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

2022 - 2023 onwards

Programme code 2502

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

2. **Preamble of the programme**:

MSc. Biotechnology is a four-semester programme that includes theory and practicals in different areas of biotechnology. In addition, it contains one research project during the fourth semester to enhance knowledge and research skills in biotechnology during the course.

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.

Eligibility for Admission

A candidate possessing a BSc. degree with a minimum of 50 % marks in Biotechnology/ Microbiology/ Biochemistry/ Zoology/ Botany/ BSc. Agriculture/ Life Sciences/ Chemistry/ B. Pharm/ as the main subject and have passed the entrance examination shall be held eligible for MSc. biotechnology programme admission.

Admission will be based on (i) the total marks obtained in the entrance test (50%) and the qualifying examination (50%) and (ii) by following the Tamil Nadu government norms of reservation.

Duration of the programme

The students shall undergo this prescribed programme of study for a period not less than two academic years (four semesters). Each semester would contain 90 working days.

3. Programme Structure:

Semester	Course Code	Course	Course Nature	Credits	Contact hours per week	Continuous internal assessment (CIA)	End semester exam (ESE)
FIRST	PBTC11	Advanced biochemistry	Core	4	4	25	75
	PBTC12	Advanced microbiology	Core	4	4	25	75
	PBTC13	Cell and molecular biology	Core	4	4	25	75
	PBTC14	Molecular genetics (e-PG Pathshala)	Core	4	4	25	75
	PBTL11	Advanced biochemistry	Practical –I	2	3	50	50
	PBTL12	Advanced microbiology	Practical -II	2	4	50	50
	PBTL13	Cell and molecular biology and Molecular genetics	Practical – III	2	4	50	50
		Elective I: any one	Elective	3	3	25	75
	PBTEA	1. Biosensors					
	PBTEB	2. Developmental biology					
	PBTEC	3. Enzyme technology					
	Sub Total			25	30		
SECOND	PBTC21	Bioanalytical techniques and bioinstrumentation	Core	4	4	25	75
	PBTC22	Bioinformatics	Core	4	4	25	75
	PBTC23	Genetic engineering	Core	4	4	25	75
	PBTC24	Immunology	Core	4	4	25	75
	PBTL21	Bioanalytical techniques and bioinstrumentation & Bioinformatics	Practical – IV	2	4	50	50
	PBTL22	Genetic engineering & Immunology	Practical –V	2	4	50	50
		Elective II: any one	Elective	3	3	25	75
	PBTED	1.Cancer biology					

	PBTEE	2. DNA fingerprinting					
	PBTEF	3. Nanobiotechnology					
		NPTEL online course	Supportive	3	3	25	75
	Sub Total			26	30		
THIRD	PBTC31	Applied Biotechnology	Core	4	4	25	75
	PBTC32	Bioprocess Technology	Core	4	4	25	75
	PBTC33	Food Biotechnology	Core	4	4	25	75
	PBTC34	Omics in Biology	Core	4	4	25	75
	PBTL31	Applied Biotechnology& Food Biotechnology	Practical –VI	2	4	50	50
	PBTL32	Bioprocess Technology & Omics in Biology	Practical – VII	2	4	50	50
		Elective III: any one	Elective	3	3	25	75
	PBTEG	1. Biopharmaceuticals					
	PBTEH	2. Biotechnology for human welfare					
	PBTEI	3. Diagnostic tools and Clinical Trials					
		NPTEL Online Course	Supportive	3	3	25	75
		Internship	Skill Development course	2	-	-	-
Sub Total				28	30		
FOURTH	PBTC41	Molecular therapeutics (e-PG Pathshala)	Core	4	4	25	75
	PBTC42	Research methodology and biostatistics	Core	4	4	25	75
	PBT	Industrial / institutional visit	Skill Development course	2	-	-	-
	PBTPP	Dissertation	Project	8	22	50	50
	Sub Total			18	30	50	50
TOTAL				97			

Scheme of evaluation:

For evaluation of theory papers (core and elective), the continuous internal assessment (CIA) will be 25 marks, and the external examination for 75 marks. Practicals carry a maximum of 100 marks with 50 marks internal and 50 marks external. The project carries 100 marks, with 50 as internal and 50 as external.

i. Core and elective papers:

Maximum marks	100
Passing minimum marks	50

a. Continuous internal assessment (CIA):

- 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 is conducted for about one and a half units of the syllabus in each course.
- The duration of each test is one hour
- The question paper pattern for the internal test is given below:
- Each test carries a maximum of 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 are divided as 15 marks for the internal written test (average of the marks from the best two tests out of three tests), 5 marks for the seminar, and 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 unit)	10 x1 = 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 the last semester.

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	Organization 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

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

Dissertation

Maximum marks	100
Passing minimum marks	50

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

Model question

Manonmaniam Sundaranar University – November 2022

First semester

MSc. Biotechnology

Advanced biochemistry

Subject code: PBTC11

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

Part A 1X10=10 marks

Answer ALL questions

1	Define the term oligomer	CO1	R
2	Establish the relationship between the enzyme's high activity and optimum pH.	CO1	A
3	Identify the factors triggering glycogenolysis.	CO2	U
4	List out the three primary metabolic fates of pyruvate.	CO2	R
5	Classify the lipids.	CO3	U
6	Appraise the importance of cholesterol biosynthesis in our bodies.	CO3	A
7	Give an example of the quaternary proteins with justification.	CO4	U
8	Name any two amino acids that are both glucogenic as well as ketogenic	CO6	R
9	Identify the DNA's most common conformation.	CO5	R
10	Mention the forces that stabilize nucleic acids.	CO5	R

Part B 5X5= 25 marks

Answer ALL questions. Each question carries equal marks

1a	Explain the necessity of water for life.	CO1	A
	(Or)		
11b	Evaluate the biological significance of buffers	CO1	E
12a	Illustrate the various steps of gluconeogenesis and its regulation.	CO2	A
	(Or)		

12b	Deduce the three main steps of the electron transport chain.		
13a	Give the classification of compound lipids with an example.	CO2	U
	(Or)		
13b	Explain the β-oxidation in detail. How will you predict its energetics?	CO3	AC
14a	How will you classify amino acids?	CO3	U
	(Or)		
14b	Compile the various steps of the uric acid cycle. Add a note on its importance.	CO4	A
15a	Compare and contrast the structure of mRNA and tRNA	CO5	UA
	(Or)		
15b	Describe the structure of vitamins with a diagram.	CO6	UA

Part C 5X8= 40 marks

Answer ALL questions. Each question carries equal marks

16a	Justify the statement "Miller-Urey experiment scientifically explored the ideas about the origin of life". Add a note on the significance of the Miller experiment.	CO1	C
	(Or)		
16b	Discuss in detail the mechanism of acid-base regulation in our body with special references to blood and gastric juice.	CO2	AU
17a	Explain in detail the structure of carbohydrates with an example. List out the important function of each type.	CO5	AR
	(Or)		
17b	Describe in detail the mechanism of acid-base regulation in our body with special references to blood and gastric juice	CO4	RE
18a	Explain the various steps of fatty acid oxidation? Add a note on their significance.	CO2	UE
	(Or)		
18b	Explain the role of various enzymes involved in the biosynthesis of cholesterol. Add a note on the estimation of the energetics of cholesterol biosynthesis	CO2	AE

19a	How can you classify the proteins based on their structure? Establish the significance β chain.	CO3	AU
	(Or)		
19b	Deduce the relationship between protein structure and its function. Infer the role of protein folding in its function.	CO3	AC
20a	Discuss in detail about Watson & Crick model of DNA. Appraise its biological importance.	CO6	UA
	(Or)		
20b	Explain in detail the various pathways regulating vitamins. Propose the natural ways to meet necessary vitamins.	CO4	AC

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 employment opportunities in various government and non-government research laboratories, institutes, bio-industries, and start-ups.

Programme specific outcomes (PSOs):

Upon successful completion of the MSc Biotechnology 2 years programme, the candidate should be able to:

PSO 1: Understand the fundamental importance of living cells, biomolecules, derived products and their processes in modern science, medicine, and industries.

PSO 2: Recall the traditional knowledge in various aspects of biotechnology with special reference to microbes and their products.

PSO 3: Develop the ability to design, plan and execute biobased experiments and apply necessary tools for their analysis, interpretation, and reproducibility.

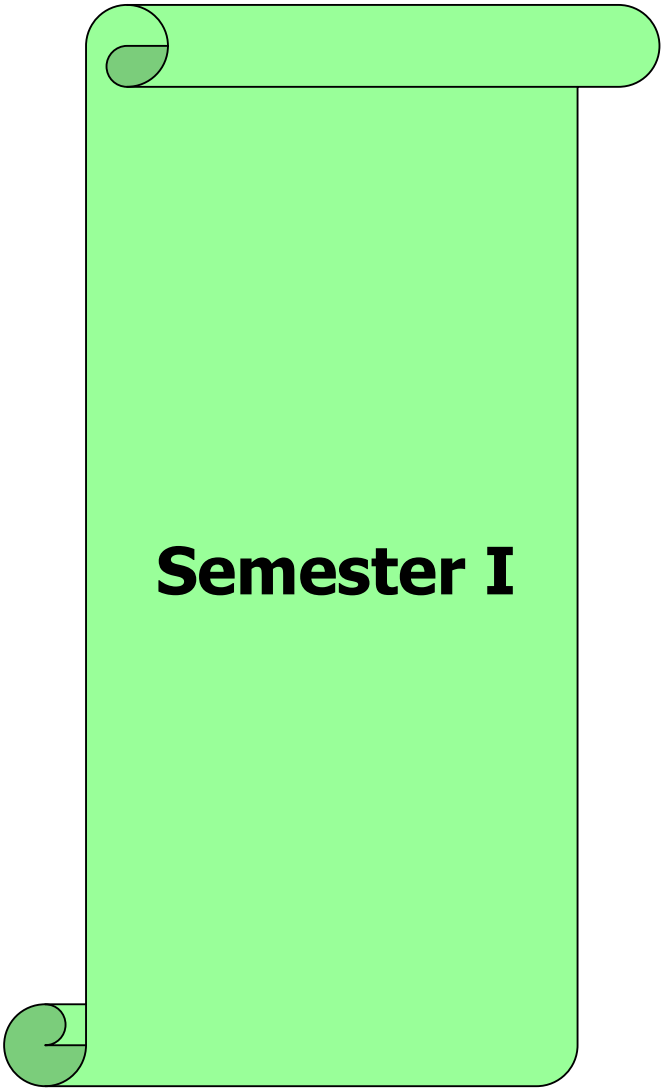
PSO 4: Know to learn, diagnose, and solve biotechnology-associated problems using appropriate modern analytical/biological software/online tools and equipment.

PSO 5: Explore all the career paths available for biotechnologists through suitable skill-based courses, training/internships and implement the same professional or career reward.

PSO 6: Integrate the knowledge acquired and concepts developed with biotechnology's ethical and industrial perspectives.

PSO 7: Recognize the need and produce innovative biological products from available resources for socio-economic development.

PSO 8: Develop empirical knowledge to design and establish new techniques and products in commercial, start-ups, and entrepreneurship


Semester I

Course Description

ADVANCED BIOCHEMISTRY

L	T	P	C
4	0	0	4

a. Course code: PBTC11

b. Course objectives:

1. To develop broad and balanced knowledge of understanding biomolecules, key biochemical concepts, principles, and theories related to biochemistry.
2. To understand various metabolic pathways, their regulation, and significance.
3. To offer students the right analytical tools and acquire theoretical, technical, and analytical skills to address questions and problems in biochemistry.

c. Course prerequisites:

- Intrinsic knowledge of biomolecules and its metabolism.

d. Course outcomes (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Identify the biomolecules of significance and their metabolic process	K1, K2
CO2	Understand and explain the carbohydrate metabolism and its significance	K2
CO3	Develop knowledge of various metabolic processes of lipids and their importance.	K3
CO4	Illustrate the structure of proteins, their classification, and the metabolism of amino acids	K4
CO5	Compare the structure of DNA and RNA, their metabolism, regulation, and roles in biological functions.	K5
CO6	Integrate the acquired knowledge and develop the capability to compete in national level examinations for higher studies.	K3, K6

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

e. Course outline

Unit I **12hrs**

Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, the composition of living matter; Water – properties of water, the essential role of water for life on earth, ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies; Metabolism: Anabolism and catabolism, compartmentalization of metabolic pathways. Principles of biophysical chemistry - pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin, and alkaline phosphatase), and biological significance of buffers. Principles and applications of colorimetry, centrifugation, chromatography.

