H	M	H	L	M	H	M	M
CO3	L	H	H	L	L	M	M	L
CO4	M	M	H	L	L	M	H	M
CO5	L	H	M	L	L	M	M	M
CO6	M	H	H	H	M	H	M	M

(L – Low, M – Medium, H – High)

g. Text Books/ References:

1) Judith A. Scheppler, Patricia E. Cassin, Rosa M. Gambier, 2014. Biotechnology explorations: Applying the fundamentals, Wiley.
2) Londa L Schiebinger, 2004. Plants and Empire, Harvard University Press.
3) Mohammed Sayeed Akhtar, Mallappa Kumara Swamy, 2019. Anti-cancer plants: natural products and biotechnological implements. Volume 2. 1st Ed, Springer.
4) Russell Paterson, Nelson Lima, 2017. Bioprospecting: success, potential, and constraints. Cham, Switzerland: Springer. Springer eBooks.
5) Subash Mandal, Vivekananda Mandal, Tetsarya Konishi, 2018. Natural products and drug discovery integrated approach. Elsevier publisher.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://www.researchgate.net/publication/221918042_Bioprospecting_Creating_a_Value_for_Biodiversity
2) https://www.researchgate.net/publication/221918042_Bioprospecting_Creating_a_Value_for_Biodiversity
3) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC309047/
4) https://www.intechopen.com/chapters/78249
5) https://onlinelibrary.wiley.com/doi/book/10.1128/9781555817770

BIOTECHNOLOGY & HUMAN HEALTH

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The core objectives of this course are:

1. Comprehend the global human health problems and the tailor-made biotechnologies ways of combatting them.
2. Demonstrate competencies in solving critical domestic and global regulatory and health care issues challenging and influencing the product development biotech and biomedical fields.

c. Course prerequisites:

- Basic knowledge of human health problems

d. Course outcome

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Describe the common human health problems and the ways of combating them by exploring biotechnology achievements.	K1, K2 & K4
CO2	Comprehend the scope and interdisciplinary nature of biotechnological principles and inventions improving global health initiatives	K2 & K5
CO3	Develop and extend the knowledge of clinical research which can be used for drug discovery and development	K2, K3 & K6
CO4	Appraise and develop appropriate biotech solutions for the emerging medical and other human health related challenges	K4 & K6

CO5	Justify the importance of genetic counselling, pre-natal and post-natal testing and the applications of modern genetic principles	K6
CO6	Create a hygienic and healthy future by way of biotech-based medicines and genetic concepts	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

UNIT I: 6 hrs

Concept of health & disease: Concept of disease Prevention, Preventive Medicine Causes of common diseases prevalent in the society: infectious and metabolic diseases: Corona, Typhoid, Hepatitis, Diabetes, Hypertension (High Blood Pressure), Obesity.

UNIT – II 6 hrs

Monoclonal antibodies and antibody engineering: Hybridoma Technology: Production of murine monoclonal antibodies (MoAbs)-Fusion strategies, HAT Selection; Strategies for production of human MoAbs-Humanization and antigenization of MoAbs. Antibody Engineering: Antibody fragments, Antibody gene cloning; Expression of recombinant antibody genes; Next generation display technologies for the production of antibodies *in vitro*.

UNIT – III 6 hrs

Microbial Biotechnology and its applications: Media and their types, pure culture isolation by streaking, serial dilution, and plating methods; Cultivation, maintenance and stocking of pure cultures, Antibiotics and antiviral agents; their mode of action. Recombinant microbial production processes in pharmaceutical industries-Streptokinase, Hepatitis-B recombinant vaccines.

UNIT – IV 6 hrs

Vaccine development Strategies: Traditional and new generation vaccines; Live vaccines-(Polio, Rotavirus); Recombinant vaccines (Hepatitis B, Covid 19); Sub unit, VLPS and DNA vaccines; mRNA-based vaccine, Nanoparticle vaccine, Preclinical and clinical evaluation of vaccines.

UNIT V: 6 hrs

Diagnostics: Nucleic acid and protein based diagnostic. Gene therapy: Concept, principle, strategies and applications. Stem Cells, Tissue Engineering and Regenerative medicine: Types of stem cells, Isolation of stem cells and cryopreservation; Therapeutic cloning, Nuclear reprogramming; Induced pluripotent stem cells; Ethical issues in stem

cell research; clinical applications(cardiovascular disease, cancer, spinal injury); Cord blood banking; Tissue engineering: Technology in general and applications; Regenerative medicine

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M	M	M	H	H
CO2	H	H	L	L	M	M	M	H
CO3	M	H	H	M	L	L	H	H
CO4	H	M	H	L	L	M	M	H
CO5	M	M	H	H	H	L	M	M
CO6	H	M	M	M	L	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	M	M	H	M	M	H
CO2	M	H	M	H	H	M	M	M
CO3	H	H	M	M	H	M	H	H
CO4	H	H	M	M	M	M	H	H
CO5	M	M	M	M	H	M	H	H
CO6	M	M	M	H	H	M	M	H

(L – Low, M – Medium, H – High)

g. Text Books/ References:

1) Lawton Robert Burns, 2014. India's Healthcare Industry Cambridge University Press.
2) Marcia Araujo Gualberto, Thais Miranda Rocha, Higo Jose Neri Da Silva, 2021. Biotechnology and Public Health, Our Knowledge Publishing.
3) Provash Chandra Sadhukhan, Sanjay Premi, 2020. Biotechnological Applications in Human Health, Springer Singapore
4) Sharon B. Buchbinder, Nancy H. Shanks, 2011. Introduction to Health Care Management, 2nd edition Jones and Bartlett Publishers, Inc.

5) Vijai Kumar Singh, Paul Lillrank, 2015.Innovations in Healthcare Management: Cost-Effective and Sustainable Solutions, 1st edition, Productivity Press.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://www.pdfdrive.com/medical-biotechnology-books.html
2) https://epgp.inflibnet.ac.in/
3) https://archive.nptel.ac.in/courses/102/104/102104056/
4) https://archive.nptel.ac.in/courses/102/104/102104052/
5) http://www.freebookcentre.net/Biology/BioTechnology-Books.html

GENETICS

Semester IV

a. Course code:

L	T	P	C
4	1	0	4

b. Course objective:

The aim objectives of this course are:

1. To enrich the student's minds with concepts concerned with genes.
2. To explore more into microbial and human genetics concepts.
3. To demonstrate the genetic analysis knowledge and practical skills for genetic disease diagnosis.

c. Course prerequisites:

- Fundamental knowledge on nature of chromosomes, genes,

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Understand the key principles behind the genome of both prokaryotes and eukaryotes.	K2
CO2	Explain the gene interaction between characters and analyse linkages and crossing over	K2 & K4
CO3	Examine the genetic issues with tests	K3
CO4	Gain the knowledge about microbes involved in genetics and their gene transfer between microbes	K1
CO5	Solve the mutational errors and alter the chromosomes	K3
CO6	Invent genetically modified innovative products for human welfare	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I: 12 hrs

Mendelian Principles- I: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, Pseudoallele, complementation tests. Linkage: Concepts, recombination, gene mapping in prokaryotes and eukaryotes, fine structure mapping

Unit II 12 hrs

Mendelian Principles- II: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, Sex linkage, sex-limited and sex influenced characters.

Unit III 12 hrs

Extrachromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human Genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative Genetics: Polygenic inheritance, heritability, and its measurements, QTL mapping

Unit IV 12 hrs

Microbial genetics: Bacteriophages - Recombination: Homologous and non-homologous recombination including transposition - Gene transfer methods – transformation, transduction, and conjugation- transposable elements.

Unit V 12 hrs

Mutation: types, causes, and detection, mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, Ploidy and their genetic implications

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	M	H	H	M	L	M	M
CO2	M	H	H	M	L	M	H	M
CO3	L	M	M	L	M	H	L	H
CO4	M	H	L	M	H	M	M	L
CO5	H	M	M	H	L	M	H	L
CO6	H	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	L	M	H	M	L	M
CO2	M	H	M	H	L	H	M	H
CO3	L	M	H	M	H	L	L	M
CO4	M	H	M	L	M	H	M	L
CO5	H	M	L	M	H	M	L	M
CO6	H	H	M	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References

1) Carroll SB, Grenier JK, Weatherbee SD, 2001. From DNA to Diversity: Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
2) Gardner, Simmons, Snustad. 2006. Principles of Genetics, 8th edition, Wiley.
3) Klug, Cummings, Spencer, 2016. Concepts of Genetics, Tenth edition, Pearson Education India.
4) Verma PS, Agarwal VK, 2010. Genetics, Ninth edition, S Chand Publishing.
5) Watson JD, Hopkins NH, Roberts JW et al. 1987. Molecular Biology of the Gene, 4th edn. Menlo Park, CA: Benjamin-Cummings.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://www.researchgate.net/publication/334330459_Practical_Manual_on_Fundamentals_of_Genetics_PBG-121
2) https://www.careers360.com/courses/genetics-course
3) https://ocw.mit.edu/courses/7-03-genetics-fall-2004/pages/lecture-notes/
4) https://nptel.ac.in/courses/102103013
5) https://archive.nptel.ac.in/courses/102/104/102104052/

Practical IV: GENETICS

a. Course code:

L	T	P	C
0	0	3	2

b. Course details

The aim objectives of this course are:

1. To enrich the student's minds with concepts concerned with genes.
2. To explore more into microbial and human genetics concepts.
3. To demonstrate the genetic analysis knowledge and practical skills for genetic disease diagnosis.

c. Course prerequisites:

- Fundamental knowledge of hereditary materials and their functioning.

d.Course outcome (COs)

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Describe the concept of laws of inheritance and the ways of character inheritance	K1
CO2	Understand the significance of pedigree analysis and probability	K2
CO3	Examine the genetic basis issues and molecular solutions available for solving them.	K3
CO4	Appraise the importance of karyotyping in detecting genetic disorders	K3 & K4
CO5	Assess and solve the mutational errors and alter the chromosomes	K3 & K5
CO6	Develop genetically-modified innovative products for human welfare	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Mendel's law of genetics - . Mono and dihybrid crosses
2. Simple Mendelian trait and pedigree analysis.
3. Mendelian genetics, probability, and statistics.
4. Polygenic inheritance with reference to height and weight – statistical analysis.
5. Chromatography of *Drosophila* eye pigments.
6. Observation of *Drosophila* – wild type and mutant.
7. Observation of meiosis in *Hibiscus*, plant genetics module
8. Barr body identification in cells of buccal smear.
9. Genetically modified foods and plants
10. Karyotyping (process, methods, chromosome structure, mutation identification, chromosome deletion).
11. Mutagenesis in bacteria: Ames test
12. Preparation of polytene chromosomes (*Chironomus* larvae salivary gland) - squash preparation.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	M	M	H	L	L	M	M
CO2	L	M	M	H	L	H	H	H
CO3	H	H	M	M	L	L	M	M
CO4	H	H	H	M	L	L	H	H
CO5	H	H	M	M	L	M	H	M
CO6	H	H	H	H	M	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	H	H	M	L	L	M
CO2	H	M	H	H	M	L	M	M
CO3	H	H	H	H	H	M	M	H
CO4	H	H	H	H	H	M	M	H
CO5	H	M	H	H	H	L	M	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References

1) Chiyedza Small, 2019. Genetics Laboratory Manual 1st Edition Kendall Hunt Publishing.
2) Chowdhury Madhumita Roy, Laboratory Manual for Molecular Genetic Tests, Jaypee Brothers Medical Publishers.
3) Christopher Blair, Genetics Laboratory Manual, New York City College of Technology, ttps://academicworks.cuny.edu/ny_oers/7
4) Gregore Koliantz, Daniel B. Szymanski, 2015. Genetics: A Laboratory Manual, Wiley.
5) Worku Mhiret, 2019. Laboratory Manual for Principles of Genetics, LAP Lambert Academic Publishing

BIOPHYSICS II

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The aim objectives of this course are:

1) To understand the basics of biophysics and develop an awareness of the interdisciplinary nature of biotechnology
2) To provide students with knowledge on techniques related to structure determination of biomolecules
3) To generate interest in the field of biophysics because of its importance in the field of biotechnology.

c. Course prerequisites:

- Understanding on the basic structure and features of biomolecules and applications of analytical tools and techniques.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Define the functionalities of spectroscopy and its application	K1
CO2	Understand the relation between biophysics and biotechnology and illustrate various biophysical methods	K2, K3
CO3	Explain the different biophysical methods applied for characterizing biomolecules.	K3
CO4	Analyze the different types of protein structures and their validation by Ramachandran plot analysis	K4, K6
CO5	Predict the structure of protein and visualize them using structure visualization tools	K5
CO6	Compile the developed knowledge for formulating a hypothesis and addressing biological problems using biophysics	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **9 hrs**

Spectroscopy- Basic principles, nature of electromagnetic radiation, Interaction of light with matter, Absorption, and emission of radiation; Atomic & molecular energy levels, Atomic & molecular spectra. Lambert Beer's Law, molar extinction coefficient and its determination, Polarization of light, Fluorescence studies of plane-polarized light; Principle, use and interpretation of Optical rotatory dispersion (ORD), Circular dichroism (CD).

Unit II **9 hrs**

Principles, Instrumental Design, Methods & Applications: UV–Visible spectroscopy, Fluorescence Spectroscopy: principles and applications, applications of UV-visible difference Spectroscopy, IR & Raman spectroscopy FT-IR, Attenuated total reflectance (ATR), near infra-red Spectroscopy (NIR) -theory and applications. Atomic Absorption spectroscopy- Inductively coupled plasma atomic emission spectrophotometry.

Unit III **9 hrs**

Bioinformatics - an overview, Scope, and applications. Bioinformatics and its relation with biophysics, Generation of large-scale molecular biology data - NMR Spectroscopy, X-Ray Diffraction, Macromolecular Structure Determination - Introduction to X-ray Crystallography: basis of crystallography theory, symmetry, instrumentation and biological applications, macromolecular diffraction and methods of phase determination; Principles of magnetic resonance spectroscopy: Nuclear Magnetic Resonance (NMR) & Electron Spin Resonance (ESR) and biological applications.

Unit IV **9 hrs**

Structure and modelling: Introduction, Classification of protein structures - Secondary, tertiary and quaternary structure prediction, Homology modelling, Fold-recognition methods, threading and ab initio method. Evolution of Protein Structure, Structure prediction tools and Ramachandran plot. PDB. Protein structure- function relationship, SCOP and CATH, Protein motifs and domain prediction, Protein profiles.

Unit V **9 hrs**

Similarity, Identity and Homology. Local and global sequence alignments (Needleman-Wunsch and Smith-Waterman algorithms), pair-wise (BLAST and FASTA algorithms) and multiple sequence alignment (Clustal W) and its importance. Dot Plots, Dynamic programming, Substitution matrices - PAM and BLOSSUM, Differences

between Distance & Similarity Matrix, Assessing the Significance of Sequence Alignments, Database similarity searching - FASTA and BLAST, Protein signatures.

f. Mapping of Course Outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	L	H	H	H	M	H
CO2	H	M	H	M	H	M	H	M
CO3	M	H	M	H	H	L	M	H
CO4	H	M	H	M	L	H	H	M
CO5	M	H	M	H	H	M	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	L	M	M	H	L	H	M
CO2	H	M	H	H	M	H	H	H
CO3	H	H	M	H	H	H	M	L
CO4	M	H	H	H	M	H	H	H
CO5	H	M	H	M	H	M	M	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Reference Books

1) Gauri Mishra, 2017. Introduction to biomolecular structure and biophysics, Springer.
2) JinXiong - Essential Bioinformatics – Cambridge University Press.
3) Lesk, A. M - Introduction to Bioinformatics – Oxford University Press
4) Rodney Cotterill, 2014. Biophysics - An Introduction, Wiley.
5) Thomas E. Creighton, 2011. The Biophysical Chemistry of Nucleic Acids & Proteins, Helvetian Press.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=31BI+Y/JyQo+vtlwaZoj+g==
2) https://onlinecourses.nptel.ac.in/noc21_bt06/preview
3) https://onlinecourses.swayam2.ac.in/cec21_bt04/preview
4) https://www.fun-mooc.fr/en/courses/big-introduction-bioinformatics-genomic-medicine/

Allied practical II: BIOPHYSICS II

a. Course code:

L	T	P	C
0	0	3	2

b. Course objective:

The aim objectives of this course are:

1. To characterize the structure of a molecule and their interaction through spectroscopy techniques
2. To comprehend the significance of bioinformatics tools in biological research
3. To understand the advanced analytical techniques and their application in biotechnology-based research

c. Course prerequisites:

- Simple knowledge of biomolecules structure and their properties.

d. Course outcomes

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Define the application of UV- vis spectroscopy analysis	K1
CO2	Describe the application of FTIR spectroscopy for the identification of functional groups of a molecule	K1 & K2
CO3	Predict the structure of bio/ phyto molecules using NMR spectroscopy	K3 & K5
CO4	Illustrate the application of bioinformatics tools and databases	K2, K3 &K4
CO5	Evaluate the sequence similarity among various organisms using a phylogenetic tree	K5
CO6	Develop advanced analytical techniques and bioinformatics software for upgrading the biological research outputs.	K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Verify Lambert-beer's law
2. FTIR (Demo)
3. NMR (Demo)
4. Retrieval of protein and nucleotide sequences from suitable databases
5. Pairwise alignment - comparison of results regarding percentage identity, and percentage gaps.
    a. Local alignment
    b. Global alignment
6. MSA and construction of the phylogenetic tree
7. Visualization and study of 3D molecular structures - Rasmol, Swiss PDB viewer

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	M	M	M	H	M
CO2	H	H	H	M	M	M	H	M
CO3	H	H	H	M	M	M	H	H
CO4	H	H	H	M	H	M	H	H
CO5	M	H	H	M	H	M	H	M
CO6	H	H	H	M	H	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	M	M	M	M
CO2	H	H	H	H	M	M	M	M
CO3	H	H	H	H	H	H	H	H
CO4	H	H	H	H	H	M	H	H
CO5	H	H	H	H	H	M	M	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manual/Reference

1) Andreas D. Baxevanis, Gary D. Bader, David S. Wishart, 2020. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins 4th Edition Wiley.
2) David W Mount, 2004. Bioinformatics-Sequence and Genome Analysis, 2nd edition, Cold Spring Harbor Laboratory Press, USA.
3) Jeanette M. van Emon, 2006. Immunoassay and Other Bioanalytical Techniques, 1st edition CRC Press.
4) Richard F. Venn, 2008. Principles and Practice of Bioanalysis, 2nd Edition, CRC Press
5) Teja Kumar Reddy Konatham P. Balan P. Kalaiselvi T. Venkatachalam Tarun Chaudhary, 2021. Modern Bioanalytical Techniques, Walnut Publication

FOOD PROCESSING

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The main objectives of this course are:

1. To create background information on the conversion of raw materials into processed, packaged, shelf-stable food products.
2. To give an idea of the effective utilization of intermediate products as food supplements.
3. To learn technologies involved in food preservation and explore in-depth the concept. Motivate the importance of the food industry and its future prospective.

c. Course prerequisites:

- Fundamental knowledge on spoilage of foods and its prevention.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive Level
CO1	Illustrate the knowledge about types of food spoilage and their end product and shelf-life increase.	K2, K3
CO2	Describe the information about food preservation and food additives.	K2
CO3	Produce the opportunities to be an entrepreneur in food processing companies with the idea of food preservation techniques.	K3
CO4	Predict the information on food preservation by Low temperature. Distinguish the ethical and unethical production of food products.	K2, K5

CO5	Evaluate the various techniques involved in food preservation and packaging.	K5
CO6	Compare the principles and concepts of technology to overcome the problems in food handling and processing.	K5

(K_1 – Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5 – Evaluate, K_6 – Create)

e. Course outline:

Unit I **12 hrs**

Food Spoilage Definition, types of spoilage - physical, enzymatic, chemical, and biological spoilage. Mechanism of spoilage and its end products, shelf-life determination.

