SYLLABUS

for

M.Sc. Biotechnology Programme

(2022-2023 ONWARDS)

Outcome Based Education (OBE)

DEPARTMENT OF

BIOTECHNOLOGY AND BIOINFORMATICS

BISHOP HEBER COLLEGE (Autonomous)

(Affiliated to Bharathiodasan University)

(Nationally Reaccredited with A Grade by NAAC with CGPA of 3.58 out of 4)

Recognized by UGC as 'College of Excellence'

Tiruchirappalli – 620 017

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

M. Sc., Biotechnology

VISION AND MISSION

OUTCOME BASED EDUCATION

VISION

The Department seeks to – create holistic development through teaching, research and extension activities with mutual love, social commitment and conscience.

MISSION

The Department of Biotechnology & Bioinformatics aims,

- To develop students in technical education and research by imparting knowledge and skill to attain academic excellence and professional competence.

- To serve humanity with exemplary values and professional ethics

PROGRAM OUTCOMES (POs)

On Successful completion of the Program, the Post graduates of Biotechnology will be able to exhibit the following abilities in the respective domains

KNOWLEDGE

PO1: Exhibit advanced knowledge in the biotechnological concepts and principles in real life in both orally and in writing, with confidence and share their views/ideas.

PO2: Critically analyze and evaluate existing hypotheses and knowledge gained through various sources, to solve long standing problems and discover new breakthrough

SKILLS

PO3: Display research-related skills through practical and project work as they are trained to plan, execute, analyze and report their experiments and also publish their findings.

PO4: Apply skills necessary to analyze and interpret qualitative as well as quantitative data independently to develop models with an open mind.

PO5: Demonstrate the outcomes of holistic education for their employment in biotechnology-related jobs and for pursuing higher education in reputed institutions by developing technical and communication skills.

PO6: Trained to identify and address the socially relevant pressing problems both in the national and global setting by using the skills acquired from the programme.

ATTITUDES

PO7: Explore and engage in lifelong learning by accessing library and ICT facilities to evolve new technologies based on the need of the job market.

ETHICAL & SOCIAL VALUES

PO8: Exhibit the art of teamwork and to conduct themselves with responsibility and character while they pursue shared/group projects and assignments.

PO9: Practice moral and social values in personal and social life to meet the needs of the society as responsible citizens.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Upon Successful Completion of the program, the graduates will be able to

KNOWLEDGE & SKILLS DOMAIN

INTELLECTUAL SKILL

PSO 1: Apply the knowledge of advanced concepts of Biotechnology to solve problems related to different fields of Biotechnology, Genomics, Proteomics, Stem cell biology, Cell biology, DNA technology and biochemistry

PSO 2: Analyze and relate the impact of biotechnological solutions for animals, plants and microbes and understand biotechnology management

PRACTICAL SKILL

PSO 3: Develop practical expertise in the area of Biochemistry, Molecular biology, Cell biology, Microbiology, Genomics, Immunology, Food Biotechnology, Plant and Animal Biotechnology and apply statistical methods.

PSO4 : Understand the applications of Biotechnology in Agriculture, Pharma Industry, Food industry, R&D activities, Clinical research and novel product development to address the societal problems.

M.Sc. BIOTECHNOLOGY Programme Structure

(For the candidates admitted in the academic year 2022 onwards)

Sem	Course	Course title	Course Code	Hours/ week	Credits	Marks		
						CIA	ESE	Total
I	Core I	Cell and Molecular Biology	P20BT101	5	5	25	75	100
	Core II	Biochemistry	P20BT102	5	5	25	75	100
	Core III	Microbiology	P20BT103	5	5	25	75	100
	Core Prac. I	Biochemistry and Cell Biology Lab.	P21BT1P1	5	3	40	60	100
	Core Prac. II	Microbiology Lab.	P20BT1P2	5	3	40	60	100
	Elective I	Bioinstrumentation/ Basics Of Bioinformatics	P20BT1:1/ P20BT 1:A	5	4	25	75	100
II	Core IV	Animal Biotechnology	P21BT204	5	5	25	75	100
	Core V	Plant Biotechnology	P20BT205	5	5	25	75	100
	Core VI	Industrial Biotechnology	P20BT206	5	4	25	75	100
	Core Prac. III	Animal, Plant and Industrial Biotechnology Lab	P20BT2P3	5	3	40	60	100
	Elective II	Research Methodology And Biostatistics / Nanobiotechnology	P20BT2:2/ P20BT2:A	4	4	25	75	100
	Elective III	Biosafety, Bioethics IPR/ Drug discovery &Development	P20BT2:3/ P20BT2:B	4	4	25	75	100
	VLO	The Big Picture Social Ethics	P22VLO21/ P22VLO22	2	2	25	75	100
III	Core VII	Gene Technology	P22BT307	5	4	25	75	100
	Core VIII	Immunology	P20BT308	5	5	25	75	100
	Core IX	Medical Biotechnology	P20BT309	5	5	25	75	100
	Core Prac. IV	Gene Technology Lab.	P20BT3P4	5	3	40	60	100
	Core Prac. V	Immunology and Medical Biotechnology Lab	P20BT3P5	5	3	40	60	100
	Elective IV	Stem Cell Biology/ Developmental Biology	P20BT3:4 P20BT3:A	4	4	25	75	100
	Generic Course1	Scientific Writing and Research Publication Ethics	P22BT3G1	1	1	100	-	100
IV	Core X	Environmental Biotechnology	P20BT410	5	4	25	75	100
	Elective V	Biotechnology management / Food Biotechnology	P20BT4:5 P20BT4:A	5	4	25	75	100
	Core Project	Project	P20BT4PJ	-	5	-	-	100
Total					90			

PROGRAMME ARTICULATION MATRIX
M.Sc., Biotechnology (2022–2023 onwards)

Should be marked on H –M-L Scale

COURSE TITLE	COURSE CODE	Correlation with Programme Outcomes and Programme Specific Outcomes												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
Cell and Molecular Biology	P20BT101	L	L	-	--	L	L	L	L	-	H	-	-	-
Biochemistry	P20BT102	L	M	-	L	L	L	L	L	-	H	-	H	M
Microbiology	P20BT103	M	M	L	M	L	L	L	L	-	M	H	-	M
Biochemistry and Cell Biology Lab.	P20BT1P1	M	M	M	M	H	M	M	H	-	L	-	H	M
Microbiology Lab.	P20BT1P2	M	M	M	M	H	M	M	H	-	M	M	H	M
Bioinstrumentation/ Basics of Bioinformatics	P20BT1:1/ P20BT 1:A	L	L	L	L	M	-	M	L	-	M	-	M	M
Animal Biotechnology	P20BT204	H	M	M	M	L	L	L	L	L	H	H	L	M
Plant Biotechnology	P20BT205	H	M	M	M	L	L	L	L	-	H	H	L	M
Industrial Biotechnology	P20BT206	H	M	M	M	L	L	L	L	-	H	H	L	M
Animal, Plant and Industrial BiotechnologyLab	P20BT2P3	H	M	H	M	H	M	M	H	-	H	H	H	H
Research Methodology And Biostatistics / Nanobiotechnology	P20BT:2/. P20BT 2:A	M	L	M	M	M	M	H	H	-	M	L	H	M
Biosafety, Bioethics IPR/ Drug discovery & Development	P20BT2:3/ P20BT2:B	M	L	L	L	L	M	M	L	H	L	M	L	M
The Big Picture Social Ethics	P22VLO21/ P22VLO22	-	-	-	-	-	-	-	M	H	-	-	-	-
Gene Technology	P22BT307	L	L	L	L	L	-	L	L	-	H	H	L	L
Immunology	P20BT308	M	M	L	M	L	-	L	L	-	M	M	L	L

COURSE TITLE	COURSE CODE	Correlation with Programme Outcomes and Programme Specific Outcomes												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
Medical Biotechnology	P20BT309	H	M	M	M	M	M	M	L	L	H	H	L	L
Gene Technology Lab.	P20BT3P4	M	L	H	M	H	L	M	H	-	H	H	H	M
Immunology and Medical Biotechnology Lab	P20BT3P5	H	M	H	M	H	M	M	H	-	H	H	H	M
Stem Cell Biology/ Developmental Biology	P20BT3:4 P20BT3:A	M	L	L	L	L	L	L	L	L	H	M	L	M
Environmental Biotechnology	P20BT410	H	M	M	M	M	H	M	H	L	M	H	-	H
Biotechnology management / Food biotechnology	P20BT4:5 P20BT4:A	M	M	L	M	L	M	M	M	-	M	H	H	H
Project	P20BT4PJ													

Structure of the Curriculum for M.Sc.Biotechnology (2022-23)

Parts of the Curriculum	No. of Courses	No. of Hours	Credits	Total Credits
Major				
Core(Theory)	10	50	48	68
Core(Practical)	5	25	15	
Core(Project)	1	-	5	
Elective(Theory)	5	23	20	20
VLO	1	2	2	2
Total	**22**	**100**	**90**	**90**

List of suggested courses

Sem	Course	Coursetitle	Course code	Hours	Credit	Marks
I	Value added course	Logical Reasoning and Analytical Ability for Competitive Examinations		30	-	Certificate will be issued
II	Value added course	EffectiveCommunicationSkills		30	-	Certificate will be issued
III	Value added course	Effective presentations using online and offline tools		30	-	Certificate will be issued
I	Self-Study course	SelectedTopics for Competitive Exam 1		30	2	100
II	Self-Study course	SelectedTopics for Competitive Exam 2		30	2	100
III	Add on course	ScientificWriting		30	2	100

Semester: 1 **Course Code: P20BT101**

Credits : 5 **Total Hrs/ Week : 5**

Core Course: I - CELL AND MOLECULAR BIOLOGY

1. Course outcomes

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

CO. No	Course Outcomes	Level	Unit
CO1	Classify the cell into prokaryotes and eukaryotes based on the intracellular structures	K2	I
CO2	Distinguish the organization and structures of different cytoskeleton	K4	II
CO3	Evaluate the mutagenicity of the chemicals	K6	III
CO4	Differentiate the process of replication, transcription and translation	K4	IV
CO5	Apply basic knowledge on siRNA to use siRNA as therapeutic agents	K3	V
CO6	Illustrate cell cycle mechanism	K2	V

2.A. Syllabus

Unit -I **15hrs**

Basics of Cell and Organelles

Discovery-Cell theory-Prokaryotes & Eukaryotes-Cellular Organelles: Structure, Organization and Functions of Plasma membrane, Nucleus & nucleolus, Mitochondria, ER-rough and smooth, Ribosomes, Golgi apparatus, Plastids, Vacuoles, Lysosomes, Peroxisomes and Microbodies. Cell junction.

Unit -II **15hrs**

Cell Cycle and Signaling

Overview, Structure and Organization of Microtubules and Microfilaments-Cell movement. Cell Division: Cell Cycle-Regulation of Cell Cycle-Cell signaling-(adrenalin receptors, acetylcholine receptors, insulin receptors) Programmed Cell Death. Transformation, Transduction and Conjugation, Recombination -Generalized and Site specific in bacteria-Holiday model.

Unit -III **15hrs**

Overview of genetic material

Structure of DNA and RNA-Composition, Types and Functions, Replication mechanisms -Enzymes involved in replication. Mutation: Origin and Classification -Types-Molecular Mechanism of Mutation-Detection of DNA damage at molecular level, Ames test, cytogenetic analysis in mammalian cells-in vitro and in vivo-Host mediated assay-DNA repair and recombination mechanisms. Transposons and transposable elements-Mechanism of transposition.

Unit -IV **15hrs**

Transcription and RNA Processing

Transcription in Prokaryotes and Eukaryotes -Post transcriptional modifications. Genetic code and Translation: Features of genetic code - Deciphering of the codon-Translation in Prokaryotes and Eukaryotes-Post translation modifications-Protein targeting.

Unit -V **15hrs**

Regulation of Gene Expression

Cistron, muton and recon -exons and introns. Regulation of gene expression in prokaryotes and eukaryotes -positive and negative control in prokaryotes-Operon models(Lac,Tryp,Ara)-Spatial and Temporal regulation of eukaryotic genes, mi RNA, siRNA,Micro-satellites.

B. Topics for self study

S.No	Topics	Web Links
1	Active Transport	Gerald, K., Cell and Molecular Biology, Third edition, John Wiley & Sons, New York, 2001
2	Passive Transport	Gerald, K., Cell and Molecular Biology, Third edition, John Wiley & Sons, New York, 2001
3	Membrane Potential	Gerald, K., Cell and Molecular Biology, Third edition, John Wiley & Sons, New York, 2001
4	Second Messenger	Gerald, K., Cell and Molecular Biology, Third edition, John Wiley & Sons, New York, 2001

C. Text Books

1. Geoffrey M Cooper, Robert E Hausman., 2013. The Cell-A Molecular Approach, 6th Edition, ASM Press, Washington.

D. Reference Books

1. Harvey Lodish., Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P, 2008. Scott Lawrence Zipursky., James Darnell., Molecular Cell Biology, 6th Edition.
2. Gerald K., 2001.Cell and Molecular Biology, 3rd Edition, John Wiley & Sons, New York.
3. Alberts B., Bray D., Hopkin K., Johnson A. D., Lewis J., Martin R., Roberts K and Walter P, 2003. Essential Cell Biology: An Introduction to the Molecular Biology of the Cell, 2nd Edition, Garland Science Taylor & Francis Group, New York.
4. Benjamin A Pierce.,2006. Genetics-A Conceptual Approach, W.H.Freeman& Company, New York, 2nd Edition.

E. Web Links

1. https://nptel.ac.in/courses/102/106/102106025/#
2. https://onlinecourses.swayam2.ac.in/cec20_ma13/preview

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Basics of Cell and Organelles**		
1.1	Discovery-Cell theory-Prokaryotes & Eukaryotes	Classify prokaryotes and eukaryotes based on their internal structures	K2
1.2	Cellular Organelles: Structure, Organization and Functions of Plasma membrane, Nucleus & nucleolus	Describe the different models proposed to explain the arrangement of protein and lipids in plasma membrane Distinguish protein import and RNA export mechanism from nucleus	K2
1.3	Mitochondria and Plastids	Illustrate the structure and function of mitochondria and plastid	K2
1.4	ER-rough and smooth, Ribosomes, and Golgi apparatus	Explain the structure and function of endoplasmic reticulum and Golgi apparatus Classify the ribosomes based on its subunits	K2
1.5	Vacuoles, Lysosomes and Peroxisomes and microbodies	List the role of lysosomes and peroxisomes	K1
1.6	Cell junction	Explain Cell Junction	K1
1.7	Mitochondria and Plastids	Illustrate the structure and function of mitochondria and plastid	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Cell Cycle and Signaling**		
2.1	Overview, Structure and Organization of Microtubules and Microfilaments-Cell movement	Illustrate the structure and organization of microtubules and microfilaments	K4
2.2	Cell Division: Cell Cycle-Regulation of Cell Cycle Cell signaling-(adrenalin receptors, acetylcholine receptors, insulin receptors)	Explain the different phases of cell cycle Categorize the cell signaling molecules based on its site of action & its location	K2
2.3	Programmed Cell Death	Distinguish the proteins involved in programmed cell death based on its function	K4
2.4	Transformation, Transduction and Conjugation	Describe the mechanisms of gene transfer between bacteria Illustrate that DNA is genetic material through an experiment	K1 K4
2.5	Recombination - Generalized and Site specific in bacteria- Holiday model	Distinguish generalized and site specific recombination in bacteria	K4
3	**Overview of genetic material**		
3.1	Structure of DNA and RNA-Composition,	Illustrate the structure and composition of nucleic acids	K4
3.2	Types and Functions, Replication mechanisms -Enzymes involved in replication.	Distinguish the enzymes involved in replication	K4
3.3	Mutation: Origin and Classification -Types-Molecular Mechanism of Mutation-	Explain the molecular mechanism of mutation	K4
3.4	Detection of DNA damage at molecular level, Ames test, cytogenetic analysis in mammalian cells-in vitro and in vivo-Host mediated assay-DNA repair and recombination mechanisms..	Identify the DNA damage at molecular level	K6
3.5	Transposons and transposable elements-Mechanism of transposition	Describe the mechanism of Transposons and transposable elements	K6
4	**Transcription and RNA Processing**		
4.1	Transcription in Prokaryotes and Eukaryotes -Post transcriptional modifications	Illustrate transcription mechanism in prokaryotes and eukaryotes	K2
4.2	Genetic code and Translation: Features of genetic code -Deciphering of the codon-Translation in Prokaryotes and Eukaryotes-Post translation modifications	Identify the amino acids coded by particular codon Differentiate the mechanism of protein synthesis in prokaryotes and eukaryotes	K3 K4
4.3	Protein targeting	Distinguish protein target mechanism of different cell organelles	K4

Unit/ Section	Course Content	Learning Outcomes	HBTLT
5	**Regulation of Gene Expression**		
5.1	Cistron, muton and recon -exons and introns Regulation of gene expression in prokaryotes and eukaryotes-positive and negative control in prokaryotes	Assess regulation of gene expression in prokaryotes and eukaryotes	K4
5.2	Operon models(Lac and Ara)	Illustrate the control of gene expression of lactose and arabinose	K2
5.3	Tryp operon	Explain Trp operon	K2

4. Mapping Scheme

P20BT101	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	H	L	M	M	L	L	L	L	H	L	L	L
CO 2	H	H	L	M	M	L	L	L	L	H	L	L	L
CO 3	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 4	H	H	L	L	L	L	L	L	L	H	L	L	L
CO 5	H	H	M	H	H	H	H	H	H	H	H	H	H
CO 6	H	H	L	M	M	L	L	L	L	H	L	L	L

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End Semester Examination
Indirect
1.Course-end survey

Name of the Course Coordinator: Dr.R.Sharmila

Semester: 1 **CourseCode: P20BT102**
Credits : 5 **Total Hrs/ Week : 5**

Core Course: II- BIOCHEMISTRY

1. CourseOutcomes

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

CO. No	Course Outcomes	Level	Unit
CO1	Recall the basic chemistry of elements & molecules and know the structure-function aspects of biomolecules	K1	I
CO2	Illustrate the biosynthesis, metabolic fates and regulation of biochemical pathways and perceive the overall scheme of energy metabolism in health and disease with a particular focus on enzymes	K2	II
CO3	Develop a keen interest for biomolecular chemistry and identify the methods of chemical analysis of various biomolecules	K5	III
CO4	Analyze, compare and contrast the structure and function of biomolecules and survey their commercial uses	K4	III
CO5	Determine and estimate various biomolecules qualitatively and quantitatively	K2	IV
CO6	Formulate strategies and plan assays to study, isolate and purify biomolecules from their natural sources	K5	V

2. A. Syllabus

Unit I **15hrs**

Chemistry of Biomolecules

Structure of atoms, molecules and chemical bonds; Covalent and Noncovalent interactions - Van der Waals, Electrostatic, Hydrogen bonding and hydrophobic interactions. Chemical foundations of Biology pH, pK, acids, bases and buffers, Henderson - Hasselbach equation, biological buffer solutions. Energy metabolism (concept of free energy); Principles of thermodynamics; Kinetics, dissociation and association constants.