Unit II **12hrs**

Carbohydrate: Composition, structure, and function of Carbohydrates, Classification of Mono, Di, and Polysaccharides, Metabolism: Glycogen metabolism - glycogenolysis, glycogen synthesis, Gluconeogenesis. Glycolysis, energetic of glycolysis. Fates of pyruvate - conversion of pyruvate to lactate, alcohol and acetyl Co-A. Citric acid cycle and its energetics. Anaplerotic reactions. Pentose phosphate pathway and its significance. Cori cycle. Electron Transport Chain.

Unit III **12hrs**

Lipid: Composition, structure, and function of Lipids, Classification of Simple & Compound lipids; Metabolism of Lipids: Oxidation of fatty acid - α, β and ω types, β-oxidation of even number saturated fatty acids. Energetics of β-oxidation. Schematic representation of biosynthesis of even number saturated fatty acids and cholesterol biosynthesis. Formation of ketone bodies

Unit IV **12hrs**

Protein: Composition, structure and function of Proteins, Classification & general characteristics - Primary, secondary, tertiary & quaternary proteins, α & β chains of proteins, Classification of amino acids, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif, and folds). Stability of proteins. Metabolism of

amino acids: General reaction of amino acid degradation - transamination, deamination, and decarboxylation. Ketogenic and glucogenic amino acids. Urea cycle and its significance.

Unit V **12hrs**

Nucleic acid: Composition, structure and function of Nucleic acids, Conformation of nucleic acids (A, B, Z), m-RNA, r-RNA, t-RNA. DNA composition, Watson & Crick model of DNA, Structure of RNA. Stability of nucleic acids, Nucleosides & nucleotides, Metabolism and regulation of nucleotides. Composition, structure and function of vitamins, Metabolism, and regulation of vitamins.

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	L	H	L	M	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	L	H	L	H	H	H	H
CO2	M	H	M	H	M	M	M	M
CO3	H	M	H	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
CO5	M	H	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) David L Nelson and 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) Donald Voet, Judith G. Voet, Charlotte W. Pratt, 2012. Fundamentals of Biochemistry: Life at the Molecular Level 4th Edition, Wiley.
4) Jeoffrey Zubay, 1995. Principles of Biochemistry Wm C. Brown Publications.
5) Lubert Stryer, Jeremy Berg, John Tymoczko, Gregory Gatto, 2019. Biochemistry, 9th Edition, New York, Freeman.

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

1) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQlU+6LM40KjY1Q==
2) https://microbenotes.com/category/biochemistry/
3) https://nptel.ac.in/courses/102106087
4) https://onlinecourses.nptel.ac.in/noc22_bt22/preview
5) https://study.com/academy/topic/biochemistry-study-guide.html
6) https://www.brainkart.com/subject/Biochemistry_302/
7) https://www.easybiologyclass.com/topic-biochemistry/

ADVANCED MICROBIOLOGY

a. Course code: PBTC12

L	T	P	C
4	0	0	4

b. Course objectives:

1. To understand the basics of the microbial world, diversity, and metabolism.
2. To explain the techniques in microbiology.
3. To explain the disease associated with them and their control.

c. Course prerequisites:

- Fundamental familiarity with microbes and the impact of their diseases on the human community.

d. Course outcomes

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

Course Outcomes	Expected outcome	Cognitive Level
CO1	Understand the history and metabolism of microbes	K2
CO2	Thorough knowledge of microbial growth	K4
CO3	Know the structural organisation of bacterial cells and their functions.	K2 & K4
CO4	Insight onto the microbial genetics	K3 & K5
CO5	Expertise on infectious diseases	K2, K4 & K5
CO6	Develop advanced techniques to diagnose microbe associated diseases	K3 & K6

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

e. Course outline

Unit I **12 hrs**

Introductory microbiology: History, Chronological development and Scope of Microbiology - Microbiology in Perspective: to the 'golden age' and beyond. Prokaryotic Diversity - the Eukaryotes of Microbiology - Acellular pathogens. Microbial metabolism.

Unit II **12 hrs**

Microbial Growth: Sterilization, Pure culture techniques, Principles of microbial nutrition, Culture media, Growth, mathematical expression of growth, growth curve, measurement of growth and growth yields, Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen, Culture collection and maintenance of cultures.

Unit III **12 hrs**

Structural and taxonomical diversity of microbes: Cell walls of eubacteria and related molecules, Outer membrane of Gram negative bacteria, Cell wall and cell

membrane synthesis, flagella and motility, Cell inclusions like endospores, gas vesicles. Bacteria: New approaches to bacterial taxonomy, including ribotyping, ribosomal RNA sequencing. Cyanobacteria, Acetic acid bacteria, Budding and appendaged bacteria, Spirilla, Spirochaetes, Gliding, and sheathed bacteria. Lactic acid and propionic acid bacteria, Endospore forming rods and cocci, Pseudomonads, Mycobacteria, Rickettsia, Chlamydia, and Mycoplasmas. Archaea: Halophiles, Methanogens, and Thermoplasmas. Viruses: General properties.

Unit IV **12 hrs**

Microbial Genetics: Transformation, Conjugation, Transduction, Recombination, Plasmids and Transposons, T4 and Lambda Phage and its life cycle, Virus - host interactions. Genetic system of Yeast and Neurospora.

Unit V **12 hrs**

Microbial diseases: Emerging and re-emerging infectious diseases - infective syndromes - hospital associated infections -Antibiotic sensitivity testing - prophylactic immunization.

f. Mapping of Course Outcomes to POs and PSOs

Mapping of COs to POs

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

(L – Low, M – Medium, H – High)

Mapping of COs to PSOs

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

(L – Low, M – Medium, H – High)

g. Textbooks/References:

1) Arora, Brij Bala Arora DR, 2019. Textbook of Microbiology-4th edition. CBS Publisher

2) Brock, Madigan, MT, Martinko JM, Parker J, 2018. Biology of Microorganisms, Prentice Hall.

3) Pelczar MJ Jr, Chan ECS, Kraig 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

CELL AND MOLECULAR BIOLOGY

L	T	P	C
4	0	0	4

a. Course code: PBTC13

b. Course objectives:

1. To strengthen the student's basic and depth knowledge of the central dogma of life, cell division, and cell cycle.
2. To explain the Techniques in cell biology.
3. To explain the synchronization of cells and the aging of cells.

c. Course prerequisites:

- Necessary information of central dogma, cell division and cell cycle.

d. Course outcomes (Cos)

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

Course outcomes	Expected outcome	Cognitive level
CO1	Understand the basic principles of DNA replication.	K2
CO2	Enhance the basic knowledge of transcription and translation of DNA.	K2 & K4
CO3	Know about cell division and cell biology techniques.	K2
CO4	Understand the density arrest of DNA replication.	K5

CO5	Understand the concepts of cell synchronization and aging of the cell.	K2 & K5
CO6	Develop the basic knowledge of molecular biology.	K6

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

e. Course outline:

Unit I **12 Hrs**

DNA Replication: Replication in Prokaryotes and eukaryotes and DNA repair, Recombination, Transposable elements and Transposon

Unit II **12 Hrs**

Transcription and Translation: Transcription in prokaryotes and eukaryotes. Post translational modification. Prokaryote and eukaryote translation and post translational modifications.

Unit III **12 Hrs**

Cell division and cell biology techniques: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. Structure of nucleosome and organization of chromatin. Role of condensing in chromatin packing. Techniques in cell biology: Cell culture, 3D culture, fluorescent microscopy, confocal microscopy, Subcell fractionation, Immunostaining, FACS analysis & sorting, live videography.

Unit IV **12 Hrs**

Genes of importance and their associated functions: 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 V **12 Hrs**

Cell Cycle: Role of Topoisomerases and Catenation process. Spindle checkpoint, protein in spindle detection. Bubr1, Role of the microtubule, kinesin, dynein, 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.

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	M	M	L	L	M	M	M
CO2	M	M	M	L	L	M	M	M
CO3	M	M	H	L	L	M	H	M
CO4	M	M	M	M	M	L	M	M
CO5	M	M	H	M	M	L	M	M
CO6	M	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	M	M	L	M	M
CO2	H	M	M	M	M	M	H	H
CO3	H	M	M	M	M	M	M	M
CO4	M	M	H	H	M	L	M	M
CO5	M	M	M	H	M	M	M	M
CO6	H	M	M	M	M	M	M	M

(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

MOLECULAR GENETICS (e-PG Pathshala)

a. Course code: PBTC14

L	T	P	C
4	0	0	4

b. Course objectives:

1. To provide an introduction to the basic principles of molecular genetics of prokaryotic and eukaryotic organisms.
2. To give detailed knowledge about model organisms, human genome projects, and molecular techniques.
3. To deliver the recombinant DNA technology applications, omics, epigenetics, and system biology will also be covered.

c. Course prerequisites:

- Simple understanding of prokaryotic and eukaryotic cell structure and their basic functions.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Describe about structural and genomic organization of prokaryotic and Eukaryotic cells	K1
CO2	Explain the molecular basis of maintenance and transmission of genetic information of prokaryotic and eukaryotic cells.	K2
CO3	Articulate about model organisms and the production of transgenic animals.	K3
CO4	Analyse the different methods for gene identification Restriction mapping, In-situ Hybridization, cloning, etc.	K4
CO5	Predict the large-scale genome analyses like Human Genome Project, System Biology, and Epigenetics.	K
CO6	Develop knowledge regarding molecular aspects of essential genetic products.	K6

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

e. Course outline:

Unit I: **12 hrs**

Changing Concepts of Genes: Part 1 & Part 2, Structural organization of genome: Genome structure and organization, Structural organization of genome: Sequence organization of the genome, Comparative Genomes, Structural organization of genome: Bioinformatics.

Unit II: **12 hrs**

Structural organization of genome: Mobile DNA elements in Prokaryotes, Mobile DNA elements in Eukaryotes, Structural organization of genome: Genome dynamics: Part 1, Structural organization of genome: Genome dynamics: Part 2, Molecular basis of maintenance of genetic information, Molecular basis of transmission of genetic information.

Unit III: **12 hrs**

Model Organisms in Genetics: *E. coli, Saccharomyces, Arabidopsis thaliana*, Model organisms in Genetics: *Drosophila melanogaster*, *Caenorhabditis elegans*, Model organisms in genetics: *Mus musculus*, Zebrafish, Transgenic animals: Part1. Methods of production, transgenic animals: applications, gene knock out and gene knock down (Model Organisms).

Unit IV: **12 hrs**

Methods for gene identification: Restriction mapping (RFLP based pedigree analysis), *In-situ* Hybridization, Southern Blot Hybridization, Cloning, Polymerase chain reaction.

Unit V: **12 hrs**

Large scale analysis of genome: Structural Genomics, functional Genomics, Metagenomics, scale Human Genome Part I, Human Genome Part II, System Biology, and Epigenetics.

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	L	L	H	L	M	M	M
CO2	H	M	M	H	H	L	H	M
CO3	H	H	M	H	L	L	M	M
CO4	H	H	M	H	M	L	M	M
CO5	H	M	M	M	M	H	M	H
CO6	H	M	M	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	L	H	H	M	M	M	H	H
CO2	L	H	H	H	M	L	M	M
CO3	M	H	H	M	H	H	H	H
CO4	H	M	L	H	H	H	H	L
CO5	M	H	H	H	H	L	M	H
CO6	M	H	H	H	M	M	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. Malden, MA: Blackwell Science.
2) Graur D, Li W-H, 1999. Fundamentals of Molecular Evolution, 2nd edn. Sunderland, MA: Sinauer Associates.
3) International Human Genome Sequencing Consortium. 2001. Initial sequencing and analysis of the human genome. Nature. 409:860 – 921.
4) Watson JD, Hopkins NH, Roberts JW et al. 1987. Molecular Biology of the Gene, 4th edn. Menlo Park, CA: Benjamin-Cummings.
5) Wolpert L, Beddington R, Jessell TM, Lawrence P, 2002. Principles of Development, 2nd edn. London/Oxford: Current Biology/Oxford University Press

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

1) https://onlinecourses.nptel.ac.in/noc22_bt07/preview
2) https://nptel.ac.in/courses/102104052
3) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA==

Practical I: ADVANCED BIOCHEMISTRY

a. Course code: PBTL11

L	T	P	C
0	0	3	2

b. Course objectives:

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 skills about chemical and buffer preparation.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Observe the instruments and relate their use for biochemical experiments.	K1, K2
CO2	Estimate the pKa value for any given solution	K2
CO3	Determine the concentration of carbohydrates, lipids, and proteins present in any given sample.	K3
CO4	Compare the methods of isolation of DNA and RNA.	K4
CO5	Estimate the concentration of DNA and RNA from bacteria.	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. Colorimetric determination of pK
2. Estimation of carbohydrates.
3. Estimation of lipids.
4. Estimation of proteins.
5. Isolation and quantitation of DNA
6. Isolation and quantitation of RNA.