Unit II: **12 hrs**

Preservation by using preservatives, Food preservation: Definition, principles, importance of food preservation, traditional and modern methods of food preservation. Food additives - definition, types, Class I and Class II preservatives.

Unit III: **12 hrs**

Preservation by use of high-temperature, Pasteurization: definition, types, Sterilization, Canning – history, and steps involved, spoilage encountered in canned foods, types of containers used for canning foods. Food irradiation – Principles, merits, and demerits, effects of irradiation and photochemical methods.

Unit IV: **12 hrs**

Preservation by use of low-temperature, Refrigeration - advantages and disadvantages, freezing: Types of freezing, common spoilages occurring during freezing, difference between refrigeration and freezing.

Unit V: **12 hrs**

Preservation by removal of Moisture Drying and dehydration - merits and demerits, factors affecting, different types of drying, Concentration: principles and types of concentrated foods.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs and PSOs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	L	M	H	M	M
CO2	M	H	L	M	M	M	M	H
CO3	M	H	L	M	M	M	M	M
CO4	M	H	M	M	M	M	H	M
CO5	M	H	M	M	L	M	M	M
CO6	M	H	M	M	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	L	M	L	M	M	M
CO2	H	M	H	L	M	H	M	M
CO3	H	H	H	L	L	M	M	L
CO4	M	M	H	L	L	M	H	M
CO5	H	H	M	L	L	M	M	M
CO6	H	H	H	M	M	M	M	M

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Gould GW, 2012. New Methods of food preservation, Springer Science Business Media.
2) Kamel A. Abd-Elsalam, Kasi Murugan, 2022. Bio-based Nano-emulsions for Agri-food Applications. Elsevier Publications.
3) Manay NS, Shadaksharaswamy M, 2004. Foods- Facts and Principles, New age international publishers, New Delhi.
4) Srilakshmi B, 2003. Food Science, New Age International Publishers, New Delhi.
5) Stephanie Clark, Stephanie Jung, Buddhi Lamsal, 2014. Food Processing: Principles and Applications, 2nd Edition, Wiley.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000015FT/P000043/M000081/LM/1454064483LM01.pdf
2) https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000444FN/P000551/M012157/LM/1459160509lm09.pdf
3) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=iWHzbXYGExXDS52DSnAzdQ==
4) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=NuAs6SreCGryddEfs4kkBA==

BIOSTATISTICS (Non-Major Elective)

a. Course code:

L	T	P	C
2	0	0	2

b. Course objectives:

The core objectives of this course are:

1. To teach students the basic principles of statistics, data types, and collection of data.
2. To make students understand the various methods of data presentation and measures of central tendency.
3. To make students understand the basic concepts of probability and Probability distribution.

c. Course prerequisites:

- Simple mathematical knowledge and computer applications.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive Level
CO1	Remember and understand the basic principles of statistics, data types, and collection of data	K1 & K2
CO2	Analyze and apply various methods of data presentation.	K3 & K4
CO3	Understand and appraise the measures of central tendency and dispersion.	K2, K4 & K5
CO4	Analyze and evaluate probability and probability distribution.	K4 & K5
CO5	Design and develop the testing of the hypothesis and its applications.	K6
CO6	Develop statistical tools to validate the research data	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create)

e. Course outline:

UNIT I: 6hrs

Data types and collection: Types of data, collection of data; primary and secondary data; classification and graphical representation of statistical data; methods of classification of data; data collection methods and source; sampling methods; types, size, and determination of sample size.

UNIT II: 6hrs

Presentation of data: Data organization: Classes, class intervals, class limits, mid-value, inclusive and exclusive method; data-types of graph: line frequency graph, histogram, frequency polygon, kite diagram, Frequency curves, cumulative frequency curve, scatter diagram; diagrammatic presentation of data: bar graph and pie diagram.

UNIT III: **6 hrs**

Measures of central tendency and dispersion: Arithmetic mean, median, mode; range, coefficient of range; mean deviation, standard deviation; variance, coefficient of variance; degree of freedom; measures of skewness moments and kurtosis.

UNIT IV: **6 hrs**

Probability and Probability distribution: Definition of probability, simple event, mutually exclusive event, non-mutually exclusive event; theorems of probability: additive and multiplicative rule; permutation and combination; compound probability; Bayes theorem, elementary ideas of binomial, Poisson, and normal distributions assumption, mean and standard deviation for all distribution.

UNIT V: **6 hrs**

Test of hypothesis: Methods of sampling; confidence level, critical region, testing of hypothesis and standard error; large sample test and small sample test; problems on the test of significance; t-test; chi-square test for goodness of fit and analysis of variance (ANOVA).

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	H	H	M
CO2	M	M	H	H	M	H	M	M
CO3	M	L	M	H	M	H	M	M
CO4	M	M	L	H	L	H	M	M
CO5	M	M	M	H	M	H	M	M
CO6	M	M	M	M	M	H	M	M

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	H	H	M	L	M	M
CO2	M	M	H	M	M	M	M	M
CO3	M	M	H	M	M	M	M	M
CO4	H	M	H	M	M	M	M	M
CO5	M	M	H	M	M	L	M	M
CO6	H	M	H	H	M	M	M	M

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Bernard Rosner, 2010. Fundamentals of Biostatistics, Seventh Edition, Cengage Learning,
2) Bratati Banerjee, 2018. Mahajan's Methods in Biostatistics for Medical Students and Research Workers, 9th edition Jaypee Brothers Medical Publishers.
3) Lisa Marie Sullivan, 2008. Essentials of Biostatistics, Jones and Bartlett Publishers.
4) Mahajan, 2010. Methods in Biostatistics: For Medical Students and Research Workers, 7th edition JPB.
5) Veer Bala Rastogi, 2010. Fundamentals of Biostatistics, Second Edition, Ane Books. Pvt. Ltd.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3469943/
2. https://link.springer.com/referenceworkentry/10.1007/978-1-4020-5614-7_255
3. https://onlinecourses.nptel.ac.in/noc19_bt19/preview

Semester V

ANIMAL & PLANT PHYSIOLOGY

a. Course code:

L	T	P	C
4	1	0	4

b. Course Objective:

The major objectives of this course are:

1) To furnish the mind with the process involving systems like blood, cardiovascular system, and digestion.
2) To gain knowledge about respiration, excretion, gland, and nervous system.
3) To learn about physiological mechanisms, energy production, and consumption process in plants.
4) To provide a fundamental scientific base about various aspects of metabolism, growth, and development of plants

c. Course prerequisites:

- Basic knowledge of plant and animal structure and their functioning.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Gain the knowledge related to the blood vessels and their circulatory digestive systems.	K1
CO2	Understand the physiology of the respiration and excretion process and dialysis	K2
CO3	Develop knowledge about the anatomy of the brain and nerve systems	K3
CO4	Understand the photosynthesis and functions of various hormones involved in plant physiology.	K4
CO5	Expand the sensory photobiology and plant stress physiology	K5
CO6	Appraise the structure and function of different organs to design and formulate the drug development process	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create)

e. Course outlines:

Unit I **12 hrs**

Circulatory system: Blood structure & function of haemoglobin, haemopoiesis, plasma function, blood volume regulation, Mechanism of blood clotting. Structure of heart, Origin, and conduction of the heart impulse, Cardiac cycle, ECG-its principle and significance. Digestion: physiology of digestion in the alimentary canal, absorption of carbohydrates, lipids, proteins, gastric ulcers, BMR.

Unit II **12 Hrs**

Respiratory system: comparison of respiration in different species, pulmonary ventilation, respiratory volume and capacities, transport of O2 and CO2 in blood, pulmonary diseases, neural and chemical regulation of respiration. Excretion: Structure of nephron, physiology of urine formation, urea cycle, nitrogenous wastes –ammonia, urea, uric acid and creatine, Counter current mechanism, Types of dialysis.

Unit III **12 Hrs**

Nerve and muscle system: structure of neurons, origin and propagation of nerve impulse through nerves, synaptic and neuro-muscular junctions, Anatomy of the brain and spinal cord, central and peripheral nervous system, Molecular and chemical basis of muscle contraction. Structure and function of pituitary, thyroid, parathyroid, adrenal and pancreas, neuroendocrine regulation.

Unit IV **12 Hrs**

Photosynthesis: Structure and function of chloroplast, light and dark reactions, Cyclic and non-cyclic electron transfer, C3, C4 and CAM pathways. Plant hormones: types & roles (auxin, gibberellins & cytokinins, ethylene, abscisic acid) Biosynthesis, Storage, breakdown & transport; Physiological effects& Mechanisms of action. Growth phases, photoperiodism, biological clocks

Unit V **12 Hrs**

Sensory Photobiology: Structure, function, and mechanisms of action of phytochromes, cryptochromes, and phototropin, stomatal movement, Transpiration, mechanisms of loading and unloading of photo assimilates. Secondary metabolites - biosynthesis of terpenes, phenols, and nitrogenous compounds and their roles. Plant stress Physiology: Responses of plants to Biotic and abiotic stress, Mechanism of resistance to biotic and abiotic stress.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	M	M	M	M	H	H
CO2	H	H	H	M	M	M	H	H
CO3	H	H	H	M	M	M	M	H
CO4	H	L	M	H	M	M	H	L
CO5	L	M	M	H	H	L	M	H
CO6	H	H	H	H	M	M	H	H

(L-Low, M-Medium, H-High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	H	M	H	M	H	H
CO2	H	M	H	M	H	M	H	H
CO3	H	M	H	H	H	M	H	H
CO4	H	L	M	M	M	L	H	M
CO5	M	H	L	M	H	M	M	H
CO6	H	M	H	M	H	M	H	H

(L-Low, M-Medium, H-High)

g. Text books/ References:

1) Hans Mohr, Peter Schopfer, 2012. Plant Physiology, Springer.
2) Jain VK, 2017. Fundamentals of Plant Physiology, Nineteenth edition, S Chand Publishing.
3) Lauralee Sherwood, HillarKlandorf, Paul Yancey, 2012. Animal Physiology: From Genes to Organisms, Cengage Learning Pvt Ltd.
4) Lincoln Taiz, Eduardo Zeiger, 2010. Plant Physiology 5th Edition, Sinauer Associates, Oxford University Pres.
5) Rastogi SC, 2007. Essentials of Animal Physiology, New Age International Publishers.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://library.viu.ca/c.php?g=189003&p=1247754
2) https://onlinecourses.nptel.ac.in/noc20_bt42/preview
3) https://onlinecourses.swayam2.ac.in/cec19_bt09/preview
4) https://www.pdfdrive.com/plant-and-animal-physiology-e1735854.html
5) https://www.uou.ac.in/sites/default/files/slm/BSCBO-303.pdf

IMMUNOLOGY

a. Course code:

L	T	P	C
4	1	0	4

b. Course objectives:

The core objectives of this course are:

1) To know the basics of immune cells, immunity
2) To understand the antigen-antibody interaction
3) Comprehend the production and application of monoclonal antibody

c. Course prerequisites:

- Knowledge about the basic immune system

d. Course outcome (COs):

After successful completion of the course, a student will be able to:

Course Outcome	Expected outcome	Cognitive Level
CO1	Identifying the cellular and molecular basis of immune responsiveness.	K2
CO2	Understand the role of the immune system in both health maintenance and disease contribution.	K2 & K4

CO3	Knowledge of immunological response – its triggering and regulation.	K3
CO4	Gain information on infection control measures and vaccination.	K5
CO5	Identify the principles of transplantation and their application.	K2 & K5
CO6	Justify the significance of immunological techniques in the diagnosis and treatment of epidemic and pandemic diseases	K4, K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I: 12 hrs

Immune System and immunity: History of immunology; innate and acquired immunity. Cells and organs involved in immune system - T-cells, B-cells, lymphoid organ, spleen and bone marrow. Antigenic properties, T and B cell epitopes, macrophages, antigen-processing cells, eosinophils, neutrophils, mast cells and natural killer cells; immune responses - cell mediated and humoral

Unit II: 12 hrs

Antigen and Antibodies: Types, structure and properties of antigens, haptens; adjuvant - Immunoglobulins - Structure, types and subtypes, properties, primary and secondary responses. Complement system - Structure, components, properties and functions, Complement fixation and complement pathways, Biological consequences

Unit III: 12 hrs

Antigen-Antibody Reactions: agglutination, precipitation, immune electrophoresis, immunofluorescence, ELISA, RIA; flow cytometry, Montaux Test. Applications of these methods in the diagnosis of microbial infections, Autoimmunity mechanisms, altered antigens, Systemic lupus erythematosus, Grave diseases, Rheumatoid arthritis, Myasthenia gravis, and multiple sclerosis..

Unit IV: 12 hrs

Hypersensitivity Reactions: Allergy, Type I-anaphylaxis; Type II-antibody dependent cell-mediated cytotoxicity, Type III- immune complex-mediated reactions, Type IV- delayed-type hypersensitivity. Symptoms and Immunological methods of diagnosis of hypersensitive reactions. Lymphokines and cytokines - assay methods

Unit V: **12 hrs**

Major Histocompatibility Complex (MHC): Structure and functions of MHC and the HLA systems. Gene regulation and Ir-genes; HLA and tissue transplantation - Tissue typing methods for transplantations in humans; graft versus host reaction and rejection. Tumor immunology: tumor-specific antigens, Immune response to tumors, immunodiagnosis of tumors - detection of tumor markers. Types of vaccines and its application, Production of monoclonal and polyclonal antibodies.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M	L	M	H	M
CO2	M	H	H	M	L	M	H	M
CO3	H	M	M	L	M	M	H	H
CO4	M	M	H	L	M	M	H	M
CO5	M	M	H	L	L	M	M	M
CO6	M	H	H	M	M	M	H	H

(L-Low, M-Medium, H-High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	M	M	M	M	M
CO2	H	H	M	H	M	M	H	H
CO3	M	H	M	H	M	M	H	H
CO4	H	M	M	H	H	M	H	H
CO5	H	H	M	H	M	H	H	H
CO6	H	H	H	H	H	M	H	H

(L-Low, M-Medium, H-High)

g. Text books/ References:

1) Ivan Maurice Roitt, 1994. Essential Immunology, Blackwell Scientific Publications.
2) Kenneth M. Murphy, Casey Weaver, 2016. Janeway's Immunobiology Ninth Edition W. W. Norton & Company.
3) Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby, 2007. Immunology, W. H. Freeman.
4) Werner Luttmann, Kai Bratke, Michael Kupper, Daniel Myrtek, 2006. Immunology, Elsevier.
5) William E. Paul, 2012. Fundamental Immunology Seventh Edition LWW.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1. https://www.nature.com/subjects/immunology/nmat
2. https://onlinecourses.nptel.ac.in/noc20_bt43/preview
3. https://nptel.ac.in/courses/102105083

MOLECULAR DIAGNOSTICS

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The core objectives of this course are:

1. To know the fundamentals of molecular diagnosis
2. To study the molecular mechanism of cellular defects
3. To learn the principles of diagnosis using molecule

c. Course prerequisites:

- Rudimentary knowledge of disease and their causatives.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Comprehensive understanding of principles of various immunological and molecular diagnostic techniques	K2
CO2	Analyze the different types of diagnosis	K4
CO3	Apply the laboratory biomedical techniques for diagnosis	K3
CO4	Describe and explain the diagnostic genetic principles.	K2 & K3
CO5	Appraise the role of biomarkers in addressing issues in health, research, and product development.	K4 & K5
CO6	Invent diagnostic biomarkers for diseases	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit – I **2 hrs**

Introduction to Molecular Diagnostics: History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario.

Unit – II **12 hrs**

Conventional and modern diagnosis- infection and non-infectious- culture, biochemical based- immune assays- medical or clinical imaging- molecular-based methods- advantages and limitations

Unit – III **12 hrs**

Cancer – Benign and Malignant neoplasms, multifactorial disposition, Cancer pathogenesis, positive and negative mediators of neoplastic development, Proto-oncogenes, Oncogenes, and Tumor suppressors, Allele loss and loss of Heterozygosity, Mitochondrial inheritance, Mitochondrial myopathy, lactic acidosis, MELAS, LHONs, identity testing.

Unit – IV **12 hrs**

Biomarkers in disease diagnostics: FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour & cancer markers, markers in inflammation, and diagnosis of cytoskeletal disorders.

Unit – V **12 hrs**

Chromosomes and their disorders: Human disorders, and cytogenetic analysis: Structure, types and organization; Chromosome organization, Euchromatin and heterochromatin, and Histone modifications. Chromosome banding and nomenclature; Nomenclature and functional significances of chromosome bands. GC and AT-rich isochores- Genomic Imprinting and disorders. FISH, CGH, Flow cytometry techniques, and clinical diagnostics.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	M	M	L	M	M	M
CO2	M	M	H	M	L	M	H	H
CO3	M	M	H	M	L	L	M	M
CO4	M	M	H	M	H	L	M	M
CO5	M	M	H	L	M	L	H	M
CO6	M	H	H	M	M	M	H	H

(L-Low, M-Medium, H-High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	M	H	M	M	M
CO2	M	H	M	H	M	M	M	H
CO3	H	M	M	H	M	M	M	M
CO4	M	H	M	M	H	H	M	M
CO5	M	H	M	H	M	M	M	H
CO6	L	H	M	H	H	M	H	H

(L-Low, M-Medium, H-High)

g. Text books/ References:

1) Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, 2014. Molecular biology of the cell, 6th Edition, W. W. Norton & Company.
2) De Robertis EDP, 2017.Cell and Molecular Biology
3) James E. Darnell, Harvey Lodish, David Baltimore, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, 1995. Molecular Cell Biology, 3rd edition, W.H.Freeman & Co Ltd.
4) Ravi Birla, 2014. Introduction to Tissue engineering, applications and challenges. 1st edition Wiley-IEEE Press.
5) Robert Lanza, Robert Langer, Joseph P. Vacanti, Anthony Atala, 2021. Principles of tissue engineering. Elsevier Publications.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) http://www.epemed.org/online/www/content2/108/469/3172/listdownloads/3175/507/ENG/dxinsights.pdf
2) https://www.sciencedirect.com/topics/medicine-and-dentistry/molecular-diagnostics

Practical V: ANIMAL & PLANT PHYSIOLOGY

a. Course code:

L	T	P	C
0	0	4	2

b. Course objectives:

The core objectives of this course are:

1. To know the fundamentals of molecular diagnosis
2. To study the molecular mechanism of cellular defects
3. To learn the principles of diagnosis using molecule

c. Course prerequisites:

- Fundamental knowledge of common disorders of human

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Describe the importance of blood cell identification	K1
CO2	Understand the concept of electrocardiogram for early diagnosis of cardiac diseases	K2
CO3	Determine the ionic components of body fluids	K3
CO4	Illustrate the significance of herbarium techniques	K2, K3 & K4
CO5	Experiment on developmental stage of dicots and monocots	K4
CO6	Justify and develop the hydroponic techniques for smart agriculture	K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Blood cells isolation (centrifuge), staining, examine under microscope.
2. Blood pressure determination, blood sugar level examination.
3. Dissection of animal model, identify the parts and sectioning
4. Dialysis process, methods, application. (Demo).
5. Skeletal muscle mechanics and the electromyogram (EMG).
6. Cardiac cycle and the electrocardiogram (ECG).

7. Effect of autonomic neurotransmitters on the function of myogenic heart.
8. Regulation of arterial blood pressure, energy metabolism.
9. Body fluid compartments and the ionic composition of body fluids.
10. BMR determination
11. Systematic study of locally available plants belonging to the families prescribed in theory syllabus.