Unit –II **15hrs**

Carbohydrates and Lipids

Monosaccharides, Disaccharides, Polysaccharides – Types, properties & their role. Homoglycans: structure and properties of starch, glycogen and cellulose. Heteroglycans: structure and properties of agar, alginic acid (sea weed polysaccharide), glycosaminoglycans and pectins. Lipids: Triglycerides, phosphoglycerols, derived lipids-steroids, prostaglandins and leukotrienes. Membrane lipids and their alignment in membrane.

Unit –III **15hrs**

Amino acids, Proteins & Lipids

Amino acids: General structure and classification. Glutathione: synthesis and function. Phenylalanine and tyrosine metabolism, Tetrapyrole from glycine, Cysteine and methionine metabolism, Coenzyme A from valine, aspartate and cysteine. Polyamines from methionine and arginine. Proteins: Peptide bond, Primary structure of proteins, structural comparison at secondary, tertiary levels (Ramchandran map), quaternary and domain structure. Protein sequencing strategies – chemical and enzymatic.

Unit –IV **15hrs**

Concept of Enzymes & Kinetics

Classification of enzymes. Mechanisms of enzyme action; Determination of Michaelis - Menten parameters, Lineweaver – Burk Plot, types of inhibition & models for substrate and product. Allosteric regulation of enzymes, pH and temperature effect on enzymes, Enzyme immobilization.

Unit –V **15hrs**

Metabolism

General scheme of metabolism, glycolysis – aerobic and anaerobic, regulation. Krebs cycle and its regulation; HMP shunt, glyoxylate and glucoranate pathways Cori's cycle. Interconversion of sugars, gluconeogenesis, synthesis of disaccharides and polysaccharides. Glycogenesis, gluconeogenesis and glycogenolysis and their regulation. TCA cycle and its central role in metabolism. Biosynthesis of purines and pyrimidines, Oxidation of fatty acids; Biosynthesis of fatty acids.

B. Topics for self study

S.No	Topics	Web Links
1.	Protein purification methods: role of buffers and detergents	https://ecampusontario.pressbooks.pub/microbio/chapter/energy-matter-and-enzymes/
2	Methods for determining biomolecular structure	http://www.chem.ox.ac.uk/vrchemistry/potential/Text/redox1.htm
3	Biochemistry of signal transduction	https://www.thermofisher.com/in/en/home/life-science/protein-biology/protein-purification-isolation/protein-purification.html
4	Reactive oxygen species in health and disease	https://www.photophysics.com/circular-dichroism/biophysical-characterization/

C. Text Books

1. Nelson L. D., Cox M.M., 2013. Lehninger's Principle of Biochemistry, Macmillan, Worth Publication Inc., 6th Edition.
2. Deb A.C., 2001. Fundamentals of Biochemistry, New Central Book Agency, Calcutta, 7th Edition.
3. David Rawn J., 2005. Biochemistry, Neil Patterson Publications.

D. Reference Books

1. Berg J.M., Stryer L., 2007. Biochemistry, W.H. Freeman & Co. NY, 7th Edition.
2. Thomas M. Devlin, 2002. Biochemistry with Clinical Correlation, Wiley- Liss Publication, 5th Edition.
3. Voet&Voet, 1995. Biochemistry, John Wiley and Sons, 2nd Edition.
4. JeoffreryZubay, 1993. Biochemistry, Wm C. Brown Publications, 3rd Edition, Volumes 1, 2, 3.
5. JeoffreryZubay, 1995. Principles of Biochemistry, Wm C. Brown Publications, 4th Edition.
6. Mathews C.K., K.E.vanHolde, 1990. Biochemistry, Benjamin/ Cumming Publications.
7. Satyanarayana U, 1999. Biochemistry, Books and Allied Pvt. Ltd., Calcutta.

E. Web Links

1. https://nptel.ac.in/courses/102/106/102106087/
2. https://nptel.ac.in/courses/104/105/104105076/
3. https://www.coursera.org/learn/energy-metabolism

3. Specific Learning Outcomes (SLO)

Unit/ Section	Course content	Learning Outcomes	HBTLT
1	**Chemistry of Biomolecules**		
1.1	Basic chemistry in life science	**Recall** High School teaching on atomic, molecular structure and chemical bonding	K1
		Compare the different elements of the periodic table	K2
		Categorize the different kinds of chemical bonds and **examine** the properties of matter based on their atomic/molecular bonding and structure	K4
1.2	Structure and properties of water	**Define** the physicochemical properties of water	K1
		Illustrate the various kinds of bonds in water	K2
		Interpret the influence of hydrogen bonding on physicochemical properties	K3
		Discover the role of structural water and influence of water on macromolecular function	K4
1.2	Measurement of pH, determination of pKa (Henderson Hasselbalch equation)	**What** are acids and bases?	K1
		Explain the concept of pH	K2
		Identify the roles of acids and bases in biochemical reactions	K3
		Measure the pH of biological solutions	K4
		Estimate the concentration of hydrogen ion or hydroxyl ion in solutions	K5
		Measure the pH of a solution using the pH electrode	K5
		Predict the pK values of compounds using chemoinformatics tools and predict the pH-based behaviour of compounds	K4
	Henderson - Hasselbach (HH) equation	**Apply** HH equation to find pH	K3
		Determine the pH of a solution	K5
		Solve for pH using HH equation	K4
	Biological buffer solutions	**What** is an acid or base?	K1
		Classify biological buffers based on pH	K2
		Solve biochemical/medical problems related to acid-base imbalance	K3

Unit/ Section	Course content	Learning Outcomes	HBTLT
		Discover the mechanisms of buffering in blood and cells	K4
		Examine the effects of acid-base imbalance	K5
		Assess changes in pH in biological buffers	K4
1.3	Energy metabolism (concept of free energy)	**Recall** the basic physics and chemistry concepts related to energy and work	K1
		Define Gibbs free energy	K2
		Compare the Gibbs free energy of high energy phosphate compounds	K3
		Discover the mechanisms of electron transfer and oxidative phosphorylation	K4
		Contrast biochemical reactions based on free energy	K2
		Assess the **influence** of free energy on the fate of biochemical reaction	K5
		Discuss the role of high energy phosphate compounds in cellular biochemistry	K4
1.4	Principles of thermodynamics	**Recall** and **define** the laws of thermodynamics	K1
		Explain free energy, enthalpy and entropy	K2
		Compare exothermic and endothermic biochemical reactions	K2
		Dissect the importance of thermodynamics in biochemistry	K4
		Measure free energy change using biochemical methods	K5
1.5	Kinetics, dissociation and association constants	**Recall** elementary concepts related to kinetics of reactions-rate and order	K1
		Identify, **analyze** and **summarize** reaction rates and orders of reactions using graphs	K2, K3
		Perceive the influence of physical and chemical factors and their influence on reaction rates in cellular/enzymatic reactions	K4
		Determine the rate of a biochemical reaction	K5
		Design experiments to determine rate, association and dissociation constants for a reaction	K4

Unit/ Section	Course content	Learning Outcomes	HBTLT
2	**Carbohydrates and Lipids**		
2.1	Monosaccharides, Disaccharides, Polysaccharides - Types, properties & their role	**Tell** the differences between different kinds of sugars **Explain** the physicochemical properties of sugars **Identify** sugars based on their chemical properties **Classify** carbohydrates into different types **Discover** the importance and role of carbohydrates in cell biology and biochemistry **Estimate** the amount of carbohydrates **Formulate** strategies to research structure-function aspects of carbohydrates	K1 K2 K4 K2 K4 K5 K4
2.2	Homoglycans: structure and properties of starch, glycogen and cellulose	**Define** homoglycans based on their properties **Classify** homoglycans based on chemical composition **Develop** a deeper understanding of homoglycans **Contrast** homoglycans based on their source and functions **Explain** the reaction and chemical properties of homoglycans **Discuss** the structures of homoglycans and their importance in biochemistry	K1 K2 K3 K4 K5 K2
2.3	Heteroglycans: structure and properties of agar, alginic acid (sea weed polysaccharide), glycosaminoglycans and pectins	**Tell** the differences between various heteroglycans **Illustrate** the structure-function aspects of heteropolysaccharides **Identify** potential sources for sea weed extraction **Discover** methods and strategies to utilize heteroglycans for human welfare **Estimate** heteroglycans and **discuss** their importance in health and human welfare	K1 K2 K3 K4 K5
2.4	Lipids: Triglycerides, phosphoglycerols, derived lipids-steroids, prostaglandins and leukotrienes	**Define** lipids based on composition, chain length and saturation **Classify** lipids based on various physicochemical aspects **Identify** the analytical methods for lipid analysis **Dissect** the biochemical roles of various lipids **Determine** the concentration of lipids using biochemical and analytical techniques **Discuss** the role of lipids in health and disease	K1 K2 K3 K4 K5 K4

Unit/ Section	Course content	Learning Outcomes	HBTLT
2.5	Membrane lipids and their alignment in membrane	**Find** the lipid composition of various membranes **Illustrate** the packing of membrane lipids **Model** membrane lipid conformations in membranes **Assess** the mode of lipid-lipid and protein-lipid interactions **Perceive** and **predict** the orientation and alignment of lipids using bioinformatics tools	K1 K2 K3 K4 K5, K6
3	**Aminoacids& proteins**		
3.1	Amino acids: General structure and classification	**What** are common and uncommon aminoacids **Classify**aminoacids based on their charge, size, side chain and pKa **Identify** the behaviour of aminoacids in proteins based on side chain and pH **Infer** the role of aminoacids in proteins **Estimate** aminoacids using biochemical assays	K1 K2 K3 K4 K5
3.2	Glutathione: synthesis and function.	**Find** the importance of glutathione in cellular redox chemistry **Demonstrate** clear knowledge of glutathione synthesis and metabolism **Develop** understanding of methods and assays to **estimate** glutathione and its redox potential **Discuss** cellular signalling associated with glutathione metabolism	K1 K2 K3, K5 K5
3.3	Phenylalanine and tyrosine metabolism, Tetrapyrole from glycine, Cysteine and methionine metabolism	**How** are aminoacids synthesized in cells? **Illustrate** various pathways and critical enzymes involved in aminoacid metabolism **Develop** strategies to purify aminoacid metabolites **Discover** the pathways and exploit them for industrial production of metabolites in bacteria **Examine** the mechanistic chemistry of aminoacid metabolism and **estimate** aminoacids (qualitative and quantitatively)	K1 K2 K3 K4 K4, K5
3.4	Coenzyme A from valine, aspartate and cysteine	**What** is the coenzyme-A production pathway **Outline** the general strategies in industries for coenzyme-A production from microbes **Compare** various methods and **Identify** avenues to increase coenzyme A yields **Improve** commercial strains by virtual cloning and mutagenesis to improve yields	K1 K2 K4 K3 K5

Unit/ Section	Course content	Learning Outcomes	HBTLT
3.5	Polyamines from methionine and arginine	**Show** the importance of polyamines **Compare** the various polyamines and their signalling/redox chemistry **Identify** the role of polyamines in cell division, redox balance and reproduction **Explain** the critical steps in polyamine biosynthesis Learn to **determine** and **estimate** polyamine concentrations	K1 K2 K3 K2 K5
4	**Concept of Enzymes & Kinetics**		
4.1	Classification of enzymes	**Define** enzymes and **outline** their mechanisms of action **Organize** enzymes into various classes, subclasses based on their reaction type **Classify** enzymes based on IUB guidelines	K1, K2 K3 K4
4.2	Mechanisms of enzyme action	**Identify** the mechanism of enzyme catalysis based on theories of enzyme action-lock and key and induced fit theory **Explain** theories of enzyme action **Illustrate** thermodynamics of enzyme action **Discover** the intricate mechanisms of ES formation and catalysis **Choose** experiments to study physicochemical properties of enzymes Critically **evaluate** existing theories of enzyme action	K3 K2 K2 K4 K5 K6
4.3	Estimation of Michaelis - Menten (MM) parameters	**Discover** the MM equation and its mathematical transformations **Express, predict** and **interpret** enzymatic rates, MM reaction constants **Solve** for K_M, K_d, K_i and other related MM parameters **Design** experiments to calculate MM parameters	K4 K4, K5 K6 K6
4.4	Lineweaver - Burk (LB) Plot, types of inhibition & models for substrate and product	**Illustrate** the mathematical transformation of MM into LB plot **Identify** the mechanisms of enzyme inhibition **Compute** and **predict** the reaction outcomes based on inhibitor type **Model** and curve-fit enzyme kinetics **Design** strategies to study the effect of substrates and products on enzyme reactions	K2 K3 K4, K5 K4 K5

Unit/ Section	Course content	Learning Outcomes	HBTLT
4.5	Allosteric regulation of enzymes	**Define** and **describe** allosteric inhibition **Review** the importance and mechanistic chemistry of allostery **Discover** and **analyze** mechanisms of allostery **Evaluate** allosteric reactions and describe their importance in biochemistry	K1 K2 K4 K5
4.6	Enzyme immobilization	**What** arethe methods of enzyme immobilization **Discover** the applications of immobilization **Demonstrate** enzyme the chemistry of immobilization **Design** immobilization reactions and **appraise** the efficacy of immobilization in industrial processes	K1 K2 K5 K5, K6
5	**Metabolism**		
5.1	General scheme of metabolism	**Recall** fundamental concepts in metabolism **Differentiate** anabolism and catabolism and the underlying thermodynamic principles **Illustrate** the importance of bioenergetics in metabolism **Examine** the regulation of metabolic pathways by hormones and messengers **Explain** and **justify** the interrelated nature of metabolic pathways	K1 K4 K2 K5 K5
5.2	glycolysis - aerobic and anaerobic, regulation	**Describe** and **discuss** the glycolytic pathway in different kinds of cells and organisms **Demonstrate** clear knowledge about glycolysis, types, feeder pathways and the rate limiting steps in the pathway **Summarize** the key reaction steps and **explain** the importance of the pathway in industries and in medicine **Construct** arguments to substantiate for regulation of glycolysis through feedback and hormonal signalling	K2, K4 K2 K2, K5 K5
5.3	Krebs cycle and its regulation	**Recall** and **describe** the TCA cycle and its anaplerotic role in metabolism **Recognize** and **examine** the role of reduced equivalents in energy metabolism **Identify** the pathways interlinked with TCA cycle and **analyz**e regulation of TCA **Elaborate** on the mechanisms of the enzymes in the entire reaction pathway	K1, K2 K2, K4 K3, K4 K5