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 NJ.

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.

Practical II: ADVANCED MICROBIOLOGY

a. Course code: PBTL12

L	T	P	C
0	0	4	2

b. Course objectives:

1. To identify the invisible living organisms 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:

- Students should have basic skills in the isolation of microorganisms and pure culture techniques.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the classification of microorganisms	K1
CO2	Understand the significance characteristic features of microorganisms	K2
CO3	Illustrate the concept of staining techniques to identify the	K3

	invisible organisms	
CO4	Differentiate Gram-positive and Gram-negative bacteria by staining and microscopic methods	K4
CO5	Analyse and evaluate the water quality by MPN method	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. Isolation of bacteria from soil
2. Staining techniques: Simple, Differential, Grams Staining, Acid fast staining, Lactophenol cotton blue staining.
3. Growth curve measurement of bacterial population by turbidometry.
4. Biochemical tests to identify bacteria
5. Water quality analysis by MPN technique.
6. Antibiotic susceptibility testing by disc diffusion 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	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.

Practical III: CELL AND MOLECULAR BIOLOGY & MOLECULAR GENETICS

a. Course code: PBTL13

L	T	P	C
0	0	4	2

b. Course objectives:

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

c. Course prerequisites:

- Primitive idea about different stages in cell division and handling of microscope.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the different stages in cell divisions	K1, K2
CO2	Understand and develop knowledge about histochemical techniques.	K2
CO3	Illustrate the basic concept of nucleic acids	K4
CO4	Evaluate the genetic causes of diseases for developing diagnostics and drugs.	K5, K3, K6
CO5	Justify the application of PCR in forensic science	K5
CO6	Facilitate the applications of 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. Stages of Mitosis.
2. Stages of Meiosis.
3. Histochemical techniques
4. Visualization of the riboflavin in earthworms by fluorescent microscopy
5. Isolation of DNA and RNA.
6. Problems based on Mendelian inheritance (at least one problem for each of the laws of segregation and law of independent assortment).
7. Isolation of genomic DNA from plant leaves
8. Agarose gel electrophoresis of isolated genomic DNA
9. Isolation of total cellular RNA from plant leaves
10. Formaldehyde-agarose denaturing gel electrophoresis of RNA
11. Isolation of plasmid DNA from bacterial cultures and visualization on agarose gels.
12. Spectrophotometric quantification and quality determination of isolated nucleic acids

13. Polymerase Chain Reaction based amplification of DNA
14. Preparation of culture media for transformation
15. Transformation of competent cells and plating
16. Selection of transformants based on blue-white colonies and evaluation of plasmids from transformed colonies.

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	M	M	M	L	L	M	M
CO2	H	M	M	M	L	L	H	M
CO3	H	H	M	M	M	L	M	M
CO4	H	H	H	H	M	M	H	H
CO5	M	H	H	M	M	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	M	H	M	M	M	M	M
CO2	M	M	H	M	M	M	M	H
CO3	M	M	M	H	H	M	M	H
CO4	H	H	M	M	H	H	H	H
CO5	H	H	H	H	H	H	H	H
CO6	H	H	H	M	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) Karp G, 2005. Cell and Molecular Biology – Concepts and Experiments, 4th Ed, USA, John Wiley and Sons Inc., New Jersey.

3) Katoch R, 2011. Analytical techniques in biochemistry and molecular biology. Springer Science & Business Media.

4) Kumar P, 2016. Fundamentals and Techniques of Biophysics and Molecular biology. Pathfinder Publication unit of PAPL.

5) Sharma RK, 2013. Basic techniques in biochemistry and molecular biology. IK International Pvt Ltd.

BIOSENSOR

a. Course code: PBTEA

L	T	P	C
3	0	0	3

b. Course objectives:

1. To understand the active principles of biosensors
2. To study the categories of biosensors
3. To explore the recent scenario for biosensor development

c. Course prerequisites:

- Should familiar with the fundamental principles of biosensors.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the basics of biosensing technology	K1 & K2
CO2	Apply the biological principles for biosensors configuration	K3 & K4
CO3	Develop and design the biosensor for the specific application	K3 &K6
CO4	Comprehend the gap between the conventional technology and the biosensor	K2
CO5	Appreciate and explain modern techniques for biosensors development	K3, K5 & K6
CO6	Propose biosensors to check pollution, food quality, and agriculture practices	K6

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

e. Course outline:

Unit I **9hrs**

Introduction to biosensor: Definitions, biological inspiration, components, target analyses, various recognition, Recognition event: Catalytic, Single and multiple enzymes, Bioaffinity: Labeled and label-free, whole cell sensing – bacteria, yeast, mammalian cell, Generation of biosensor; Biomolecule immobilization techniques.

Unit II **9hrs**

Biosensor types: biocatalysis based biosensors, bioaffinity based biosensors, and microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions.

Unit III **9hrs**

Biosensor parameters: Considperations calibration, dynamic range, signal to noise, sensitivity, selectivity, Interference recognition/transduction membrane protein sensors: ion channels, Types of transducers, Optical; Fiber optic, ECL, Surface plasmon resonance, Electro chemical; FET, Impedance, Piezoelectric; Cantilever

Unit IV **9hrs**

Biosensors in diagnosis: diabetes management, Micro fabricated biosensors and point-of-care diagnostics systems, Noninvasive biosensors in clinical analysis; Surface plasmon resonance and evanescent wave biosensors, Biosensor in cancer and HIV early diagnosis.

Unit V **9hrs**

Nano materials in biosensors: Carbon based nano material, Metal oxide and nano particle, Quantum dots, Role of nano material in signal amplifications, Detection and transducer fabrication

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	M	L	M	L	M	H
CO2	M	H	M	L	M	M	H	H
CO3	H	H	M	M	M	M	H	H
CO4	M	M	M	M	L	M	M	M
CO5	M	H	M	M	L	M	M	H
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	M	H	H	M	H	M
CO2	M	M	H	H	H	M	M	H
CO3	M	M	M	H	H	M	H	H
CO4	M	M	M	M	M	H	M	H
CO5	M	H	M	H	M	H	H	H
CO6	H	H	M	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Textbooks/References:

1) Elizabeth A, Hall, 1990. Biosensors, First Edition, Open University, Milton Keynes.
2) Graham Ramsay, 1998. Commercial Biosensors, First edition, John Wiley & Sons, Inc.
3) Jagriti Narang, Pundir C.S, 2017. Biosensors-An Introductory Textbook1st Edition Jenny Stanford Publishing
4) Joshi Rajmohan, 2006. Biosensors. Isha Books
5) Tran Minh Canh, 1993. Sensor Physics & Technology - Biosensors, First Edition, Chapman & Hall.

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

1) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4986445/
2) https://onlinecourses.nptel.ac.in/noc20_ph13/preview
3) https://nptel.ac.in/courses/102104062
4) https://www.scribd.com/document/490583359/NPTEL-Biosensor-introduction
5) https://www.youtube.com/watch?v=kQ6CY1qpGjY

DEVELOPMENTAL BIOLOGY

a. Course code: PBTEB

L	T	P	C
3	0	0	3

b. Course objectives:

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:

- Background knowledge about fundamental biology.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	State the history and basic concepts of embryology and explain the process of Organ and embryo development	K 1 & K2
CO2	Understand and categorize the early stages of embryonic development	K 2& K4
CO3	Understand the process of Embryonic differentiation and analyze the transcriptional and post-translational levels.	K2 & K4
CO4	Understand the relevance of developmental biology in helping childless couples to give birth	K 2

CO5	Analyze and understand the molecular basis of fetal development diagnosis, 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: 9hrs

Introduction to developmental biology: 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: 9hrs

Embryogenesis: 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: 9hrs

Embryo 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: 9hrs

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

UNIT V: **9hrs**

Role of genes in 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, TBX5 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 outcomes 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	M	H	M	M	M	H	M	M
CO2	M	H	M	M	M	M	H	M
CO3	M	M	M	M	M	H	M	M
CO4	M	H	H	M	M	M	M	M
CO5	M	M	M	L	M	H	H	M
CO6	M	H	M	H	H	H	M	M

(L – Low, M – Medium, H – High)

g. Textbooks/References:

1. Balinsky BI, 2008. An introduction to Embryology, International Thomson Computer Press.
2. Balinsky BI, 2012. An introduction to Embryology, 5th ed. Cengage Learning India.

3. Gilbert SF, 2006. Developmental Biology, 8th ed. Sinauer Associates, Inc., publishers, Sunderland, Massachusetts, USA.
4. Kalthoff, 2000. Analysis of Biological Development, 2nd revised ed., McGraw-Hill Publishing

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

ENZYME TECHNOLOGY

a. Course code: PBTEC

L	T	P	C
3	0	0	3

b. Course objectives:

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:

- Intrinsic comprehension about enzymes and its properties.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Understanding the biological principles of enzymes	K2
CO2	Develop insight into the essentials of enzyme kinetics	K2, K4& K6
CO3	Analyze the methods for enzyme extraction	K3
CO4	Comprehensive understanding of enzymes regulation	K2 & K5
CO5	Appraise the biotechnological applications	K3 & K5
CO6	Acquire a strong knowledge of enzyme technology	K6

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

e. Course outline:

Unit I **9hrs**

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

Unit II **9hrs**

Kinetics of Enzymes: Enzyme specificity, Kinetics of single-substrate enzyme-catalyzed reactions-derivation of Michaelis Menten equation, modification of Michaelis Menten equation, significance of Michaelis Menten equation, Rapid reaction kinetics-pre-steady kinetics, and relaxation kinetics.

Unit III **9hrs**

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

Unit IV **9hrs**

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, significance of sigmoidal kinetics

Unit V **9hrs**

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 of small macromolecules, influence of immobilization on enzyme activity, rDNA technology, and bioinformatics.

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	L	L	M	M
CO2	H	M	H	M	L	M	H	M
CO3	M	H	M	M	L	L	H	H
CO4	H	M	M	M	H	H	M	H
CO5	H	H	M	H	M	H	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	M	M	M	M	M	H
CO2	M	H	M	L	M	M	H	H
CO3	M	H	H	M	M	M	H	M
CO4	M	H	M	M	M	M	M	M
CO5	M	M	H	M	H	M	H	H
CO6	M	H	M	M	M	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/References:

1. Emil L. Smith, Robert L. Hill, I. Robert Lehman, Robert J. Lefkowitz, Philip Handler, Abraham White, 2002. Principles of Biochemistry, 8th edition, McGraw-Hill International book Company.
2. Lehninger, Nelson, Cox, 2002. Principles of Biochemistry, 3rd Ed CBS publishers.
3. Donald Voet, Judith G. Voet, Charlotte W. Pratt, 2016. Fundamentals of Biochemistry, 5th Edition, John Wile and Sons, Inc.
4. Murray, R.K, Granner DK, Mayers PA, Rodwell VW, 2001. Harper's Biochemistry, Prentice - Hall International.

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

Semester II

BIOANALYTICAL TECHNIQUES AND BIOINSTRUMENTATION

L	T	P	C
4	0	0	4

a. Course code: PBTC21

b. Course objectives:

1. To strengthen the student's basic and depth knowledge of all biological phenomena, which are answerable with the aid of general principles of physical sciences.
2. To explain the functional skill in fundamental and advanced analytical instruments.
3. To enrich the ability to understand and work methods of various instruments.

c. Course prerequisites:

- Students should have cardinal idea of bioanalytical techniques.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Understand the basic principles of instruments and analytical techniques used in the biotechnology field	K1 & K2
CO2	Enhance the basic knowledge of analysis and interpretations of the resulting output	K2 & K4
CO3	Know to handle basic and advanced instruments and find troubleshooting in the biological and pharmaceutical industries	K3
CO4	Understand the impact of noxious materials and handling of these materials	K5
CO5	Complete perception in bioanalytical techniques for the possible applications in diverse applied 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 **12hrs**

Microscopy: principle and applications – Dark field, phase contrast, fluorescence, confocal, polarization microscopy, electron microscopy: TEM & SEM.