    Demonstration of herbarium techniques & study of photosynthesis - Light reactions
12. Structure of pollen grains using whole mounts (*Catharanthus, Hibiscus, Acacia*, Grass)
13. Demonstration of Pollen viability test using *in-vitro* germination (*Catharanthus*).
14. Study of ovule types and developmental stages of embryo sac using permanent slides /Photographs.
15. Developmental stages of onion root tip & study of plasmolysis by using onion.
16. Section the parts of plants & structure of endosperm (nuclear and cellular); Developmental stages of dicot and monocot embryos using permanent slides/ photographs
17. Demonstration of hydroponics system
18. Isolation and mounting of embryo (using Symopsis / Senna / Crotalaria)
19. Isolation of chloroplast DNA, isolation of chlorophyll & measuring chlorophyll in leaves & study of plant hormone

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	M	L	L	L	H	H
CO2	H	H	M	M	L	L	H	H
CO3	M	H	H	M	L	L	H	H
CO4	L	L	M	L	L	L	H	M
CO5	M	H	L	M	L	L	H	M
CO6	L	H	M	H	L	L	H	H

(L-Low, M-Medium, H-High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	H	H	M	L	M	H
CO2	H	H	H	H	H	M	M	H
CO3	H	H	H	H	H	M	M	H
CO4	M	M	H	H	H	L	L	M
CO5	M	M	M	M	M	L	L	M
CO6	M	H	H	H	H	L	M	H

(L-Low, M-Medium, H-High)

g. Textbooks/ References:

1) Chandrasekar, 2011. Practical Physiology Record Book, CBS
2) Daniel Trembly Macdougal, 2017. Practical Text-Book of Plant Physiology, Forgotten Books
3) Mali RP, A Practical Manual on Innovative Animal Physiology, 2015. Oxford Book Company
4) Manju Bala, Sunita Gupta, Gupta NK, Sangha MK, 2016. Practicals in plant physiology and biochemistry, Scientific Publishers
5) Siva Kumar, 2015. Practical Plant Physiology, Narendra Publishing house.

Practical VI: IMMUNOLOGY

a. Course code:

L	T	P	C
0	0	4	2

b. Course objectives:

The aim objectives of this course are:

1. To understand the basic concept and applications of immunology
2. To know the basics of immune cells and types of immunity.
3. To understand the major histocompatibility complex.

c. Course prerequisites:

- Simple knowledge about immunology and immunity

d. Course outcomes (COs):

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the concept of immunology	K1
CO2	Discuss the application of immunology to diagnose hazardous diseases	K2
CO3	Construct the immunological tools / techniques for human welfare	K3 & K6
CO4	Classify the immune cells based on their significant features	K2 & K4
CO5	Evaluate the blood grouping by Rh factors	K4 & K5
CO6	Justify the antigen-antibody reaction for diagnosis of various infectious and non-infectious diseases	K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Counting of blood cells by heamocytometer
2. Identification of blood cells
3. Haemagglutination reactions- Blood grouping – forward and reverse, Rh Typing, Coomb's test, TPHA.
4. Identification of various immune cells by morphology – Leishman staining, Giemsa staining.
5. Agglutination reactions- Latex agglutination reactions- RF, ASO, CRP
6. Serum electrophoresis.
7. Serum myeloperoxidase activity.
8. Serum lysozyme activity.
9. Separation of leucocytes from spleen
10. Antigen-antibody reactions**:** agglutination, precipitation
11. Immunoelectrophoresis

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	M	M	L	H	M
CO2	H	H	H	M	M	L	H	H
CO3	H	H	H	M	H	H	H	H
CO4	H	H	H	M	L	L	H	H
CO5	M	H	H	M	M	L	H	H
CO6	H	H	H	M	H	L	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	H	H	M	H	H
CO2	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	M	H	H
CO4	H	H	H	H	M	M	H	H
CO5	H	H	H	H	H	M	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manual/Reference

1. Asim Kumar Roy, 2019. Immunology theory and practical, Kalyani publications.
2. Frank. C. Roy, 2002. Practical Immunology, fourth edition. Blackwell Science Ltd, Blackwell Publishing Company
3. Karthik Kalia Perumal et.al, 2017. Practical immunology a laboratory manual, first edition, LAP LAMPERT Academic Publishing.
4. Talwar GPSK, Gupta, 2017. A handbook of practical and clinical Immunology, Volume- II, second edition CBS.
5. Shrimati Dharmapal Shetty, 2020. ICMR-NIIH Practical Guide to Laboratory Immunohematology, Jaypee Brothers Medical Publishers

Semester VI

BIOANALYTICAL TECHNIQUES

a. Course code:

L	T	P	C
4	1	0	4

b. Course objectives:

The core objectives of this course are:

1. To reinforce the student's basic knowledge of all biological concepts with the general theory of physical sciences.
2. To develop working skills in fundamental and advanced analytical instruments.
3. To enhance the ability to understand and work methods of various instruments.

c. Course prerequisites:

- Fundamental knowledge of working of analytical instruments.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Understand the theoretical and practical applications of instruments and analytical techniques used in the biotechnology field	K2
CO2	Improve the basic knowledge of instrumental analysis and interpret the resulting output	K2 & K4
CO3	Know to handle basic and advanced instruments and find errors in various industrial operations	K1 & K4
CO4	Understand the impact of noxious materials through advanced analytical instruments	K5
CO5	Complete insight in bioanalytical techniques and apply it in various research areas	K3 & K5
CO6	Design and develop innovative techniques for early diagnosis of human-associated diseases and disorders	K3 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **12 hrs**

Microscopy: Light, Phase Contrast, Confocal, Fluorescence Microscopy, Electron microscopy - principle and application - Scanning Electron Microscopy, Transmission Electron Microscopy.

Unit II **12 hrs**

Centrifugation - basic principles and applications, sedimentation, types of rotors, types of centrifuges - preparative and analytical centrifuges, differential, density gradient centrifugation and ultra-centrifugation.

Unit III **12 hrs**

Chromatography: Principle and application of chromatography techniques, Paper chromatography, TLC, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography.

Unit IV **12 hrs**

Electrophoresis: Basic theory and application of electrophoresis, SDS-PAGE, Agarose gel electrophoresis, Iso-electric focusing, pulse field gel electrophoresis, PCR

Unit V **12 hrs**

Sophisticated analytical instruments: Basic principle of UV- visible, FTIR, NMR, X-ray crystallography, Mass spectroscopy, Fluorescence spectroscopy, Surface plasmon resonance (SPR)

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	M	H	M	M	M	H	H
CO2	M	H	H	L	L	M	H	H
CO3	L	H	H	L	L	H	H	H
CO4	L	M	H	L	L	H	M	M
CO5	H	H	H	M	L	M	H	H
CO6	H	H	H	H	H	M	H	H

(L-Low, M-Medium, H-High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	M	M	L	M	H
CO2	M	M	H	M	H	M	M	M
CO3	M	M	H	H	M	M	M	M
CO4	H	M	M	H	M	H	M	M
CO5	H	H	M	H	M	M	H	H
CO6	M	H	H	M	M	M	M	H

(L-Low, M-Medium, H-High)

g. Textbooks/ References:

1) Campbell ID, Dwek R., 1984. Biological Spectroscopy, Benjamin Cummings Publication Co. Inc.
2) Cantor CR, Schimmel WH, 1981. Biophysical Chemistry Part-II, Freeman & Co.
3) Van Holde KE, Johnson W, Ho PS, 1981. Principles of Physical Biochemistry, Prentice Hall.
4) Willard HH, Merritt L, Dean JA, Settle FA, 1985. Instrumental Methods of Analysis, 7th Ed., Wadsworth Publishing Co.
5) Wilson K, Walker J, 2005. Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed. Cambridge University Press.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=1+p0z2ZbAGSfsyfLITzgZQ==
2) https://nptel.ac.in/courses/102103044
3) https://nptel.ac.in/courses/102107028

DEVELOPMENTAL BIOLOGY

L	T	P	C
4	1	0	4

a. Course code:

b. Course objectives:

The specific objectives of the course are:

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

c. Course prerequisites:

- Fundamental knowledge of growth and development of animals.

d. Course outcome (COs):

After successful completion of this course, the student will be able to:

Course Outcome	Expected outcome	Cognitive level
CO 1	State the history and basic concepts of embryology explaining the process of organ and embryo development	K 1 & K2
CO 2	Understand and categorize the early stages of embryonic development	K 2& K4
CO 3	Understand the process of embryonic differentiation and analyze the transcriptional and post-translational levels.	K2 & K4
CO 4	Evaluate the relevance of developmental biology in helping childless couples to give birth	K 5
CO 5	Analyze and understand the molecular basis of development fetal diagnosis, fetal development, medication, monitoring, counseling, and support	K3 & K 4
CO6	Generalize the concept of developmental biology to facilitate the knowledge of modern biology	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

UNIT I: **12 hrs**

Gametogenesis and fertilization: Definition, scope, and historical perspective of development biology; gametogenesis: spermatogenesis and oogenesis; fertilization: mechanism and types of fertilization; different types of eggs based on the yolk.

UNIT II: 12 hrs

Early embryonic development: Embryo cleavage types, patterns and mechanism; process, types and mechanism of blastulation; gastrulation; cell movements: epiboly, emboly, extension, invagination, convergence, de-lamination; formation and differentiation of primary germ layers; fate maps in early embryos.

UNIT III: 12 hrs

Embryonic differentiation: Differentiation; cell commitment and determination; the epigenetic landscape: a model of determination and differentiation; control of differentiation at the level of genome, transcriptional and post-translational levels; concept of embryonic induction: primary, secondary and tertiary embryonic induction; neural induction and induction of vertebrate lens.

UNIT IV: 12 hrs

Organogenesis: Neurulation, notogenesis, development of vertebrate eye; fate of different primary germ layers; development of behaviour: constancy and plasticity; extra embryonic membranes; placenta in mammals.

UNIT V: 12 hrs

Molecular biology of development: Role of homeotic genes (*Hox* gene) and maternal effect genes (*bicoid* and *nanos*) in *Drosophila* development; axis specification in amphibians: concept of primary organizer; role of *β-catenin* gene and the origin of Nieuwkoop centre; vulval induction in *C. elegans*; role of *TBX* 4*, TBX*5 and *Sonic hedgehog* genes in the development of tetrapod limb in vertebrates; development symbiosis; genomic imprinting; role of maternal effect genes in plant development.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	M	H	M	L	L	M	M
CO2	H	M	M	M	L	L	M	M
CO3	H	M	M	H	L	L	H	M
CO4	H	M	H	H	L	L	H	M
CO5	H	H	H	M	M	L	H	M
CO6	H	M	M	M	M	M	H	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	L	H	M	M	M	M	M	M
CO2	M	H	H	M	M	M	M	M
CO3	L	H	H	M	M	M	M	M
CO4	M	M	H	H	M	M	H	H
CO5	L	H	M	M	M	H	M	M
CO6	M	H	M	H	H	H	M	M

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Balinsky BI, 2012. An introduction to Embryology, 5th ed. Cengage Learning India.
2) Gilbert SF, 2006. Developmental Biology, 8th ed. Sinauer Associates, Inc., publishers,
3) Gilbert SF, 2006. Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
4) Kalthoff, 2000. Analysis of Biological Development, 2nd revised ed., McGraw-Hill Publishing
5) Kalthoff, 2000. Analysis of Biological Development, II Edition, McGraw-Hill Professional.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA==
2) https://nptel.ac.in/courses/102106084
3) https://onlinecourses.nptel.ac.in/noc21_bt43/preview
4) https://www.digimat.in/nptel/courses/video/102106084/L26.html
5) https://www.youtube.com/watch?v=TDBk2zoSAq8

MEDICAL BIOTECHNOLOGY

L	T	P	C
4	1	0	4

a. Course code:

b. Course objectives:

The aim objectives of this course are:

1) To know the principles of biotechnology in medicine
2) To study the cellular physiology of diseases
3) To be familiar with the biotechnology applications in disease diagnosis and treatment

c. Course prerequisites:

- Essential knowledge in medical procedures

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Comprehensive understanding of biotechnology in medicine	K2
CO2	Apply the physiological mechanism for the medicine development	K3
CO3	Analyse the types of vaccines	K4
CO4	Illustrate the essentials of metabolism in medicine	K3
CO5	Describe diverse diseases and disorders	K1 & K2
CO6	Develop methods to produce pharmaceutical and diagnosing products	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit 1 **12 hrs**

Medicinally important bioproducts: pharmaceutical and diagnosing productsIntroduction – history and development –systems of medicine – medicinal natural

products, synthetic drugs and biological products – examples – Therapeutically and pharmacological use and classification of medicinal products.

Unit 2 **12 hrs**

Patho-physiology: Cellular physiology – homeostasis – membrane transport – membrane potential- cardiovascular physiology and patho-physiology of cardiovascular system- Gene therapy, Respiratory physiology and patho- physiology of respiratory system Renal physiology. Endocrine physiology, patho-physiology of endocrine disorders and gene therapy.

Unit 3 **12 hrs**

Prognosis and prevention: Vaccines, types, mechanism, production, Interferons, applications of animal cell culture, Monoclonal antibody technology, Biosensors,

Unit 4 **12 hrs**

Medical targets: Basics in experimental medicine- metabolic mechanisms – receptor mediated signal transduction – primary messenger – hormones and drugs-secondary messenger and neurotransmitters. G- protein coupled receptors – cyclic AMP – calcium ions –Nitric oxide (NO) – prostaglandin and inositol tri phosphates.

Unit 5 **12 hrs**

Immunomolecular of diseases: and logical Introduction – molecular and immunological basis of diseases-molecular mechanism of diabetic mellitus- (Insulin dependent and non – insulin dependent) cancer and cholera. Introduction to conventional and futuristic developments in molecular and immunological basis of disease elevation-combinatorial antibody designing – Gene therapy- Anti sense therapy- RNA

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	M	M	M	H	H
CO2	H	H	M	M	M	H	H	M
CO3	M	H	H	H	M	M	H	H
CO4	H	H	M	M	M	M	H	H
CO5	H	H	H	M	M	L	M	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	M	M	H	H
CO2	M	H	M	H	H	M	H	H
CO3	H	H	H	H	H	M	H	H
CO4	H	M	M	H	H	M	M	M
CO5	H	M	M	H	M	M	M	M
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Bernard R. Glick, Cheryl L. Patten, Terry L. Delovitch, 2013. Medical Biotechnology: Principles and Applications of Recombinant DNA, 1st edition, ASM Press.
2) Gennady E Zaikov, Rajmund Orlicki, Cezary Cieńciala, Larisa Petrovna Krylova, Jan Pielichowski, 2013. Pharmaceutical & Medical Biotechnology: New Perspectives (Recent Trends in Biotechnology), Nova Science Publishers Inc; UK.
3) Martin L. Yarmush, Mehmet Toner, Robert Plonsey, Joseph D. Bronzino, 2003. Biotechnology for Biomedical Engineering, Ist edition, CRC Press.
4) Pratibha Nallari, Venugopal Rao V, 2010. Medical Biotechnology Oxford University Press.
5) Thomas M. Devlin, 2010. Textbook of Biochemistry with Clinical Correlations, 7th edition, Wiley-Liss.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://archive.nptel.ac.in/courses/102/106/102106057/
2) https://www.digimat.in/nptel/courses/video/102106057/L08.html

DRUG DESIGNING

a. Course code

L	T	P	C
4	0	0	4

b. Course objectives:

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 knowledge about computer-aided drug design.

3) To give students an overview of the drug delivery system, and pre-clinical and clinical testing.

c. Course prerequisites:

- Elementary understanding of the drugs and their mechanism.

d**. Course outcome (COs):**

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

Course Outcome	Expected outcome	Cognitive level
CO 1	Recall the process of drug development and designing	K 1
CO 2	Understand, analyze and evaluate the significance of drug targeting biomolecules	K 2, K3 & K6
CO 3	Analyze and evaluate the prodrug delivery methods and its activation mechanisms	K3, & K5
CO 4	Apply and evaluate the *in-silico* **and** virtual screening	K 3, K 4 & K6
CO 5	Design and develop pre-clinical and clinical testing methods for drug analysis.	K 3, K 4 & K6
CO 6	Justify the significance of drug design and development for various infectious and non-infectious diseases	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

UNIT I: 12 hrs

Introduction to drug design: Introduction to drug discovery; source of drugs: derived from natural products, existing drugs as a source for new drug discovery; using disease models as screens for new drug leads; physiological mechanisms: the modern "rational approach" to drug design; approaches to lead optimization.

UNIT II: 12 hrs

Enzymes and receptors as targets of drug design: Introduction to enzymes as drug targets; approaches to the rational design of enzyme inhibitors; introduction to types of receptors; receptors as targets of drug design: receptor theory and receptor complexes; receptor binding assays, lead compound discovery of receptor agonists and antagonists.

UNIT III: **12 hrs**

Prodrug design and applications: Introduction to prodrug; prodrug design considerations; prodrug forms of various functional groups, ester prodrugs of compounds containing -COOH or -OH, prodrugs of compounds containing amides and amines, prodrugs for compounds containing carbonyl groups; drug release and activation mechanisms: simple one-step activation, cascade release/activation systems.

UNIT IV: **12 hrs**

Computer-aided drug design: Instruction to Docking and virtual screening, molecular dynamics and binding free energy methods; stages of in silico drug discovery; protein docking and its applications; tools for docking: AutoDock and SwissDock; *in silico* ADMET predictions; pharmacogenomics.

UNIT V: **12 hrs**

Drug Delivery, pre-clinical and clinical testing: Drug delivery methods: drug delivery routes, drug delivery vehicles; drug pharmacokinetics, pharmacodynamics, and toxicity testing of drugs; drug testing on small animals; clinical trials on humans; ethical issues related to clinical trials.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M	H	M	H	M
CO2	H	M	M	H	H	L	H	H
CO3	M	H	H	H	H	M	H	H
CO4	M	H	H	M	H	L	H	H
CO5	M	H	H	M	H	M	H	H
CO6	M	H	H	M	M	M	H	M

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	H	H
CO2	H	M	H	H	H	M	H	M
CO3	M	M	M	H	H	M	H	H
CO4	M	H	H	H	H	M	H	H
CO5	H	M	H	H	H	H	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Chittipolu Ajay Kumar, Divya Sreepada, 2021. Computer Aided Drug Design and Tools Directory AkiNik Publication
2) Gad SC, 2005. Drug Discovery Handbook, 1st ed. Wiley-Interscience.
3) Hill RG, Rang HP, 2012. Drug Discovery and Development: Technology in Transition. 2nd ed. Churchill Livingstone.
4) Kenakin TP, 2012. Pharmacology in Drug Discovery, 1st ed. Elsevier.
5) Stromgaard K, Krogsgaard-Larsen P, Madsen U, 2016. Textbook of Drug Design and Discovery, 5th ed. CRC press.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://onlinecourses.nptel.ac.in/noc21_bt29/preview
2) https://archive.nptel.ac.in/courses/102/106/102106070/
3) https://www.digimat.in/nptel/courses/video/102106070/L01.html
4) https://nptel.ac.in/courses/104105120

MINI PROJECT

Semester VII

ADVANCED CELL & MOLECULAR BIOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The core objectives of this course are:

1. To understand the basic biological molecules, cells, cell division, and cell cycle.
2. To explain the density arrest, cell synchronization, and aging of cells.
3. To explain the cell biology techniques.

c. Course prerequisites:

- Basic knowledge about the cellular evolution and replication

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Define and understand the essential of biomolecules and the concept of cell theory	K1 & K2
CO2	Illustrate the significance of cell division and cell cycle.	K2, K3 & K4

CO3	Understand the density arrest, Irregular duplication of genome, centrosome	K2
CO4	Focus on Cell synchronization and aging of the cell.	K4
CO5	Appraise and justify the importance of cell biological techniques in the diagnosis and treatment of various hazardous diseases	K4, K5 & K6
CO6	Create knowledge in advanced cell and molecular biology techniques	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **12 hrs**

Diversity of cell size and shape. Cell theory. Isolation and growth of cells. Cytoskeletons and stem cells, types of stem cells, stem cell markers, pluripotency & totipotency, nuclear transfer.