Unit/ Section	Course content	Learning Outcomes	HBTLT
5.4	HMP shunt, glyoxylate and glucuronate pathways, Cori's cycle	**Show** the biochemical foundations for carbohydrate metabolism	K1
		Explain the pathways and their physiological relevance	K2
		Discover the similarities and differences	K4
		Identify the key steps in these pathways and **explain** their regulation mechanisms	K3, K5
		Elaborate on the connections between these pathways and their significance	K5
5.5	Interconversion of sugars, gluconeogenesis, synthesis of disaccharides and polysaccharides	**Relate** the interconversion of sugars to cellular metabolic fates and **match** gene corresponding expression profiles	K2, K1
		Discover the importance of simple sugars and their roles as fuel and building blocks	K2
		Develop knowledge of *in vivo* biosynthesis and **dissect** the importance of epimerases and isomerases	K3, K4
5.6	Glycogenesis, gluconeogenesis and glycogenolysis and their regulation	**Show**, **demonstrate** and **analyze** the importance of glucose in metabolism	K1, K4
		Compare the different fates of glucose and **explain** the regulation of glucose metabolism	K2, K5
		Construct logical inferences for changes in glucose metabolism during health and disease	K5
5.7	TCA cycle and its central role in metabolism	**Recall** and **describe** the TCA cycle and its anaplerotic role in metabolism	K1, K2
		Recognize and **examine** the role of reduced equivalents in energy metabolism	K4
		Identify the pathways interlinked with TCA cycle and **analyz**e regulation of TCA	K3, K4
		Elaborate on the mechanisms of the enzymes in the entire reaction pathway	K5
5.8	Biosynthesis of purines and pyrimidines	**Find** the differences between de novo synthesis and salvage pathway	K1
		Illustrate the pathways and mechanisms of purine and pyrimidine biosynthesis	K2
		Identify, discover and **discuss** the applications such as hybridoma technology	K3, K4, K5

Unit/ Section	Course content	Learning Outcomes	HBTLT
5.9	Oxidation of fatty acids; Biosynthesis of fatty acids	**Show** the physiological role of lipids and **explain** their roles in metabolism **Identify** the key steps and enzymes involved in fatty acid, triglyceride, phospholipid, sphingolipid and other compound/derived lipid biosynthesis **Compare** and **examine** the role of fatty acids in cellular architecture, signalling & energy metabolism and discuss their structure-function aspects	K1, K2 K3 K2, K4

4. Mapping Scheme

P20BT102	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO 3	PSO 4
CO1	M	H	L	M	H	L	H	L	L	H	M	L	L
CO2	H	H	H	H	M	M	H	M	L	H	L	M	L
CO3	H	H	H	M	H	H	H	M	M	H	H	H	M
CO4	H	H	H	H	M	M	M	L	L	M	H	M	M
CO5	H	H	H	H	L	H	M	M	L	H	H	M	L
CO6	H	H	H	H	M	H	H	M	L	H	H	H	L

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.S.Sriram

Semester: 1 **Course Code: P20BT103**
Credits : 5 **Total Hrs/ Week: 5**

Core Course : III -MICROBIOLOGY

1. Course Outcome

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

CO.No	Course Outcomes	Level	Unit
CO1	Recollect the basic concepts of microbiology and advanced developments	K2	I
CO2	Explain the advanced concepts and significance of the microbial physiological process	K2	II
CO3	Articulate the various mechanisms of microbial control and apply the concepts for obtaining practical solutions and breakthrough towards drug resistance in research	K3	III
CO4	Analyze the role of microbes as tools in finding sustainable solutions related to environment and societal issues	K4	IV
CO5	Evaluate the significance of biopesticides over chemicals	K5	IV
CO6	Develop strategies to understand the pathogenicity and identify the modes of transmission of microbial diseases and their control	K5	V

2. A.Syllabus

Unit – I **15hrs**

Discovery and Diversity of microbes

Discovery and development of microbiology-contributions by Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Microbial taxonomy-kingdom concept, domain concept, molecular characterization-16S rRNA, Numerical, DNA-DNA hybridization. Characteristic features of bacteria, algae, fungi, protozoans and viruses.

Unit – II **15hrs**

Bacterial cell organization and genetics

Overview of prokaryotic cell- Cell wall of Gram positive and Gram negative bacteria, cell membranes, capsules, slime, endospores, flagella and motility.

Bacterial recombination-bacterial plasmids, fertility factors, conjugation, transformation and transduction-generalized and specialized.

Unit – III **15hrs**

Microbial metabolism and control

Bacterial respiration and photosynthesis. Bacterial growth-requirements, factors, growth curve and measurement agents - physical and chemical. Antibiotics (each with one example) affecting cell membrane, nucleic acid synthesis, protein synthesis and metabolism & their side effects - Antifungal and antiviral drugs. Drug resistance. Bioactive natural products.

Unit – IV **15hrs**

Applied Microbiology

Bioinsecticides, Mycoinsecticides - advantages and mode of action - Bacillus thuringiensis, Baculoviruses. Biodegradation of xenobiotics, Bioleaching, Biodetoriation, Bioremediation, Phytoremediation. Biostimulation of oil spill degradation.

Unit – V **15hrs**

Diseases

Microbial Disease- Water borne disease (Cholera), food borne disease (Typhoid), Air borne (tuberculosis), Sexually transmitted disease (Syphilis), Vector borne disease (Malaria), Viral disease (HIV), Fungal disease (Mycoses), Nosocomial infection (Pneumonia).

B. Topics for self- study

S.No	Topics	Web Links
1.	Viral taxonomy	www.ncbi.nlm.nih.gov › pmc › articles
2	Extremozymes	www.frontiersin.org
3	Different Approaches to a Coronavirus Vaccine	www.nytimes.com
4	Biospray	www.infectioncontroltech.com

C. Text Books

1. Prescott, Harley, Klein.,2016. Microbiology, 10th Edition, Mc Graw – Hill.
2. Ananthanarayan ,Paniker,2013, C.TEXT BOOKS of Microbiology, 9th edn.,Univ Press, New Delh

D. Reference Books

1. Glazer and Nikaido, Microbial Biotechnology, 2nd Edition,Cambridge University Press,2007.
2. Ronald M. Atlas., Richard Bartha R., Microbial Ecology, Fundamentals and Applications, Pearson Education Limited,2004.
3. Jacquelyn G. Black, Microbiology Principles &Explorations, 7th Edition, John Wiley,2008.
4. Gerard J. Tortora., Berdell R. Funke., and Christian L.Case,.Microbiology: An Introduction, 12th Edition, Benjamin Cummings Publications, 2015.
5. Rajan S., Selvi Christy R., Essentials of Microbiology, CBS Publishers,2018
6. Satyanarayana U and Charapani U, Biotechnology.12th Edition., Books & Allied (P) Ltd. Kolkata, 2019.

E. Web Links

1. https://onlinecourses.swayam2.ac.in/cec19_bt11/preview
2. https://nptel.ac.in/courses/102/103/102103015/
3. https://onlinecourses.swayam2.ac.in/cec19_bt11

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Discovery and Diversity of microbes**		
1.1	Discovery of microbial world & growth of microbiology	State the scope of microbiology Discuss the growth of microbiology Describe the contributions of great scientists towards the growth of microbiology	K2 K2 K2
1.2	Features of microbes & Kingdom &Domain concept	Summarize the features of microbes Analyse the principles involved in classifying microorganisms	K2 K4
1.3	New approach of bacterial taxonomy	Differentiate bacteria by comparing their similarities and differences Apply new molecular techniques to classify bacteria	K5 K3

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Bacterial cell organization and genetics**		
2.1	Structure & synthesis of cell wall and organelles	Explain the structure & synthesis of bacterial cell wall	K2
		Differentiate the cell wall composition of Gram positive and Gram negative bacteria	K4
2.2	Bacterial cell membranes, capsules, slime, endospores, flagella and motility	Understand the structure and function of cellular extensions	K2
2.3	Bacterial recombination-Conjugation, Transformation, Transduction	Comprehend the process & significance of bacterial recombination	K2
		Evaluate the significance of the different types of recombination	K5
3	**Microbial metabolism and control**		
3.1	Bacterial Respiration	Explain the concept & process of bacterial photosynthesis	K2
3.2	Bacterial Photosynthesis	Discuss the mechanism and significance of bacterial reproduction	K2
3.3	Bacterial growth measurement	Distinguish the various stages of bacterial growth & to infer the measurement of growth	K4
3.4	Control of bacteria-Physical, Chemical, Antibiotics	Categorize the various methods of bacterial control and evaluate their efficiency	K5
4	**Applied Microbiology**		
4.1	Bioinsecticides-Bacillus thuringiensis, Baculovirus & Mycoinsecticides	Analyze the role of bacteria, virus &fungi as biocontrol agents	K4
4.2	Biodegradation of xenobiotics	Categorize the success of biodegradation of xenobiotics	K4
4.3	Bioleaching, Biodeterioration	Identify the significance of the process of bioleaching & biodeterioration	K2
4.4	Bioremediation & Phytoremediation	Evaluate the pros & cons of bioremediation & phytoremediation	K5
4.5	Degradation of oil spills	Solve the problems in petroleum degradation employing microbes	K3
5	**Diseases**		
5.1	Water borne disease-cholera	Identify the spread of *V.cholera*& role of toxins in disease production	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
5.2	.Food borne disease-typhoid	Determine the cause & control of typhoid	K2
5.3	Air borne-Tuberculosis	Relate the diagnosis & symptoms of Pneumonia	K4
5.4	Sexually transmitted -syphilis	Describe the transmission of syphilis	K2
5.5	Vector borne-Malaria	Assess the transmission of malaria through vector	K5
5.6	Viral disease-HIV	Explain the diagnosis, transmission & pathogenicity of HIV	K2
5.7	Fungal-Mycoses	Comprehend the symptoms, spread and control of mycotic infections	K2
5.8	Nosocomial -Pneumonia	Report on the complications and spread of Pneumonia through hospitals	K4

4. Mapping Scheme

P20BT103	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	M	L	L	M	L	-	L	M	-	H	L	-	-
CO2	M	M	M	H	H	M	L	M	L	H	M	-	-
CO3	H	M	H	H	M	M	M	H	M	H	H	M	M
CO4	H	H	H	H	H	M	M	M	H	M	H	H	H
CO5	M	-	M	L	H	L	-	L	M	L	M	M	M
CO6	M	L	H	M	H	M	M	M	H	H	M	L	L

L: Low M: Medium H: High

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II
2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation
3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.Beatrice Valdaris

Semester: 1 **Course Code: P21BT1P1**
Credits : 3 **Total Hrs/ Week : 5**

Core Practical : I - BIOCHEMISTRY AND CELL BIOLOGY LAB

1. Course Outcomes

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

CO. No	Course Outcomes	Level	Experiments Covered
CO1	To recall the basic concepts pertaining to preparation of various kinds of reagents (molar, normal solutions) and buffers	K1	1 , 2
CO2	To observe how a spectrophotometer works and how to assay the concentrations of unknown solutions	K2	3
CO3	To develop working knowledge of estimation of biomolecules and learn to report their findings through construction of tables and lab reports	K5	4,5
CO4	To apply theoretical knowledge of Biochemistry in the laboratory setting and formulate newer alternative methodologies to estimate the concentration of biomolecules	K4	6,7
CO5	To distinguish between assay methods and comprehend the principle underlying the assays/experiments	K4	8
CO6	The student will learn to stain cells, visualize them and to isolate as well as estimate nucleic acids from various sources	K3	9, 10, 11, 12, 13

2. Syllabus

List of Experiments

Biochemistry **15hrs**

1. Preparation of primary and secondary solutions (Molarity and Normality).
2. (Colorimetry): To demonstrate Beer Lambert's law and construction of standard graph

3. Spectrophotometry: Quantitative estimation of biomolecules by means of spectrophotometer.
    - Estimation of Protein by Bradford Method
    - Estimation of Carbohydrates(Glucose & Starch) by Anthrone Method
    - Estimation of Cholesterol by Zaks Method
4. Absorption spectra of Proteins and Nucleic Acids
5. Determination of Pka values of Buffers
6. Paper Chromatography of Amino Acids.
7. Thin Layer Chromatography of Plant Pigments.
8. Separation of proteins using FPLC technique.
9. Extraction, seperation and determination of absorption spectra of plant pigments-qualitative and quantitative assessment through UV-Visible spectrophotometry.
10. Enzyme kinetics and effect of inhibitors for a) Lactate dehydrogenase b) Alpha amylase-Determination of Michaelis-Menten constant (KM), Vmax,/C50, Ki and identification of inhibitor type using Lineweaver-Burke (LB) plot.

Cell Biology **15hrs**

1. Mitosis of Onion root tip
2. Observation of Giant Chromosomes from Chironomus larva
3. Isolation of DNA from Buccal smear
4. Isolation of Genomic DNA from plants
5. Isolation of Genomic DNA from animal tissues

Reference Books

1. Jayaraman. J, Techniques in biology, Higginbothams Pvt., Ltd., 1972.
2. Jayaraman. **J,** Laboratory manual in Biochemistry, Wiley Eastern Ltd.,1992,
3. Sam Brook et al., Molecular Cloning : A Laboratory Manual Volumes I – III, Cold spring Harbor Laboratory, 1989.
4. Frederick M. Ausbel, Roger Breut, Short protocols in Molecular Biology, Volumes I & II, 5th Edition, John Wiley & Sons Inc., 2002.

Web Link

1. https://nptel.ac.in/courses/104/105/104105102/
2. https://onlinecourses.nptel.ac.in/noc21_bt36/preview
3. https://nptel.ac.in/courses/102/103/102103012/#

3. Specific Learning Outcomes(SLO)

Exercises	Course Content	Learning Outcomes	HBTLT
EX 1	**Biochemistry**		
EX 1.1	Preparation of primary and secondary solutions (Molarity and Normality).	**Recall** basic concepts related to solution preparation	K1
		Compare the different types of reagents	K2
		Categorize solutions and calculate the amount of solute and solvent required to prepare solutions	K4
		Develop the skill of reagent preparation	K5
EX 1.2	Colorimetry: To demonstrate Beer Lambert's law and construction of standard graph	**Define** Beer-Lambert's law	K1
		Illustrate the importance of Beer-Lambert's law in analytical biochemistry and spectroscopy	K2
		Interpret the effect of solute concentration on absorbance	K3
		Discover the applications of spectroscopy	K4
		Construct a standard graph and **test** the concentration of solute in an unknown solution	K5
EX 1.3	Spectrophotometry: Quantitative estimation of biomolecules by means of spectrophotometer. • Estimation of Protein by Bradford Method • Estimation of Carbohydrates(Glucose & Starch) by Anthrone Method • Estimation of Cholesterol by Zaks Method	**What** is a spectrophotometer?	K1
		Explain the roles of the parts of a spectrophotometer	K2
		Identify the importance of analytical biochemistry in everyday life	K3
		Determine and Analyze- a) wavescan b) single wavelength c) kinetics d) λ_{max} e) isosbestic point	K5, K4
		Estimate the concentration of solutes in a given solution	K5
		Measure the pH of a solution using the pH electrode	K5
		Predict and **deduce** the solute concentration from absorbance in estimation of proteins, carbohydrates and cholesterol	K6
		Test real samples in clinical and analytical biochemistry fields	K5

Exercises	Course Content	Learning Outcomes	HBTLT
EX 1.4	Absorption spectra of Proteins and Nucleic Acids	**How** and **why** estimation of nucleic acids is important	K1
		Compare the UV absorbance of single/double stranded DNA and RNA	K2
		Identify the differences in λ_{max} for proteins and nucleic acids	K3
		Analyze the concentration of DNA and RNA using UV spectra data	K4
		Discover the influence of temperature on DNA structure	K4
		Determine the T_m of DNA	K3
		Formulate strategies and experiments to test the influence of binding agents on spectral signature of nucleic acids	K5
EX 1.5	Determination of Pka values of Buffers	**Recall** the importance of buffers in biological research	K1
		Define pH, Ka, pKa, buffer action and buffer capacity	K2
		Compare different kinds of buffers and their applications	K3
		Contrast buffers based on pKa	K4
		Measure the pH of buffers and solutions	K5
		Discuss the change in pH when dilute solutions of acid/base are added	K4
EX 1.6 to EX 1.8	Paper Chromatography of Amino Acids Thin Layer Chromatography of Plant Pigments Separation of proteins using FPLC technique	**Recall** and **define** the principles of chromatography	K1
		Explain the importance of solvents	K2
		Compare the effect of hydrophilic and hydrophobic solvents on solute separation	K2
		Dissect the importance of chromatography in analytical chemistry	K4
		Measure the R_f value of separated solutes	K5
EX 1.9.	Extraction, separation and determination of absorption spectra of plant pigments-qualitative and quantitative assessment through UV-Visible spectrophotometry.	Examine and differentiate the spectra of photosynthetic pigments based on their spectral signatures.	K2
		Estimate the concentration of different photosynthetic pigments.	K4
		Correlate the structure of photosynthetic pigments and their UV-Vis spectraldata,and thereby,perceive structure -function aspects of pigments in photosynthesis.	K5

Exercises	Course Content	Learning Outcomes	HBTLT
EX 1.10.	Enzyme kinetics and effect of inhibitors for a) Lactate dehydrogenase b) Alpha amylase-Determination of Michaelis-Menten constant (KM), Vmax,/C50, Ki and identification of inhibitor type using Lineweaver-Burke (LB) plot.	Practically determine the enzymes kinetics parameters-KM and V max for two different enzymes and thereby,understand,compare and test different enzymes. Practically evaluate the mechanism of enzyme inhihibition by inhibitors and differentiate the patterns of enzyme inhibition Perceive and analyze the mathematical transformation of enzymes kinetics profiles using different kinds of plots-MM,LB and Eadie-Hofstee.	K1 K2 K3
EX 2	**Cell Biology**		
EX 2.1	Mitosis of Onion root tip	**Tell** the differences between different stages of mitosis **Explain** the role of cell division in plants **Identify** various stages based on morphological appearances under the microscope **Classify** various stages of mitosis and understand the underlying biochemical processes **Discover** the importance and role of cell division in biology **Formulate** strategies to research how cell structure is affected by mitosis inhibitors such as colchicine	K1 K2 K4 K2 K4 K5
EX 2.2	Observation of Giant Chromosomes from Chironomus larva	**Define** the importance of chromosomes in living organisms **Compare** giant chromosomes with other normal chromosomes **Develop** a deeper understanding of how DNA is packed into chromosomes **Examine** the morphological features of giant chromosomes **Explain** the role of polytene chromosomes in cells **Propose** reasons for the existence of polytene chromosomes	K1 K2 K3 K4 K5 K4