Unit II **12hrs**

Centrifuge and spectroscopic techniques: Basic principle and application of centrifugation techniques – different types of centrifuges and rotors, analytical and preparative centrifuges, ultracentrifugation methods. Basic principle and applications of spectroscopic techniques – Electromagnetic radiations; UV-visible, fluorescence, X-ray crystallography, NMR, mass spectrometry

Unit III **12hrs**

General principle and applications of chromatographic methods: – ion exchange, gel filtration, affinity, gas chromatography, and liquid chromatography techniques

Unit IV **12hrs**

Basic theory and applications of electrophoresis: horizontal & vertical gel electrophoresis, isoelectric focusing, 2D, pulse field, and immune electrophoresis

Unit V **12hrs**

Radioisotope techniques: basic concepts, GM and scintillation counter, autoradiography, RIA, applications in biological science. Polymerase chain reaction, DNA sequencing, ELISA

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	L	M	M	L	M
CO2	H	M	H	L	L	H	M	M
CO3	M	H	H	M	L	M	H	L
CO4	M	L	M	L	L	M	H	M
CO5	H	H	M	L	L	H	M	H
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	M	M	L	M	L	H
CO2	L	M	M	H	M	L	M	M
CO3	M	M	H	M	L	L	H	H
CO4	H	H	L	M	L	M	L	L
CO5	H	H	M	H	M	L	M	M
CO6	H	H	H	H	M	H	H	H

(L – Low, M – Medium, H – High)

g. Textbooks/References:

1) Campbell, ID, Dwek RA, 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 LL, Dean JA, Settle FA, 1986. 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
4) https://nptel.ac.in/courses/103108100
5) https://onlinecourses.swayam2.ac.in/cec20_bt22/preview

BIOINFORMATICS

L	P	T	C
4	0	0	4

a. Course code: PBTC22

b. Course objectives:

1. To understand the concepts and importance of bioinformatics and its correlation with molecular biology
2. To access bioinformatics databases and tools in understanding sequence alignments, phylogeny, and structure prediction of proteins.
3. To acquire advanced knowledge in bioinformatics for pharmaceutical research and vaccine development applications.

C**. Course prerequisites:**

- Fundamental proficiency about computer and their operation.

d. Course outcomes (CO):

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

Course outcome	Expected outcome	Cognitive level
CO1	Define the concepts of bioinformatics and its applications.	K1
CO2	Understand the various bioinformatics databases & tools and illustrate the different matrices available for sequence alignment	K2, K3
CO3	Explain the different types of the phylogenetic tree and infer the evolutionary relationship among the sequences	K3, K4
CO4	Analyze the structure of the protein, validate by different validation tools and correlate the structure-function relationship	K4, K6
CO5	Predict the domain & motif of proteins and formulate assays for drug design and discovery	K5, K6
CO6	Develop knowledge of the role of bioinformatics in pharmaceutical research	K6

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

e. Course outline

Unit I **12hrs**

Introduction to bioinformatics: Definition, Concepts, History, Scope and importance of Bioinformatics, Database: Introduction and concepts, structure and applications, Protein and nucleotide databases, Information retrieval from biological databases, database searching -similarity searches using BLAST and FASTA.

Unit II **12hrs**

Biological Databases: Classification, Structure, and Sequence databases. Nucleotide Sequence Databases: Primary and Secondary. Protein databases. Homology, Identity, and Similarity, Pairwise Alignment - Algorithms, Global Alignment (Needleman and Wunsch algorithm), Local Alignment (Smith and Waterman Algorithm). Pairwise Database Searching. Multiple Sequence Alignment: BLAST: Nucleotide BLAST, Protein BLAST, PSI-BLAST. Scoring Matrices- PAM and BLOSUM - Gap penalties, applications.

U

Sequence alignment: Multiple Sequence Alignment, Concept of Consensus, Phylogenetic tree - Definition, Types of Trees, Construction of trees - Character based methods; Distance based methods. Phylogenetic analysis, Importance of Phylogenetic trees.

Unit IV **12hrs**

Protein Database: 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 **12hrs**

Drug discovery: Introduction, Concepts in Drug Design: Lead Discovery, Target identification, Hit discovery, Assay Development, optimization and validation. Molecular Docking – rigid and flexible, protein-protein and protein-ligand. Immunoinformatics – databases, epitope prediction and vaccine development. Drug Administration- ADMET. Role of omics in pharmaceutical drug research, Current challenges and conclusion.

f. Mapping of course outcomes to POs and PSOs

Mapping of COs to POs

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

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

(L – Low, M – Medium, H – High)

g. Text books/References:

1) Attwood TK, Parry Smith DJ, Samiron Phukan, 1999. Introduction to Bioinformatics: Pearson Education Ltd.
2) Campbell, A. Malcolm, Laurie J. Heyer, 2007. Discovering Genomics, Proteomics & Bioinformatics, 2nd edition, Pearson Benjamin Cummings.
3) Claverie, Jean-Michel, Cedric Notredame, 2013. Bioinformatics for Dummies, 2nd Edition, John Wiley & Sons.

4) Jonathan Pevsner, 2009. Bioinformatics and Functional Genomics, Second Edition, John Willey & sons INC Publications.
5) Xiong, Jin, 2006. Essential Bioinformatics, Cambridge University 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/

GENETIC ENGINEERING

a. Course code: PBTC23

L	T	P	C
4	0	0	4

b. Course objectives:

1. To understand the fundamentals of genetic engineering and its tools.
2. To explore the depth of knowledge in the manipulation of genetic material for the benefit of humanity.
3. To make students apply these techniques in their research experiments.

c. Course Prerequisites:

- Comprehend the principles behind the genetic concepts.

d. Course outcome:

After completion of the course, students will be able to

Course outcome	Expected outcome	Cognitive level
CO1	Explain the steps involved in genetic engineering	K2
CO2	Prioritize a specific cloning vector for cloning in prokaryotes and eukaryotes.	K3 & K4
CO3	Know the specific model organisms used for recombinant protein production.	K2

CO4	Appraise the efficiency of PCR-based cloning in comparison with traditional cloning strategies.	K4
CO5	Identify the genetic information with various techniques.	K2
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 **12hrs**

Introduction to genetic engineering: merits and demerits of genetic engineering – Restriction modification system – Restriction enzymes: function, classification – Other DNA modifying enzymes and their functions/uses in r-DNA technology. DNA polymerases, Klenow fragment, Ligase, S1 nuclease, Mung Bean nuclease, alkaline phosphatase, Terminal transferase, Polynucleotide kinases, alkaline phosphatases, RNAse A, RNAse H, DNAse 1, Exonucleases, Reverse transcriptase.

Unit II **12hrs**

Introduction to cloning vectors: Plasmids (Types, copy number, properties, origin of replication and incompatibility group, plasmid amplification) – bacteriophages e.g.: λ (Life cycle, genome organization, feasibility as a cloning vehicle) – Types of cloning vectors (structure and general features of cloning vectors, shuttle vectors) – Examples of cloning vectors (pBR322, pUC series of vectors, λ insertional and replacement vectors) – Derivatives of phages and plasmids (cosmids, phagemids, phasmids) – cloning vectors for large DNA fragments using YACs, PACs, YEP and BACs.

Unit III **12hrs**

General strategies for isolation of genomic and plasmid DNA: Strategies for isolation of gene of interest (restriction digestion, PCR) – Creation of rDNA (restriction digestion, modification of vector and insert, linker, adaptors, homopolymer tailing, ligation,) – PCR cloning, selectable and screenable markers, reporter genes- molecular markers: RFLP, RAPD, AFLP, SSCP, and SNP, 16s rDNA typing.

Unit IV **12hrs**

Gene Transfer Methods: Selection of host and vector, Host organisms and their

genotypes- Prokaryotic and eukaryotic systems, Methods of gene transfer- Physical (microinjection, gene gun/biolistic, electroporation), Chemical (calcium chloride, calcium phosphate precipitation method, liposome mediated) and biological methods (*Agrobacterium* and viral)

Unit V **12hrs**

Methods for clone identification: direct screening (insertional inactivation of marker gene, visual screening methods), indirect screening (PCR and hybridization-based techniques-colony PCR/ hybridization and dot blot hybridization), hybridization techniques – Southern blotting, Northern blotting, Western blotting. Examples of Transgenic plants and animals, current status of commercial rDNA products, Gene editing: ZFNs, TALENs, CRISPR.

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	M	L	M	H	H	L	M
CO2	M	H	M	H	L	M	H	H
CO3	L	M	H	M	H	L	M	H
CO4	M	H	L	L	M	H	H	M
CO5	H	M	M	H	L	M	L	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	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	M	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Textbooks/References:

1) Brown T.A., 2007.Genomes 3, Third Edition, Garland Science Publishing.

2) Das HK, 2020.Genetic Engineering: Replication, Expression, Cloning, Manipulation. Wiley Publishers
3) Glick, B.R. and J.J. Pasternak, 2010.Molecular Biotechnology: Principles and Applications of Recombinant DNA" 4th Edition. ASM.
4) Primrose, SB, and Twyman, RM, 2006. Principles of Gene Manipulation and Genomics, 7th ed. Blackwell publishing.
5) Sambrook, Joseph and David W. Russell, 2006. The Condensed Protocols: From Molecular Cloning: A Laboratory Manual" Cold Spring Harbor.

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

IMMUNOLOGY

L	P	T	C
4	0	0	4

a. Course code: PBTC24

b. Course objectives:

1. To know the basics of immune cells and types of immunity.
2. To understand the major histocompatibility complex.
3. To understand the antigen-antibody reactions and hypersensitivity to allergens.

c. Course prerequisites:

- Ultimate knowledge about immunology and immunity of human system.

d. Course outcomes

After successful completion of the course, the 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 immune system's role 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 vaccines.	K5
CO5	Thorough knowledge of transplantation principles.	K3 & K5
CO6	Justify the significance of immunological techniques for 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: 12hrs

Immune System and immunity: History of immunology; innate and acquired immunity. Cells and organs involved in the 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: 12hrs

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: **12hrs**

Antigen-Antibody Reactions: agglutination, precipitation, immunoelectrophoresis, immunofluorescence, ELISA, RIA; flow cytometry, Mantoux test. Applications of these methods in diagnosis of microbial infections, autoimmunity mechanisms, altered antigens, systemic lupus erythematosus, Grave's diseases, rheumatoid arthritis, myasthenia gravis, multiple sclerosis.

Unit IV: **12hrs**

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: **12hrs**

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 their application, Production of monoclonal and polyclonal antibodies – 15 hrs

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	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	H	M	M	H	M
CO2	M	H	M	H	M	H	H	M
CO3	M	M	M	H	H	H	M	M
CO4	H	M	H	H	M	H	H	H
CO5	M	M	M	H	M	M	H	M
CO6	H	H	H	H	H	M	H	H

(L – Low, M – Medium, H – High)

g. Textbooks/References:

1) Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, 2019. Basic Immunology: Functions and Disorders of the Immune System 6th Edition, Elsevier
2) Ivan Maurice Roitt, 1994. Essential Immunology, Blackwell Scientific Publications.
3) Kenneth M. Murph, Casey Weaver, Leslie J. Berg 2022. Janeway's Immunobiology, Tenth Edition, W. W. Norton & Company
4) Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby, 2007. Immunology, W. H. Freeman.
5) Werner Luttmann, Kai Bratke, Michael Kupper, Daniel Myrtek, 2006. Immunology, Elsevier

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

1) https://nptel.ac.in/courses/102105083
2) https://onlinecourses.nptel.ac.in/noc20_bt43/preview
3) https://onlinecourses.nptel.ac.in/noc21_bt49/preview
4) https://onlinecourses.swayam2.ac.in/cec20_bt05/preview

Practical IV: BIOANALYTICAL TECHNIQUES AND BIOINSTRUMENTATION & BIOINFORMATICS

a. Course code: PBTL21

L	T	P	C
0	0	4	2

b. Course objectives:

1. Comprehend the general principle and applications of instruments and analytical techniques.
2. Train the students on basic tools and techniques needed for biotechnology-oriented industries.
3. Understand the various databases, tools, and software available for biological research

c. Course prerequisites:

- Should have cardinal skill of bioanalytical techniques and instrumentation handling.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Comprehend the general principles of instruments and improvise student's analysing skills in result output and interpretation	K2 & K4
CO2	Understand the significance of advanced instruments in diagnosing diverse diseases and disorders	K2
CO3	Infer the bioanalytical techniques and conquer the errors in diverse applied research areas	K3 & K5
CO4	Define the various databases and tools in bioinformatics available for sequence similarity search	K1 & K2
CO5	Explain the different types of sequence alignments and differentiate the usage of local and global alignment	K3, K4
CO6	Construct and analyze phylogenetic tree for evolutionary analysis and identification of consensus	K4, K6