Unit II **12 hrs**

Cell division and cell cycle - Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. Structure of nucleosome and organization of chromatin. Role of condensin in chromatin packing

Unit III **12 hrs**

Cell division checkpoints: Density arrest. Genes associated with Density arrest: RB, p53, ATM, Chk2, Cdc25A, Wee1 and Cyc D and E. Disease associated with failure of density arrest. DNA replication licensing factor, Gemini, Cdc45, Intra-S checkpoint, ATR, ATRIP, Chk1, Cdc25C, Wee1, Cdc2/CycE. Irregular duplication of genome, centrosome and associated diseases.

Unit IV **12 hrs**

Role of topoisomerases and catenation process. Spindle checkpoint, protein in spindle detection. Bubr1, Role of microtubule, kinesin, dynin, Aurora A and Aurora B. Cohesin and separsae. Cytokinesis. Cell synchronization: G0/G1, S and mitotic cell synchronization. Factors influence the cell cycle: Chemical, physical and biological. Aging of cell: Quiescence, Senescence, Apoptosis, Immortalization of cell.

Unit V **12 hrs**

Techniques in cell biology: Cell culture, 3D culture, fluorescent microscopy, confocal microscopy, Subcell fractionation, Immunostaining, FACS analysis & sorting, live videography.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	M	H	M	M	M	H	M
CO2	H	M	M	M	L	L	H	M
CO3	H	H	M	M	L	L	H	M
CO4	H	M	H	M	M	L	H	M
CO5	H	H	H	M	M	M	H	H
CO6	H	M	H	M	M	M	H	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	M	M	M	H	H
CO2	M	M	H	H	M	M	H	H
CO3	M	H	H	H	M	M	M	M
CO4	M	H	H	M	M	M	M	M
CO5	H	H	H	H	H	M	H	H
CO6	M	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter, 2002. Molecular Biology of the Cell, 4th edition, Garland Science, New York.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Kelsey C. Martin, Michael Yaffe, Angelika Amon, 2016 Molecular Cell Biology, 9th edition.
3. Leonard P. Freedman, 1998, Molecular Biology of Steroid and Nuclear Hormone Receptors, Springer
4. Watson James D, Baker Tania A, Bell Stephen P, Gann Alexander, Levine Michael, Losick Richard, 2017. Molecular Biology of the Gene, 7th Edition, Pearson Education.
5. Wilson EB, Macmillan, 2004. Cell in Development and Inheritance, MacMillan, New York

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/102106025
2) https://www.britannica.com/science/cell-biology
3) https://www.bu.edu/gk12/nishant/cellbioarticle.htm
4) https://www.slideshare.net/MichaelHo6/lecture-notes-cell-biology
5) https://www.uou.ac.in/sites/default/files/slm/BSCBO-301.pdf

ENZYMOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The core objectives of this course are:

1. To learn the biochemical principles of enzymes
2. To study the factors influencing enzyme activity
3. To learn the application of enzymes

c. Course prerequisites:

- Elementary knowledge of enzyme

d. Co**urse outcome (COs):**

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Describe and understand the biological principles of enzymes	K1 & K2
CO2	Develop insight into the essentials of enzyme kinetics	K3 & K6
CO3	Analyse the methods for enzyme extraction	K4
CO4	Comprehensive understanding of enzymes regulation	K2
CO5	Apply and appraise the enzymes for diverse biotechnological applications	K4 & K5
CO6	Acquire knowledge to find appropriate employment in food and other biotech industries	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **12 hrs**

Enzymes an introduction: classification characteristics-, factors contribution to enzyme catalytic rates, single and multi-substrate enzymes, regulatory enzymes.

Unit II **12 hrs**

Enzyme specificity & kinetics: Enzyme specificity & kinetics of single-substrate enzyme-catalyzed reactions-derivation of Michalis Menton equation, modification of Michalis Menton equation, the significance of Michalis Menton equation, Rapid reaction kinetics pre-steady kinetics, and relaxation kinetics

Unit III **12 hrs**

Enzyme extraction methods from the plant, animal, and microbial sources, recombinant strains- enzyme purification techniques- enzymes assays- enzyme stability- Immobilization- application of immobilized enzymes

Unit IV **12 hrs**

Enzyme activity regulation: General introduction of enzyme regulation, feedback inhibition, and feed-forward stimulation, enzyme repression, induction and degradation, reversible and irreversible covalent modification of enzymes, Sigmoidal kinetics, and allosteric enzymes, the significance of sigmoidal kinetics

Unit V **12 hrs**

Enzymes as analytical reagents-Principles of enzymatic analysis, application of enzymatic analysis in medicine and industry. - Biotechnological applications of enzymes-physical and chemical methods for enzyme immobilization, influence of immobilization on enzyme activity, applications of rDNA technology and bioinformatics.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	H
CO2	H	H	M	M	L	L	M	M
CO3	H	M	M	M	L	L	H	M
CO4	H	M	M	M	L	M	H	M
CO5	H	H	H	H	M	M	H	H
CO6	L	M	H	M	M	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	M	M	H	M	H	H
CO2	M	M	M	M	H	M	M	H
CO3	M	M	H	M	M	M	H	H
CO4	M	H	H	M	M	M	H	M
CO5	H	H	H	H	M	M	H	H
CO6	H	M	M	M	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Donald Voet, Judith G. Voet, Charlotte W. Pratt, 2016. Fundamentals of Biochemistry: Life at the Molecular Level, John Wiley and Sons, Inc.
2) Emil L. Smith, 2002. Principles of Biochemistry, 8th edition McGraw-Hill International book Company.
3) Lehninger, Nelson, Cox, 2002. Principles of Biochemistry, 3rd Ed, CBS publishers.
4) Murray RK, Granner DK, Mayer PA, Rodwell VW, 2001. Harper's Biochemistry, Prentice - Hall International.
5) Satyanarayana, 2021. Biochemistry, 6th edition, Elsevier.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/102102033
2) https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
3) https://www.youtube.com/watch?v=5g61pEe0C1U

GENETIC ENGINEERING & RECOMBINANT DNA TECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The main objective of this course is:

1. To understand the cloning strategies, expression patterns, and various techniques involved in genetic engineering
2. To envisage the recombinant techniques in experiments
3. Deep insight into transgenic technology and gene editing

c. Course prerequisites:

- Understanding on the basics of genetic information and its transfer.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Understand the cloning strategies and construct the genomic libraries	K2
CO2	Predict the finest vectors for both prokaryote and eukaryotic host system	K3
CO3	Know the techniques involved in gene recombination and gene transfer	K3
CO4	Apply the PCR technologies in disease profile, forensic science, and DNA footprinting.	K3&K5
CO5	Assess the current trends in transgenic and gene-editing technology	K3 & K5
CO6	Invent genetically modified innovative products for human welfare	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit: I **12 hrs**

Genetic materials and enzymes: History of genetic material, DNA modifying enzyme, restriction endonucleases, Isoschizomers, classification of restriction enzymes, DNA topoisomerase, DNA methyltransferases, DNA polymerases.

Unit: II **12 hrs**

Application of DNA replication: DNA replication in prokaryotes and eukaryotes, Polymerase chain reaction, PCR based methods for site-directed mutagenesis, Evolution in enzymology, generalized cloning schemes and strategies, GATEWAY cloning.

Unit III **12 hrs**

Genetic engineering vectors: Plasmids; lambda based vectors and derivatives, insertion vectors, replacement vectors, cosmids, phasmids, phagemids, invitro packaging, high-cloning capacity vectors, single stranded DNA vectors: YACs, BACs, PACs, BIBACs, Central Dogma of life, Understanding the architecture of genes-gene to genome, understanding the architecture of proteins-protein to proteome.

Unit: IV **12 hrs**

Genomics: Classification of genomics: functional genomics, common techniques related to functional genomics, protein expression vector, protein extraction and purification, protein-protein interaction and its requirements, protein micro array, techniques involved in protein-protein interaction, Sanger's di-deoxy chain termination method.

Unit: V **12 hrs**

Plant transformation vectors Ti-, Ri- plasmids, Binary, conjugate, selection schemes, Microscopy based imaging and applications, fluorescence In situ hybridization, pulse field gel electrophoresis method and application, gene therapy and its role in disease.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M	L	M	H	H
CO2	H	H	M	L	L	L	H	H
CO3	H	L	H	M	L	M	H	L
CO4	M	L	H	M	M	H	L	H
CO5	H	M	L	H	H	H	M	M
CO6	H	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	M	M	L	M	L	H
CO2	H	L	H	H	M	L	M	M
CO3	M	M	H	L	L	L	H	M
CO4	H	H	L	M	L	M	L	M
CO5	H	H	M	H	M	L	M	M
CO6	H	H	M	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Benjamin Lewin, 2001. Genes VII, Oxford University Press
2) Brown TA, 2020. Gene Cloning and DNA Analysis: An Introduction, 8th edition, Wiley-Blackwell.
3) Chaudhari K, 2015. Microbial Genetics, The Energy and Resources Institute
4) Desmond ST. Nicholl, 2008. An Introduction to Genetic Engineering 3rd Edition, Cambridge University Press.
5) Sandy B. Primrose, Richard M. Twyman, Robert W. Old, 2002. Principles of Gene Manipulation 6th Edition Wiley-Blackwell

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P001357/M021491/ET/1501755083geneticengineeringetextpathshaala(corrected.pdf
2) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==
3) https://nptel.ac.in/courses/102103013
4) https://nptel.ac.in/courses/102103074

MICROBIAL BIOTECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objective:

The core objectives of this course are:

1. To understand the concept of microbial biotechnology.
2. To understand the scope and application of fermentation technology
3. To explore the significance of industrially important microbial products

c. Course prerequisites:

- Preliminary understanding on ecological role of microorganisms and their related physiology.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Describe the prominence of industrially important microbes	K1 & K2
CO2	Understand and appraise the importance of Fermentation.	K2, K4 & K5

CO3	Exploration of microorganisms for novel day-to-day applications.	K3
CO4	Develop a better eco-friendly sustainable environment by the utilization of microbes	K3 & K6
CO5	Prepare and formulate microbial products to facilitate human healthcare applications	K3 & K6
CO6	Justify the importance of non-pathogenic microorganisms in the development of bioproducts for human welfare	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **12 hrs**

Microbes in action: Biotechnology, definition, examples, & applications, Historical perspectives, scope and applications. Industrially important microbes, Strain improvement and selection. Isolation and cultivation of microbes and their preservation methods, Growth of microorganisms; batch and continuous culture.

Unit II **12 hrs**

Fermentation: Brief history of fermentation; Fermentation - general concepts, Applications of fermentation; Range of fermentation process - Microbial biomass, enzymes, metabolites, recombinant products, transformation process; Component parts of a fermentation process.

Unit III **12 hrs**

Media and substrates: Microbial substrates and media formulation; Types of fermentations - Aerobic and anaerobic fermentation, Submerged and solid-state fermentation; Factors affecting submerged and solid-state fermentation; Substrates used in SSF and its advantages.

Unit IV **12 hrs**

Microbial products: Production of microbial products - Enzymes (proteases, amylases and lipases) - Organic acids (citric acid, acetic acid) - Vitamins (B_2, B_{12}) - Amino acids (lysine, glutamic acid, tryptophan)

Unit V **12 hrs**

Microbial products of recent interest: Production of solvents, beverages and other microbial products - (ethanol, acetone, beer, Wine) - Biosurfactants- Biofuels (methane, hydrogen) - Biocosmetics (hyaluronic acid) - Biopolymers (PHA & PHB).

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	L	L	H	H
CO2	H	H	M	H	L	L	H	H
CO3	M	H	M	H	M	M	H	H
CO4	M	H	H	H	M	H	H	H
CO5	M	H	H	H	M	M	H	H
CO6	H	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	H	H
CO2	H	H	M	M	M	L	H	H
CO3	H	H	M	H	H	M	H	H
CO4	H	M	H	M	H	H	H	H
CO5	H	H	M	H	H	M	H	H
CO6	H	H	H	H	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Casida LE Jr, 1968. Industrial Microbiology, Reprint Edition, New Age International Publisher.
2) Peter F Stanbury, Allan Whitaker, Stephen J Hall, 2016. Principles of Fermentation Technology, 3rd edition, Butterworth-Heinemann.
3) Samuel Cate Prescott, Cecil Gordon Dunn, Gerald Reed (Ed), 1982. Prescott & Dunn's Industrial Microbiology, 4th edition, Palgrave Macmillan.
4) Shuler ML, Karg IF, 2001. Bioprocess Engineering Basic Concepts, 2nd edition Prentice Hall.
5) Wulf Crueger, Anneliese Crueger, Brock TD, 1990. Biotechnology. A Textbook of Industrial Microbiology, 2nd edition, Sinauer Associates Inc., U.S.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://archive.nptel.ac.in/courses/102/103/102103015/
2) https://nptel.ac.in/courses/102103015
3) https://nptel.ac.in/courses/102105058

Practical VII: ADVANCED CELL & MOLECULAR BIOLOGY and ENZYMOLOGY

a. Course code:

L	T	P	C
0	0	4	2

b. Course objectives:

The aim objectives of this course are:

1. Gain the required laboratory skills to perform, interpret and analyse widely used molecular biology techniques.
2. Train the students in understanding genetics and hereditary.
3. To impart the enzymology knowledge in applications of various human health care**.**

c. Course prerequisites:

- Necessary knowledge about cellular organisation and reagent preparation.

d. Course outcomes (COs):

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the basic concept of nucleic acids	K1& K2
CO2	Understand and develop knowledge about histochemical techniques.	K2, K3 & K6
CO3	Illustrate the basic concept of gene cloning	K2, K3 & K4
CO4	Evaluate the genetic causes of diseases, for the development of diagnostics and therapeutics.	K4& K5
CO5	Justify the application of enzyme	K5 & K6
CO6	Facilitate the development of novel enzymology techniques for the welfare of the society.	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Electrophoresis: Polyacrylamide gel electrophoresis (PAGE), agarose gel electrophoresis (AGE), native PAGE, SDS-PAGE.
2. Isolation and purification: (a) DNA (genomic and plasmid) (b) RNA and (c) proteins.
3. Gene Cloning: Cloning vectors, molecular cloning, and construction of DNA libraries.
4. DNA amplification: Polymerase chain reaction (PCR), RT- PCR.
5. Genome mapping: RFLPs, RAPD, AFLP, and FISH. Genome expression analysis: Microarray and EST.
6. Restriction digestion & ligation of DNA
7. Histology, immunohistochemistry, immunoblot
8. Absorbance of NADH by UV spectroscopy
9. Assay of trypsin enzyme.
10. Assay of urease enzyme.
11. Assay of LDH from rat liver.
12. Subcellular fractionation of cellular organelles from liver cells.
13. Purification of β – Glucuronidase from rat liver.
14. Determination of kinetic constant of enzymes.
15. Effect of substrate concentration on enzyme activity
16. Effect of inhibitors on enzyme activity.

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	L	H	M
CO2	H	H	H	M	L	L	H	M
CO3	H	H	H	H	L	M	H	H
CO4	H	H	H	M	H	L	H	H
CO5	H	H	H	H	M	H	H	H
CO6	H	H	H	H	M	H	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	H	H
CO2	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H
CO4	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	M	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manuals / References:

1) Carson S, Miller HB, Srougi MC, Witherow DS, 2019. Molecular biology techniques: a classroom laboratory manual. Academic Press.
2) Hans Biswanger, 2019. Practical Enzymology 3e, Wiley-VCH Verlag GmbH
3) Karp G, 2005. Cell and Molecular Biology – Concepts and Experiments, 4th Ed, USA, John Wiley and Sons Inc., New Jersey.
4) Katoch R, 2011. Analytical techniques in biochemistry and molecular biology. Springer Science & Business Media.
5) Kumar P, 2016. Fundamentals and Techniques of Biophysics and Molecular biology. Pathfinder Publication unit of PAPL.

Practical VIII: GENETIC ENGINEERING & rDNA TECHNOLOGY and MICROBIAL BIOTECHNOLOGY

L	T	P	C
0	0	4	2

a. Course code:

b. Course objectives:

The aim objectives of this course are:

1. To understand the basic concept and application of genetic engineering for the development of transgenic varieties
2. To know the basics of microbial cells and types of microorganisms.
3. To understand the major histocompatibility complex.

c. Course prerequisites:

- Comprehension about the genetic and immunology principles.

d. Course outcomes (COs):

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the concept of restriction enzymes	K1
CO2	Discuss the application of cloning vector	K2
CO3	Construct transgenic plants / animals using genetic engineering tools and techniques for human welfare	K3 & K6
CO4	Classify the microorganisms based on their significant features	K2 & K4
CO5	Evaluate the industrially important microorganisms from the natural environment	K4 & K5
CO6	Justify the role fermented products in uplifting the human welfare.	K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Isolation of plasmid DNA from bacterial culture
2. Restriction, digestion, ligation & transformation into bacteria (CaCl2, electric shock & heat shock methods)
3. Cloning and amplification.
4. Types of cloning vectors (PBR322, bacteriophage, cosmid vectors, phasmid vector, M13 phage vectors) & their application.
5. Transformations of recombinants in E.coli (Preparation of competent cells).
6. Selection & screening of rDNA antibiotic resistance, blue–white colony.
7. PCR amplification (demo).
8. Strain Improvement- Mutation experiments, Protoplast isolation.
9. Isolation of DNA from bacteria, plants, and animal cells
10. Preparation of competent cell
11. Gene transfer in microbes – calcium-mediated, vector-mediated
12. Identification of recombinants – antibiotic markers, Blue-white colony selection
13. Isolation of RNA
14. Blotting techniques (Southern)
15. Isolation and screening of industrially important microorganisms from natural the environment.
16. Production of wine by fermentation.
17. Production and estimation of ethanol from Sucrose by Yeast.

18. Immobilization of Yeast.
19. Fermentative production of α-amylase.

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	H	H
CO2	M	H	H	H	M	M	H	H
CO3	M	H	H	H	M	H	H	H
CO4	M	H	H	H	M	H	H	H
CO5	M	H	H	H	M	H	H	H
CO6	H	H	H	H	M	H	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	H	H
CO2	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H
CO4	H	H	H	M	H	M	H	H
CO5	H	H	H	H	H	M	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manual/Reference

1) Alexander N. Glazer, 2007. Hiroshi Nikaido, Microbial Biotechnology, Cambridge University Press.
2) Carson S, Miller HB, Srougi MC, Witherow DS, 2019. Molecular biology techniques: a classroom laboratory manual. Academic Press.
3) Jerzy Długoński, 2022. Microbial Biotechnology in the Laboratory and Practice: Theory, Exercises, and Specialist Laboratories, Jagiellonian University Press

4) Karp G, 2005. Cell and Molecular Biology – Concepts and Experiments, 4th Ed, USA, John Wiley and Sons Inc., New Jersey.
5) Surajit Das, Hirak Ranjan Dash, 2015. Microbial biotechnology -- a laboratory manual for bacterial systems, Springer.

AQUACULTURE BIOTECHNOLOGY

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The core objectives of this course are:

1. To impart knowledge on fish culture techniques,
2. To enhance the health management measures of aquatic organisms
3. To study the fish preservation and packing

c. Course prerequisites:

- Simple knowledge about aquatic organisms and aqua products

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive level
CO1	Understand the biology and current status of aquaculture in India	K 2
CO2	Interpret the basic culture methods and farm management practices	K2
CO3	Analyze the merits and demerits of different methods of integrated fish farming	K 4
CO4	Acquire and apply knowledge on feed organisms and feed formulation and disease management	K 4 & K5
CO5	Apply the principles and concepts of fish processing and preservation	K 3
CO6	Integrate innovative strategies in aquaculture to develop products associated with human health	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit I **9 hrs**

Aquaculture in practice: History, definition, scope, and significance of aquaculture, comparison of aquaculture with agriculture and commercial fisheries. Different aquaculture systems. Aquaculture - Global and Indian scenario

Unit II **9 hrs**

Culture methods and Farm Management: Polyculture, integrated fish farming – paddy - cum fish culture, animal husbandry - cum fish culture, Management of culture ponds - control of water quality parameters - fertilization - control of predators and weeds.