Exercises	Course Content	Learning Outcomes	HBTLT
EX 2.3	Isolation of DNA from Buccal smear Isolation of Genomic DNA from plants Isolation of Genomic DNA from animal tissues	**Recall** the structural aspects of DNA and **how** they can be purified **Illustrate** the roles of various reagents on purification methodology **Identify** the mechanism of DNA precipitation and purification **Discover** how DNA can be purified and quantified **Estimate** the concentration of DNA from samples and apply the findings in analytical biochemistry	K1 K2 K3 K4 K5

4. Mapping Scheme

P20BT1P1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	L	H	M	L	L	L	M	L	M	M	H	H
CO2	H	L	M	M	M	L	L	M	L	M	M	H	H
CO3	H	L	H	H	H	L	L	L	L	H	H	H	H
CO4	H	M	H	H	H	L	L	L	L	M	M	H	H
CO5	M	H	H	M	H	L	L	L	L	H	H	H	H
CO6	M	L	M	M	M	L	L	L	L	L	M	H	M

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.M.G Daniel Andrew

Semester: 1 **CourseCode: P20BT1P2**
Credits : 3 **Total Hrs/ Week : 5**

Core Practical : II - MICROBIOLOGY LAB

1. Course Outcomes

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

CO. No	Course Outcomes	Level	Experiments Covered
CO1	Apply basic knowledge on basic staining techniques to differentiate bacteria based on grams reaction	K3	1
CO2	Differentiate bacterial spores from vegetative cells	K4	2
CO3	Design and conduct experiments involving bacterial growth	K5	3,4
CO4	Analyze the role of various factors affecting bacterial growth	K4	3,4,5,6
CO5	Apply pure culture techniques in isolation of bacteria from different samples and analyzing the quality based on microbial load	K3	2
CO6	Evaluate the potability of water sample	K4	7

2. Syllabus

List of Experiments

Microbiology **15hrs**

1. Staining- Differential (Gram staining), spore staining
2. Isolation & Enumeration of organisms from soil, water & food samples
3. Turbidometric measurement of bacterial growth
4. Effect of temperature and pH on bacterial growth
5. Effect of disinfectant on bacterial growth-phenol co-efficient test
6. Effect of radiation (UV) on bacterial growth
7. Assess water quality by MPN test

Reference Books

1. Collins J., Microbial Methods, 7th Edition, CRC Press,1995.
2. Robert Cruickshank, Medical Microbiology, Guide to the laboratory Diagnosis & Control of Infection, 12th Edition, Churchill Livingstone Publishers,1973.
3. Cheever F.S., Laboratory Manual of Microbiology, Pubmed Central,2006.

Web links

1. https://catalog.byu.edu/life-sciences/microbiology-and-molecular-biology/ general-microbiology-laboratory
2. https://vlab.amrita.edu/?sub=3&brch=73&sim=1105&cnt=3750
3. https://courses.lumenlearning.com/suny-microbio-labexperience/ front-matter/introduction-2/

3. Specific Learning Outcomes (SLO)

Exercises	Course Content	Learning Outcomes	HBTLT
EX 1.	Staining- Differential (Gram staining), spore staining	Apply the Gram staining protocol and differentiate Gram positive and Gram negative bacteria	K3
		Practice spore staining to differentiate spores from vegetative cells	K3
EX 2.	Isolation & Enumeration of organisms from soil, water & food samples	Apply the principles of pure culture technique to isolate the bacteria from various samples	K3
		Analyze the quality of samples by estimating the bacterial load	K4
EX 3	Turbidometric measurement of bacterial growth	Differentiate the various stages of bacterial growth	K4
EX 4	Effect of temperature and pH on bacterial growth	Evaluate the effect of temperature and pH on bacterial growth	K5
EX 5	Effect of disinfectant on bacterial growth-phenol co-efficient test	Formulate an experiment to determine the influence of phenol on bacterial growth	K5
EX 6	Effect of radiation (UV) on bacterial growth	Evaluate the effect of radiation on bacterial growth	K6
EX 7	Assess water quality by MPN test	Evaluate the quality of different water samples	K5

4. Mapping Scheme

P20BT1P2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	-	-	H	H	H	H	L	H	L	M	M	H	M
CO2	-	-	H	H	H	H	L	H	L	M	M	H	M
CO3	-	-	H	H	H	H	L	H	L	M	M	H	M
CO4	-	-	H	H	H	H	L	H	L	M	M	H	M
CO5	-	-	H	H	H	H	L	H	L	M	M	H	M
CO6	-	-	H	H	H	H	L	H	L	M	M	H	M

L: Low M: Medium H: High

5. Course Assessment Methods

Direct
1. Periodical Assessment 2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained 3. Model Practical Examination 4. End Semester Practical Examination
Indirect
1. Course-end survey

Name of the Course Coordinator Dr.Beatrice Valdaris

Semester: 2 **CourseCode: P20BT1:1**
Credits : 4 **Total Hrs/ Week : 5**

Elective Course : IA - BIOINSTRUMENTATION

1. CourseOutcomes

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

CO. No	Course Outcomes	Level	Unit
CO1	Construct the basic operators of Centrifuges	K1	I
CO2	Understand the characteristics of chemical reactions	K2	I
CO3	Analyze and categorize the concepts of Chromatography	K4	II
CO4	Describe the principle of Electrophoresis and list out its types	K2	III
CO5	Define the accession and passing arguments in functions of Spectroscopy	K5	IV

2. A. Syllabus

Unit – I **15hrs**

Electrochemistry and Centrifugation

Principles of Electrochemical Techniques, Redox Reactions, the pH Electrode, Glass Electrode and Reference Electrode. Centrifugation: Small Bench Top Centrifuges, Large Capacity Refrigerated Centrifuges, High Speed Refrigerated Centrifuges, Preparative and Analytical Ultra Centrifuge.

Unit – II **15hrs**

Chromatography

Principles of Chromatography, Ion Exchange and Affinity Chromatography. High Performance Liquid Chromatography (HPLC), Gas liquid Chromatography (GLC), Thin layer Chromatography (TLC), Paper Chromatography.

Unit -III **15hrs**

Electrophoresis

Principles of Electrophoresis, Electrophoresis of Proteins: SDS-PAGE, 2D-PAGE, Detection, Estimation and Recovery of Proteins, Electrophoresis of

Nucleic Acid: Agarose Gel Electrophoresis of DNA, Pulsed Field Gel Electrophoresis.

Unit - IV **15hrs**

Spectroscopy and Microscopy

Properties of Electromangnetic Ionic Radiation. UV and Visible Spectroscopy, FTIR, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, ICP, Spectrofluorimetry, Mass Spectroscopy (GC-MS), and XRD. Types of Microscopes-TEM and SEM.

Unit -V **15hrs**

Radioactivity

The nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller Counter- principles and applications. Detection based on excitation- Liquid Scintillation Counter- principles and applications. Supply, storage and purity of radio labelled compounds, specific activity, inherent advantages and restrictions of radiotracer experiments, safety aspects, applications of radio isotopes in biological sciences. Autoradiography labelling.

B. Topics for self study

S.No	Topics	Web Links
1.	The role of central instrumentation facility in a research institute/ university	http://www.iitgn.ac.in/research/facilities/cif https://www.pondiuni.edu.in/department/central-instrumentation-facility/ https://www.jnu.ac.in/airf_Instruments
2	How can we differentiate different types of microscopes	Prescott, Harley, Klein., 2016. Microbiology, 10th Edition, Mc Graw – Hill.
3	Explain the mechanism of nuclear power reactors	R K Singal , 2014, Nuclear Reactors. https://www.energy.gov/ne/articles/nuclear-101-how-does-nuclear-reactor-work
4	Enumerate the applications of radioisotopes	Jadiyappa S. Radioisotope: applications, effects, and occupational protection. Principles and Applications in Nuclear Engineering: Radiation Effects, Thermal Hydraulics, Radionuclide Migration in the Environment. 2018 Sep 19:19.

C. Text Books

1. Keith Wilson., and John Walker., Principles and Techniques of Biochemistry and Molecular Biology, Seventh Edition, Cambridge University Press London, UK, 2010
2. Arumugam , Bioinstrumentation, MJP Publications,Chennai, 2018(Reprinted).

D. Reference Books

1. Douglas A. Skoog., James Holler F., and Stanley R. Crouch, Instrumental Analysis, Cengage Learning India Pvt., Ltd., New Delhi, 2009
2. Puri B.R., Sharma L.R., and Madan S. Pathania., Principles of Physical Chemistry, Vishal Publishing Co., Jalandhar, 2005
3. Singh P.R., Gupta D.S., and Bajpal K.S., Experimental Organic Chemistry, Vol (1),- Basic Techniques and preparations, Tata Mc-Graw-Hill Publishing Company Ltd., 1980
4. Harborne J.B., Phytochemical Methods – A Guide to Modern Techniques of Plant Analysis, Third Edition, Published by Chapman and Hall (L), London, 1998

E. Web Links

1. https://onlinecourses.nptel.ac.in/noc20_bt16/preview
2. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
3. https://nptel.ac.in/courses/102/103/102103044/

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Electrochemistry and Centrifugation**		
1.1	Principles of Electrochemical Techniques, Redox Reactions, the pH Electrode, Glass Electrode and Reference Electrode	Define the basic concepts Electrochemical Techniques.	K1
1.2	Centrifugation Small Bench Top Centrifuges, Large Capacity Refrigerated Centrifuges, High Speed Refrigerated Centrifuges, Preparative and Analytical Ultra Centrifuge.	Illustrate the concepts of Centrifugation and RCF Apply the principle of Centifuge to isolate the molecular samples.	K1 K4

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Chromatography**		
2.1	Principles of Chromatography, Ion Exchange and Affinity Chromatography. High Performance Liquid Chromatography (HPLC),Gas liquid Chromatography (GLC), Thin layer Chromatography (TLC), Paper Chromatography.	Classify the Types of Chromatography and Separate the Amino acids and various Biochemical Samples. Analyze separation of mixture of chemical Compounds by chromatography	K2 K4
3	**Electrophoresis**		
3.1	Principles of Electrophoresis, Electrophoresis of Proteins: SDS -PAGE, 2D-PAGE, Detection, Estimationand Recovery of Proteins.	Describe electrophoretic method of separating protein samples. Explain the different types of electrophoresis	K2 K2
3.2	Electrophoresis of Nucleic Acid: Agarose Gel Electrophoresis of DNA, Pulsed Field Gel Electrophoresis.	Describe the concept of Electrophoresis Discuss the method of analyzing the DNA samples to identify the Mol wt.	K2 K2
4	**Spectroscopy and Microscopy**		
4.1	Properties of Electromagnetic Ionic Radiation. UV and Visible Spectroscopy, FTIR, Infrared and Raman Spectroscopy	Explain the principle of Electromagnetic radiation. Apply the concept and mechanism of Spectroscopy.	K2 K3
4.2	Nuclear Magnetic Resonance Spectroscopy, ICP, Spectrofluorimetry ,Mass Spectroscopy (GC-MS),and XRD. Types of Microscopes-TEM and SEM	Interpret the concept and applications of NMR Spectrum. Identify the applications of various types of spectroscopy. Analyze the applications of TEM and SEM	K2 K2 K4
5	**Radioactivity**		
5.1	The nature of radioactivity, detection and measurement of radioactivity	Review the various concepts of Radioactivity.	K2
	Detection based on gas ionization- Geiger Muller Counter- principles and applications. Detection based on excitation- Liquid Scintillation Counter- principles and applications.	Analyze the accession of using Radioactive Detecting methods/ Instruments. Apply the usage of expression and arrays in pointers	K4 K3
5.2	Applications of radio isotopes in biological sciences. Autoradiography labeling.	List out the applications of radioisotopes in biology	K2

4. Mapping Scheme

P20BT1: 1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	M	L	L	M	L	-	L	M	-	H	L	-	-
CO2	M	M	M	H	H	M	L	M	L	H	M	-	-
CO3	H	M	H	H	M	M	M	H	M	H	H	M	M
CO4	H	H	H	H	H	M	M	M	H	M	H	H	H
CO5	M	-	M	L	H	L	-	L	M	L	M	M	M
CO6	M	L	H	M	H	M	M	M	H	H	M	L	L

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Cordinator Mr.J.Dinesh Raja

Semester: 1 **Course Code: P20BT1: A**
Credits : 4 **Total Hrs/ Week : 5**

Elective Course: IB - BASICS OF BIOINFORMATICS

1. CourseOutcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Understand the basic information of Bioinformatics tools and software	K2	I
CO2	Describe the features of the Biological databases	K1	II
CO3	Analyze the pair wise sequence alignment methods	K4	III
CO4	Determine the major principle aspects of protein-protein interaction, BLAST and PSI-BLAST	K3	IV
CO5	Apply and explain the application of Bioinformatics	K3	V
CO6	Distinguish the importance of Bioinformatics in the drug designing	K5	V

2. A. Syllabus

Unit – I **15hrs**

Introduction to Bioinformatics

Overview : Definition and History. Milestones in Bioinformatics. Methods in Bioinformatics. Role of Bioinformatics in various fields. Useful Bioinformatics web sites. Dogmas: Central and Peripheral. Introduction to single letter code of aminoacids, symbols used in nucleotides. Pubmed: Europen molecular biology network Bioinformatics programme in India

Unit -II **15hrs**

Biological Data and Databases

Introduction to Biological Databases- Nucleotide sequence database, Protein sequence & Structure Databases, Organism specific databases.Metabolic pathway databases, Bibliographic databases, Biodiversity databases and Specialized databases.

Unit -III **15hrs**

Sequence formats and Information retrieval

Sequence formats in Biological databases: FASTA, Phylip, Clustal, Genbank, EMBL, SWISS PROT. Data retrieval: Entrez, SRS, Protein identification resources (PIR), Expasy, Ensembl.

Unit -IV **15hrs**

Database Searches- Similarity, homology, assessing significance of sequence similarity- Z score, P value, E value. Similarity search programs-fast searching methods-BLAST, FASTA, Dynamic programming searching methods, profile based methods-PSI- BLAST, Sensitivity and Specificity.

Unit -V **15hrs**

Applied Bioinformatics

Commercial bioinformatics, Survey of bioinformatics companies in India and abroad –Economics prospects, pharama informatics, combinatorial chemistry, HT screening – in silico screening - from lead to commercialization. Role of bioinformatics resources: Agricultural-Transgenic plants and Animals. Pharmaceutical-Drug design and medical-SNP, Genetic disorders.

B. Topics for self study

S.No	Topics	Web Links
1.	Bioinformatics help in handling and analysis of the genomics data and annotation	https://www.intechopen.com/books/bioinformatics-updated-features-and-applications/bioinformatics-basics-development-and-future
2.	Structural bioinformatics: molecular folding, modeling, and design	Ibrokhim Y. Abdurakhmonov (July 27th 2016). Bioinformatics: Basics, Development, and Future, Bioinformatics
3.	Biological networks and system biology	https://www.hindawi.com/journals/bmri/2014/428570/
4.	Intelligent Systems for Molecular Biology	https://academic.oup.com/bioinformatics/article-abstract/10/2/199/184414?redirectedFrom=fulltext

C. Text Books

1. M. Michael Gromiha, Protein Bioinformatics - From Sequence to Function, Elsevier India Pvt. Ltd, New Delhi, 2010.
2. Lesk, A.M, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003

D. Reference Books

1. Attwood T.K., and Parry-Smith D.J., 2004. Introduction to Bioinformatics, Pearson Education Ltd., New Delhi.
2. Westhead D.R., Parish J.H., and Twyman R.M.2003. Instant notes in Bioinformatics, Viva Books Pvt. Ltd.
3. Manju Bansal., 2009. Basic Bioinformatics, Atlantic Publishers & Distributors.
4. Harshawardhan, P, 2005.Bioinformatics principles and application, Tata McGraw Hill Publishers,New Delhi.
5. Mount, D.W, 2005. Bioinformatics Sequence and Genome Analysis, Second Edition, CBS Publishers, New Delhi.