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

e. Course outline

1. Imaging microbial cells using light microscopy
2. Visualize the riboflavin in earthworms by fluorescent microscopy
3. Principle and demonstration of SEM
4. General principle and demonstration of TEM
5. Estimation of proteins by UV-Vis spectroscopy
6. Identification of phytochemical by thin layer chromatography
7. Identification of plant compounds by paper chromatography
8. Examination of DNA by agarose gel electrophoresis
9. Detection of protein by polyacrylamide gel electrophoresis
10. Demonstration of DNA sequencing
11. BLAST and its types
12. Pairwise alignment
    a. Local alignment
    b. Global alignment
13. Multiple sequence alignment and identification of Consensus
14. Phylogenetic tree construction and analysis
15. Protein structure visualization
16. Protein classification, domain identification, signature matching - PFAM, Prodom, Prosite

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	M	M	M	L	H	M
CO2	H	H	H	M	L	L	H	M
CO3	M	H	H	H	M	M	H	H
CO4	M	M	M	M	H	L	M	M
CO5	M	M	M	L	H	L	M	M
CO6	M	M	M	M	H	L	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	M	M	H	H	H	M	M
CO3	H	H	H	H	H	H	H	H
CO4	M	M	M	H	M	M	M	M
CO5	M	M	M	H	M	L	M	M
CO6	M	M	M	H	L	L	M	M

(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

Practical V: GENETIC ENGINEERING & IMMUNOLOGY

a. Course code: PBTL22

L	T	P	C
0	0	4	2

b. Course objectives:

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

c. Course prerequisites:

- Student should have fundamental skills in genetic techniques and handling of equipments.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Discuss the concept of restriction enzymes	K2
CO2	Describe the application of cloning vector	K1
CO3	Construct transgenic plants/animals using genetic engineering tools and techniques for human welfare	K3
CO4	Classify the immune cells based on their significant features	K4
CO5	Evaluate the blood grouping by Rh factors	K5
CO6	Integrate the antigen-antibody reactions and the diagnosis of various infectious and non- infectious diseases	K6

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

e. Course outline

1. Isolation of plasmid DNA and size analysis
2. Restriction, digestion, ligation & transformation into bacteria ($CaCl_2$, 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. Identification of various immune cells by morphology – Leishman staining, Giemsa staining.
9. Counting of blood cells by haemocytometer
10. Identification of blood cell
11. Blood grouping
12. Antigen-antibody reactions**:** agglutination, precipitation
13. Immunoelectrophoresis
14. Heamagglutination reactions- blood grouping – forward and reverse, Rh Typing,Coomb's test, TPHA

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	M	M	H	M	L	H	M
CO2	M	H	M	H	M	L	H	M
CO3	M	H	H	H	M	M	H	H
CO4	H	M	M	M	L	L	M	M
CO5	M	L	L	L	L	L	M	H
CO6	M	M	M	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	M	M	M	M	M	M
CO2	M	M	H	H	M	M	M	H
CO3	H	H	H	H	H	H	H	H
CO4	M	M	H	H	M	M	M	M
CO5	H	H	M	M	H	H	H	H
CO6	M	M	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) John Vennison S, 2009. Laboratory Manual for Genetic Engineering, PHI.

4) Karthik Kalia Perumal et.al, 2017. Practical immunology a laboratory manual, first edition, LAP LAMPERT Academic Publishing.

5) Talwar GPSK, Gupta, 2017. A handbook of practical and clinical Immunology, Volume- II, second edition CBS.

CANCER BIOLOGY

L	T	P	C
3	0	0	3

a. Course code: PBTED

b. Course objectives:

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:

- Essential understanding about the Cancer, treatment and diagnosis.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Comprehensive understanding of cancer development and types	K2 & K4
CO2	Familiar with carcinogenesis process	K1, K2 & K4
CO3	Appreciate and explain the molecular biology of cancer	K3 & K5
CO4	Apply the methods for cancer diagnosis	K3, K4 & K5
CO5	Appraise the principles of cancer therapy	K2, K3 & K5
CO6	Understanding the concepts of cancer biology	K6

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

e. Course outline:

Unit I **9hrs**

Types and Defenses: 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 **9hrs**

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**

Principles of Molecular Cell Biology of Cancer: 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 **9hrs**

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 **9hrs**

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 the therapy of cancer; Gene therapy.

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	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	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	M	H	H	H	M	H	M	M
CO2	M	M	H	H	M	H	M	H
CO3	M	H	H	H	M	M	M	M
CO4	M	H	H	M	M	H	H	H
CO5	M	M	H	M	H	M	M	M
CO6	M	H	H	H	M	H	M	H

(L – Low, M – Medium, H – High)

g. Text books/References:

1) Fiona Macdonald, Christopher Ford, Alan Casson, 2004. Molecular Biology of Cancer, 2nd Edition. Taylor and Francis.
2) Francesco Pezzella, Mahvash Tavassoli, David J. Kerr, 2019. Oxford Textbook of Cancer Biology, Oxford University Press, Oxford.
3) Pradeep Kumar, 2022. The Textbook of Cancer Biology, Taneesha Publishers
4) Raymond W Ruddon, 2007. Cancer Biology, Oxford University Press
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

DNA FINGERPRINTING

a. Course code: PBTEE

L	T	P	C
3	0	0	3

b. Course objectives:

1. To understand the basic concept of DNA
2. Comprehend the significance of the DNA sequencing process
3. Know the concept of forensic science

c. Course prerequisites:

- Should know the significance of forensic science.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Understand the concept of cell theory and DNA composition	K1 & K2
CO2	Illustrate the isolation and stabilization of DNA	K2 & K4
CO3	Understand the basic concept of DNA sequence	K2
CO4	Categorize the DNA sequencing techniques	K4
CO5	Appraise the concept of forensic analysis	K3 & K5
CO6	Justify and develop molecular biology-based techniques to solve critical problems in forensic science	K4, K5 & K6

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

e. Course outline:

Unit I: 9hrs

Diversity of cell: cell size and shape. Cell theory. Isolation and growth of cells. Nucleus size and shape- Chemical composition of DNA.

Unit II: 9hrs

DNA Processing: Isolation of DNA from various sources. Storage of DNA. *In vivo* and *in vitro* stability of DNA.

Unit III: 9hrs

DNA sequencing: single letter code for nucleotide, comparison of DNA sequences. Similarity and variation between individuals.

Unit IV: 9hrs

Human chromosome: Gene repeats in the DNA genome. DNA characterization: DNA sequencing technique, Polymerase chain Reaction (PCR)

Unit V: **9hrs**

Forensic DNA analysis: Restriction length Polymorphism (RFLP), Autosomal Short Tandem Repeats (STR), Y-chromosome autosomal Short Repeats (YSTRs), Single Nucleotide Polymorphisms (SNPs)

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	M	M	M	H	M	M	L
CO2	H	H	H	H	M	M	H	H
CO3	M	M	M	L	M	M	H	H
CO4	M	M	H	M	M	M	H	H
CO5	M	M	H	M	M	L	H	M
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	M	M	H	H	M	M	H	H
CO2	M	M	H	M	M	H	M	H
CO3	M	H	H	M	H	M	M	H
CO4	M	M	H	H	M	M	H	H
CO5	M	H	H	M	M	H	H	H
CO6	H	M	H	H	H	H	M	H

(L – Low, M – Medium, H – High)

g. Text books/References:

1) Davies JA, Reznikoff WS, 1992. Milestones in Biotechnology. Classic papers on Genetic Engineering, Butterworth-Heinemann Publication.
2) Glover DM, Hames BD, 1995. DNA Cloning: A Practical Approach, IRL Press, Oxford.
3) Kaufman PB, Wu W, Kim D, Cseke LJ, 1995. Molecular and Cellular Methods in Biology and Medicine, CRC Press, Florida,

4) Kingsman SM, Kingsman AJ, 1998. Genetic Engineering Introduction to gene analysis an exploitation in eukaryotes, Blackwell Scientific Publications, Oxford.
5) Mickloss DA, Freyer GA, 1990. DNA Science: A First Course in Recombinant Technology, Cold Spring Harbor Laboratory Press, New York.
6) Primrose SB, 1994. Molecular Biotechnology (2nd Edn), Blackwell Scientific Publishers, Oxford.

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
5) https://www.mooc-list.com/tags/fingerprinting
6) https://www.sifs.in/course-details/online-course-forensic-dna-fingerprinting

NANOBIOTECHNOLOGY

L	T	P	C
3	0	0	3

a. Course code: PBTEF

b. Course objectives:

1. The course aims to provide a general and broad introduction to the multidisciplinary field of nanotechnology.
2. It develops new and exciting cross-disciplinary research fields and technologies with biotechnology.
3. The course will also give an insight into complete systems where nanotechnology can be used to improve everyday life.

c. Course prerequisites:

- Vital knowledge about synthesis and applications of nanoparticles.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Describe the basic science behind the properties of materials at the nanometer scale	K2 & K3
CO2	Understand the principles behind the advanced experimental and computational techniques for studying nanomaterials	K2
CO3	Comprehend to handle basic and advanced instruments and finding the size, morphology of nanomaterials	K3
CO4	Know the applications of nanoparticles in human health care	K4 & K5
CO5	Understand the safety issues, ethics, and significance of nanoparticles in various fields	K5
CO6	Design and develop nano-enabled strategies to produce innovative products for the development of a sustainable environment	K3, K5 & K6

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

e. Course outline:

Unit I **9hrs**

Introduction to Nanoscience: Concepts, historical perspective, Nanobiotechnology: recent developments and applications, Cellular nanostructures, Nanopores, Biomolecular motors, Bio-inspired nanostructures.

Unit II **9hrs**

Types of nanomaterials and their classifications: Microbial and plant mediated nanoparticles synthesis, characterization of different nanomaterials, thin films, Colloidal nanostructures, Self assembly, Nanovesicles, Nanospheres, and Nanocapsules.

Unit III **9hrs**

Applications of nanoparticles: S-layers, Chemistry and structure, Magnetosomes, Bacteriorhodopsins, Liposomes, Cubosomes and Hexosomes, biopolymers – drug

delivery, drug targeting, tissue engineering and scaffolds, Iron oxide nanoparticles for functional MRI

Unit IV **9hrs**

Biosensors: definition and classification, Nanoparticles application in removal of environmental hazards, Nanomaterials and cancer diagnosis and therapy, biologically inspired nanocomposites, nanotechnology in Agriculture (Fertilizers and pesticides)

Unit V **9hrs**

Nanomaterials in consumer markets: Is nanotechnology bad or good? Implications of nanotechnology: Health and safety implications from Nanoparticles: Environmental issues, Need for regulation, Potential benefits and risks for developing countries, Criticism of Nanotechnology

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	L	H	M	M	M	M	M
CO2	L	L	H	M	M	M	M	H
CO3	H	L	H	M	M	H	M	H
CO4	H	M	H	M	H	M	M	H
CO5	H	M	M	L	M	H	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	L	M	H
CO2	M	M	H	M	H	L	M	H
CO3	L	M	M	H	M	L	M	M
CO4	H	H	M	H	H	M	M	H
CO5	L	M	M	H	M	H	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) Christ of M. Neimeyer, Chad.A. Mirkin (eds.,), 2004.Nanobiotechology: Concepts, Applications and perspectives, Wiley VCH Weinheim.
3) David.S. Goodsell, 2004. Bionanotechnology: concepts, Lessons from Nature, Wiley-Liss.
4) Greco RS, Prinz FB, Smith RL, 2005. Nanoscale Technology in Biological Systems, CRC press.
5) Pulickel M Ajayan; Linda S Schadler; Paul V Braun, 2010. Nanocomposite Science & Technology Weinheim Wiley-VCH
6) Tuan Vo-Dinh, 2005. Protein Nanotechnology Protocols, Instrumentation and Application, Series; Methods in Molecular Biology.

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

NPTEL online course

Semester III

APPLIED BIOTECHNOLOGY

L	T	P	C
4	0	0	4

a. Course code: PBTC31

b. Course objectives:

1. To understand the various principles of biotechnology.
2. To learn the biotechnology principles for important industrial products
3. To the impact of biotechnology on agriculture and the environment

c. Course prerequisites:

- Primitive knowledge on biotechnological concepts

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Demonstrate professional and scientific communication appropriate for the biotechnology sector	K1 & K2
CO2	Comprehensive understanding of industrial processes and products utilizing rDNA and microbial technology	K2 & K4
CO3	Analyze the biotechnological application in agriculture and the environment	K4
CO4	Apply the biotechnological principles in the therapeutics development	K3 & K5
CO5	Appraise the current regulatory control or ethical policies that impact biotechnology	K2 & K5
CO6	Integrate the concept of biotechnology in various disciplines to solve problems and facilitate the employability in diverse sectors	K6

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

e. Course outline:

Unit I **12 hrs**

Introduction to Biotechnology: An overview – What is Biotechnology, Biotechnology, an interdisciplinary pursuit, old and new biotechnology, scope and importance, commercial potential, public perception of Biotechnology, Biotechnology in India.