Unit III **9 hrs**

Culture techniques Finfish - culture of Indian major carp (Catla) - seed collection, breeding and culture techniques, Shellfish - culture of marine prawn, pearl oyster; shrimp culture and related techniques.

Unit IV **9 hrs**

Feeds and diseases: Fish feed and disease management, Fish feed – artificial feed - feed formulation and composition of formulated feed, live feed organisms. Common diseases – white spot disease, dropsy, fin rot, gill rot, saprolegniasis. Parasites - argulus, lernea - prevention and management. Principles of fish health management

Unit V **9 hrs**

Fish processing and preservation: Fish preservation – freezing, canning, dry curing, salt curing, smoke curing, irradiation, special cured products. Preservation and export techniques.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	M	M	L	M	H	M
CO2	M	H	M	L	L	M	M	M
CO3	L	H	M	M	L	M	H	M
CO4	H	H	M	M	M	M	H	M
CO5	M	H	H	H	L	M	H	M
CO6	M	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	M	H	L	M	H
CO2	M	M	M	M	H	L	H	H
CO3	H	H	M	M	M	M	M	H
CO4	H	H	H	H	M	H	H	H
CO5	H	H	M	H	H	M	H	H
CO6	H	H	H	M	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Agarwal SC, 1994. A Hand book of Fish Farming. Naranda Publishing House, Delhi.
2) Chaudhuri AB, 2009. Aquaculture Resurgence Birth of Blue Revolution. Daya Publishing House, Delhi.
3) Dinabandhu Sahoo, Qasim SZ, 2009. Sustainable Aquaculture. A.P.H Publishing Co, NewDelhi.
4) Sailendra Ghosh, 2009. Fisheries and Aquaculture Management. Adhyayan Publisher & Distributors, New Delhi.
5) Santhana Kumar, Selvaraj AM, 2006. Concepts of Aquaculture. Mac ram Publications, Nagercoil.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/120108002
2) https://nptel.ac.in/courses/126105022
3) https://www.fao.org/3/ac169e/ac169e00.htm

BASICS OF FORENSIC SCIENCE

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The core objectives of this course are:

1. To develop the post-graduate-level students with the specific knowledge of handling different types of pieces of evidence and their examinations
2. To develop the laboratory skills in examining different types of evidence found at the crime scene

3. To prepare the students to compete for employment in State and central level Organizations.

c. Course prerequisites:

- Introductory understanding on forensic science concepts.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Describe and understand the fundamental principles and functions of forensic science and its significance to human society.	K1, K2 & K3
CO2	Discuss the significance of molecular biology techniques in forensic science	K4
CO3	Apply the principles and concept of immunochemical techniques in crime investigations	K2 & K3
CO4	Appraise the application of microscopic and spectroscopic techniques in forensic science	K2, K4 & K5
CO5	Evaluate the crime investigation by applying the law	K4 & K5
CO6	Manage various crime investigations through molecular biology and immunochemical tools and techniques	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit I **9 hrs**

Forensic Science - definition, scope, history and development, Basic principles of forensic science, Organizational structure of forensic science laboratories at the state and central level, CDTS (Central Detective Training School), Ethics in forensic science, Duties of forensic scientist, Laboratory management system and importance of accreditation in forensic science laboratories.

Unit II **9 hrs**

DNA fingerprinting: Introduction of DNA, nature, sources of DNA, Extraction of DNA, Basics of DNA profiling: Polymerase chain reaction. (PCR), Restriction fragment length polymorphism (RFLP,) Short tandem repeat (STR), Forensic significance of DNA fingerprinting.

Unit III **9 hrs**

General principles of immunochemical technique, Antigen-antibody binding, Production of antibodies, Precipitin reaction, Gel immunodiffusion, Immunoelctrophorsesis, Complement fixation, Radio immuno assay, ELISA, Fluorescent immunoassay.

Unit IV **9 hrs**

Herbal drug: Introduction, taxonomy, macroscopic and microscopic characteristics, Forensic analysis by presumptive tests, Colour tests, TLC, GC-FID, GC-MS and HPLC.

Unit V **9 hrs**

Law - General idea to IPC, IEA, CrPC, and its relevant sections related to forensic science, Introduction to offences against person.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	L	M	L	M	M
CO2	M	L	M	L	M	L	M	M
CO3	M	M	M	L	M	M	M	H
CO4	H	M	H	L	M	M	M	M
CO5	M	M	M	M	M	M	H	M
CO6	M	H	M	M	M	M	M	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	M	M	M	M	L	M
CO2	M	M	L	M	M	M	M	M
CO3	M	M	M	H	M	L	M	M
CO4	H	H	H	M	H	L	M	H
CO5	M	H	M	M	M	L	M	M
CO6	M	M	M	H	M	M	M	M

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Bell Suzanne, 2019. Forensic Science: An Introduction to Scientific and Investigative Techniques, Fifth Edition, CRC Press.
2) George M. Malacinski, 2003. Essentials of Molecular Biology, 4th Ed. Jones and Bartlet Pub.
3) Keith Wilson, John Walker, 2000. Practical Biochemistry- Principles & Techniques, 5th edition, Cambridge University Press.
4) Paul K. Roberts, 2010. Steroid Use and Abuse ,Nova Science Publishers ,USA
5) Sharma, BR, 1974. Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) http://adpcollege.ac.in/online/attendence/classnotes/files/1621505941.pdf
2) http://www.csun.edu/~cmalone/pdf360/Ch16,17rDNA.pdf
3) https://microbenotes.com/dna-fingerprinting-principle-methods-applications/
4) https://nptel.ac.in/courses/102103017

CANCER BIOLOGY

L	T	P	C
3	0	0	3

a. Course code:

b. Course objectives:

The core objectives of this course are:

1. To understand the clinical features of cancer
2. To study the cancer induction molecular mechanisms
3. To learn the viable therapeutic approaches for cancer treatment

c. Course prerequisites:

- Basic knowledge about the mutations and their control.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive level
CO 1	Comprehensive understanding of cancer development and types	K2 & K4
CO 2	Illustrate the significance of carcinogenesis and its impact on human health	K1, K2 & K4

CO 3	Appraise and explain the molecular biology of cancer	K3 & K5
CO 4	Apply the methods for cancer diagnosis	K3, K4 & K5
CO 5	Design and appraise the diverse cancer therapies	K3,K5 & K6
CO6	Formulate methods to study different stages of cancer and design drugs for cancer therapy	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **9 hrs**

Introduction to cancer: Types of cells, cancer- types or nomenclature, morphological, physiological, and biochemical characteristics of cancer cells- stages or phases of cancer- defense mechanism against cancer. Regulation of cell growth and apoptosis- metastatic mechanism- angiogenesis

Unit II **9 hrs**

Carcinogenesis: Principles of Carcinogenesis- Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.

Unit III **9hrs**

Molecular biology of cancer: Principles of cancer molecular biology - signal targets and cancer, activation of kinases; oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. oncogenes/proto-oncogene activity, growth factors related to transformation, telomerases.

Unit IV **9 hrs**

Cancer diagnosis- conventional and modern methods- clinical or medical imaging- types- mechanism- applications and limitation- radiological methods- biochemical assays- histological methods- molecular methods.

Unit V **9 hrs**

Current therapies of cancer: new molecules for cancer therapy. Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	L	L	M	H	M
CO2	M	M	H	L	M	L	M	M
CO3	M	M	M	M	M	L	H	M
CO4	H	M	H	L	L	M	H	H
CO5	M	H	H	M	M	L	M	M
CO6	M	H	H	M	M	M	M	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	M	M
CO2	H	H	H	H	H	M	M	H
CO3	M	H	H	H	M	M	M	H
CO4	H	H	M	H	H	M	M	H
CO5	H	H	M	H	H	M	H	H
CO6	H	H	H	H	M	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Alain L Fymat, 2021. Cancer: The Pernicious Clonally Evolving Disease Braided in our Genome, Tellwell Talent.
2) Fiona Macdonald, Christopher Ford, Alan Casson, 2004. Molecular Biology of Cancer, 2nd Edition, Taylor and Francis.
3) Francesco Pezzella, Mahvash Tavassoli, David J. Kerr (Ed.), 2022. Oxford Textbook of Cancer Biology, Oxford University Press.
4) Roger King, Mike Robins, 2006. Cancer Biology, 3rd edition, Prentice Hall
5) Weinberg, RA, 2007. The Biology of Cancer Garland Science.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://onlinecourses.nptel.ac.in/noc20_ee14/preview
2) https://onlinecourses.swayam2.ac.in/aic20_ge02/preview
3) https://www.classcentral.com/course/swayam-cancer-fundamentals-19817

Semester VIII

AGRICULTURAL BIOTECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The specific objectives of the course are as follows:

1) To give an overview of the application of biotechnology in agriculture.
2) To teach the physical and chemical characterization of soil, microflora, microbial interaction, biopesticides, and biogeochemical cycles.
3) Aims to provide fine job opportunities in agriculture-based industries.

c. Course prerequisites:

- Fundamental acquaintance with agriculture practices.

e. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive level
CO 1	Remembering and understanding the basics of agricultural biotechnology and analyzing the soil microorganism and their properties.	K 1 & K2
CO 2	Understanding and determining the role of microbes on the environment and interaction between microbes and soil.	K 2 & K3
CO 3	Understanding, remembering, and summarizing the causative agents and control measures of the plant disease.	K1, K2, & K3
CO 4	Applying and analyzing the positive and negative interactions between soil microbes leading to the biopesticide and biofertilizer development	K 3 & K 4
CO 5	Understanding and applying biotechnological techniques for the micropropagation and tissue culture of plants.	K 2 & K 4
CO 6	Design and develop biotechnology-based strategies to enhance the agriculture and its products	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit I **12 hrs**

Microbes in agriculture: Introduction to agricultural biotechnology. Properties of soil - physical and chemical - microbial flora of soil - bacteria, fungi, algae, actinomycetes and nematodes. Factors affecting soil microbial population.

Unit II **12 hrs**

Microbial interactions: Biogeochemical cycle- carbon, phosphorus, nitrogen – biological nitrogen fixation – symbiotic (*Rhizobium*) and asymbiotic (*Azotobacter*) – root nodule formation - and Nitrogenase, Hydrogenase. Interactions between microbes - Mutualism, Commensalism, Competition, Amensalism, Parasitism and Predation. Interaction between microbes and plants – rhizosphere and phyllosphere.

Unit III **12 hrs**

Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic medications and aspects of safety in their use; biofungicides: Expected outcome of mode of actions and mechanisms (e.g., *Trichoderma, Pseudomonas fluorescens*)

Unit IV **12 hrs**

Biofertilizers: symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application. Study of biopesticides used in agriculture (neem as example).

Unit V **12 hrs**

Crop improvement: hybridization and plant breeding techniques. Micropropagation and plant tissue culture technique and its application in agriculture. Somatic hybridization, haploid production and cryopreservation. Integrated pest management.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	M	L	L	M	M
CO2	M	H	H	H	L	M	M	M
CO3	M	H	H	H	L	L	H	M
CO4	M	H	H	H	M	M	H	H
CO5	M	H	H	H	M	L	H	H
CO6	M	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	M	H	M	M	H	H
CO2	M	H	H	M	H	M	M	H
CO3	M	M	H	H	H	M	M	H
CO4	H	H	M	H	H	M	M	H
CO5	M	H	H	M	H	M	H	H
CO6	H	H	H	H	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Atlas and Bartha, 2003. Microbial Ecology-Fundamentals and applications, Benjamin and Cummings.
2) Dinesh Kumar Srivastava, Ajay Kumar Thakur, Pankaj Kumar, 2022. Agricultural Biotechnology: Latest Research and Trends, Springer.
3) Dubey RC, 2014. A Text Book of Biotechnology. Fifth revised Edition. S Chand & Co. New Delhi.
4) Dubey RC, Maheshwari DK, 2013. A Text Book of Microbiology. S. Chand & Co. New Delhi.
5) Talaro KP, Talaro A, 1999. Foundations in Microbiology WCB Me Graw Hill.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://onlinecourses.nptel.ac.in/noc19_bt21/preview
2) https://onlinecourses.nptel.ac.in/noc22_bt25/preview
3) https://pravara.in/wp-content/themes/twentyseventeen/essentials/pdf/elearn/Principles-of-Plant-Biotechnology.pdf

FOOD BIOTECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The specific objectives of the course are as follows:

1. Offer a good command of basic biotechnological principles employed in food processing industries and apply the same for meeting the growing and dynamic needs of food industries.

2. Understand the food technologists' strategies for enhancing mass production, nutritional value, safety, and organoleptic properties of food.
3. Aims at knowing the aspects of food ingredients, food fermentation, Food Safety and Standards Authority of India (FSSAI) regulations, and food toxicants and pathogens rapid detection techniques.

c. Course prerequisites:

- Necessary understanding on food processing and preservation methods.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Impart an in-depth understanding of biotechnology principles behind traditional and fermented foods.	K2
CO2	Familiarise students with the basic unit operation, principles of various food processing methods, and product development	K2 & K4
CO3	Equip students with basic hands-on training on food processing methods and analysing the produced food products.	K2, K3 & K5
CO4	Appreciate the relevance of biotechnological principles for ensuring food safety and security.	K4 & K5
CO5	Understand the advantages, safety, and risk of genetically modified food organisms and associated ethical and legal concerns.	K2 & K5
CO6	Understand and analyze different pharmaceutical parameters for current and future biotechnology-related products.	K2, K4

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit I **12 hrs**

Basics and ingredients: Food Biotechnology, Definition, Scope, Application. Basics of food chemistry, microbiology, biochemistry, Energy value of foods, Requirements, and role of carbohydrates, proteins, lipids, water, vitamins, and minerals in human health, effect of processing, preservation, and storage on the nutritional quality of foods.

Unit II- **12 hrs**

Historical application and modern development: Traditional applications of food biotechnology, role of biotechnology in fermented food products (dairy, meat, vegetable); Starter culture development, process development; Enzymes in the dairy industry: cheese making and whey processing.

Unit III **12 hrs**

Processing and novel foods: Introduction to food processing, processing of various foods viz. bakery, agri commodities and newer developments such as fabricated foods, functional foods, designer food, nutraceuticals, probiotics, and prebiotics. Concept of personalized nutrition and special food for infants, women, etc.

Unit IV **12 hrs**

Food hazards and monitoring: Types of food hazards: biological, chemical, and physical; Risk assessment; Existing and emerging pathogens due to globalization of food trade; Animal studies including LD50; Ames test for teratogenicity; Natural toxic constituents in plant foods; Shellfish poisoning; Newer systems of safety evaluation-FSSAI food safety guidelines.

Unit V **12 hrs**

GMO Foods: Genetically modified foods - Definition, examples of GM foods and their production, advantages and disadvantages, ethical and legal concerns, safety aspects of foods produced by biotechnology and genetic engineering.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	H	L	M	H	H
CO2	M	H	H	H	M	L	H	H
CO3	M	M	H	M	M	M	H	H
CO4	M	M	M	M	L	L	H	M
CO5	H	H	M	H	L	L	H	H
CO6	M	H	H	M	H	M	M	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	M	H	H	H	H
CO2	H	H	M	H	H	M	H	H
CO3	H	H	H	H	H	M	H	H
CO4	H	H	H	M	H	M	H	H
CO5	H	H	H	M	H	H	H	H
CO6	H	M	H	M	M	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin, 2005. Food Biotechnology, CRC Press.
2) Benjamin K. Simpson, Leo M.L. Nollet, Fidel Toldra, et al., 2012. Food Biochemistry and Food Processing, 2nd Edition. Wiley.
3) Byong H. Lee, 2015. Fundamentals of Food Biotechnology, 2nd Edition. Wiley
4) Frazier, West Hoff, 1995. Food Microbiology, Tata McGraw Hill publishing company Ltd, New Delhi.
5) Maurice E. Shils, Moshe Shike, A. Catharine Ross, Benjamin Caballero, Robert J. Cousins, 2005. Modern nutrition in health and disease,10th edition, Lippincott Williams and Wilkins.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/103107088
2) https://onlinecourses.nptel.ac.in/noc20_ag02/preview
3) https://nptel.ac.in/courses/126105011
4) https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000015FT/P000043/M000081/LM/1454064483LM01.pdf
5) https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000444FN/P000551/M012157/LM/1459160509lm09.pdf
6) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=iWHzbXYGExXDS52DSnAzdQ==
7) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=NuAs6SreCGryddEfs4kkBA==

GENOMICS & PROTEOMICS

L	T	P	C
4	0	0	4

a. Course code:

b. Course objectives:

The specific objectives of the course are as follows:

1. To understand the genome organization and various genome analysis
2. To access genomic and proteomic databases which will help explore the datasets and understand the roles of genes and proteins as a wholesome approach
3. To create interest in advanced genomic and proteomic techniques to study the functional aspects which help to explore options for research, and jobs in national labs, institutes, and biotech industries.

c. Course prerequisites:

- Knowledge of basic bioinformatics tools and databases

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Describe the structure and organization of the genome, chromosome mapping	K1
CO2	Explain the various types of sequencing methods and sequence analysis	K2
CO3	Illustrate the construction of microarray, screening, and multiple variations in PCR for gene analysis	K3
CO4	Compare and analyze the human genome using genomic tools and various gene annotation studies	K2, K4
CO5	Critique the methods of analyzing and identifying proteins using proteomic techniques	K2, K5
CO6	Facilitate the opportunity to grab positions in pharma and biotech industries	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit I **12 hrs**

Genomes: organization, and structure of genomes, Genome size, Sequence complexity, Introns and exons. Genome acquisition and analysis - homologies - SNPs -

genetic analysis, linkage mapping, high resolution chromosome mapping, and analysis - physical mapping, YAC, Hybrid mapping, strategies, sequence specific tags (SST), Sequence tagged sites (STS), ISH, FISH, RFLP, and RAPD

Unit II **12 hrs**

DNA sequencing- methods, Maxim and Gilbert method, ladder, Fluorescent, shot gun, mass spectrometry, automation sequencing - gene mutations, implications of DNA - sequencing and sequencing genomes

Unit III **12 hrs**

Genomic tools: Genome data bank, Metabolic pathway data - Construction and screening of cDNA, Libraries and microarrays - Application of DNA arrays - PCR - variations in PCR - Gene disruptions - Sage and sade, Pharmacogenomics.