E. Web Links

1. https://nptel.ac.in/courses/102/106/102106065/
2. https://onlinecourses.swayam2.ac.in/cec21_bt04/preview

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Introduction to Bioinformatics**		
1.1	Overview- Definition and History. Milestones in Bioinformatics. Methods in Bioinformatics. Role of Bioinformatics in various fields. Useful Bioinformatics web sites.	Apply the most common problems of modeling biological processes at the molecular level	K4
1.2	**Dogmas:** Central and Peripheral. Introduction to single letter code of aminoacids, symbols used in nucleotides.	Understand the properties of amino acid by charge, hydrophobicity and polarity.	K4
1.3	**Pubmed:**Europen molecular biology network Bioinformatics programme in India.	Apply the molecular biology network through PUBMED center.	K3

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Biological Data and Databases**		
2.1	Introduction to Biological Databases-Nucleotide sequence database, Protein sequence & Structure Databases, Organism specific databases.	Differentiate between nucleotide and protein sequences retrieved from the Biological databases.	K4
2.2	Metabolic pathway databases, Bibliographic databases, Biodiversity databases and Specialized databases.	Illustrate how reactions carry on linkage pathways and KEEG pathway of reaction mechanisms including that enzyme commission number (EC).	K5
3	**Sequence formats and Information retrieval**		
3.1	**Sequence formats in Biological databases:**FASTA, Phylip, Clustal, Genbank, EMBL, SWISS PROT.	Analyze the different formats of sequences input in their respective Biological databases.	K4
3.2	**Data retrieval:** Entrez, SRS, Protein identification resources (PIR), Expasy, Ensembl.	Evaluate the biological processes at the molecular level from the respective data retrieval.	K5
4	**Database Searches**		
4.1	Similarity, homology, assessing significance of sequence similarity-Z score, P value, E value. Similarity search programs-fast searching methods-BLAST, FASTA, Dynamic programming searching methods, profile based methods-PSI- BLAST, Sensitivity and Specificity.	Discuss the mechanism of various Biological parameters and substitute the reaction for biological applications.	K2
5	**Applied Bioinformatics**		
5.1	Commercial bioinformatics, Survey of bioinformatics companies in India and abroad -Economics prospects, pharama informatics, combinatorial chemistry, HT screening - in silico screening - from lead to commercialization.	Apply the various bioinformatics tools in biological research	K3
5.2	Role of bioinformatics resources: Agricultural-Transgenic plants and Animals. Pharmaceutical-Drug design and medical-SNP, Genetic disorders	Analyze and identify the drug targets for vaccine design	K4

4. Mapping Scheme

P20BT1: A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	H	H	H	M	M	M	M	M	L	L	L	M
CO2	M	L	L	M	M	L	L	H	H	H	H	L	M
CO3	M	L	H	M	M	L	L	M	H	H	M	L	L
CO4	H	M	M	H	H	L	L	L	L	L	H	H	H
CO5	L	H	H	H	H	M	M	M	M	H	H	H	H
CO6	H	M	M	H	M	H	H	H	H	L	M	H	H

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototypeor Product Demonstratione tc.(as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Cordinator : Dr.M.Rajadurai

Semester: 2 **Course Code: P21BT204**
Credits : 5 **Total Hrs/ Week : 5**

Core Course IV - ANIMAL BIOTECHNOLOGY

1. Course Outcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Understand the significance of maintenance of cell lines & their application in cancer studies & toxicity testing	K2	I
CO2	Gain knowledge in the various techniques such cell synchronization & cell hybridization	K2	I
CO3	Compute the methods of construction of viral vectors in transfer of gene of interest to host in gene therapy	K3	II
CO4	Analyze the importance & advantages of recombinant vaccines over conventional vaccines	K4	II
CO5	Appraise the use of transgenic animals as models for human disease & for commercial products & explain the concepts in selective & cross breeding	K5	IV
CO6	Evaluate the application of employing *C.elegans*, mice, zebra fish & drosophila as alternative animal models in research	K5	V

2. A. Syllabus

Unit - I **15hrs**

Animal Cell Culture

Development and maintenance of cell lines, continuous cell lines, culture media for cultured cells & tissues - natural & defined media, Preparation of various tissue culture media, sterilization, Cell hybridization, hybridoma & monoclonal antibodies production. Cell synchronization.

Unit -II **15hrs**

Biology and Methods for the Construction of Animal Viral Vectors

SV 40, adeno virus, retro virus, vaccinia virus, herpes virus, adeno associated virus and Baculo virus. Recombinant vaccines (r-subunit vaccine, r-live vaccines, Anti-idiotipic), Interferon and growth factor and other therapeutic proteins and gene therapy.

Unit - III **15hrs**

Conventional Methods of Animal Improvement

Selective and Cross Breeding. Artificial insemination, Superovulation, Oestrus Synchronization. In vitro maturation of animal oocytes - Methods of transferring genes into animal oocytes, eggs, embryos and specific tissues - IVF - gamete selection - In vitro culture of Oocyte / embryo and storage. Embryo collection, sex selection and transfer. Somatic cell cloning.

Unit – IV **15hrs**

Transgenics

Transgenic animal production and application; transgenic animals as models for human disease; transgenic animals as living bioreactors-transgenic animals in livestock improvement; transgenic in industry; chimera production; xenografting; ethical issues in animal biotechnology.

Unit – V **15hrs**

Animal models

Animal models to assess and understand toxicology-Life cycle and genetics of Drosophila, *Caenorhabditis elegans*, Mice and Zebra fish.

B. Topics for self study

S.No	Topics	Web Links
1.	Animal feed additives	www.wattagnet.com
2	Role of Probiotics in enhancing animal health	www.mdpi.com
3	Intracellular mini-binders	www.nature.com› nature methods
4	From gene editing to genome engineering	www.botanik.kit.edu › molbio

C. Text Books

1. Freshney R.I., Culture of Animal Cells, Manual of Basic technique, 4th Edition, John Wiley Publications,2000.
2. Ranga M.M.,Animal Biotechnology, 2nd Edition, Agrobios, India, 2004.
3. SasidharaR.,Animal Biotechnology, MJP Publishers, 2006.

D. Reference Books

1. Babiuk L.A., John. P. P., and Murray M., Animal Biotechnology, Pergamm Press, Oxford, 1989
2. Primrose, S.B., Twyman, R.W., Principles of Gene Manipulation and Genomics, VII edition, Wiley Blackwell, 2006.
3. Glick B. R., and Pasternak J. J., Molecular Biotechnology- Principles and Applications of Recombinant DNA, 3rd Edition, American Society for Microbiology,2003.
4. Watson J.D., Caudy A. A., Myers R. M., Witkowski J.A., Recombinant DNA: Genes and Genomics: A short course, 3rd Edition, W.H.Freeman& Co Ltd.,2006.
5. Ashish Verma, Anchal Singh, Animal Biotechnology: Models in Discovery and Translation, Academic Press, 1st Edition, 2014.

E. Web Links

1. https://www.coursera.org/lecture/methods-of-molecular-biology/animal-biotechnology-and-its-methods-0DFte
2. http://ecoursesonline.iasri.res.in/course/view.php?id=350
3. https://nptel.ac.in/noc/courses/noc21/SEM2/noc21-bt47/

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Animal Cell Culture**		
1.1	Introduction -Animal Cell Culture	Explain the basics of animal cell culture	K2
1.2	Cell lines & media	Describe the maintenance and culture of cell lines	K2
1.3	Media for cultured cells & tissues - natural & defined media, Preparation of various tissue culture media, sterilization	Discuss the different types of cell culture media	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1.4	Cell hybridization Hybridoma technology & Monoclonal antibodies production. Cell synchronization	Assess the application of hybridoma technique in production of Monoclonal antibodies Analyze the significance of cell hybridization and cell synchronization technique	K5 K4
2	**Biology and Methods for the Construction of AnimalViral Vectors**		
2.1	Viral vectors for gene transfer	Explain the construction of viral vectors Assess the role of viruses as vectors	K2 K5
2.2	Recombinant vaccines	Evaluate the significance of recombinant vaccines	K5
2.3	Therapeutic Proteins	Explain recombinant therapeutic proteins and highlight the significance of therapeutic proteins	K3
2.4	Gene therapy	Discuss the application of gene therapy for solving genetic disorders	K4
3	**Conventional Methods of Animal Improvement**		
3.1	Conventional Methods of Animal Improvement- a. Selective and Cross Breeding b. Artificial insemination c. Super ovulation, Oestrus Synchronization	Explain the concept of selective and cross breeding Analyze the significance of artificial insemination Demonstrate the applications of Super ovulation, Oestrus Synchronization	K2 K4 K3
3.2	*In vitro* fertilization	Evaluate the pros and cons of *in vitro* fertilization	K5
3.3	Somatic cell cloning	Explain steps in somatic cell cloning	K2
4	**Transgenics**		
4.1	Transgenics- production & Application a.Transgenic animal production and application b.Transgenic animals as models for human disease c. Transgenic animals in livestock improvement & industry	Explain the mechanism involved in the production of transgenic animals Evaluate the advantages and disadvantages of transgenic animals	K3 K5
4.2	Chimera production	Describe the features of chimera	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
4.3	Xenografting	Illustrate the significance of xenografting	K2
4.4	Ethical issues in animal biotechnology.	Analyze the various ethical issues in animal biotechnology	K4
5	**Animal models**		
5.1	1. Animal models to assess & understand toxicology	Evaluate the levels of toxicology using animal models	K5
5.2	2. Life cycle and genetics of Drosophila	Explain the use of drosophila as alternate animal model	K2
5.3	3. Life cycle and genetics of *Caenorhabditis elegans*	Investigate the application of *C.elegans* as animal model	K4
5.4	4. Life cycle and genetics of mice	Assess the use of mice as animal model	K3
5.5	5. Life cycle and genetics of Zebra fish	Justify the use of zebra fish as animal model	K4

4. Mapping Scheme

P20BT204	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	M	H	H	L	-	-	H	H	H	-
CO2	H	L	M	M	M	-	-	-	-	M	M	H	-
CO3	H	M	M	H	H	H	-	-	L	M	H	H	-
CO4	H	H	H	M	H	M	-	-	L	H	H	H	-
CO5	H	H	H	H	H	M	-	L	-	M	H	H	M
CO6	H	H	M	M	H	M	-	M	M	H	M	H	M

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II
2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation
3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.R.Jasmine

Semester : 2 **Course Code : P20BT205**
Credits : 5 **Total Hrs/ Week : 5**

Core Course : V-PLANT BIOTECHNOLOGY

1. Course Outcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Explain the basics, methodology and applications of plant tissue culture	K2	I
CO2	Experiment with the function and composition of different plant structures, tissues, and organelles	K3	II
CO3	Categorize the role of GM crops and products in the market and pipeline, and their contributions towards food security, sustainable environment and medicine	K4	III
CO4	Determine plant transformation, selection of desirable genes for crop improvement, design binary vector and procedure for generating GM crops	K5	IV
CO5	Compose plant related research, government regulatory bodies, education, food industry and other plant-based product development and related businesses	K5	V
CO6	Combinethe topics of technical insights into plant breeding, tissue culture, plant genes and genetic modification	K5	V

2. A. Syllabus

Unit – I **15hrs**

Genome Organization in Plants

Genome Organization in Nucleus, Chloroplast and Mitochondria, Molecular Marker-Aided Breeding: RFLP maps, Linkage Analysis, RAPD markers, STS, Microsatellites. Plant Hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

Unit –II **15hrs**

Plant Cell and Tissue Culture

Brief historical account, Laboratory organization, Tissue culture media composition and preparation, Callus and Cell suspension culture, Somaclonal variation, Micropropagation, Organogenesis, Somatic embryogenesis, Embryo culture, Synthetic seeds, Protoplast isolation, Somatic hybridization and Cybrids, Anther, Pollen and Ovary culture for production of haploid plants.

Unit –III **15hrs**

Plant Genetic Transformation Methods

Cryopreservation and DNA banking for Germplasm conservation. Production of secondary metabolites, Genetic engineering of metabolic pathways, Production of secondary metabolites in bioreactors and downstream processing.

Unit –IV **15hrs**

Application of Plant Genetic Transformation

Agrobacterium and Crown gall tumours, Mechanism of T-DNA transfer, Ti and Ri plasmid vectors, Agro infection. Direct transfer of plants by physical methods, Selectable marker and reporter genes, Chloroplast transformation. Mechanism of soil bacteria and cyanobacteria for enhanced nitrogen fixation, Azola as biofertilizers, advantage of biofertilizers over chemical fertilizers, activity to control insect pests, Plant host-insect interactions- nif and nod genes.

Unit – V **15hrs**

Metabolic Engineering and Biopharmaceuticals

Transgenic plants: Genetic engineering of plants for herbicide resistance, Pest resistance, Virus resistance, Disease resistance, Stress tolerance, Cytoplasmic male sterility, Delayed fruit ripening. Genetic engineering in floral industries Genetic engineering of seed storage proteins. Vaccine production in plants-plantibodies, Edible vaccine, Transgenic plants: Bt cotton, Bt brinjal, vitamin enrichment, Golden rice.

B. Topics for self study

S.No	Topics	Weblinks
1	BioFEDs	https://www.frontiersin.org/articles/10.3389/fpls.2020.598103/full
2	Plant Science's Contribution to Fighting Viral Pandemics: COVID-19 as a Case Study	https://www.frontiersin.org/research-topics/13779/plant-sciences-contribution-to-fighting-viral-pandemics-covid-19-as-a-case-study
3	Gene stacking by recombinases	https://www.bionity.com/en/publications/852877/gene-stacking-by-recombinases.html
4	Green catalysts	https://pubmed.ncbi.nlm.nih.gov/29914650/

C. Text Books

1. Mantell S.H., and Smith H., Plant Biotechnology, Cambridge University Press, UK, 1983.

D. References Books

1. Mantel., Mathews., and Mickee., An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publishers, London, 1985
2. Pierik R.L.M., In Vitro Culture of Higher Plants, MartinusNijhoff Publisher, Dordrecht, 1987
3. Dixon R.A., and Gonzales R.A., Plant Cell Culture. A Practical Approach. Second Edition, Oxford University Press, Oxford, 1994
4. Donald Grierson., and Convey S.V., Plant Molecular Biology, Blackie and Son Limited. New York, 1984
5. Henry R.J., Practical Application of Plant Molecular Biology, Chapmans and Hall, 1997
6. KirsiMarjaOksmanCaldentey., and Wolfgang H. Barz., Plant Biotechnology and Transgenic Plants, Marcel Dekker, Inc., New York, 2002.

E. Web Links

1. https://nptel.ac.in/courses/102/103/102103016/
2. https://nptel.ac.in/content/storage2/courses/102103016/module1/lec1/5.html

3. Specific Learning Outcomes (SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Genome Organization in Plants**		
1.1	Genome Organization in Nucleus	Define Gene & Genome Recall the structure of Gene & Genome Explain the organization in nucleus	K1 K2
1.2	Chloroplast and Mitochondria	Recall the structure of Gene & Genome Compare the structure of the chloroplast and mitochondria	K2
1.3	Molecular Marker-Aided Breeding	Explain the molecular marker-Aided breeding Differentiate molecular marker- aided breeding with other breeding	K3
1.4	RFLP maps	What is RFLP? Explain the RFLP maps	K2
1.5	RAPD markers	Define RAPD Explain RAPD maps	K1
1.6	Linkage Analysis	What is Linkage ? Explain Linkage Analysis	K4
1.7	STS	Define STS Classify STS List out the advantages of STS	K1 K2
1.8	Microsatellites	Define & classify Microsatellites Show the advantages of using Microsatellites	K1 K3
1.9	Plant Hormones	Define plant hormone Classify the types of plant hormones Highlight the advantages of using plant hormones	K2 K3 K3
1.10	Biosynthesis Storage, breakdown, transport physiological effects and mechanisms of action.of plant hormone	Explain about the biosynthesis of plant hormones Explain the storage, breakdown & transport of plant hormones Compare the physiological effects and mechanisms of action of different plant hormones	K2 K2 K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Plant Cell and Tissue Culture**		
2.1	Brief historical account	Trace the history of plant tissue culture	K2
2.2	Laboratory organization	Demonstrate the organization of plant cell laboratory	K3
2..3	Tissue culture media composition and preparation	Determine the significance of the tissue culture media Recall the media composition	K2
2.4	Callus & Cell suspension culture	Explain the methodology of callus production Determine the development of callus	K2 K4
2.5	Micropropagation & Protoplast isolation	Describe the technique of micropropagation Review protoplast isolation method	K2 K2
2.6	Embryo culture & Organogenesis	Develop invitro embryo culture Experiment with Organogenesis Distinguish direct and indirect organogenesis	K4 K4 K4
2.7	Somaclonal variation & Somatic embryogenesis	Describesomaclonal variation Experiment with somatic embryogenesis	K2 K3
2.8	Synthetic seeds	Identify and choose proper seeds Recall the media composition Develop synthetic seeds	K2 K4
2.9	Somatic hybridization & Cybrids	Identify somatic hybridization Experiment with somatic hybridization Determine the significance of cybrids	K3
2.10	Anther, Pollen and Ovary culture for production of haploid plants.	Define haploid plants Compare between anther, pollen and ovary culture	K1
3	**Plant Genetic Transformation Methods**		
3.1	Cryopreservation and DNA banking for Germplasm conservation	Identify cryoprotectants Analyze DNA banking Assume Germplasm conservation	K3
3.2	Production of secondary metabolites	Analyze the secondary metabolites Categorize the secondary metabolites	K4
3.3	Genetic engineering of metabolic pathways	Compare various metabolic pathways Determine Genetic engineering of metabolic pathways	K3