Unit II **12 hrs**

Industrial Biotechnology: Isolation and screening of micro-organisms, Bioreactors, process development, scale-up and media design for fermentation processes, food and beverage fermentation, enzymes and food processing, immobilization of enzymes, biotransformation, production of single cell protein (SCP), SCP derived from algae, wastes, crops and economic implications of SCP, production of bioethanol and biodiesel, biosensors.

Unit III **12 hrs**

Biotechnology in Agriculture and Environment: Biotechnology methods of crop improvement- plant tissue culture, transgenesis, transgenic plants, applications of transgenic plants, transgenic animals, novel and better bioinsecticides, biofertilizers. Contributions of biotechnology in waste water treatment and environmental management, biodegradation of xenobiotic compounds.

Unit IV **12 hrs**

Biotechnology and Health care: Conventional vaccines, recombinant vaccines, DNA vaccines, monoclonal antibodies and detection of genetic diseases, interferons, drug designing, gene therapy, forensic medicine applications of human genetic research.

Unit V **12 hrs**

Ethics in Biotechnology: Legal aspects – genetically manipulated organisms and environment, biosafety, Social, Moral and Ethical Considerations

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	H	M	M	H	H
CO2	M	H	H	H	L	L	H	H
CO3	M	H	H	H	L	H	H	M
CO4	M	H	H	M	M	M	H	H
CO5	M	M	M	H	M	H	M	M
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	M	H	M	H	H	M	M	M
CO2	M	H	M	H	H	M	H	H
CO3	H	M	H	M	H	H	H	H
CO4	H	M	M	M	M	H	H	H
CO5	H	M	M	M	M	H	L	H
CO6	H	H	H	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/References:

1) Abilash Jain, Jain V. Khetrapal, 2012. Applied Biotechnology Pacific Books International

2) Gupta, P.K. 2010. Elements of Biotechnology Rastogi Publications.

3) John E. Smith. 2012. Biotechnology, 5th Ed Cambridge Press Kumar H.D., 2009.Modern Concepts of Biotechnology Vikas Publishing House Pvt. Ltd.

4) Kaler RS, Kulkarni M, Umesh Gupta, 2009. Applied Biotechnology I K International Publishing House Pvt. Ltd

5) Sudhir U. Meshram, Shinde GB, 2009. Applied Biotechnology I K International Publishing House Pvt. Ltd

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

1) https://onlinecourses.nptel.ac.in/noc21_bt23/preview
2) https://nptel.ac.in/courses/102103083
3) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==

BIOPROCESS TECHNOLOGY

a. Course code: PBTC32

L	T	P	C
4	0	0	4

b. Course objectives:

1. The course explains the role of biotechnology in the fermentation process.
2. It gives details about converting a small-scale laboratory process into a large-scale industrial process.
3. It also deals with the various vital products produced by bioprocess techniques.

c. Course prerequisites:

- Introductory information of fermenter, fermentation process, and microbial metabolism.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Recognize the fundamentals of fermentation technology and indicate the improvement of the inoculum.	K1, K2
CO2	Analyze the different sterilization processes and criticize different types of fermenters.	K4, K5
CO3	Assess basic requirements in bioreactors, modeling of bioprocesses, traditional and new concepts in bioprocess monitoring, and the biological basis for industrial fermentations.	K5, K3
CO4	Evaluate the various procedures used in the downstream processing and gain information on product recovery.	K5

CO5	Integrate the scientific and technological knowledge on the use of bioprocesses for industrial products on the cell and process level.	K6
CO6	Produce, analyze and interpret data from bioprocesses.	K2, K4

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

e. Course outline:

Unit I: 12hrs

Introduction and History of fermentation: Fermentation process: - Strain, culture collection, criteria used in media formulation, Inoculum preparation, Scale up of the inoculum - Sterilization, Batch and Continuous sterilization of medium, Aseptic operation.

Unit II: 12hrs

Methods of Sterilization: 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. Types of Fermentation Processes: Batch, Fed-batch and continuous bio reactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors, pulsed, fluidized, photo bioreactors.

Unit III: 12hrs

Fermentation control systems: Manual and automatic control in fermentation processes. Architecture of Fermentation systems, temperature measurement and control, flow measurement and control, pressure measurement and control, measurement of pH and dissolved oxygen and related sensors, Computer applications in fermentation technology.

Unit IV: 12hrs

Downstream Processing: Introduction, Removal of microbial cells and solid Matter, foam separation, precipitation, Membrane-based purification: Ultrafiltration; Reverse osmosis; Dialysis; centrifugation, cell disruptions, liquid-liquid extraction, and

chromatography, Precipitation, Drying, and Crystallization. Effluent treatment: BOD and COD. Treatment and disposal of effluents.

Unit V: **12hrs**

Microbes-Industrial Applications: Industrial bioprocess Industrial Production: Anaerobic (ethanol, lactic acid) aerobic process (citric acid, Streptomycin and single cell protein), Acids (citric), solvents (glycerol), Antibiotics (penicillin, streptomycin) Single cell Protein, Use of microbes in mineral beneficiation and oil recovery.

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	M	M	M	L	H	H	H
CO2	H	H	L	H	M	M	H	H
CO3	L	H	M	H	M	L	H	H
CO4	L	H	H	H	L	M	M	H
CO5	H	H	H	L	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	M	M	M	L	M	H	H
CO2	H	H	M	H	M	M	H	H
CO3	L	M	H	H	M	M	H	H
CO4	M	H	H	M	H	H	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. Text books/References:

1) Doran PM, 2013. Bioprocess Engineering Principles. 2nd Edition, Academic Press, Harcourt Brace and Company Publishers.
2) Mansi MTEL, Bryle CFA, 2002. Fermentation Microbiology and Biotechnology, Taylor & Francis Ltd, UK.
3) Stanbury PF, Whitaker A, and Hall SJ, 2003. Principles of Fermentation Technology, Butterworth Heinemann.
4) Wulf Cruege, Anneliese Crueger, 2000. Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, India.
5) Young MM, Reed, 2004. Comprehensive Biotechnology. The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4, Elsevier India Private Ltd, India.

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/

FOOD BIOTECHNOLOGY

a. Course code: PBTC33

L	T	P	C
4	0	0	4

b. Course objectives:

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 to know 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:

- Vital knowledge on significance of food processing and preservation

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Impart an in-depth understanding of biotechnology principles behind traditional and fermented foods	K2
CO2	Familiarize 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 analyzing the produced food products	K2, K3 & K5
CO4	Appreciate the relevance of biotechnological principles for ensuring food safety and security. Practical experience in biotechnology in food industry product safety, risk assessment, and regulatory compliance	K4 & K5
CO5	Understand the advantages, safety, and risk of genetically modified foods 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

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

e. Course outline:

Unit I **12hrs**

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 **12hrs**

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 **12hrs**

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 **12hrs**

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 **12hrs**

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 outcomes 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	M	H	M	H	L	H	H
CO2	H	M	M	M	H	M	H	M
CO3	M	M	H	H	M	M	H	H
CO4	M	M	H	H	M	H	H	M
CO5	H	M	M	M	H	M	M	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, 2012. Food Biochemistry and Food Processing, 2nd Edition. Wiley.
3) Byong H. Lee, 2015. Fundamentals of Food Biotechnology, 2nd Edition. Wiley.
4) Catherine Ross, Shils, Maurice E Shike, Moshe. 2013. Modern nutrition in health and disease.11th edition, Jones & Bartlett Learning
5) Frazier, West Hoff, 1995. Food Microbiology, Tata McGraw Hill publishing company Ltd, New Delhi.

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==

OMICS IN BIOLOGY

L	T	P	C
4	0	0	4

a. Course code: PBTC34

b. Course objectives:

1. To understand the genome organization, sequencing, and applications of genomics
2. To study the role of genes and proteins by genomic and proteomic technologies
3. To create interest in advanced omics fields like metabolomics and interactomics to study the functional aspects of genes and proteins as a wholesome approach for its various clinical implications

c. Course prerequisites:

- Essential intelligence in bioinformatics concepts

d. Course outcomes (CO):

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

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the genome organization and various types of sequencing methods and analysis	K1
CO2	Explain the concepts of different fields of genomics and their applications	K2
CO3	Illustrate the construction of protein microarray and dissection of protein interactions	K3, K4
CO4	Compare and analyze the gene expression using genomic tools and annotation studies.	K4, K5
CO5	Critique the methods to interpret metabolomics & interactomics data and their implications in clinical studies	K3, K5
CO6	Facilitate the opportunity to acquire positions in pharma and biotech industries	K6

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

e. Course outline

Unit I **12hrs**

Genomics: Genome Organization, Genome Sequencing: Maxum-Gilbert Method, Sanger Methods, Pyrosequencing. Next Generation Sequencing methods, Genome assembly and annotation, Genome mapping, Human Genome Project, DNA Polymorphism, SNPs, distribution of SNPs, Applications of SNP technology. HapMap Project. Role of SNPs in Pharmacogenomics. Meta-genomics, Comparative genomics: Basic concepts and applications and databases. Functional genomics, RFLP, RAPD, Microarray.

Unit II **12hrs**

Proteomics: Introduction and scope of proteomics, protein separation techniques, Peptide sequencing, Protein expression analysis: 2D-PAGE, Protein microarray, Mass spectrometry, Western blotting. Molecular interactions: Protein-Protein interactions, Protein-DNA interactions. Methods to predict molecular interactions: Y2H method, Phage-display method, Phylogenetic foot printing, Gene fusion method, Protein profiling.

Unit III **12hrs**

Transcriptomics: Transcription: Pre-processing of RNA, mRNA, Types and function of RNA, RNA interference (RNAi), RNA-induced silencing complex (RISC), Biogenesis of miRNA and siRNA. Transcriptome project (Human, Mouse, Cancer, Fungal), EST-expressed sequence tags, Serial analysis of gene expression (SAGE), SAGE data analysis, Transcriptomics applications.

Unit IV **12hrs**

Metabolomics: Metabolome and Metabolomics, Metabolic profiling and fingerprinting, Metabolic pathway analysis and metabolic networks, Single Cell Metabolomics, Metabotype Concept. Computational Methods to Interpret and Integrate Metabolomic Data, Metabolomics data processing workflow, Chemical ontologies, online metabolic databases (Human Metabolome Databases, KEGG, BioCyc) and pipelines. Applications of Metabolomics: Metabolic Pathway as a target

for Drug-screening, Metabolomics approach for hazard identification in human health assessment of environmental chemicals, Clinical implications of Metabolomics. Plant metabolomics.

Unit V **12hrs**

Interactomics: Introduction to Interactomics and Protein Arrays, MIST, DAPA, and Halotag Arrays, NAPPA Technology and Protein Arrays Biomarkers: Harnessing the immune system for early detection of disease, Microarray Data Analysis, Use of SPR in unravelling domain motif interactions of proteasomal assembly chaperones Protein-small molecule interaction study: Immobilization & binding analysis, Protein-small molecule interaction study: Kinetic analysis.