Unit IV **12 hrs**

Genomics - introduction, scope of genomics, DNA and disease association, DNA fingerprinting, Human genome project, Genomic annotation, Gene ontology, Genotyping tools: DNA chips, diagnostic assay, comparative genomics; Mapping- linkage mapping, High resolution chromosome mapping, Hybrid mapping. Application of genomics

Unit V **12 hrs**

Proteomics - Introduction and scope of proteomics, PAGE, Iso-electric focusing, 2D PAGE and analysis, Mass spectrometry, Strategies for protein identification, Protein sequencing- Edman protein microsequencing, Protein modifications, Synthesis of peptides using Merrifield method, Protein-Protein interaction, Protein engineering, Protein chip technology, Application of proteomics.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	H	H	L	H	L	L	H
CO2	H	H	H	H	M	H	H	M
CO3	H	M	H	H	H	M	M	H
CO4	M	H	H	M	M	H	H	H
CO5	H	H	M	H	H	H	M	M
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	M	M	L	H
CO2	H	H	H	M	H	H	H	M
CO3	H	L	M	H	L	M	H	H
CO4	M	H	H	M	H	H	M	H
CO5	H	M	M	H	M	H	H	M
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Campbell A. Malcolm, Laurie J. Heyer, 2007. Discovering Genomics, Proteomics & Bioinformatics, 2nd edition, Pearson Benjamin Cummings.
2) Daniel C. Liebler, 2001. Introduction to proteomics: Tools for new biology, Humana Press.
3) Miguel Rudolph, 2019. Genomics and Proteomics: Functional and Computational Aspects, Syrawood Publishing House.
4) Mount DW, 2004. Bioinformatics: Sequence and genomic analysis, 2nd edition Cold Spring Harbour Laboratory Press.
5) Sandy B. Primrose, Richard Twyman, 2002. Principles of Genome analysis and Genomics, Third edition, Wiley-Blackwell.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) http://alttox.org/mapp/emerging-technologies/omics-bioinformatics-computational-biology/
2) https://archive.nptel.ac.in/courses/102/104/102104056/
3) https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001859/M030486/ET/1526878699P11_M25_ET.pdf
4) https://nptel.ac.in/courses/102101082
5) https://nptel.ac.in/courses/102103017
6) https://www.ncbi.nlm.nih.gov/books/NBK202165/

NANOBIOTECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The core objectives of this course are:

1) The course aims at providing a general and broad introduction to the multidisciplinary field of nanotechnology.
2) Aims at developing new and exciting cross-disciplinary research fields and technologies with biotechnology.
3) Aims at providing an insight into complete systems where nanotechnology can be used to improve everyday life.

c. Course prerequisites:

- Simple know-how on nanomaterials production and applications

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Describe the basic knowledge needed to understand the concepts of nanobiotechnology	K2 & K3
CO2	Know the general principles of advanced techniques used for studying nanomaterials	K4
CO3	Comprehend to handle basic and advanced instruments for characterizing the size, shape, and other properties of nanomaterials	K2 & K3
CO4	Know the escalating applications of nanoparticles in agriculture, the environment, and human health care	K2, K4 & K5
CO5	Understand the safety issues, risks, and ethics of nanoparticles	K4 & K5
CO6	Design and develop nano-enabled strategies for innovative product production towards sustainable environmental development.	K3 , K5 & K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit I **12 hrs**

Nanobiotechnology overview: | ScienceDirect Topics Introduction to nanobiotechnology - Concepts, historical perspective, Different formats of nanomaterials and their applications with an example for specific cases, bio-inspired nanostructures, thin films, colloidal nanostructures, self-assembled nanospheres.

Unit II **12 hrs**

Nanomaterials - types, synthesis - microbial and plant mediated nanoparticles synthesis, characterization of nanomaterials – UV-Vis spectroscopy, X-ray diffraction, SEM, TEM.

Unit III **12 hrs**

Nanoparticles applications: Nanoparticles for drug delivery, drug targeting, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, zinc and iron oxide nanoparticles.

Unit IV **12 hrs**

Imaging and diagnostics applications: Nanoparticles for diagnostics and imaging, concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanoparticles for biosensor development, Nanomaterials for catalysis, development and characterization of nanobiocatalysts, nanoparticles in agriculture.

Unit V **12 hrs**

Nanomaterial's hazards and safety: Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment, Fate of nanomaterials in environment, Ecotoxicity models and assays, Potential benefits and risks for developing countries.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	M	L	L	M	L	M
CO2	M	M	M	M	L	M	H	M
CO3	M	M	M	L	L	M	M	M
CO4	H	H	M	M	M	M	H	H
CO5	M	H	M	M	L	M	M	H
CO6	M	H	H	M	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	H	H	M	M	H
CO2	M	M	M	M	H	M	M	H
CO3	M	H	M	M	M	L	H	M
CO4	H	H	M	M	H	M	H	H
CO5	M	M	M	H	H	M	H	H
CO6	H	H	M	H	M	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Challa SS, Kumar R (Ed), 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co.
2) David S. Goodsell, 2004. Bionanotechnology: Lessons from Nature, Wiley-Liss
3) Greco RS, Prinz FB, Smith R, 2005. Nanoscale Technology in Biological Systems, CRC press.
4) Nanobiotechology: Concepts, Applications and perspectives, Christ of M.Neimeyer, Chad.A.Mirkin (eds.,) Wiley VCH Weinheim (2004)
5) Neelina H. Malsch, 2005. Biomedical Nanotechnology, CRC Press

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://www.mooc-list.com/tags/nanotechnology
2) https://nptel.ac.in/courses/118107015
3) https://nptel.ac.in/courses/102107058
4) https://www.youtube.com/watch?v=ebO38bbq0_4

Practical IX: AGRICULTURAL BIOTECHNOLOGY & FOOD BIOTECHNOLOGY

a. Course code:

b. Course objectives:

L	T	P	C
0	0	4	2

The aim objectives of this course are:

1. To strengthen the student in advanced tools and modern techniques for ensuring their employability in emerging areas.
2. To equip the students with all technical and practical skills required in the agro-food industries.
3. To prepare and sensitize the students on the scopes available for research and their industrial applications.

c. Course prerequisites:

- Essential familiarity in microbial handling and maintenance

d. Course outcomes (COs):

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Recognize the importance of soil microorganisms and their development into candidate organisms for industrial application.	K1
CO2	Differentiate the microorganisms of agricultural importance and scale up them for agricultural applications.	K2 & K4
CO3	Describe the methods used for determining the quality of water and other foods.	K1
CO4	Understand the concepts and ways of applying various food preservation techniques.	K2 & K3
CO5	Evaluate the application of single-cell proteins in ensuring nutritional and food security.	K5
CO6	Develop the student's appreciation for sustainable development of food industry.	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Isolation of soil microorganisms- *Azotobacter*, Cyanobacteria, and Mycorrhiza.
2. Estimation of soil alkalinity.
3. Estimation of micro and macro nutrient from soil
4. Isolation of *Rhizobium* from root nodules.
5. Determination of soil pH.
6. Determination of soil temperature.
7. Quantitative assay of microbes in soil.
8. Quantitative assay of microbes in rhizosphere.
9. Quantitative assay of microbes in phyllosphere.
10. Isolation of phosphate solubilizing bacteria.
11. Isolation of phosphate solubilizing fungi
12. Determination of microbiological quality of water by MPN method.
13. Presumptive and confirmatory tests for coliform bacteria in water.

14. Enumeration of microorganisms from bread.
15. Food coloring and food preserving technique, pasteurization technique and method.
16. Determination of TDT&TDP.
17. Production and estimation of Biomass (SCP) using dry and wet weight methods.

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	H	H	H
CO2	H	H	H	H	M	M	H	H
CO3	M	H	H	M	L	H	H	H
CO4	M	H	H	M	L	L	H	H
CO5	H	H	H	H	L	M	H	H
CO6	M	H	H	H	L	L	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	H	H
CO2	H	H	H	H	H	M	H	H
CO3	H	H	H	M	H	L	H	H
CO4	H	H	H	H	H	M	H	H
CO5	H	H	H	M	H	M	H	H
CO6	H	H	H	H	H	M	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manual/Reference

1. Dutta, Sunita, Dutta Abhijit, Choudhary Ashok, 2011. Experimental Biotechnology (Practical Manual Series) New India Publishing Agency.
2. Harisha S, 2007. Biotechnology Procedures and experiments handbook, Infinity Science Press Llc, Hingham, Massachusetts, New Delhi, India
3. Janarthanan, 2007. Practical Biotechnology: Methods & Protocols, First edition, Universities Press.

4. Swagat Kumar Das Hrudayanath Thatoi, Supriya Dash, 2020. Practical Biotechnology: Principles and Protocols, Dreamtech Press
5. Cangliang Shen, Yifan Zhang, 2017. Food Microbiology Laboratory for the Food Science Student: A Practical Approach 1st Ed, Springer.

Practical X: GENOMICS AND PROTEOMICS & NANOTECHNOLOGY

a. Course code:

L	T	P	C
0	0	4	2

b. Course objectives:

The aim objectives of this course are:

1. To study the role of genes and proteins by genomic and proteomic techniques
2. To gain knowledge on metabolomics and interactomics to study the functional aspects of genes and proteins
3. To understand the concept of techniques in nanotechnology

c. Course prerequisites:

- Awareness on available on bioinformatics tools and nanotechnology

d. Course outcomes

After successful completion of the course, the student will be able to:

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the bioinformatics tools	K1
CO2	Compare and analyze the gene expression using genomic tools	K4& K5
CO3	Critique the methods to proteomics data and their implications in cancer research	K3 & K5
CO4	Facilitate the opportunity to acquire positions in pharma and biotech industries	K6
CO5	Understand and apply the concept of various synthesis techniques in Nanotechnology	K2 & K3
CO6	Justify the application of instruments in characterisation on nanoparticles	K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

1. Markers for Genetic Mapping; RFLP, SSLP
2. PCR based marker systems – RAPD, AFLP
3. Microarray technology - SAGE and analysis
4. Proteomics - ID–SDS-PAGE, 2D-PAGE
5. Basics of Mass Spectroscopy- MALDI-TOF, Tandem MS/MS
6. Synthesis of silver and titanium oxide nanomaterials using chemical method
7. Synthesis of silver nanoparticles using plants
8. Synthesis of silver nanoparticles using bacteria
9. Production of zinc oxide nanoparticles by plants
10. Synthesis of ZnO/Ag nanocomposite using plants
11. Synthesis of MgO/Ag nanocomposite using chemical method
12. Characterization of silver nanoparticles using UV spectrophotometer
13. Characterization of zinc oxide nanoparticles using UV spectrophotometer
14. Characterization of ZnO/Ag nanocomposite using UV spectrophotometer
15. Characterization of MgO/Ag nanocomposite using UV spectrophotometer

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	M	M	M	H	L	H	H
CO2	L	M	M	H	L	L	H	H
CO3	H	H	H	M	M	L	H	H
CO4	H	H	H	H	H	H	H	H
CO5	M	H	H	M	L	H	H	H
CO6	L	H	L	L	L	M	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	H	H	H	L	M	H
CO2	H	H	H	H	H	M	M	H
CO3	H	H	H	H	H	M	M	H

CO4	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	M	H	H
CO6	M	H	H	H	H	L	H	H

(L – Low, M – Medium, H – High)

g. Laboratory manual/Reference

1) Andreas D. Baxevanis, Gary D. Bader, David S. Wishart, 2020. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins 4th Edition, Wiley.
2) Andreas Hofmann, Samuel Clokie, 2018.Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edition, Cambridge University Press.
3) Cangliang Shen, Yifan Zhang, 2017. Food Microbiology Laboratory for the Food Science Student: A Practical Approach 1st Ed, Springer
4) Rastogi SC, Namita Mendiratta, Parag Rastogi, 2013. Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) 4th Edition, PHI Learning
5) Upendranath Nandi, Debnarayan Jana, 2017. Nanomaterials Theory Problems and Solutions, Techno World

PHARMACEUTICAL BIOTECHNOLOGY

a. Course code:

b. Course objectives:

L	T	P	C
3	0	0	3

The main objectives of this course are:

1. To provide an outline about identifying drug targets and strategies to develop drugs.
2. To learn about the basic and essential qualities of the drugs and testing methods.
3. To understand the fundamentals of obtaining drug approval and important aspects of commercialization.

c. Course prerequisites:

- Basic knowledge of drugs and antibiotics.

d. Course outcome (COs):

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

Course	Expected outcome	Cognitive

outcome		level
CO1	Evaluate the efficacy of drugs and their mode of action used in different pharmaceutical firms.	K5
CO2	Summarize the knowledge about natural sources of drugs, and the interaction of drugs with different types of biological molecules.	K2
CO3	Learn about administration aspects of drug development and how various biological systems can be used for biopharmaceutical production that needs to be implied during new drug development.	K2,K3 & K6
CO4	Obtain comprehensive knowledge about toxicity and clinical testing in obtaining approval for new drugs.	K3
CO5	Understand the roles, responsibilities, and organizational structure of regulatory bodies and ways of preparing drug approval applications.	K2,3
CO6	Stimulate students practical skills to be employed in drug discovery efforts	K3

(K_1 – Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5 – Evaluate, K_6 – Create)

e. Course outline:

Unit I: **9 hrs**

Pharmaceutical biotechnology concepts: Introduction to pharmaceutical biotechnology. Source of drugs – plant, animals, microbes, and minerals. Drug isolation and evaluation. Drug metabolism – pharmacokinetics – absorption, distribution, metabolism and excretion (ADME), Pharmacodynamics – mechanism of drug action. Physico - chemical properties of the drugs. Drug receptors.

Unit II: **9 hrs**

Biopharmaceuticals: Prokaryotic Cells – bacteria, actinomycetes and yeast in pharma production, Plants and animal cell culture as bioreactors for pharmaceuticals. Biopharmaceutical products – hormones, vitamins, enzymes and coenzymes, antibiotics, blood products, nucleic acids of therapeutic interest, adjuvants from biological organisms. Application of biopharmaceuticals as therapeutic enzymes and antibodies.

Unit III: **9 hrs**

Pharmaceuticals potency tests: Routes of administration, scope and limitation of bioassay, bioassay of some official drugs Sources of active principles; Biological

evaluation of drugs-screening and evaluation (including principles of screening, development of models for diseases: *In vivo* models/*In vitro* models/cell line study. Assay systems and models (e.g., Knock-out mice) Protein molecular modelling by computer: Docking studies; structure-based drug designing using software.

Unit IV: **9 hrs**

Toxicity screening: Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenicity and mutagenicity. Various guidelines for toxicity studies.

Unit V: **9 hrs**

Pharmaceuticals regulation and approval: Regulatory authorities - food and drug administration (USA)- Investigational new drug application, New drug application; European regulations-National regulatory authorities, European medicines agency and the new EU drug approval system, Centralized procedure, mutual recognition; Drug registration in Japan; World harmonization of drug approvals.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs and PSOs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	L	M	H	L	M	H
CO2	M	H	H	H	M	M	H	H
CO3	H	H	H	M	H	M	M	H
CO4	M	M	M	M	H	H	H	H
CO5	L	M	H	H	M	M	H	H
CO6	M	H	H	H	H	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	M	M	M	H	H
CO2	H	H	M	M	H	M	H	H
CO3	H	H	H	H	M	L	H	H
CO4	M	H	M	M	M	M	M	H

CO5	M	H	M	H	M	H	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Crommelin DJA, Sindelar RD, Meibohm B. 2019. Pharmaceutical Biotechnology Fundamentals and Applications. 5th Edition, Springer.
2) Gary Walsh (Ed), 2011. Pharmaceutical Biotechnology – Concepts and Application, Wiley.
3) Graham P Bunn, 2019. Good Manufacturing Practices for Pharmaceuticals, CRC Press.
4) Kokate, Jalapure, Hurakadle, 2011.Text book of Pharmaceutical Biotechnology, Elsevier Health - INR.
5) Vyas SP, Dixit VK, 2019. Pharmaceutical Biotechnology, CBS.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=WR+tSjp4YS3g7BIFEffOcw==
2. https://nptel.ac.in/courses/104102113
3. https://nptel.ac.in/courses/129105005
4. https://onlinecourses.nptel.ac.in/noc19_cy29/preview

BIOSAFETY & BIOETHICS

a. Course code:

b. Course objectives:

L	T	P	C
3	0	0	3

The core objectives of this course are:

1) To understand the importance of bioethics and biosafety in biological research.
2) To understand the legal social and economic impacts of biotechnology.
3) To understand regulatory guidelines and ethical implications of biotechnology.

c. Course prerequisites:

- Basic knowledge about safety and ethical issues.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Understand the importance of bioethics and biosafety in biotechnology	K2

	research	
CO2	Describe the basic knowledge of legal social and economic impacts of biotechnology.	K1 & K2
CO3	Classify the levels of biosafety and biosafety regulations in India	K4
CO4	Understand and appraise the biodiversity convention and Indian biodiversity act	K2 & K4
CO5	Appraise and Justify the ethical implications in healthcare and food research in biotechnology.	K5 & K6
CO6	Generalize and structure the guidelines to handle hazardous microorganisms and justify the ethical value in the human-associated research and development of hybrid food products.	K5 & K6

(K_1 – Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5 – Evaluate, K_6 – Create)

e. Course outline:

UNIT I **9 hrs**

Biological hazards and risks: an overview | ScienceDirect Topics Biosafety: Definition – Causes classification, identification of hazards – Issues. Handling – Types of accidents, first aid and precautionary measures – Clean room procedures: Classification specification – Basic methods for safe handling, transport, and storage of biological and chemical materials – Equipment related hazards.

UNIT II 9 **hrs**

Biosafety levels and biosecurity: Biological safety cabinets: Horizontal and vertical laminar air flow cabinet, Fume hood – Primary and secondary containments – Biosafety levels of specific Microorganisms (food and water borne pathogens), Infectious agents (chemicals and carcinogens) – Biosafety assessment of biotech pharmaceutical products – Material safety data sheet.

UNIT III **9 hrs**

Biosafety regulations: Biosafety guidelines and national and international regulations OECD, EPA, RCGM, GEAC, IBSC, FSSAI and BRAI (including Cartegana protocol of government of India). Framework of biosafety regulation in India; Structure and functions of committees; DBT guidelines on biosafety in conducting research in biotechnology; Roles of institutional biosafety committee. Regulations of genetically modified organisms in India, Biosafety regulation for transgenic plants and animals, labeling of GM foods.

UNIT IV **9 hrs**

Bioethics: Introduction to ethics and bioethics and its framework; Bioethics of IPR, Ethical criteria in biotechnology, Animal ethics and animal rights/welfare; Guidelines for use of lab animals. Licensing of animal house; Human rights and responsibilities; Ethical clearance norms for conducting studies on human subjects. Convention on biodiversity, Indian biodiversity act, Legal implications, Biodiversity and farmers' rights.