Unit/ Section	Course Content	Learning Outcomes	HBTLT
3.4	Production of secondary metabolites in bioreactors and downstream processing	Classify the bioreactors List out the production of secondary metabolites using bioreactors Inspect the process of downstream processing	K2
4	**Application of Plant Genetic Transformation**		
4.1	Agrobacterium and Crown gall tumours, Mechanism of T- DNA transfer	Compare the relationships of Agrobacterium and crown gall tumours Determine the mechanism of T-DNA transfer	K2
4.2	Ti and Ri plasmid vectors &Agro infection	Discover the presence of Ti and Ri plasmid vectors Compare the Ti and Ri plasmid vectors	K2
4.3	Direct transfer of plants by physical methods	Classify the direct transfer of plants by physical methods Categorize the natural methods Survey the artificial methods Distinguish natural and artificial methods	K2 K2 K4
4.4	Selectable marker and reporter genes	Determine the selectable markers Categorize the reporter genes	 K2
4.5	Chloroplast transformation	Explain the structure of chloroplast Analyse chloroplast transformation mechanism	K2 K4
4.6	Mechanism of soil bacteria and cyanobacteria for enhanced nitrogen fixation	Analyse the process of nitrogen fixation Describe the mechanism of soil bacteria and cyanobacteria	K4 K2
4.7	Azola as biofertilizers	Examine Azola as biofertilizers	K2
4.8	Advantage of biofertilizers over chemical fertilizers Activity to control insect pests	Determine the activity of insect pest control, Compare biofertilizers and chemical fertilizers Determine the advantages of biofertilizers	K2
4.9	Plant host-insect interactions-*nif*and *nod* genes	Analyze plant host-interactions Categorize nif and nod genes	K4
5	**Metabolic Engineering andBiopharmaceuticals**		
5.1	Transgenic plants : Genetic engineering of plants for herbicide resistance	Determine genetic engineering of plants Explain herbicide resistance Evaluate the genetically engineered herbicide resistance plants	K2 K5

Unit/ Section	Course Content	Learning Outcomes	HBTLT
5.2	Pest resistance plants	Explain pest resistance Discuss about the advantages of pest resistant plants	K2
5.3	Virus resistance plants	Explain virus resistance Discuss about the advantages of virus resistant plants	K2
5.4	Disease resistance plants	Explain disease resistance Discuss about the advantages of disease resistant plants	K2
5.5	Stress tolerance plants	Explain pest resistance Discuss about the advantages of pest resistance plants	K2
5.6	Cytoplasmic male sterility	Determine cytoplasmic male sterility Explain cytoplasmic male sterility Elaborate the importance of cytoplasmic male sterility	K2
5.7	Delayed fruit ripening	Define delayed fruit ripening Explaindelayed fruit ripening Elaborate the mechanism of delayed fruit ripening	K1
5.8	Genetic engineering in floral industries & Genetic engineering of seed storage proteins	Explain the genetic engineering process Describe the floral industries and seed storage proteins Discuss about genetic engineering in floral industries and seed storage proteins Evaluate the advantages of seed storage proteins	K2 K2
5.9	Vaccine production in plants: Plantibodies	Explain the plantibodies Analyze the types of plantibodies DISCUSS the advantages of plantibodies	K2 K4 K4
5.10	Edible vaccine	Define edible vaccines Explain the mechanism of edible vaccines DESCRIBE the advantages of edible vaccines	K1 K2 K4
5.11	Transgenic plants: Bt cotton, Bt brinjal, vitamin enrichment, Golden rice	Explain the production of transgenic plants Estimate the advantages of transgenic plants	K2 K4

4. Mapping Scheme

P20BT205	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	L	H	L	L	L	-	-	H	L	H	-
CO2	H	H	M	H	M	M	H	M	H	H	M	H	-
CO3	M	L	H	L	M	L	M	L	M	L	H	H	-
CO4	H	H	M	M	H	M	H	M	H	M	H	H	-
CO5	M	M	M	H	H	H	H	M	M	M	M	H	M
CO6	M	L	M	H	H	M	H	M	H	H	M	H	M

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator : Dr.C.Cynthia

Semester: 2 **Course Code: P20BT206**
Credits : 4 **Total Hrs/ Week : 5**

Core Course : VI - INDUSTRIAL BIOTECHNOLOGY

1. Course Outcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	To acquire knowledge about the screening techniques of industrially important microbes	K1	I
CO2	To understand the nutrition sources, types and stages of fermentation systems	K2	II
CO3	To distinguish the components and types of fermentor	K4	II
CO4	To comprehend about the downstream processing	K5	III
CO5	To apply the knowledge about the production of industrially significant products using fermentation technology	K3	IV
CO6	To apply the knowledge in the production of commercially valuable	K3	V

2. A. Syllabus

Unit - I **15hrs**

Industrial Fermentation

Screening of Primary and Secondary Metabolites; Strain Development for Metabolite Production; Substrates used for Industrial fermentation; Carbon and Nitrogen Sources; Methods of Fermentation - Batch and Continuous fermentation, Different Fermentation Systems, Different Stages of Fermentation Process.

Unit -II **15hrs**

Fermentor Design:

Introduction - Basic functions of fermentor, Components of fermentor: Impellor, Sparger and Baffles. Sterilization of fermentor. Bioreactor control and monitoring process. Role of computer in fermentation technology. Types of reactors: Air lift fermentor, Stirred tank fermentor, tower fermentor, cyclone column fermentor and Rotating disc fermentor.

Unit –III **15hrs**

Down Stream Processing:

Solid –liquid separation-flotation, flocculation, filtration , centrifugation ; Release of intracellular products; Concentration- evaporation, liquid –liquid extraction, membrane filtration, precipitation, adsorption; Purification- Ion exchange , Formulation- drying, freeze drying, crystallization.

Unit –IV **15hrs**

Production of Industrially Significant Products/Secondary Metabolites:

Antibiotics Production- Tetracycline, Erythromycin; Amino acid Production- L-Threonine, L-Phenyl alanine; Vitamins – Riboflavin, Carotenes.

Unit -V **15hrs**

Commercially Valuable Bioproducts:

Fermented Foods- Cheese; Microorganisms and Substrates used for Production of SCP, Advantages of using Microorganisms; Production of Edible Mushrooms; Production of Microbial Polysaccharides- Xanthan

B. Topics for self study

S. No.	Self - study Topics	Web Links
1.	Enzymes in industry: production and applications.	https://www.cabdirect.org/
2.	Cheese Production by Donkey's Milk Using an Aspartic Protease from Plant Origin	https://www.longdom.org/scholarly/industrial-biotechnology
3.	White /Industrial Biotechnology	https://www.omicsonline.org/scholarly/whiteindustrial-biotechnology
4.	The role of biotechnology in pharmaceutical drug design	https://pubmed.ncbi.nlm.nih.gov/

C. Text Books

1. Stanbury P.F., Whitaker, A., and Hall S.J., Principles of Fermentation Technology, Third Edition, Butterworth- Heinemann Publishers, 2016.
2. A.H. Patel., Industrial Microbiology, 1st Edition, MacMillan Publication, 20008.

3. U. Satyanarayan and U. Charapani, Biotechnology, 12th Edition, Books and allied (P) Ltd., 2019.

D. Reference Books

1. Casida Jr, L. E. Industrial Microbiology, 1st Edition, New age International (P) Ltd., 2007.
2. Wulf Cruger W., Anneliese Crueger A and K.R.Aneja, Crueger's Biotechnology: A Textbook of Industrial Microbiology, 3rd Edition, Medtech Publishers, 2017.
3. Presscott, D., Industrial Microbiology, 4th Edition, Agrobios (India) CBS Publication, 2005.
4. S.M. Reddy, S. Ram Reddy, G. Narendra Babu, Basic Industrial Biotechnology, 1st Edition, New Age International, 2012.
5. Glazer , A.N and Nikaido H., Microbial Biotechnology, W.H.Freeman& Company, New York, 1995.

E. Web Links

1. https://www.careers360.com/university/indian-institute-of-technology-kharagpur/industrial-biotechnology-certification-course
2. https://www.coursera.org/learn/industrial-biotech
3. https://onlinecourses.nptel.ac.in/noc19_bt20/preview

3. Specific Learning Outcomes (SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Industrial Fermentation**		
1.1	Screening of Primary and Secondary Metabolites;	To examine the soils samples for screening the industrially important microorganisms.	K1
1.2	Strain Development for Metabolite Production;	To distinguish the strains and improve the quality for more yield.	K2
1.3	Substrates used for Industrial fermentation; Carbon and Nitrogen Sources;	To classify the components of the media required for fermentation.	K2
1.4	Methods of Fermentation - Batch and Continuous fermentation,	To compare batch and continuous fermentation techniques.	K2
1.5	Different Fermentation Systems,	To differentiate fermentation systems.	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1.6	Different Stages of Fermentation Process.	To describe various stages of fermentation processes.	K2
2	**Fermentor Design**		
2.1	Introduction - Basic functions of fermentor, Components of fermentor: Impellor, Sparger and Baffles.	To analyze the functions of the fermentor. To classify the basic components of the fermentor.	K4
2.2	Sterilization of fermentor.	To analyze the sterilization techniques of the fermentor.	K4
2.3	Bioreactor control and monitoring process. Role of computer in fermentation technology.	To illustrate how the bioreactor is controlled and monitored.	K2
2.4	Types of reactors: Air lift fermentor, Stirred tank fermentor, tower fermentor, cyclone column fermentor and Rotating disc fermentor.	To correlate and explain the mechanism of different types of fermentor.	K4
3	**Down Stream Processing**		
3.1	Solid -liquid separation-flotation, flocculation, filtration , centrifugation ; Release of intracellular products;	To assess various stages of downstream processing.	K5
3.2	Concentration- evaporation, liquid -liquid extraction, membrane filtration, precipitation, adsorption;	To distinguish the techniques involved in concentrating the product during downstream processing.	K2
3.3	Purification- Ion exchange , Formulation- drying, freeze drying, crystallization.	To estimate the product how far it is pure.	K5
4	**Production of Industrially Significant Products**		
4.1	Antibiotics Production- Tetracycline, Erythromycin;	To discuss a methodology for the production of antibiotics	K4
4.2	Amino acid Production- L-Threonine, L-Phenyl alanine;	To explain the production of Amino acids industrially	K2
4.3	Vitamins - Riboflavin, Carotenes.	To explain the production of vitamins.	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
5	**Commercially Valuable Bioproducts**		
5.1	Fermented Foods- Cheese; Microorganisms and Substrates used for Production of SCP, Advantages of using Microorganisms;	To formulate the process for the production of commercially valuable products such as cheese and SCP	K6
5.2	Production of Edible Mushrooms;	To establish the method of production of edible mushroom	K6
5.3	Production of Microbial Polysaccharides- Xanthan.	To assess the production of microbial polysaccharide- xanthan by fermentation technology.	K6

4. Mapping Scheme

P20BT206	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	M	M	M	M	-	-	-	H	H	H
CO2	H	H	-	-	M	M	-	-	-	-	H	M	-
CO3	H	M	-	-	-	-	-	-	-	-	-	-	-
CO4	-	H	H	H	M	-	-	-	-	H	H	-	H
CO5	M	H	H	H	H	H	-	-	-	H	H	H	H
CO6	M	H	H	H	H	H	-	-	-	H	H	H	H

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator : Dr.Beatrice Valdaris

Semester: 2 **Course Code: P20BT2P3**
Credits : 3 **Total Hrs/ Week : 5**

Core Practical : III - ANIMAL, PLANT & INDUSTRIAL LAB

1. Course Outcomes

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

CO. No	Course Outcomes	Level	Experiments Covered
CO1	Understandthe organization of plant and animal culture labs	K2	1,6
CO2	Familarise in preparation of plant and animal culture media	K2	1,4,7
CO3	Apply the theoretical knowledge in developing practical skills in plant tissue culture techniques	K3	6,7
CO4	Analyse the effect of toxicants in human cells by MTT assay	K4	10,13
CO5	Visualize the live cells and differentiate them from dead cells	K4	2
CO6	Explore the significance of extra cellular enzyme producers	K5	11,12

2. Syllabus

List of Experiments

Animal Biotechnology Laboratory

1. Media Preparation for Animal Cell Culture
2. Cell viability test- by trypan blue
3. Cell toxicity testig-MTT assay
4. Primary cell culture-Isolation of cells from organs
5. Serum Preparation

Plant Biotechnology Laboratory

6. Preparation of Plant tissue culture Medium
7. Micropropagation of medicinal plants
8. Callus induction
9. Somatic Embryogenesis
10. Synthetic seeds

Industrial Biotechnology

11. Isolation and screening of antibiotic producers by crowded plate technique
12. Isolation and screening of microorganism producing proteases
13. Isolation and screening of microorganism producing amylases
14. Isolation of nitrogen fixers from soil.

D. Reference Books

1. Collins J., Microbial Methods, 7th Edition, CRC Press,1995.
2. Robert Cruickshank, Medical Microbiology, Guide to the laboratory Diagnosis & Control of Infection, 12th Edition, Churchill Livingstone Publishers,1973.
3. Cheever F .S., Laboratory Manual of Microbiology – Pubmed Central, 2006.
4. Sharma and Anshan., Manual of Microbiology Tools and Techniques, 2007.
5. Ian Freshney R., Culture of Animal Cells: A Manual of Basic Technique, Fifth Edition, John Wiley and Sons Inc., Hoboken, New Jersey, 2005.
6. LingarajSahoo.,Plant Biotechnology Laboratory Manual., IIT – Gwahathi, 2012.
7. McNeil and Harvey., Fermentation– A Practical Approach, IRL Press, 1990.
8. Cooney., Wang and Daniel., Computer Aided Material Balancing for Production of Fermentation Parameters, Biotech. Bio Engineering, 1997.
9. Scragg, Bioreactors in Biotechnology- A Practical Approach, Ellis Harwood Ltd.,1991.
10. Janarthanan S., Vincent S.,Practical Biotechnology, 1st Edition, Universities Press, Hyderabad, 2007.

Web Link

1. https://www.careers360.com/university/indian-institute-of-technology-kanpur/cell-culture-technologies-certification-course
2. http://ecoursesonline.iasri.res.in/course/view.php?id=350
3. https://nptel.ac.in/courses/104/105/104105102/

3. Specific learning outcomes (SLO)

Exercises	Course Content	Learning Outcomes	HBTLT
EX 1	**Animal Biotechnology**		
EX 1.1	Media Preparation and filter sterilization for Animal Cell Culture	Remember the media composition and the significance of all components Perform the technique of filter sterilization	K1 K3
EX 1.2	Cell viability test-by trypan blue	Differentiate viable and non-viable cells by trypan blue method	K4
EX 1.3	Cell toxicity testing-MTT assay	Evaluate the toxicity of chemicals or natural compounds by estimating cell death	K5
EX 1.4	Primary cell culture- Isolation of cells from organs	Demonstrate the protocol of isolating cells from organs	K3
EX 1.5	Serum Preparation	Illustrate serum separation from whole blood	K2
EX2	**Plant Biotechnology**		
EX 2.1	Preparation of Plant tissue culture medium	Execute the preparation of MS medium from the basic chemicals	K3
EX 2.2	Micropropagation of medicinal plants	Illustrate the technique of micropropagation	K2
EX 2.3	Callus induction	Employ the technique of callus induction	K3
EX 2.4	Somatic Embryogenesis	Demonstrate the technique of somatic embryogenesis	K3
EX 2.5	Synthetic seeds	Prepare synthetic seeds	K5
EX 3	**Industrial Biotechnology**		
EX 3.1	Isolation and screening of antibiotic producers by crowded plate technique	Analyze antibiotic producers	K4
EX 3.2	Isolation and screening of microorganism producing proteases	Assess the production of protease by microbes	K5
EX 3.3	Isolation and screening of microorganism producing amylases	Perform an experiment to isolate amylase producers	K3
EX 3.4	Isolation of nitrogen fixers from soil.	Conduct an experiment to isolate nitrogen fixers from root nodules	K3

4. Mapping Scheme

P20BT2P3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	-	-	H	H	H	H	L	H	L	M	M	H	M
CO2	-	-	H	H	H	H	L	H	L	M	M	H	M
CO3	-	-	H	H	H	H	L	H	L	M	M	H	M
CO4	-	-	H	H	H	H	L	H	L	M	M	H	M
CO5	-	-	H	H	H	H	L	H	L	M	M	H	M
CO6	-	-	H	H	H	H	L	H	L	M	M	H	M

L: Low M: Medium H: High

5. Course Assessment Methods

Direct
1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Mr.J.Dinesh Raja

Semester: 2 **Course Code: P20BT2:2**
Credits : 4 **Total Hrs/ Week : 4**

Elective Course: IIA
RESEARCH METHODOLOGY AND BIOSTATISTICS

1. CourseOutcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Define the Concept of Research	K1	I
CO2	Understand the characteristics of Research in Biological Sciences	K2	II
CO3	Understand the method to write research reports, thesis, and manuscript for publication	K3	III
CO4	Analyze and categorize the concepts of Measuring Central Tendency	K4	IV
CO5	Describe the principle of Mean, Median, and Mode	K5	IV
CO6	Define the accession and passing arguments using Software in Biostatistics	K2	V

2. A. Syllabus

Unit – I **15hrs**

Research Design

Meaning of research, design, research method versus methodology, objectives of research, Types of research, Types of research , significance of research, Criteria of good researches.