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	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	M	H	H	H	M	H	L	H
CO2	H	H	H	M	H	H	H	M
CO3	H	H	M	H	H	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) David Mount, 2004. Bioinformatics: Sequence and Genome Analysis. 2nd edition, Cold Spring Harbor Laboratory.
2) Fan, Teresa Whei-Mei, Lane, Andrew N, Higashi, Richard M, 2012. The Handbook of Metabolomics, Springer Protocols
3) Greg Gibson, Spencer V Muse, 2009. A Primer of Genome Science. 3rd edition, Oxford University Press.
4) Hector C Keun, 2018. NMR-based Metabolomics, Royal Society of Chemistry
5) Michael K, Claudia K, Andreas S, 2017. Functional Genomics: Methods and Protocols, Springer Protocols
6) Raftery, Daniel, 2014. Mass Spectrometry in Metabolomics: Methods and Protocols, Springer Protocols

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

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

Practical VI: APPLIED BIOTECHNOLOGY & BIOPROCESS TECHNOLOGY

a. Course code: PBTL31

L	T	P	C
0	0	4	2

b. Course objectives:

1. To strengthen the student in advanced tools and techniques for ensuring their employability
2. To equip the students with all techniques of bioprocess technology applied in industries

3. To prepare and sensitize the students on applied biotechnology & bioprocess technology research scope and their industrial applications.

c. Course prerequisites:

- Primary skills in handling and maintenance of microbes.
- Understanding fermentation type and sterilization techniques.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Recognize the industrially important microorganism and its development.	K1
CO2	Differentiate the microbial biomass and their products widely produced through the fermentation process.	K2
CO3	Explain the procedures followed for the production and estimation of alcohol-like industrial products.	K3, K4
CO4	Assess antimicrobial sensitivity like bioassay techniques and other cell immobilization techniques' role in product realization.	K5
CO5	Analyze different uses of fermentation methods in the industry and their products.	K4
CO6	Develop students' appreciation for industrial pieces of training and employment.	K6

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

e. Course outline

1. Production of microbial polysaccharides and determination of yield.
2. Isolation and cultivation of *Azotobacter, Rhizobium*, Phosphate solubilizers
3. Cultivation of edible mushroom
4. Quantitation of DNA and Protein using UV absorption
5. Growth of bacteria-estimation of biomass, calculation of specific growth rate.

6. Selective isolation of actinomycetes – study their growth characteristics.
7. Isolation and enumeration of lactic acid bacteria.
8. Wine production by yeast – setting up a lab experiment.
9. Estimation of alcohol content by colorimetric method
10. Immobilization of yeast cell by alginate beads.
11. Bioassay techniques for antibiotics.

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	M	M	M	L	H	H	H
CO2	H	H	L	H	M	M	H	H
CO3	L	H	M	H	M	L	H	H
CO4	L	H	H	H	L	M	M	H
CO5	H	H	H	L	M	M	H	H
CO6	H	M	M	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	H	M	M	M	L	M	H	H
CO2	H	H	M	H	M	M	H	H
CO3	L	M	H	H	M	M	H	H
CO4	M	H	H	M	H	H	H	H
CO5	H	H	H	M	H	M	H	H
CO6	M	H	H	M	M	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) Sunil D Purohit, Neelu Joshi, 2007. Molecular Biology & Biotechnology (A Practical Manual), Apex Publishing House
5) Swagat Kumar Das Hrudayanath Thatoi, Supriya Dash, 2020. Practical Biotechnology: Principles and Protocols, Dreamtech Press

Practical VII: FOOD BIOTECHNOLOGY & OMICS IN BIOLOGY

a. Course code: PBTL32

L	T	P	C
0	0	4	2

b. Course objectives:

1. To understand the concept of food processing and preservation methods
2. To study the characteristics and functional of genes and proteins by genomic and proteomic techniques
3. To gain knowledge on metabolomics and interactomics.

c. Course prerequisites:

- Primordial information of foodborne pathogens
- Fundamental skills of bioinformatics tools

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Describe the methods used for determining the quality of water and other foods.	K1
CO2	Understand the concepts and ways of applying various food preservation techniques.	K2 & K3

CO3	Illustrate the application of single-cell protein	K3
CO4	Compare and analyse the gene expressions using genomic tools	K4, K5
CO5	Critique the methods for proteomics data and their implications in cancer research	K3, K5
CO6	Facilitate the opportunity to acquire positions in pharma and biotech industries	K6

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

e. Course outline

1. Determination of microbiological quality of water by MPN method.
2. Presumptive and confirmatory tests for coliform bacteria in water.
3. Enumeration of microorganisms from bread.
4. Food coloring and food preserving technique, Pasteurization technique and method.
5. Determination of TDT & TDP.
6. Production and estimation of Biomass (SCP) using dry and wet weight methods.
7. Markers for Genetic Mapping; RFLP, RAPD, AFLP, CAPS, SCAR, SSRs,
8. Microarray technology - SNP detection techniques, SAGE – principles and application.
9. Mass spectrometry and analysis - MALDI, LC/MS-MS;
10. ORF scanning – Codon bias, Exon- Intron boundaries - Exon trapping, CpG island, Gene location – Southern and Northern blotting hybridization, Zoo blotting. Studying a transcriptome – Microarray or chip analysis, SAGE.
11. Proteomics - ID–SDS-PAGE, 2D-PAGE. Detection and quantitation of proteins in gels. Protein staining techniques. Affinity purification of proteins.

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	H	H	L	H	L
CO2	H	H	H	M	H	H	H	H
CO3	H	H	H	H	H	M	M	H
CO4	H	M	M	H	M	H	H	M
CO5	H	H	H	H	H	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	M	H	H	H	M	H	L	H
CO2	H	M	H	H	H	H	H	M
CO3	H	H	M	M	H	M	H	H
CO4	H	M	H	H	H	H	M	H
CO5	H	H	M	M	H	H	H	M
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) 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

BIOPHARMACEUTICALS

a. Course code: PBTEG

L	T	P	C
3	0	0	3

b. Course objectives:

1. Strong foundation and advanced information on biopharmaceutical aspects concerning drug development.
2. Providing core responsibilities for developing and monitoring the drug and preparing medicines according to the norms.
3. To gain knowledge in physicochemical properties, pharmacology, and the formulation of commonly used biopharmaceuticals.

c. Course prerequisites:

- Basic understanding of pharmaceutical products, antibiotics and chemical composition of drugs.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Describe the basic principles of pharmacology, pharmacokinetics, and the metabolism of drugs	K2
CO2	Evaluate the pharmacological substances from different origins- plants, animals, and microbes.	K6
CO3	Understand the mode of action of drugs on different organs towards developing novel drugs.	K2, K3, K6
CO4	Distinguish the advanced drug delivery system and develop an idea of drug approval procedures.	K2, K3, K6
CO5	Describe an idea about the drug formulation process and recommend entries of pharmacology concerns.	K2, K5
CO6	Understand and analyze different pharmaceutical parameters for current and future biotechnology-related products.	K2, K4

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

e. Course outline:

Unit I **9hrs**

Introduction of pharmacology: Definition of drug, Sources of drugs, route of administration, mechanism of action of drugs. Pharmacogenetics and pharmacokinetics: absorption, distribution, metabolism and excretion of drugs.

Unit II **9hrs**

Sources of Drugs: Pharmaceutical substances of microbial origin: the macrolides and ansamycins, peptides, and other antibiotics. Pharmaceutical substances of plant origin - Alkaloids, atropine and scopolamine, morphine, and cocaine. Pharmaceuticals of animal origin - The sex hormones, the androgens, estrogens, progesterone, and progestogens.

Unit III **9hrs**

Action of Drugs: Drugs acting on the central nervous system: - Analgesics, antipyretics, anti-inflammatory, antidepressants, and CNS stimulants. Drug acting on the cardiovascular system: Anti-hypertensive drugs and anti-hyper lipidemic drugs. Drug acting on urinary system: Diuretics and anti-diuretics. Drug acting on respiratory system: -Anti-asthmatic drug.

Unit IV **9hrs**

Delivery of biopharmaceuticals: Oral delivery systems, pulmonary delivery, nasal, transmucosal and transdermal delivery systems. Clinical trials, The role and remit of regulatory authorities, Food and drug administration, The new drug application, National regulatory authorities, The EMEA and the new EU drug approval systems and the centralized procedure.

Unit V **9hrs**

Drug formulations: Compressed tablets, Wet granulation, Dry granulation or slugging, Direct compression, Tablet presses, Formulation, coating, Capsules sustained dosage forms, Parental solutions, Oral liquids Injections, Ointments, Standards of hygiene and good manufacturing practice.

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	L	M	M
CO2	M	H	H	H	L	M	M	H
CO3	H	H	L	M	H	M	H	H
CO4	L	M	H	M	H	H	M	H
CO5	M	L	H	L	M	M	M	M
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	M	L	M	H	M	H	H
CO2	H	L	H	H	M	M	H	H
CO3	H	M	H	L	M	M	H	M
CO4	L	M	H	M	H	H	M	H
CO5	M	H	M	M	L	M	H	H
CO6	H	M	H	M	M	M	H	H

(L – Low, M – Medium, H – High)

g. Text books/References:

1) Basanta Kumara Behera, 2020. Biopharmaceuticals: Challenges and Opportunities, 1st edition CRC Press.
2) Gareth Thomas, 2000 Medicinal Chemistry. An introduction. Wiley.
3) Gary Walsh, 2003. Biopharmaceuticals, second edition. University of Limerick, Ireland.
4) Katzung BG, 1995. Basic and Clinical Pharmacology, Prentice Hall of Intl.
5) Richard Finkel, Michelle Alexia Clark, Luigi X. Cubeddu, 2009. Lippincotts Illustrated Reviews Pharmacology IVth Edition. Wolters Kluwer / Lippincott Williams and Wilkins.

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

BIOTECHNOLOGY FOR HUMAN WELFARE

a. Course code: PBTEH

L	T	P	C
3	0	0	3

b. Course objectives:

1. Describe the biotechnologist's role in human welfare and facilitate the same for developing products and technologies improving human life.
2. To develop non-toxic therapeutic drugs for human welfare.

c. Course prerequisites:

- Elementary facts about the human welfare and drugs.

d. Course outcomes

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

Course outcome	Expected outcome	Cognitive level
CO1	Examine the potential benefits of bioprocesses for improving human life.	K1 & K2
CO2	Analyze the investigations and augment forensic scientists and legal experts to solve violent crimes, identity thefts, legal suits, and terrorism	K2 & K4
CO3	Apply biotechnological processes and tools for industrial production of high-value fine chemicals and molecules	K3
CO4	Achieve sustainable agriculture through bioresources utilization	K5
CO5	Focus on non-hazardous vaccines and antibodies for human healthcare applications	K3 & K5
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 **9hrs**

Industrial application: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation

UNIT II **9hrs**

Biotechnology in Agriculture: Organic farming, Integrated farming, N2 fixation: transfer of pest resistance genes to plants; Vermicompost, Crop Improvement; qualitative improvement of livestock

UNIT III **9hrs**

Environment: Waste management – Solid, liquid, sewage, municipal waste, organic pollutant, and hydrocarbon degradation; biodegradable polymers such as PHB development.

UNIT IV **9hrs**

Application in Forensic science: Solving violent crimes such as murder and rape; solving claims of paternity and theft, etc., using various DNA fingerprinting methods.

UNIT V: **9hrs**

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

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	M	H	L	L	H	H
CO2	M	H	M	L	L	M	M	M
CO3	H	H	M	M	L	M	H	M
CO4	M	H	M	M	M	L	M	M
CO5	H	H	H	H	M	M	H	H
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	H	M	H	M	H	H	H	M
CO2	M	L	L	M	M	H	M	M
CO3	H	M	H	H	H	M	H	H
CO4	M	M	M	M	H	M	H	H
CO5	H	M	H	H	H	H	M	H
CO6	M	M	M	H	H	M	M	H

(L – Low, M – Medium, H – High)

g. Text books/References:

1) Aman Biswas, Subroto Biswas, 2020. Biotechnology and Human Welfare for Competitive Examinations. McGraw Hill India.
2) Irfan Ali Khan, Atiya Khanum, 2005. Biotechnology in the Welfare of Mankind. Ukaaz Publications, Hyderabad.
3) Kaliwal BB, Kulkarni GK, Kaliwal RB, Sadashiv SO, 2017. Biotechnology for Human Welfare: Role of Animal Sciences in National Development (Vol.2) Today & Tomorrows Printers and Publishers.
4) Tilak Saha, Bipransh Kumar Tiwary (Editors), 2018. Microbes, Environment and Human Welfare. Nova Science Publishers, Inc.
5) Vaidyanath K, Pratap Reddy K, Satya Prasad K, 2019. Introduction to Biology and Biotechnology, CRC Press.

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

1. https://www.mooc-list.com/tags/human-welfare
2. https://nptel.ac.in/courses/129105005

DIAGNOSTIC TOOLS & CLINICAL TRIALS

a. Course code: PBTEI

L	T	P	C
3	0	0	3

b. Course objectives:

1. To understand the traditional and molecular diagnosis.
2. To understand the drug development processes and various phases of clinical trials.