UNIT V **9 hrs**

Bioethics in health care and food – patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy and transplantation. Bioethics in stem cell research, human genome project and cloning. Ethical implications of GM crops, GMOs.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	H	L	M	H	M
CO2	M	M	H	H	M	L	M	H
CO3	M	M	H	H	M	M	M	H
CO4	M	M	M	M	L	L	M	M
CO5	H	H	M	H	L	L	M	H
CO6	M	H	H	H	M	M	H	M

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	M	H	M	M
CO2	H	M	H	H	M	M	M	H
CO3	M	H	M	H	H	H	M	H
CO4	M	H	M	M	H	M	M	M
CO5	H	H	H	H	H	H	M	H
CO6	M	H	M	H	H	M	M	M

(L – Low, M – Medium, H – High)

g. Textbooks/ References:

1) Muthuraj, M. Usharani B, Anbazhagi S, Vidya Raj CK, 2019. Biosafety in Microbiological Laboratories, Notion Press.
2) Rajmohan Joshi (Ed.). 2006. Biosafety and Bioethics. Isha Books, Delhi.
3) Sateesh MK, 2008. Bioethics and Biosafety I K International Publishing House
4) Sree Krishna V, 2007. Bioethics and Biosafety in Biotechnology, New age international publishers
5) U.S. Department Of Health And Human Services, 2016. Biosafety in Microbiological and Biomedical Laboratories, lulu.com.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1. https://nptel.ac.in/courses/109106092
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7121592/
3. https://www.slideshare.net/sanguru1977/bioethics-and-biosafety-in-biotechnology

Semester IX

ANIMAL BIOTECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The core objectives of this course are:

1. To understand the concepts of animal cell culture, applications, safety, the composition of media, and maintenance of cell cultures
2. Offers knowledge on establishing and characterization of the cell line, contamination issues, cryopreservation, recent issues in cell line research, and cytotoxicity techniques
3. Provides knowledge regarding stem cell culture and application
4. To provide knowledge on the production and application of transgenic animals and assisted reproduction

c. Course prerequisites:

- Basic familiarity in animal cell culture and transgenic animals

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level

CO1	Understand the basic concepts of animal cell culture, its applications, aseptic techniques, risk assessment and safety issues, cell culture methods	K1, K2 & K4
CO2	Gain knowledge on cell line characterization, proliferation, cytotoxicity assays, transformation, establishment, and recent issues in research on cell lines	K2, K3 & K4
CO3	Learn the basics of stem cell culture, characteristics and applications, tissue engineering	K3 & K4
CO4	Understand the concepts of production & application of transgenic animals, cloning	K2, K4 & K5
CO5	Know the applications of animal biotechnology, mammalian cells based pharmaceutical products, and cell culture-based vaccines	K3, K4 & K5
CO6	Integrate the concept of biomaterials, cloning, and in-vitro fertilization for society	K6

(K_1 – Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5 – Evaluate, K_6 – Create)

e. Course outline:

Unit I **12 hrs**

Basics of animal cell culture: Introduction, cell culture laboratory-Design, layout and maintenance. Equipment and instrumentation. Methods of sterilization, Types of culture media, composition, preparation and metabolic functions. Role of CO_2, serum, supplements, Growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein free defined media

Unit II **12 hrs**

Culture and maintenance of cell lines: primary and established cell lines. Biology of cultured cells, culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, Gene transfer, cytotoxicity, growth parameters, cell death and apoptosis, Expression of culture efficiency

Unit III **12 hrs**

Stem cells and tissue engineering: Scope, embryonic and adult stem cells, properties, identification, Stem cells culture, techniques and their applications in modern clinical sciences. Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues

Unit IV **12 hrs**

Transgenic animals and animal cloning: Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for livestock and humans

Unit V **12 hrs**

Applications of animal biotechnology: Improvement of biomass, disease resistant, recombinant vaccines for poultry, livestock - pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture-based vaccines

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	H	M	M	L	M
CO2	M	M	H	H	M	H	M	M
CO3	M	M	H	H	M	H	M	H
CO4	H	H	M	M	H	H	L	M
CO5	H	H	M	H	M	M	H	H
CO6	M	H	H	H	M	M	M	M

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	M	M	M	L	H	H
CO2	M	M	M	H	H	M	H	H
CO3	H	H	M	M	M	L	M	M
CO4	M	H	L	M	L	M	H	H
CO5	M	H	M	M	H	M	H	H
CO6	H	H	M	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Ashish S. Verma, Anchal Singh, 2020. Animal Biotechnology: Models in Discovery and Translation, Academic Press
2) Ballinic CA, Philips JP, Moo Young M, 1989. Animal Biotechnology. Pergamon press, New York.
3) Birbal Singh, Gorakh Mal, Sanjeev K. Gautam, Manishi Mukesh, 2019. Advances in Animal Biotechnology, Springer.
4) Dharmar Manimaran, 2016. Animal Biotechnology, LAP LAMBERT Academic Publishing
5) Ramadass P. 2019.Animal Biotechnology: Recent Concepts And Developments MJP Publishers

h. MOOC, SWAYAM, NPTEL, online and e-resources

1. https://onlinecourses.swayam2.ac.in/cec22_bt07/preview
2. https://nptel.ac.in/courses/102104059
3. https://nptel.ac.in/courses/129105005
4. https://onlinecourses.nptel.ac.in/noc20_me04/preview

INDUSTRIAL BIOTECHNOLOGY

a. Course code:

b. Course objectives:

L	T	P	C
4	0	0	4

The main objectives of this course are:

1. To understand the basics of Fermentation and bioprocess engineering.
    1. To understand the basics of fermentation techniques and to enable the students to learn about the design of fermenters.
    2. To know about the principles and techniques involved in Upstream and downstream bioprocessing.

c. Course prerequisites:

- Basic knowledge in the fermentation process and microbial metabolism.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Identify the basic principles of bioprocess technology and development of inoculums	K2

CO2	Analyze the different sterilization processes and control measurements of the fermenter	K4
CO3	Develop and assess the conditions for efficient and sustainable design of bioreactors.	K3, K6
CO4	Evaluate the various techniques used in the downstream processing and gain information on product formulation.	K5
CO5	Integrate the scientific and technological knowledge on the use of bioprocesses for industrial products on the cell and process level.	K6
CO6	Understand the diverse fermentation and subsequent processing	K2

(K_1 – Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5 – Evaluate, K_6 – Create)

e. Course outline:

Unit I: 12 hrs

Fundamentals of bioprocess engineering: Introduction to bioprocess engineering. Media design and usage in fermentation: Types of media, composition of media – carbon sources, nitrogen sources, vitamins and growth factors, mineral, inducers, precursors and inhibitors. Microbial growth: Isolation, preservation and maintenance of industrial microorganisms. Inoculum development: Development of inoculum for yeast, bacterial, mycelial and vegetative fungal processes.

Unit II: 12 hrs

Sterilization methods: moist heat; dry heat, flame, filter, gas (ethylene oxide), HTST (high temperature/short time) treatments – continuous sterilizers and pasteurizers - sterility, asepsis– medium sterilization, batch sterilization, continuous sterilization, filter sterilization. Aseptic inoculation of the fermenter. Basic components – agitator, aerator, valves and steam traps, seals, stirrer glands; measurement and control of parameters (online and off line sensors) – temperature, flow rate, pressure, pH, DO, gas analysis, control pathways, computer in controlling.

Unit III: 12 hrs

Bioreactors: batch and fed-batch bioreactors, Continuous bioreactors; solid state and submerged; aerobic and anaerobic fermentation; mixed microbial populations; immobilization of cells and co-immobilization; immobilized cell reactors; bioreactor operation; sterilization; aeration; sensors; instrumentation; specialized bioreactors (pulsed, fluidized, photo bioreactors etc.,).

Unit IV: 12 hrs

Downstream processing: biomass removal: separation of microbial cells and solid matter; Centrifugation; Sedimentation; Flocculation; Microfiltration; Disintegration of microorganism: Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration; Reverse osmosis; Dialysis ; Diafiltration ; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (ammonium sulfate, solvent); Electrophoresis(capillary); Extraction(solvent, aqueous two phase, super critical), Drying – spray driers, drum driers and freeze driers.

Unit V: **12 hrs**

Production, harvest, recovery of microbial products: Production, harvest, recovery and uses – enzymes, Antibiotics (penicillin, tetracycline, streptomycin), vitamins (B2, B12), Aminoacids (lysine, glutamic acid), Organic solvents (ethanol, glycerol); Organic acids (acetic acid, citric acid, lactic acid). Single Cell Protein (algae/fungi). Biofertilizer (*Rhizobium, Azospirillum, Azolla*, Phosphobacteria), Biopesticides (*Bacillus thruingiensis*, NPV, Pseudomonas), Use of microbes in mineral beneficiation and oil recovery.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs and PSOs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	M	H	L	M	H	H
CO2	H	H	L	M	M	M	H	H
CO3	H	H	H	M	H	L	M	H
CO4	H	M	M	M	L	M	H	H
CO5	H	H	H	H	M	L	H	H
CO6	H	H	H	M	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	H	H	L	H	H
CO2	H	M	H	H	H	M	M	H
CO3	M	H	H	M	M	L	H	H
CO4	H	M	M	H	H	M	H	M
CO5	H	M	L	H	H	M	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) El-.Mansi, Bryce CFA, Demain AL, Allman AR, 2007. Fermentation microbiology and Biotechnology. Second edition, Taylor and Francis.
2) Gerald Reed (Ed.), 2007. Prescott and Dunns Industrial Microbiology, 4th edition, Chapman & Hall publications.
3) Rao DG, 2007. Introduction to Biochemical engineering, I edition, McGraw-Hill publications.
4) Stanbury PF, Whitaker A. 2005. Principles of fermentation technology, Second edition, Pergamon press.
5) Wulf Crueger, 2019. Cruegers Biotechnology: A Textbook of Industrial Microbiology, Medtech.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P001357/M021492/LM/1501755473BioprocessEnglearnmore.pdf
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==
3. https://online-learning.tudelft.nl/courses/industrial-biotechnology/

PLANT BIOTECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The core objectives of this course are:

1. Understand the principles, practices, and application of plant tissue culture techniques.
2. Introduce advanced technologies employed for crop improvement.
3. Enrich the students' knowledge concerning different applications of transgenic technology.

c. Course prerequisites:

- Basic knowledge about plant physiology, diversity, and plant breeding.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Discuss the concepts of plant tissue culture and its applications.	K2
CO2	Apply tissue culture techniques for the large-scale production of food crops and medicinal plants with economically useful traits.	K3
CO3	Develop various preservation techniques to avoid contamination and conserve rare endangered species	K3, K4, K5 & K6
CO4	Appraise and develop molecular markers for the identification of traits in various genomes	K5 & K6
CO5	Demonstrate the application of transgenic technology and apply that knowledge effectively in relevant areas.	K2 & K3
CO6	Justify and integrate the concept of genetic engineering tools to develop genetically improved traits	K5 & K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **12 hrs**

Principles and techniques of plant tissue culture: Historical account, General techniques in plant biotechnology, Totipotency. Preparation of stock solutions and nutrient media for callus culture initiation and plant regeneration. Processing of various explants (mature seed, leaf base, node) for culture initiation. Aseptic techniques-Sterilization of nutrient media. Pretreatment and surface sterilization of various explants collected from field for aseptic culture initiation.

Unit II **12 hrs**

Callus and suspension culture: Establishment and maintenance of callus and suspension culture. Subculture and regeneration of shoots and roots from callus cultures through organogenesis and somatic embryogenesis. Shoot tip culture. Protoplast isolation and fusion. Transfer and establishment of whole plants in soil

Unit III **12 hrs**

Germplasm conservation: Cryopreservation-methodology and steps, Synthetic seed preparation from intact regenerable explants of medicinal plants using sodium alginate. Plant conversion from synthetic seeds. Micropropagation of medicinal plants by various explants. Secondary metabolites from plant cells.

Unit IV **12 hrs**

Methods in plant biotechnology: Genomic DNA extraction and purification - principle and methods. Isolation and purification of Ti-plasmid DNA. *Agrobacterium* mediated transformation of plants - Culture initiation, explant preparation, co cultivation, selection, and regeneration. PCR analysis of transformed plants. Transient ß-glucuronidase (GUS) gene expression assays in transformed intact explants and callus tissues by histochemical method.

Unit V **12 hrs**

Genetic improvement: insect resistance: Cry genes and BT crops. Other genes for insect resistance (PDR and non PDR)-Virus resistance-(antisense RNA approach); Resistance to fungal and bacterial disease; Herbicide resistance: Resistance to abiotic factors (drought/salt). Transgenic plant with modified quality (improved starch, oil, seed protein quality). Plant derived vaccines; Plants with improved nutrient value (Golden rice). Problems in gene transfer: gene silencing. GM crops-current status-concerns about GM crops- regulations of GM crops.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	H	L	L	H	H
CO2	M	H	H	H	L	M	H	H
CO3	M	H	H	H	M	L	H	M
CO4	M	H	H	H	M	H	H	M
CO5	M	H	H	H	M	M	H	H
CO6	M	H	H	H	M	L	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	M	H	M	M	H
CO2	H	H	H	M	H	M	M	H
CO3	M	H	M	M	H	M	M	M
CO4	M	H	H	H	H	M	H	H
CO5	M	H	H	M	H	M	H	H
CO6	H	H	M	M	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Chawla HS, 2020. Introduction to Plant Biotechnology, 3rd edition Oxford & IBH Publishing.
2) John H. Dods, Lorrin W.Roberts, 1995. Experiments in Plant Tissue Culture, Cambridge University Press, USA.
3) Robert N, Trigiano, Dennis J. Gray, 1996. Plant Tissue Culture Concept and Laboratory Excersises. CRC Press, London.
4) Slater, 2008. Plant Biotechnology: The Genetic Manipulation of Plants, Second edition Oxford Publication.
5) Srivasta PS, 1998. Plant Tissue Culture and Molecular Biology, Narosa Publishing House, New Delhi.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/102103016
2) https://nptel.ac.in/courses/102106080
3) https://pravara.in/wp-content/themes/twentyseventeen/essentials/pdf/elearn/Principles-of-Plant-Biotechnology.pdf

RESEARCH METHODOLOGY & BIOSTATISTICS

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The main objectives of this course are:

1. Understand the research and research problem
2. Develop the date collection methods and its application
3. Equip the students to write the scientific presentations
4. Learn the technique in biostatistics.

c. Course prerequisites:

- Basic knowledge about research tools and data interpretation.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive level
CO 1	Remember and Understand the types of research and research problem	K 1 & K2
CO 2	Apply various data collection methods for create a detailed survey reports on selected spot	K 2 & K3
CO 3	Analyze and appraise the scientific documents like research proposal, Report and thesis	K4& K5
CO 4	Appraise the central tendency to validate the data	K5 & K6
CO 5	Evaluate and develop statistical software to report and validate the data	K5 & K6
CO 6	Develop statistical tools for validating the acquired research data	K3 & K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

Unit I: **12 hrs**

Research methodology: introduction – meaning, objective and types of research. Defining research problem – selection of problems. Sampling design – random sample. Measurement and scaling techniques, error in measurement.

Unit II: **12 hrs**

Methods of data collection – primary data – interview method, questionnaire, secondary data, case study method. Online data base library. The computer and its role in research. Literature survey: sources of information- primary, secondary, tertiary sources – journals, reviews, books, monographs etc. bibliography. Web resources-E-Journal, Journal access, TOC alerts, E-consortium, UGC inflipnet, E-Books, Internet discussion groups and communities, Scirus, Pubmed, Google Scholar, ChemIndustry, Wiki Databases, Science Direct, SciFinder, Scopus

Unit III: **12 hrs**

Research proposal: Purpose and scope, Sponsor identification, format, Proposal development, structure of research proposal, Research report: Types of reports, Technical report, Popular report, Contents-styles of reporting- Steps in drafting reports, Editing the final draft, Evaluating the final draft Preparation of scientific documents: Data management, Research papers, review articles, format of journals, proof reading. Journals: Standard of research journals, impact factor, citation index, H-Index, methods of citation. Oral presentation, poster presentation, bibliography, thesis writing, Publications of scientific works in journals, proceedings and chapters in book, Plagiarism

Unit IV: **12 hrs**

Measures of central tendency – mean, median, mode, dispersion – range, quartile deviation, mean deviation, standard deviation, coefficient of variation. Standard error, correlation, correlation coefficient, regression.

Unit V: **12 hrs**

Hypothesis – definition, basic concepts concerning testing of hypotheses, test of hypotheses and its limitations, significance test and fixing level of significance, Chi square test, students t test. ANOVA – one way and two way. Use of statistical softwares.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	M	M	M
CO2	M	M	M	H	M	M	M	M
CO3	M	M	M	M	M	M	M	M
CO4	M	H	H	H	M	M	M	M
CO5	M	H	H	H	H	M	H	M
CO6	M	H	H	H	M	H	M	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	M	M
CO2	M	M	H	H	H	M	M	M
CO3	M	M	H	H	M	M	M	M
CO4	M	M	H	H	M	M	M	M
CO5	M	M	H	H	M	M	M	M
CO6	H	M	H	H	M	M	M	M

(L – Low, M – Medium, H – High)

g. Text books/ References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers 'Distributors.
2. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, 2nd Ed., Pearson Education, Singapore.
3. Davis GB, Parkar CA, 1997. Writing the doctoral dissertation, 2nd edition Barrons Educational series.
4. Duncary P, 2003. Authoring a Ph.D. thesis: how to plan, draft, write and finish a doctoral dissertation, Macmillan.
5. Krathwohl DR, 1993. How to prepare a research proposal, 3rd edition,: Syracuse University Press, Syracuse, NY.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) http://www.revolutionpharmd.com/2013/03/biostatistics-research-methodology.html?m=1
2) https://fdocuments.in/document/research-methodology-notes.html
3) https://onlinecourses.nptel.ac.in/noc22_ge08/preview
4) https://www.medipdf.in/2022/02/biostatistics-and-research-methodology-notes-b-pharm.html
5) https://www.pharmacynotes.in/2022/03/biostatisitcs-and-research-methodology .html
6) https://www.pharm-dnotes.com/biostatistics%2 0and%20research %20methodology

Practical XI – ANIMAL BIOTECHNOLOGY & INDUSTRIAL BIOTECHNOLOGY

a. Course code:

L	T	P	C
0	0	4	2

b. Course objectives:

The main objectives of this course are to:

1. Make the students appreciate the fine aspects of animal biotechnology
2. Prepare and sensitize the students to scope for research, the increasing for skilled scientific manpower with an understanding of research, industrial applications.
3. Know the principles of utilizing recombinant cells/ transgenic animals for clinical/ industrial applications.

c. Course Prerequisites:

- Simple knowledge about cells and their mass cultivation techniques.

d. Course outcomes (COs):

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

Course outcome	Expected outcome	Cognitive level
CO 1	Describe the media formulation and basic techniques used in animal cell culture laboratory.	K1, K2
CO 2	Develop the knowledge in scope and uses of genetic engineering in animal biotechnology.	K3
CO 3	Evaluate the application of animal biotechnology knowledge in livestock industry.	K4
CO 4	Distinguish the uses of the microorganisms in the industry and formulate the products.	K4, K5

CO 5	Produce real time experience in downstream processing techniques	K3, K6
CO 6	Independently formulate the experiments in the areas of Animal biotechnology and bioprocess technology.	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

1. Preparation of media for animal tissue culture
2. Preparation of metaphase chromosomes from cultured cells
3. Isolation of DNA and demonstration of apoptosis of DNA laddering
4. Gene expression in *E.coli* and analysis of gene product
5. Handling of lab animals (Mice, Zebrafish, Earthworms)
6. Study of embryonic induction during development in chick
7. Initiation of mammalian cell culture and maintenance.
8. Growth studies by viable cell count analysis
9. Effect of growth factors on cell proliferation
10. Isolation of industrially important microorganisms.
11. Selective isolation of actinomycetes – study their growth characteristics.
12. Isolation and enumeration of lactic acid bacteria.
13. Wine production by yeast – setting up a lab experiment.
14. Estimation of alcohol content by colorimetric method
15. Enzyme production – amylase production.
16. Immobilization of yeast cell by alginate beads
17. Bioassay techniques for antibiotics.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	L	H	M	M	M	H
CO2	M	M	M	H	L	M	H	H
CO3	H	H	M	H	M	M	M	M
CO4	H	H	M	H	M	M	L	M
CO5	H	M	M	M	M	H	M	H
CO6	H	M	M	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	M	M	M	H	H
CO2	L	H	H	M	M	L	M	M
CO3	M	M	H	M	H	M	H	H
CO4	H	M	L	H	M	M	H	L
CO5	M	H	H	M	M	M	M	M
CO6	H	M	M	H	M	H	H	M

(L – Low, M – Medium, H – High)

g. Laboratory manuals /Reference:

1) Amanda Capes-Davis, R. Ian Freshney, 2021. 8th Edition, Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Wiley-Blackwell.
2) Bhattacharya TK, Pushpandra Kumar, 2008. Animal Biotechnology: A Practical Guide, Kalyani Publishers.
3) Chellapandi P, 2007. Laboratory Manual in Industrial Biotechnology, Pointer Publishers.
4) Cornelia Kasper. Verena Charwat, Antonina Lavrentieva, 2018. Cell Culture Technology (Learning Materials in Biosciences Book 4) 1st Ed, Springer.
5) Sarfaraz K. Niazi, Justin L. Brown, 1970. Fundamentals of Modern Bioprocessing, CRC Press.

Practical XII: PLANT BIOTECHNOLOGY AND RESEARCH METHODOLOGY & BIOSTATISTICS

a. Course code:

L	T	P	C
0	0	4	2

b. Course objective:

The aim objectives of this course are:

1. This practical course ensures a hands-on experience of different media preparation, sterilization, and cultures from explants.
2. This course gives practical knowledge about extraction and separation of DNA and protein from plant samples and separation through electrophoresis techniques.
3. This course makes the students use MS Excel and SPSS for the collection and measurements of various biological data.

c. Course Prerequisites:

- Elementary understanding on plant cells and their growth pattern.

d. Course outcomes (COs):

At the end of the Course, the student will be able to –

Course outcome	Expected outcome	Cognitive level
CO 1	Describe and understand the specific requirements of each culture medium and prepare them for different cultures in the tissue culture laboratory	K1 & K2
CO 2	Illustrate the importance of DNA isolation techniques	K2, K3 & K4
CO 3	Collect and validate the experimental data by statistical soft wares	K3
CO 4	Calculate central tendency, dispersion and preparation of diagrammatic representation	K3
CO 5	Assess and analyse the population and samples by employing SPSS and MS Excel.	K5
CO 6	Reporting the findings using statistical tools	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

1) Basic sterilization techniques and culture media preparation for plant tissue culture.
2) Types of plant tissue culture shoot tip culture, root culture, endosperm culture and anther culture.
3) Isolation and analysis of plant DNA.
4) Isolation of Protoplast and culturing techniques.
5) Restriction digestion of genomic DNA and PAGE analysis.
6) Analysis the plant genes using PCR and RAPD.
7) Sample collection methods.
8) Determine the central tendency.
9) Estimation of population mean.
10) Determine the standard deviation for classified data
11) Correlation and regression analysis
12) Valuate the chi-square test and t – test
13) Analysis of variance of a one-way classified data

14) Analysis of variance of a two-way classified data.