Unit –II **15hrs**

Research Problem

Defining of Research problem, Research Design-Meaning – need – Features – Concepts relating to research design – Different Research design –basic Principles of Experimental Design.

Unit –III **15hrs**

Interpretation and Report Writing

Interpretation – Meaning, Technique, Precaution; report writing– Significance, Steps in Report Writing –Significance, Steps in Report writing Layout of research report and thesis. writing Preparation of manuscript for publication, Citation and Bibliography, Impact factor.

Unit –IV **15 hrs**

Scope of Biostatistics

Scope on Biostatistics in biological research – Variables – Data; Sources and Collection Classification, Presentation; Measure of Central Tendency-Mean(Arithmetic),median-mode, Measures Dispersion- Standard deviation and Standard error-Skewness and kurtosis, coefficient of Variance.

Unit – V **15hrs**

Correlation

Correlation types, Correlation Coefficient , Regression – Simple Linear Regression, Basis Idea of significance test - Hypothesis testing –Type I error – Level of Significance –tests based on Student test, Chi Square Test, ANNOVA,'F' TEST (one way analysis). Introduction to SPSS.Data analysis using Graphpad.

B. Topics for self study

S.No.	Topics	Web Links
1	Indian Institute of Science	https://www.iisc.ac.in/
2	Census Method in India	https://censusindia.gov.in/
3	Tiger Census in India	http://moef.gov.in/wp-content/uploads/2020/07/Tiger-Status-Report-2018_For-Web_compressed_compressed.pdf
4	Field Survey of Wild Animals	zsi.gov.in/App/content.aspx?link=1602

C. Text Books

1. Panner Selvam R., Research Methodology, Prentice- Hall of India Private Limited, New Delhi, 2006

D. Reference Books

1. Pillai R.S.N., and Bhavathy V., Statistics, S.Chand Company Ltd., 2005
2. Joseph G., MLA Hand Books for Writers of Research Papers, Sixth Edition, Affiliated East West Press Pvt. Ltd., New Delhi, 2004
3. Prasad S., Elements of Statistics, First Edition, Jaico Publishing Home, Mumbai, 2004.

E. Web Links

1. https://onlinecourses.nptel.ac.in/noc19_ge21/preview
2. https://onlinecourses.swayam2.ac.in/cec20_hs17/preview

3. Specific learning outcomes (SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1.	**Research Design**		
1.1	Meaning of research, design, research method versus methodology	Understand the basic concepts of research Acquire the Knowledge in Research	K1 K2
1.2	Objectives of research, Types of research, Types of research, significance of research, Criteria of good researches.	Illustrate the General principles of Research Recognize main difference between the types of Research	K1
2	**ResearchProblem**		
2.1	Defining of Research problem, Research Design-Meaning - need - Features - Concepts relating to research design	Recognize the concept of Research Problem	K2
2.2	Different Research design -basic Principles of Experimental Design.	Illustrate methods of Experimental Design.	K1
3	**Interpretation and Report Writing**		
3.1	Interpretation - Meaning, Technique, Precaution; report writing-	Understand the technique of writing research report.	K1
3.2	Steps in Report Writing – Significance, Steps in Report writing Layout of research report and thesis. writing Preparation of manuscript for publication,Citation and Bibliography, Impact factor.	Illustrate the steps and significance of research report writing.	K1

Unit/ Section	Course Content	Learning Outcomes	HBTLT
4	**Scope of Biostatistics**		
4.1	Scope on Biostatistics in biological research - Variables - Data; Sources and Collection Classification, Presentation;	Define the basic concepts of finding Average and Mean, SD	K1
4.2	Measure of Central Tendency- Mean (Arithmetic),median-mode, Measures Dispersion- Standard deviation and Standard error-Skewness and kurtosis, coefficient of Variance.	Experiment with calculation in Correlation from the given Data.	K1
5	**Biostatistical Measures**		
5.1	Correlation-types and methods of correlation	Illustrate Correlation Methods. Experiment with calculation in Correlation from the given Data.	K4
5.2	regression, simple regression equation, fitting prediction,	Define the Concept of Regression and its role in Statistics.	K4
	Similarities and dissimilarities of correlation and regression.	Classify the concepts and theory between correlation and regression.	K4
5.3	Statistical inference -hypothesis - simple hypothesis -	Define the principle of Hypothesis Summarize the facts in writing the Hypothesis.	K4
5.4	student't' test -chi square test,	Outline the formula and methods of Student "t" Test. Demonstrate the applications of Student "t" Test.	K4
5.5	ANOVA,SPSS.	Experiment the ANOVA test by using Software.	K5

`4. Mapping Scheme

P20BT2:2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO 2	PSO3	PSO4
CO1	M	M	L	H	L	L	L	-	-	H	L	L	L
CO2	H	H	M	H	M	M	H	M	H	H	M	M	M
CO3	M	L	H	L	M	L	M	L	M	L	H	M	M
CO4	H	H	M	M	H	M	H	M	H	M	H	H	H
CO5	M	M	M	H	H	H	H	M	M	M	M	H	H
CO6	M	L	M	H	H	M	H	M	H	H	M	H	H

L: Low M: Medium H: High

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator : Dr.A.Anita Margret

Semester: 2 **Course Code: P20BT2:A**
Credits : 4 **Total Hrs/ Week : 4**

Elective Course : IIB - NANOBIOTECHNOLOGY

1. Course Outcomes

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

CO. No	Course Outcomes	Level	Unit
CO1	Understand the concepts of nanoscale and its related dimension among natural components	K1	I
CO2	Associate the perception of nanotechnology in biotechnology and promote its interdisciplinary aspect	K2	I
CO3	Construe the working mechanisms of instruments in synthesizing and characterizing nanomaterials	K3	II
CO4	Focus on the various approaches of fabricating nanomaterials, along with significance and limitations	K3	III
CO5	Appraise the importance of engineered nanomaterials for biomedical, therapeutic and environmental applications	K4	IV
CO6	Formulate novel implants to improve physical impairments and evaluate the potential toxic effects of nanotechnology on living organisms related to the environment	K6	V

2. A. Syllabus

Unit – I **15hrs**

Biology Inspired Concepts

Introduction to Nanoscience and basic concepts; Interaction of surface molecules and its chemical and physical properties; Nanoprocess in nature - lotus effect, colour patterns in butterflies, adhesive pads in lizards- Reflections of Nanotechnology on Nanobiotechnology.

Unit –II **15hrs**

Synthesis and Characterization of Nanoparticles

Synthesis of nanoparticles - The principle of self assembly – Top down and bottom up approaches-Synthetic method –physical and chemical method-

Biological method-using plants and microbes; Characterization of nanoparticles – Instrumentations and their working principle in perspective of nanoscale- spectroscopic methods (UV-visible, FTIR, Raman spectroscopy, NMR), microscopic (AFM, Scanning and Transmission Electron microscopy), Structural (XRD), EDAX.

Unit –III **15hrs**

Types and fabrication of Nanomaterials

Types of nanomaterials -Quantum, wells, wires and dots-nano rods,nanowires, nano fibers, nano shells- Nano tubes-Carbon nano tubes(CNTs).Fabrication of nanomaterials: Lithography and Thin film deposition, high energy Arc discharge. Polymer nanoparticles, biomaterials, nanocomposities- Its Significance and application.

Unit –IV **15hrs**

Biomedical applications of nanoparticles

Drug carriers-liposomes, nanoshells, micelles, dendrimers and hydrogels; functionalisation of nanomaterials and Targeted drug delivery.Imaging technique; quantum dots and magnetic nanoparticles, Bionanosensors: nanocantilevers based on single stranded DNA.

Unit – V **15hrs**

Health environmental issues and Future Challenges about nanoparticles

Nanotoxicology, Immune response to nanoparticles, Safety concerns about using nanotechnology Guidelines for working with nanomaterials. New generations ofprosthetic and medical implants - artificial organs and implants- orthopaedic , vascular artificial scaffolds or biosynthetic coatings – biocompatibility and reduced rejection ratio - retinal,cochlear.

B. Topics for self study

S.No	Topics	Web Links
1.	Bionanopolymers in drug delivery	Fasiku V.O. et al. (2019) Bionanopolymers for Drug Delivery. In: Gnanasekaran D. (eds) Green Biopolymers and their Nanocomposites. Materials Horizons: From Nature to Nanomaterials. Springer, Singapore. https://doi.org/10.1007/978-981-13-8063-1_8

S.No	Topics	Web Links
2	Green Nanotechnology for the Environment and Sustainable Development	Dhorali Gnanasekaran,2019 Green Biopolymers and their Nanocomposites. Springer Nature Singapore Pte Ltd. 10.1007/978-981-13-8063-1,XXII, 437
3	Bucky balls for disease diagnosis	Sisodia, Siddhraj & Bharkatiya, Darshana & K., Nema. (2018). Bucky balls: A novel drug delivery system. Journal of Chemical and Pharmaceutical Research. 2010, 2. 240-248.
4	Nanotoxicants as a hazardous pollutant	Ray, P. C., Yu, H., & Fu, P. P. (2009). Toxicity and environmental risks of nanomaterials: challenges and future needs. Journal of environmental science and health. Part C, Environmental carcinogenesis & ecotoxicology reviews, 27(1), 1–35. https://doi.org/10.1080/10590500802708267

C. Text Books

1. Balaji, S. Nanobiotechnology. MJ.P.Publications, New Delhi,2010.
2. Tuan Vo Dinh, Nanotechnology in Biology and Medicine: Method, Devices and Applications.
3. CRC Press, 2007
4. Murthy B.S., Shankar P., Raj B., Rath B. B. and J. Murday, Textbook of Nanoscience and Nanotechnology, Universities Press-IIM, 2012.

D. Reference Books

1. LeggettG.J., Jones R. A. L, John. Bionanotechnology: In Nanoscale Science and Technology",
2. Wiley & Sons, Hoboken, New Jersey, United States, 2005.
3. Bhatia, M. Nanotechnology. Anmol Publications Pvt.Ltd.,, New Delhi, 2007.
4. Chattopadhyay, K.K. and Banerjee, A.N. Introduction to Nanoscience and Nanotechnology. PHI Learning Pvt. Ltd., New Delhi,2012
5. Niemeyer, C.M. and Mirkin, C.A. Nanobiotechnology Concepts: Application and properties.
6. Wiley, VCH Publishers, 2006.
7. Poole, Jr. C.P. and Owens, F.J. Introduction to Nanotechnology. Wiley India Pvt. Ltd., New Delhi, 2009.
8. Goodsell, D.S. Bionanotechnology ,John Wiley & Sons , Hoboken, New Jersey, United States

9. Springer Handbook of Nanotechnology Eds: Bhushan, 2nd edition, 2004.
10. Encyclopedia of Nanoscience and Nanotechnology", Eds: H. S. Nalwa, American Scientific Publishers,2004
11. Pradeep, T. Nano: The Essentials. Tata Mc Graw Education Private Ltd., New Delhi, 2011.
12. Ratner, M and Ratner, D.Nanotechnology: A Gentle Introduction to the Next Big Idea. Pearson education.Inc.2005.

E. Web Links

1. https://nptel.ac.in/courses/118/107/118107015/
2. https://nptel.ac.in/courses/118/106/118106019/

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Biology Inspired Concepts**		
1.1	Introduction to Nanoscience and basic concepts; Interaction of surface molecules and its chemical and physical properties;	Enumerate the attributes of nanoparticles and their interactive aspects	K1
1.2	Nanoprocess in nature - lotus effect, colour patterns in butterflies, adhesive pads in lizards-Reflections of	Associate and justify the nanoscale properties in natural systems and organisms.	K2 K5
1.3	Nanotechnology on Nanobiotechnology.	Analyze the influence of Nanotechnology on Nano biotechnology based on applications	K4
2	**Synthesis and Characterization of Nanoparticles**		
2.1	Synthesis of nanoparticles - The principle of self-assembly - Top down and bottom up approaches- Synthetic method -physical and chemical method-Biological method-using plants and microbes;	Understanding the principal mechanisms of various methods of nanoparticle synthesis.	K2
2.2	Characterization of nanoparticles - Instrumentations and their working principle in perspective of nanoscale-spectroscopic methods (UV-visible, FTIR, Raman spectroscopy, NMR), microscopic (AFM, Scanning and Transmission Electron microscopy), Structural (XRD), EDAX	Experimenting the produced nanoparticles by effective characterization using definite instruments.. .	K5

Unit/ Section	Course Content	Learning Outcomes	HBTLT
3	**Types and fabrication of Nanomaterials**		
3.1	Types of nanomaterials -Quantum, wells, wires and dots-nano rods, nanowires, nano fibers, nano shells Nano tubes Carbon nano tubes(CNTs).	Differentiating the various types of nanomaterials interactions .	K1
3.2	Fabrication of nanomaterials: Lithography and Thin film deposition, high energy Arc discharge.	Devise production strategies to fabricate nano materials	K4
3.3	Polymer nanoparticles, biomaterials, nanocomposities- Its significance and application.	Produce compatible nano composites using polymer and biomaterials which can be manifested in living systems.	K6
4	**Biomedical applications of nanoparticles**		
4.1	Drug carriers-liposomes, nanoshells, micelles, dendrimers and hydrogels; functionalisation of nanomaterials and Targeted drug delivery.	Cataloging and inferring the specific properties of biological drug carriers.	K1
4.2	Imaging technique; quantum dots and magnetic nanoparticles	Apply the features of nanoparticle in disease diagnosis	K3
4.3	Bionanosensors: nanocantilevers based on single stranded DNA	Validate and sense the influence of external factors in changing the serenity of environment using nano scale devices	K5
5	**Health environmental issues and Future Challenges about nanoparticles**		
5.1	Nanotoxicology, Immune response to nanoparticles, Safety concerns about using nanotechnologyGuidelines for working with nanomaterials.	Justify the influence of nanotoxicity in the o the environment	K5
5.2	New generations of prosthetic and medical implants - artificial organs and implants-orthopaedic , vascular artificial scaffolds or biosynthetic coatings - biocompatibility and reduced rejection ratio - retinal, cochlear.	Construct artificial inserts to support the physiological deformity in system	K6

4. Mapping Scheme

P20BT2:A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	M	M	L	H	L	L	L	-	-	H	L	L	L
CO2	H	H	M	H	M	M	H	M	H	H	M	L	L
CO3	M	L	H	L	M	L	M	L	M	L	H	M	M
CO4	H	H	M	M	H	M	H	M	H	M	H	M	M
CO5	M	M	M	H	H	H	H	M	M	M	M	H	H
CO6	M	L	M	H	H	M	H	M	H	H	M	H	H

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End Semester Examination
Indirect
1. Course-end survey

Semester: 2 **Course Code: P20BT2:3**
Credits : 4 **Total Hrs/ Week : 4**

Elective Course: III - BIOSAFETY, BIOETHICS AND IPR

1. CourseOutcomes

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

CO1	Discuss the importance of Biosafety	K2	I
CO2	Explain the role of Ecological and Ethical issues related to GMOs	K3	II
CO3	Discuss about the Ethical issues biomedical research	K2	III
CO4	Understand the basics of IPR and marketing regulations	K1	IV
CO5	Illustrate the role of IPR in pharm sector	K4	IV
CO6	Evaluate the risk management in IPR commercialization	K5	V

2. A. Syllabus

Unit - I **15hrs**

Principles of Biosafety

The Cartagena Protocol in Biosafety (CPB, 2000). Advanced Informed Consent, Precautionary Principle, Substantial Equivalence. GMO Labeling, Containment, Post- market Surveillance and Evolution and Management of Risks arising from the use release of GMOs.

Unit - II **15hrs**

Safety of Food & Animal Feed Derived From GM Crops

Nutritional and Toxicological Difference in the Food Environmental impacts; invasiveness / Persistence; toxicity to wildlife; Development and resistance; New Weed Control Strategies; Horizon; Changes in agricultural practices; Limitation of Science.

Unit –III **15hrs**

Bioethics

The growing impact of the new genetics on the courts - Integrating DNA Technology into the Criminal Justice System; Genes, Dreams & Reality- the

promises and risks of the new genetics; Protecting Genetic Privacy; Gene testing - Pros & Cons. Human Cloning & Human Dignity - an ethical enquiry; Ethical, Legal and Social Issues concerning recent advancements in key areas of biotechnology such as pre-natal diagnostics, GMF etc

Unit –IV **15hrs**

Patents

IP patents – case studies on patents –Basmati Rice, Turmeric, and Neem, Copyrights and related rights- Trade mark – Industrial designs andintegratedcircuits–geographicalindications-protectionatnational and international levels-Applicationprocedures

Unit – V **15hrs**

International Convention relating to intellectual property

Establishment of WIPO mission and activities – History – General agreement on trade and tariff (GATT) Legal Protection of Biotechnological Inventions. Indian IPR legislation commitments to WTO, WTO guidelines.