3. To understand and analyze the description of managing clinical data and international clinical trials.

c. Course prerequisites:

- Basal literacy about the molecular diagnosis.

d. Course outcomes

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

Course outcomes	Expected outcome	Cognitive level
CO1	Define and discuss the microbial pathogenicity and infectious diseases	K1 & K2
CO2	Describe in detail traditional and molecular diagnosis	K1 & K3
CO3	Understanding the steps involved in the drug development process	K2, K3 & K4
CO4	Appraise good clinical practice and responsibilities	K4 & K5
CO5	Create the clinical trials data management and understand the International clinical trials	K2, K5 & K6
CO6	Focus on pandemic diseases and design, formulate drugs against various infectious and non-infectious diseases for better life of humans	K4 & K6

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

e. Course outline:

Unit I **9hrs**

Introduction and History: Definition 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 **9hrs**

Methods of diagnosis: Traditional disease diagnosis methods and tools. Diagnosis of major bacterial and fungal infections · Diagnosis of DNA and RNA viruses. Major metabolic disorders and their causes. Traditional methods for the diagnosis of metabolic errors. Neonatal and prenatal disease diagnostics. Analysis of mitochondrial DNA for maternal inheritance. Molecular diagnosis for early detection of cerebral palsy, Down syndrome etc.

Unit III **9hrs**

Drug development: The Drug Development Process - Pre-clinical studies –Various phases of clinical trials- Application to market new drugs and biologics - developing new devices - Post marketing surveillance of drugs, biologics, and devices.

Unit IV **9hrs**

Clinical practice guidelines: Good clinical practice – Responsibilities: Principal Investigator, Sponsor responsibilities: Institutional review boards - Monitoring, Audits, and Inspections; Common components of a protocol - Study organization - Objectives/endpoints - Study design; Monitoring - study start-up Phase - Study maintenance phase - Study completion and close-out phase.

Unit V **9hrs**

Regulations of clinical trial: Guidelines and regulations regarding clinical trial data – Study site responsibilities; Regarding clinical trial data – Source document verification of clinical trial data – Confidentiality of clinical trial data – International clinical trials – Ethnic and racial differences – Ethical issues and cultural sensitivities; International regulations – Future efforts

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	L	M	M
CO2	M	M	M	L	M	M	H	H
CO3	H	M	M	M	H	L	H	H
CO4	M	H	H	H	M	L	M	H
CO5	M	M	H	M	M	L	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	M	H	H	M	H	M	M
CO2	M	M	H	H	H	H	M	H
CO3	H	H	M	H	M	M	H	H
CO4	M	M	H	M	M	M	H	H
CO5	M	M	H	M	M	H	M	H
CO6	H	M	M	H	H	H	H	H

(L – Low, M – Medium, H – High)

g. Text books/References:

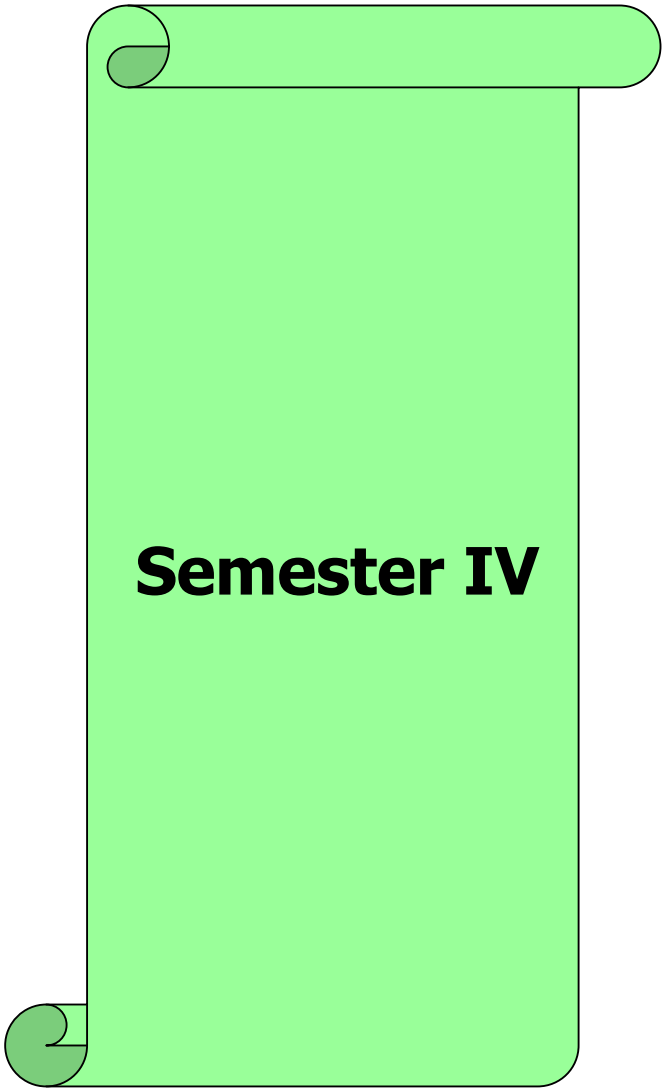
1) Alice Kuruvilla, Paul AD, 2013. Clinical Trials A Beginner's Guide 1st Edition, Paras Medical Publisher
2) Gallin JI, Ognibene FP, Johnson L, 2017. Principles and Practice of Clinical Research, 4th Edition, Academic Press.
3) Lawrence M. Friedman, Curt D. Furberg, David L. DeMets, David M. Reboussin, Christopher B. Granger, 2015. Fundamentals of Clinical Trials, Fifth Edition, Springer.
4) Liu MB, Davis K, 2010. Clinical trials manual from the Duke Clinical Research Institute: lessons from a horse named Jim, 2nd Edition, John Wiley & Sons, Ltd.
5) Tom Brody, 2016. Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, 2nd edition, Academic Press.

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

NPTEL online course

Internship


Semester IV

MOLECULAR THERAPEUTICS (e-PG Pathshala)

L	T	P	C
4	0	0	4

a. Course code: PBTC41

b. Course objectives:

The core objectives of this course are:

1. To understand the human associated metabolic and infectious diseases.
2. To know the significance of advanced therapeutic methods for human welfare.

c. Course prerequisites:

- Fundamental acquaintance on various infectious diseases

d. Course outcomes (COs):

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

Course outcome	Expected outcome	Cognitive level
CO1	Define and understand the concept of biomedical research and molecular research.	K1 & K2
CO2	Understand the significance gene therapeutic methods	K2
CO3	Examine the drug targeting molecules for various diseases	K1 & K3
CO4	Analyse and evaluate the biological based therapeutic methods against bacterial, viral and protozoal diseases	K4 & K5
CO5	Justify the hallmarks of cancer and stem cells	K5 & K6
CO6	Design and develop advanced therapeutic techniques for human	K6

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

e. Course outline:

UNIT-I **12 hrs**

Bioethics and biostatistics: Ethics in Biomedical Research, Biosafety and biocontainment I, Biosafety and Biocontainment II, Animal models in metabolic and infectious diseases, Animal models in molecular therapeutics, Animal handling and experimentation, Research Inference and various statistical procedures, Biostatistics in research Part I, Biostatistics in research Part II

UNIT-II **12 hrs**

Molecular therapeutics: Basics of Molecular Therapeutics Part I, Basics of molecular therapeutics II, Basics of molecular therapeutics III, Fundamentals of Gene Therapy, Gene editing, Gene regulation and gene silencing, Nutrigenomics the latest trends, Cellular and molecular aspects of stem cells, nuclear reprogramming in moleculartttherapeutics, Vaccines and vaccinology I, Vaccines and VaccinologyII

UNIT-III **12 hrs**

Pathogenesis: Identification of Drug Targets and screening of inhibitors/modulators, Molecular mechanisms of pathogenesis, Basics of biotherapy/bioimmunotherapy, Cellular therapy, Antibody therapeutics, Cytokine therapy

UNIT-IV **12 hrs**

Biology and biotherapy of diseases: Biology of viral diseases, Biotherapy for viral diseases, Biotherapy of cancer, Biotherapy of bacterial diseases, Biology of fungal diseases, Biotherapy of fungal diseases, Biology of protozoan diseases, Biotherapy of protozoal diseases

UNIT-V **12 hrs**

Cell culture therapeutics: Cancer Stem Cell, Recombinant protein therapeutics, Opioid peptide biotherapeutics, Basics of Cancer Biology, Basics of mammalian Cell Culture Techniques, frontiers in human genome

Mapping of COs to POs

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

(L – Low, M – Medium, H – High)

g. Text books/ References:

1) David Whitehouse, Ralph Rapley, 2012, Molecular and Cellular Therapeutics, John Wiley & Sons, Ltd

2) David Whitehouse, 2012. Molecular and Cellular Therapeutics John Wiley & Sons Inc

3) Georg F. Weber, 2015. Molecular Therapies of Cancer, Springer International

4) Klaus Schindhelm, Robert Nordon, 1999. Cells and Genes in Molecular Therapeutics ex Vivo Cell Therapy, Academic Press.

5) Pamela Greenwell, Michelle McCulley, 2007. Molecular Therapeutics: 21st Century Medicine 1st edition, Wiley-Interscience.

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

1) https://4dmoleculartherapeutics.com/
2) https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==

RESEARCH METHODOLOGY & BIOSTATISTICS

a. Course code: PBTC42

L	T	P	C
4	0	0	4

b. Course objectives:

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:

- Primeval information on types of research and statistical tools for data analysis

d. Course outcome (COs):

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

Course outcomes	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

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

e. Course outline

Unit I: 12 hrs

Introduction on research: 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**

Data collection and web resources: 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 inflibnet, 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**

Biostatistics: 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**

Tests for significance: 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 ways. Use of statistical software.

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	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) Davis, GB, Parkar CA, 1997. Writing the doctoral dissertation. 2nd edition, Barrons Educational series.

2) Dawson Catherine, 2002. Practical Research Methods, New Delhi, UBS Publishers 'Distributors.

3) Duncary, P, 2003. Authoring a Ph.D. thesis: how to plan, draft, write and finish a doctoral dissertation. Palgrave Macmillan.43.

4) Kothari CR, 1985. Research Methodology- Methods and Techniques, Wiley Eastern Limited.

5) Krathwohl DR, 1993. How to prepare a research proposal (3rd edition) Syracuse University Press.

6) Kumar, Ranjit, 2005. Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.), Pearson Education.

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

1) https://onlinecourses.nptel.ac.in/noc22_ge08/preview
2) https://www.pharm-dnotes.com/biostatistics%20and%20research%20methodology
3) https://fdocuments.in/document/research-methodology-notes.html
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) http://www.revolutionpharmd.com/2013/03/biostatistics-research-methodology.html?m=1

Industrial / institutional visit

Dissertation

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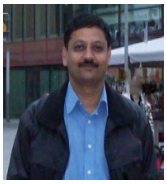
	Prof.(Dr) S. Sudhakar	Member	Professor, Department of Biotechnology, Manonmaniam Sundaranar University Tirunelveli -12, Cell: 9940998936, email: sudhakarmsu@yahoo.com
	Prof.(Dr) S. Uma Maheswari	Member	Professor, Department of Biotechnology Manonmaniam Sundaranar University, Tirunelveli -12 Cell: 9940998936, email: umamsu@gmail.com
	Dr.S. Venkatesh	Member	Assistant Professor, Manonmaniam Sundaranar University Tirunelveli - 12 Cell: 9443164684, email: venkatesh@msuniv.ac.in
	Prof.(Dr) K. Balamurugan	External expert	Professor, Dept of Biotechnology, Alagappa University, Karaikudi, Mobile: 9486426931. Email: bsuryar@yahoo.com
	Prof.(Dr) Chandraraj Raj Krishnan	External expert	Professor, Indian Institute of Technology (IIT), Madras, Chennai-600036, No:91-44-2257-4111, Email:keraj@iitm.ac.in

	Prof.(Dr) V.Stalin Raj	External expert	Associate Professor, School of Biology(IISER), Indian Institute of Science Education and Research, Thiruvananthapuram-695551, Kerala No:+91(0)471-2778160, Email:stalin@iisertvm.ac.in
	Dr.J. Mathiyarasu	External expert	Senior Principal Scientist, CSIR- Central Electrochemical Research Institute, Karaikudi- 630003, Emait: almathi@cecri.res.in
	Dr. G. Ponnuthurai	Alumni	Assistant Professor, Dept of Microbiology and Biotechnology, MMSSVN College, Nagamalai, Puthukottai, Madurai - 19 Mobile: 9025157061, Email: ponmani9999@gmail.com
	S. Syed Ali Fathima	Student rep.	MSc Biotechnology, Dept of Biotechnology Manonmaniam Sundaranar University, Email: anwarfathi339@gmail.com
	Dr.G. Sasikumar	Industrialist	Director, Amazing Biotech, Marakkanam, Villupuram Dt. -604 303. Mobile:9884163638, Email: contact@amazingbiotech.in
	Prof. R.S. Rajesh		Dean, Faculty of Science Manonmaniam Sundaranar University, Tirunelveli -12