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	L	M	H	H
CO2	M	H	H	M	L	L	H	H
CO3	M	H	M	H	L	H	H	H
CO4	L	M	M	M	L	H	H	H
CO5	L	M	M	M	L	H	H	H
CO6	L	M	L	H	L	H	H	H

(L – Low, M – Medium, H – High)

Mapping of Cos to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	H	H	M	H	H
CO2	H	M	H	H	M	L	H	H
CO3	M	M	H	H	M	M	M	H
CO4	M	M	H	H	M	L	M	H
CO5	M	M	H	H	M	L	L	M
CO6	H	M	H	H	M	L	M	H

(L – Low, M – Medium, H – High)

g. Laboratory manuals /Reference:

1) Giri CC, Giri Archana, 2007. Plant Biotechnology Practical Manual, I K International Publishing House.
2) Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.
3) Prasanth K, 2017. Guide To Research Methodology and Biostatistics, CBS
4) Shankar Madhan, Rajesh EM, 2013. A Practical Manuel on Basic Techniques in Biotechnology, International E-Publication.
5) Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.

MANAGEMENT IN BIOTECHNOLOGY

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The core objectives of this course are:

1) To study the management process in biotechnology-based companies.
2) To explain the functions of the organization, leadership, and management control
3) To enrich the techniques, product recovery, product cost estimation, patents, and recent trends in biotechnology industries and to start and manage a biotechnology industry.

c. Course prerequisites:

- Basic knowledge about the management and requirement and usage of biotechnology-based products.

d. Course Outcome

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Understand the basic principles of management and management process in the biotechnology industry	K2
CO2	Appraise the Management Control, MIS process of Design and Management	K2 & K4
CO3	Develop the basic and advanced Process Techniques	K3
CO4	Understand and enrich the product recovery, product cost estimation, patents, and recent trends in the biotechnology industries	K5
CO5	Create an MOU relationship between industries and universities	K3 & K6
CO6	Design and structure the production guidelines and techniques to initiate the biotechnology-based industries and start-ups.	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **9 hrs**

Theory principles of management, Management process, Functions of organization. Functions of managers – Delegation, decentralization and leadership

Unit II **9 hrs**

Motivation – management control, MIS process of design and management. Use of flow sheets in the design of a process

Unit III **9 hrs**

Process techniques, Raw material preparation, Product recovery and purification, Formulation packaging and quality control. Economic considerations – Cost estimation, Total product cost, Capital investment and profitability

Unit – IV **9 hrs**

Manufacturing cost estimates, Capital investment and resources, Cost benefit analysis. Patents and exploitation of inventions. Bioindustry and Prospects – Recent trends in the development of bio industry, Selection, transfer and adaptation of technologies

Unit V **9 hrs**

Training of qualified personnel, New relationship between industries and universities. International cooperation. Scope and status of biotechnology industry in India

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M	M	M	M	M
CO2	M	H	H	H	M	M	M	M
CO3	M	H	H	H	M	M	H	H
CO4	H	H	H	H	M	M	H	H
CO5	M	H	H	H	M	M	H	H
CO6	M	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	H	H
CO2	H	H	M	H	H	M	M	M
CO3	H	H	H	H	H	M	H	H
CO4	H	H	H	H	H	M	H	H
CO5	H	M	M	M	M	M	H	H
CO6	H	H	M	M	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Arun Kumar A, 2018. Knowledge Management in Indian Biotechnology Industry, LAP Lambert Academic Publishing.
2) Craig Shimasaki, Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Academic Press, Elsevier, 2014.
3) Francoise Simon, Philip Kotler, Kevin Sharer, 2009. Building Global Biobrands: Taking Biotechnology to Market
4) Martin Grossmann, 2003. Entrepreneurship in Biotechnology: Managing for Growth from Start-Up to Initial Public Offering, Physica.
5) Pete Harpum, 2011. Portfolio, Program, and Project Management in the Pharmaceutical and Biotechnology Industries, Wiley Interscience.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://www.researchgate.net/publication/315014503_Role_of_intellectual_property_rights_in_biotechnology_and_pharmaceutical_industries

MOLECULAR DIAGNOSIS TOOLS

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The main objectives of the course are:

1. To study the diverse types of diseases and diagnosis
2. To learn major metabolic disorders genes
3. To demonstrate diverse bio diagnosis techniques associated with diseases

c. Course prerequisites:

- Basic knowledge about microbe-associated diseases and their diagnostics techniques.

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Understand the active principles of molecular diagnosis	K2
CO2	Analyze the traditional methods for diseases diagnosis	K4
CO3	Apply the modern biotechnology principles for disease diagnosis	K3
CO4	Explain molecular-based methods application in genetic and nongenetic disease diagnosis	K2 & K3

CO5	Appraise and develop the diagnostic methods for blood disorders	K4, K5 & K6
CO6	Develop tools for diagnosis to treat infectious diseases and congenital disorders	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **9 hrs**

Human diseases: Introduction and history of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites.

Unit II **9 hrs**

Disease diagnosis: Traditional disease diagnosis methods and tools - diagnosis of infection caused by *Streptococcus*, Coliforms, *Salmonella, Shigella, Vibrio,* and *Mycobacterium*, Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of DNA and RNA viruses-

Unit III **9 hrs**

Metabolic disorders: Major metabolic disorders and its causes. Traditional methods for the diagnosis of metabolic errors. Disease due to genetic disorders - Identifying human disease genes.

Unit IV **9 hrs**

Genetic disorders: Sickle cell anaemia, Duchenne muscular dystrophy, Retinoblastoma, Cystic fibrosis and sex – linked inherited disorders. Neonatal and prenatal disease diagnostics. Gender identification using amelogenin gene locus. Amplification of Y chromosome specific short Tandem repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance. Molecular diagnosis for early detection of cerebral palsy, Down syndrome etc.

Unit V **9 hrs**

Blood disorders (haemoglobinopathies, sickle cell anemia, hemophilia), Bone disorders (Osteogenesis imperfecta, Rheumatoid arthritis), Eye disorder (Retinitis pigmentosa), Muscle disorders (Duchene muscular dystrophy-DMD, Becker's muscular dystrophy-BMD, spinal muscular atrophy-SMA), Skin disorder (Albinism),

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	M	M	L	H	M
CO2	H	H	H	M	M	L	H	M
CO3	M	H	H	M	L	L	H	M
CO4	M	H	H	M	M	L	H	M
CO5	H	H	M	M	L	L	H	H
CO6	M	H	H	M	M	L	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	M	M	H
CO2	H	H	H	H	H	H	M	H
CO3	H	H	H	H	H	M	H	H
CO4	H	M	H	H	M	M	M	H
CO5	H	M	M	H	M	M	M	H
CO6	H	H	H	H	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Betty A. Forbes, Daniel F. Sahm, Alice S. Weissfeld, Ernest A. Trevino, 2002. Bailey & Scott's Diagnostic Microbiology, C.V. Mosby.
2) David E. Bruns, Edward R. Ashwood, Carl A. Burtis, 2007. Fundamentals of Molecular Diagnostics, Saunders Group.
3) Greenwood, D, Slack, R and Peutherer, J, 1997. Medical Microbiology, ELST Publishers.
4) Jeffery S, Booth J, Myint S, 2000. Molecular Diagnosis, Springer Verlag.
5) Stefan Riedel, Stephen A. Morse, Timothy A. Mietzner, 2019. Jawetz Melnick & Adelbergs Medical Microbiology, 28th edition, McGraw Hill.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/127106137
2) https://www.lshtm.ac.uk/study/courses/masters-degrees/clinical-trials-online
3) https://www.youtube.com/watch?v=B99fSmffXFQ

STEM CELLS & REGENERATIVE BIOLOGY

a. Course code:

L	T	P	C
3	0	0	3

b. Course objectives:

The main objectives of this course are:

1. To learn the characterization and application of stem cells
2. To demonstrate isolation and identification of stem cells
3. To study the engineering principles for tissue regeneration

c. Course prerequisites:

- Simple knowledge about regeneration and stem cells

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Remember and understand the principles of stem cells	K1 & K2
CO2	Apply and appraise stem cells research for regenerative medicine	K3, K4 & K5
CO3	Analyze the methods for stem cell culturing	K4
CO4	Apply the gene therapeutic principles	K3
CO5	Appraise and develop the tissue engineering concepts for human healthcare	K5 & K6
CO6	Solve challenges in stem cell-based therapy and regenerative medicine	K6

(K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create)

e. Course outline:

Unit I **9 hrs**

Human stem cells: Organ and Characterization of human stem cells and potential applications for stem cell research Origin and characteristics of human stem cell, plasticity of human somatic stem cells research, Novel stem cell based therapies, Scientific and technical obstacles to overcome before realizing the potential clinical uses of novel human stem cell based therapy, Cord blood and Stem cell marker.

Unit II **9 hrs**

Human embryonic stem cell research: Possible sources for human embryonic stem cell, growing human ESC in laboratory, Current advantages and limitations of hESC and human somatic cells, examining the need for new hES cell lines, Developments regarding establishment of human stem cell banks and registries.

Unit III **9 hrs**

Protocols for isolation and identification of stem cells: Preparation of complete human neuroculture, Culturing and subculturing human neurospheres, Differentiation of cells from human, neurospheres into neurons, astrocytes and oligodendrocytes; Immuno labeling procedure.

Unit IV **9 hrs**

Gene therapy: Possibilities to overcome immuno-rejection responses in stem cell therapy, Haematopoietic stem cell transplantation-A new therapy for autoimmune disease, Prenatal diagnosis of genetic abnormalities using foetal CD 34+ stem cells, Stem cells in treatment for major diseases and reparative medicine, ESC a promising tool for cell replacement therapy, germ – line therapy.

Unit V **9 hrs**

Tissue Engineering: Basic principles and consideration- Cell type and source, Metabolic requirements of cells, Reconstruction of connective tissues, Reconstruction of epithelial or endothelial surfaces- cells embedded in extracellular matrix material, Culture on a single surface and sandwich configuration, Bioreactor design on tissue engineering- Hollow fiber systems, Microcarrier based systems.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	M	M	L	H	H
CO2	H	H	H	M	L	L	H	M
CO3	M	H	H	H	L	L	H	M
CO4	M	H	M	M	M	L	H	M
CO5	H	H	H	M	L	L	H	M
CO6	H	H	H	H	M	L	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	H	M	H	M	H
CO2	M	H	H	H	H	H	M	H
CO3	M	M	H	H	H	H	M	H
CO4	H	H	H	H	H	H	M	H
CO5	H	H	H	H	H	H	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Babak Arjmand, 2020. Genomics, Proteomics, and Metabolomics: Stem Cells Monitoring in Regenerative Medicine (Stem Cell Biology and Regenerative Medicine), Humana.
2) Freshney RI, John RW. Master, 2000. Animal cell culture- A practical Approach, Oxford University Press.
3) Jeanne Wilson-Rawls, Kenro Kusumi, 2018. Innovations in Molecular Mechanisms and Tissue Engineering (Stem Cell Biology and Regenerative Medicine) Humana.
4) Jeffery A. Hubbel, Robert P. Lonsey, Joseph D. Bronzino, 2003. Tissue Engineering. Principles and Applications in Engineering, CRC Press.
5) Michael Boylan, Kelvin, Brown, 2000. Genetic Engineering: Science and Ethics on the new frontier, Pearson Education.

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://nptel.ac.in/courses/102106036
2) https://onlinecourses.nptel.ac.in/noc21_bt43/preview
3) https://onlinecourses.nptel.ac.in/noc21_bt31/preview

Semester X

ENVIRONMENTAL BIOTECHNOLOGY

a. Course code:

L	T	P	C
4	0	0	4

b. Course objectives:

The main objectives of this course are:

1. Understand the role of biotechnology in providing a solution to various environmental problems.
2. Develop the concepts of biofuels and the process of bioremediation and their varied applications.
3. Equip the student with the process of formulation of biofertilizers and learn its applications.
4. Learn the techniques for pollution detection and biotransformation of pollutants.

c. Course prerequisites:

- Essential understanding on environmental degradation and its causatives.

d. Course outcome (COs):

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

Course outcome	Expected outcome	Cognitive level
CO 1	Understanding and remembering the role of biotechnology in environmental protection, and ecological systems	K 1 & K2
CO 2	Appraise the concepts of Conventional fuels and their environmental impact.	K3 & K5
CO 3	Apply and develop bio/ phytoremediation technology for making a sustainable environment	K3, K5& K6
CO 4	Practice microbes for the development of smart agriculture applications.	K3 & K6
CO 5	Focus and design biotechnological tools to control various pollution	K4 & K6
CO 6	Design and integrate the principles, tools, and techniques of biotechnology for the development of a sustainable environment and utilization of bioresources	K3 & K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit: I **12 hrs**

Environmental pollution concepts and abatement: Basic concepts and environment, Types of environmental pollution, land pollution arising from high-input agriculture, air and water pollution and its control, methodology of environmental management, waste water treatment, Physical and biological process, need for water and nature resource management.

Unit: II **12 hrs**

Bioremediation and biodegradation: biofuel- gaseous, biohydrogen and biomethanol, bioremediation of soil and water contaminated with pesticide and toxic chemicals, biodegradation of lignin and cellulose, Aerobic process, anaerobic process; digestion, filtration etc. conventional fossil fuel and environmental impact, renewable and nonrenewable resources of energy.

Unit III **12 hrs**

Biotechniques managing pollution: Microbial biohydrogen production, conversion of sugar to alcohol; gasohol, biopesticides; biofertilizers, composting; vermiculture, Treatment schemes of domestic waste and industrial effluents, food, feed and energy from solid waste, biotechnological approaches for management environmental problems. Green house effects, and acid rain, biodiversity and its conservations

Unit: IV **12 hrs**

Biosafety: General principles for the laboratory and biosafety, national biosafety policies and regulatory framework, biotechnological methods for pollution detection, biosafety and risk assessment issues and risk management issues, biomineralization, genetically engineered microbes in biotreatment of waste and environmental safety.

Unit: V **12 hrs**

Environmental toxicology, allergenicity and health: analysis of biological material and xenobiotics, role of probiotics in water quality management, biotechnological methods in pollution abatement, convention on biological diversity, intellectual properties, implications of IPRs on commercial-lization of biotechnology products, copyright, trademarks, trade secrets, patents, geographical indications.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	M	H	L	H	M	M
CO2	M	H	M	M	L	H	M	M
CO3	M	H	M	M	L	H	H	M
CO4	M	H	H	H	L	H	H	M
CO5	M	H	M	M	M	H	H	M
CO6	M	H	H	H	M	H	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	H	H	M	M	H
CO2	M	M	H	H	H	M	M	H
CO3	M	H	H	H	H	M	H	H
CO4	H	H	H	M	H	M	H	H
CO5	M	M	H	M	M	M	H	H
CO6	M	H	H	M	H	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) Alan Scragg, 2005, Environmental Biotechnology, Pearson Education Limited, England.
2) Chatterji AK, 2011. Introduction to Environmental Biotechnology, PHI Learning publishers, 2011.
3) Gothandam KM, Shivendu Ranjan, Nandita Dasgupta, 2020. Environmental Biotechnology, Springer.
4) Jogdand SN, 2010. Environmental biotechnology, Himalaya Publishing House. Bombay.
5) Pramod Kumar, Vipin Kumar, Pravin Kumar Sachan, 2019. Textbook of Environmental Biotechnology, WPI Publishing

h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==
2) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=0Xvq9yUM2ILDrJ07FvlArQ=

IPR & ENTREPRENEURSHIP

L	T	P	C
4	0	0	4

a. Course code:

b. Course objectives:

The core objectives of this course are:

1. To understand legal social and economic impacts of biotechnology.
2. To understand ethical implications of biotechnology.
3. To offers opportunity to start biotechnology based companies.

c. Course prerequisites:

- Basic knowledge about scientific invention.
- Know the ways to become an entrepreneur

d. Course outcome (COs):

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

Course Outcome	Expected outcome	Cognitive Level
CO1	Define and classify the types of IPRs and Indian patent law.	K1 & K2
CO2	Apply and appraise the patent for diverse innovative products	K3, K4 & K5
CO3	Analyse and evaluate the legal protection of IPR	K4 & K5
CO4	Develop biobusiness and bioentrepreneurship for upgrade human welfare	K3 & K6
CO5	Organise and frame structure to initiate market research for company start-up	K4 & K6
CO6	Compile biotechnology based strategies to increase the individual employability and socio-economic development	K6

(K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create)

e. Course outline:

Unit I **12 hrs**

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

UNIT II **12 hrs**

Patentability: Types of patent, copyrights, trade-marks, design rights, geographical indications – importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – patent databases - country-wise patent searches (USPTO, EPO, India) Role of a Country Patent office – Patent applications: Forms and guidelines– Types of patent application – Patent specification: Patent Application Procedure in India, Treaties and Conventions of Patents, Patent Cooperation Treaty, TRIPS and Pharmaceutical Industry, issues and prospects –Patent infringement: Case studies on Turmeric and Neem.

Unit III **12 hrs**

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

Unit IV **12 hrs**

Bio-entrepreneurship: Basic contracts and agreements for joint ventures and development, Business plan preparation including strategy and legal requirements, Business feasibility study, financial management, collaborations and partnerships. Information technology in biobusiness; Assessment, development and upgradation of technology, Technology transfer, Quality control. Regulatory Compliances and procedures [CDSCO, ISO, NBA GMP, GLP], Public private agencies for bio-entrepreneurship (MSME, BIRAC and TTB-DST).

Unit V **12 hrs**

Company start up: Structure of a Company, Start-up of a Company, New Product Development. Market Research. Sales & Marketing Principles. Intellectual Property Principles in Biotechnology. Health Care, Overview and Role of Government in Biotechnology. Ethical and Other Legal Issues in Biotechnology.

f. Mapping of course outcome to POs and PSOs

Mapping of COs to POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	H	M	L	M	H
CO2	M	M	H	M	M	M	H	H
CO3	M	M	H	H	M	M	H	H
CO4	M	H	H	H	M	M	H	H
CO5	M	M	H	H	H	M	H	H
CO6	H	H	H	H	M	M	H	H

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	M	H	M	M	H	H
CO2	M	H	M	M	H	M	H	H
CO3	H	H	M	M	H	M	H	H
CO4	H	H	M	M	H	M	H	H
CO5	H	H	M	M	H	M	H	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) David H. Holt, 2016. Entrepreneurship: New Venture Creation, First edition, Pearson Education India.
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h. MOOC, SWAYAM, NPTEL, online and e-resources

1) https://www.wileyindia.com/management-textbooks/intellectual-property-rights-bioethics-biosafety-and-entrepreneurship-in-biotechnology.html
2) https://www.researchgate.net/publication/315014503_Role_of_intellectual_property_rights_in_biotechnology_and_pharmaceutical_industries
3) www.ipr-helpdesk.org/
4) www.patentoffice.nic.in/ipr/patent/patents.htm
5) www.bangalorebio.com/GovtInfo/ipr.htm

DISSERTATION/PROJECT

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