B. Topics For Self Study

S.No	Topics	Web Links
1.	Register of Patents	V.K.Ahuja, Law relating to Intellectual Property rights, 2 nd Edition, (2013) LexisNexis Dr. Bhandari, M.K. Law relating to IPR, Central Law Publication, (4th Edition 2015) Hyde William Cornish, Intellectual Property Right, New Delhi: Global Vision Publication House.
2	Preservation of Patents	
3	Protection of Industrial Designs	
4	Plant Patent Protection in India	
5.	Licensing Process and Management	

C. Text Books

1. Trayror P.C., Frederic R., and Koch M., Biosafety Board of Trustees, Michigan State University, USA, 2002
2. Sasson A., Biotechnologies and Development, UNESCO Publications, 1988
3. Sibi G. Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology New Delhi and Karnataka State Council for Science and Technology, Bangalore 2020.

D. Reference Books

1. Paul R.C., Situation of Human Rights in India Efficient Offset Printers, 2000
2. Belmont T.L., and Leroy W., Cotemporary Issue in Bioethics, Wards Worth Publishing Co Belmont, California, 1999
3. Vadakar Praveen., Theories and Practice of Human Rights, Raja Publication, 2000.

E. Web Links

1. https://nptel.ac.in/courses/109/106/109106092/
2. https://nptel.ac.in/courses/110/105/110105139/

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Principles of Biosafety**		
1.1	The Cartagena Protocol in Biosafety (CPB, 2000). Advanced Informed Consent, Precautionary Principle, Substantial Substantial Equivalence. GMO Labeling, Containment, Post- market Surveillance and Evolution and Management of Risks arising from the use release of GMOs.	Understand the mechanisms of protocol of Biosafety Analyze the influence of Genetically modified foods based on applications Understand the concept of genetically engineered labeling analysis.	K1 K4 K1
2	**Safety of Food & Animal Feed Derived From GM Crops**		
2.1	Nutritional and Toxicological Difference in the Food Environmental impacts; invasiveness / Persistence; toxicity to wildlife.	Define the nutrition. Classify the types of nutrition and toxicity.	K1 K2
2.2	Development and resistance; New Weed Control Strategies; Horizon; Changes in agricultural practices; Limitation of Science	Recall the development of weed control or management strategies.	K1
3	**Bioethics**		
3.1	The growing impact of the new genetics on the courts - Integrating DNA Technology into the Criminal Justice System.	Understanding the basic mechanism of DNA Technology.	K1

Unit/ Section	Course Content	Learning Outcomes	HBTLT
3.2	Genes, Dreams & Reality- the promises and risks of the new genetics; Protecting Genetic Privacy.	Analyze the applications of Genetic testing in the prediction of the risk of developing a genetic disease.	K4
	Gene testing - Pros & Cons. Human Cloning & Human Dignity - an ethical enquiry; Ethical, Legal and Social Issues concerning recent advancements in key areas of biotechnology such as pre-natal diagnostics, GMF etc	Analyze the ethical, legal, and social issues in human cloning.	K4
4	**Patents**		
4.1	IP patents – case studies on patents -Basmati Rice, Turmeric, and Neem, Copyrights and related rights.	Understand the role of Intellectual property rights and Copyright as legal means of protecting an author's work.	K1
4.2	Trade mark - Industrial designs and integrated circuits – geographical indications- protection at national and international levels-Application procedures	Explain the process of Patents, Utility Models Cultural, artistic and literary works, including computer software and compilation of data Copyright.	K2
5	**International Convention relating to intellectual property**		
5.1	Establishment of WIPO mission and activities - History - General agreement on trade and tariff (GATT) Legal Protection of Biotechnological Inventions.	Understanding the General Agreement on Tariffs and Trade (GATT) and legal agreement minimizing barriers to internationFal trade.	K1
5.2	Indian IPR legislation commitments to WTO, WTO guidelines.	Discuss aboutworld trade organization rules and agreements. Recall fundamental concepts in WTO	K1 K1

4. Mapping Scheme

P20BT2:3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	M	M	L	H	L	L	L	-	-	H	L	L	H
CO2	H	H	M	H	M	M	H	M	H	H	M	M	M
CO3	M	L	H	L	M	L	M	L	M	L	H	M	M
CO4	H	H	M	M	H	M	H	M	H	M	H	M	H
CO5	M	M	M	H	H	H	H	M	M	M	M	M	H
CO6	M	L	M	H	H	M	H	M	H	H	M	H	H

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II
2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Projectreport, Poster preparation, Prototype or Product Demonstration etc.(as applicable)
3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.M.Vineeth

Semester: 2 **Course Code: P20BT2:B**
Credits : 4 **Total Hrs/ Week : 4**

Elective Course: III B DRUG DISCOVERY AND DEVELOPMENT

1. Course Outcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Describe the detailed study of drugs dosage and its type of nature, particularly their actions on living systems	K2	I
CO2	Understand the drug discovery process, starting with target selection, to compound screening to designing lead candidates	K2	II
CO3	Analyze the various drug action of ADME process and methods that are used for finding and identifying a new drug	K4	III
CO4	Determine the major principle, method and designing a new drug	K3	III
CO5	Predict the importance of chemotherapeutic value and pharmacokinetic action of drugs in human bodies	K5	IV
CO6	Design the basic concepts of drug manufacturing principles and development of product and its importance	K6	V

2. A. Syllabus

Unit I **15hrs**

Drugs

Definition, source and nature, types of classification and nomenclature, dose response curve and LD50. Role of drugs, Drug – protein interactions, routes of drug administration.

Unit - II **15hrs**

Drug targets

Enzymes, receptors, carrier proteins. Structural proteins, nucleic acids, lipids and carbohydrates. Forces in drug : receptor interaction, Receptor

theories. Therapeutic Categories Vitamins, Analgesics, Antibiotics, Hormones.

Unit -III **15hrs**

Pharmacophore design

Drug absorption, distribution, metabolism, excretion and dosing.Pharmacokinetic oriented drug design – Drug solubility and drug stability.

Unit –IV **15hrs**

Biological testing and bioassays

Testing drugs in vitro and in vivo. Drug discovery. Lead compounds – Natural sources and synthetic sources. Radio activity pharmacokinetic action of drugs in human bodies.

Unit – V **15hrs**

Drug development

Target – oriented drug design, computer aided drug design, Quantitative structure, activity relationship – binding interaction, Functional groups and Pharmacophore. High thoroughput screening and Molecular docking.

B. Topics for self study

S.No	Topics	Web Links

C. Text Books

1. Barar F.S.K., Essentials of Pharmacotherapeutics, S. Chand &Co,Ltd., New Delhi, 2004
2. Patrick G., Medicinal Chemistry, Instant Notes Series, Viva Books, 2002.
3. Practical Pharmacology for the Pharmacy Technician, USA, 2019.

D. Reference Books

1. Trends in Molecular Pharmacology, Elsevier Publications.
2. Marshall and Motoc., Molecular graphics in drug design

3. Luca Pinzi and Giulio Rastelli. Molecular Docking: Shifting Paradigms in Drug Discovery;Int. J. Mol. Sci.20, 4331, 2019.

E. Web Links

1. http://downloads.lww.com/wolterskluwer_vitalstream_com/samplecontent/9780781773485_Sakai/samples/Sakai_Ch03.pdf.

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Drugs**		
1.1	definition, source and nature, types of classification and nomenclature, dose response curve and LD_{50}.	To define the mechanism of pharmacokinetic DDIs focusing the interest on their clinical implications. To determine the concentration of drug in the blood stream, and is dependent upon the ADME processes.	K1 K3
1.2	Role of drugs, Drug – protein interactions, routes of drug administration.	To analyze the drug target features for getting a better understanding on principles of their mechanisms. To understand how the drug targets work in the PPI network.	K2 K4
2	**Drug targets**		
2.1	Enzymes, receptors, carrier proteins. Structural proteins, nucleic acids, lipids and carbohydrates.	To identified the drug targets in the biomedical research To analyze the detailed structural characteristics of drug targets.	K2 K4
2.2	Forces in drug - receptor interaction, Receptor theories. **Therapeutic Categories** Vitamins, Analgesics, Antibiotics, Hormones.	To recognize the different type of receptors and it actions. To understand the binding of drug receptors and its effect. To determine that binding of drug targets to an adjacent site or a different site on a receptor	K1 K2 K3

Unit/ Section	Course Content	Learning Outcomes	HBTLT
3	**Pharmacophore design**		
3.1	Drug absorption, distribution, metabolism, excretion and dosing.	To explain the meaning of the terms absorption, distribution, metabolism, and excretion.	K2
3.2	Pharmacokinetic oriented drug design - Drug solubility and drug stability.	To study the bodily processes that affects the movement of a drug in the body.	K3
4	**Biological testing and bioassays**		
4.1	Testing drugs in vitro and in vivo. Drug discovery. **Lead compounds –** Natural sources and synthetic sources. Radio activity pharmacokinetic action of drugs in human bodies	Explain how bioavailability can impact drug response and product selection. Compare the roles of passive diffusion and carrier-mediated transport in drug absorption. Describe two types of drug interaction and explain how they might affect drug response and safety.	K2 K3 K4
5	**Drug development**		
5.1	Target – oriented drug design, computer aided drug design, Quantitative structure, activity relationship - binding interaction, Functional groups and Pharmacophore. High thoroughput screening and Molecular docking.	To explain the large numbers of compounds, high throughput virtual screening and molecular docking. To understanding the mechanisms of molecular recognition between small and large molecules, uses and applications of docking in a new drug.	K2 K3

4. Mapping Scheme

P20BT2:B	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	L	M	M	M	M	M	L	M	L	L
CO2	M	L	L	M	M	L	L	M	M	M	H	L	L
CO3	M	L	H	M	L	M	M	M	M	M	M	H	H
CO4	H	M	M	H	H	L	L	L	L	L	H	L	L
CO5	L	H	H	H	M	M	M	M	M	M	M	H	H
CO6	H	M	M	H	M	H	H	H	H	H	H	L	L

L: Low M: Medium H: High

5. COURSE ASSESSMENT METHODS

Direct
1. Continuous Assessment Test I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Projectreport, Poster preparation, Prototype or Product Demonstration etc.(as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

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Semester: 3 **Course Code: P22BT307**
Credits : 4 **Total Hrs/ Week : 5**

Core Course : VII – Gene Technology

1. Course Outcomes

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

CO. No	Course Outcomes	Level	Unit
CO1	Recollect the basic knowledge about the strategies of cloning used in genetic engineering	K1	I
CO2	Understand the tools of recombinant DNA technology and genetic engineering	K2	II
CO3	Compare the principle and working mechanisms of DNA sequencing methodologies	K3	III
CO4	Analyze the function and expression of genes by using various expression vector systems	K4	IV
CO5	Develop steps into the promising area of research in the field of recombinant DNA technology	K5	V
CO6	Assess the genome 4.Mapping Scheme and sequencing and methods for gene therapy	K6	V

2. A. Syllabus

Unit – I **15hrs**

DNA Modifying Enzymes and Molecular Scissors

Generation of DNA in prokaryotic and eukaryotic system, Construction of cDNA library, Cutting and joining of DNA molecules- exonucleases, endonucleases, ligases, DNA modifying Enzymes - methylase, alkaline phosphatase, topoisomerase, DNA gyrase; linkers, adaptors, genome 4.Mapping Scheme and chromosome walking.

Unit – II **15hrs**

Carrier Systems

Basic system of genetic engineering: Vectors in Gene Cloning: Natural - Plasmids, Bacteriophages, (λ phage, M13 phage), Phagemids, Cosmids, Fosmids, Tumor inducing plasmids and Root inducing Plasmids. Artificial - PAC, Bacterial Artificial Chromosomes, Yeast Artificial Chromosomes, Human artificial chromosome, Expression Vectors, Shuttle Vectors.

Unit – III **15hrs**

DNA Manipulation Techniques

Purification of genomic DNA from living cells, manipulation of purified DNA; construction of prototype vector pBR322, cloning strategies. Chemical synthesis of DNA, DNA sequencing methods- chemical degradation, chain termination and automated sequencing. Genome editing –CRISPR

Unit – IV **15hrs**

Gene Transfer Methods

Natural Methods: Bacterial Transformation, Conjugation, Transposition, Phage Transduction, Agrobacterium Mediated Transfer, Retroviral Transduction. Artificial Methods -Physical Methods: Microinjection, Macroinjection, Biolistic Transformation. Chemical Methods: Calcium phosphate mediated DNA transfer, Use of polyethylene glycol (PEG), Use of DEAE- Dextran (diethyl aminoethyl), Use of liposomes. Electrical Methods: electroporation, electrofusion).

Unit – V1 **5hrs**

Selection and screening

Selection of recombinants (antibiotics, expression basis - GUS expression), blotting techniques-Southern, Northern and Western Blot. Principles, types and applications of PCR. DNA finger printing - restriction fragment length polymorphism (RFLP); random amplified polymorphic DNA (RAPD); DNA footprinting.

B. Topics for self study

S.No	Topics	Weblinks
1	Silencing genes with CRISPR/TALEN/RNAi	https://old.abmgood.com/marketing/knowledge_base/Gene-Silencing-CRISPR-TALEN-RNAi.php
2	Prime Editing as a Precision Gene Editing Tool	https://www.synthego.com/guide/crispr-methods/prime-editing
3	NIPD	https://www.genomicseducation.hee.nhs.uk/blog/what-is-nipd/
4	CRISPR'd babies: human germline genome editing	https://academic.oup.com/jlb/article/6/1/111/5549624

C. Text Books

1. Primrose S.B., and Twyman R.M., Principles of Gene Manipulation and Genomics, University of California, Seventh Edition,2006

D. Reference Books

1. Glick B.R., and Pasternak J.J., Molecular Biotechnology, ASM Press, USA,2003
2. GloverD.M.,and HamesB.D.,DNA cloning Iand2,IRLPress, 1995
3. Sambrook J., Fritsch E.F., and Maniatis T., Molecular Cloning, A Laboratory Manual, Second Edition, Cold Spring HaT Laboratory, USA,1987
4. Primrose S.B., Molecular Biotechnology, Second Edition, Blackwell Scientific Publishers, Oxford,1994.

E. Web Links

1. https://nptel.ac.in/courses/102/103/102103013/
2. https://nptel.ac.in/courses/102/103/102103074/

3. Specific Learning Outcomes (SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**DNA Modifying Enzymes and Molecular Scissors**		
1.1	Generation of DNA in prokaryotic and eukaryotic system	To define the DNA To classify Prokaryotes and Eukaryotes To relate and distinguish between the Prokaryotes and Eukaryotes	K1 K2 K2
1.2	Construction of cDNA library	To find the Construction methods	K2
1.3	Cutting and joining of DNA molecules- exonucleases, endonucleases, ligases	To explain the techniques to list out the cutting and joining molecules To show how far it is useful for rDNA	K2 K1 K2
1.4	DNA modifying Enzymes – Methylase, alkaline phosphatase, topoisomerase, DNA gyrase, Linkers and adaptors	To explain the modifying enzymes To summarize the most useful enzymes	K2 K2
1.5	Genome 4.Mapping Scheme& chromosome walking.	To relate the 4.Mapping Scheme To label the techniques	K2 K1

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Carrier Systems**		
2.1	Basic system of genetic engineering	To show the basic knowledge To illustrate genetic engineering techniques	K2 K2
2.2	Vectors in Gene Cloning: Natural vectors- Plasmids,Bacteriophages (λ phage, M13 phage), Phagemids, Cosmids, Fosmids, Tumor inducing plasmids, Root inducing Plasmids Artificial vectors- PAC, Bacterial Artificial Chromosomes, Yeast Artificial Chromosomes, Human artificial chromosome, Expression Vectors, Shuttle Vectors	To explain the vector To classify the vectors To construct the vectors To choose the various types of vectors To select the most advantageous vectors	K3 K2 K3 K3 K1
3	**DNA Manipulation Techniques**		
3.1	Purification of genomic DNA from living cells	To apply the purified products	K3
3.2	manipulation of purified DNA	To analyze the manipulated DNA	K4
3.3	construction of prototype vector pBR^{322}	To construct the pBR^{322} To compare with natural vector	K3 K4
3.4	cloning strategies	To analyse the cloning strategies	K4
3.5	Chemical synthesis of DNA	To identify the chemical synthesis	K2
3.6	DNA sequencing methods: chemical degradation, chain termination, automated sequencing	To contrast the DNA sequencing To compare the methods To choose the best characters Assume the method	 K2 K4
3.7	Genome editing -CRISPR	To select the genome editing To utilize the CRISPR technology To assume the miRRNAse	K4 K3 K4
4	**Gene TransferMethods**		
4.1	Natural Methods :Bacterial Transformation, Conjugation, Transposition, Phage Transduction, Agrobacterium Mediated Transfer, Retroviral Transduction.	To apply the natural methods To compare the methods To Evaluate the methods	K3 K2 K5

Unit/ Section	Course Content	Learning Outcomes	HBTLT
4.2 4.2.1	Artificial Methods : Physical Methods: Microinjection, Macro injection, Biolistic Transformation	To explain the methods To compare the methods	K3 K5
4.2.2	Chemical Methods:Calciumphosphate mediated DNA transfer,Use of polyethylene glycol (PEG),Use of DEAE-Dextran(diethyl aminoethyl),Use of liposomes.	To explain the methods To compare the methods	K3 K5
4.2.3	Electrical Methods: electroporation, electrofusion	To explain the importance of electrical methods	K4
5	**Selection and screening**		
5.1	Selection of recombinants: antibiotics, expression basis - GUS expression.	To measure the recombinants	K5
5.2	Blotting techniques : Southern blot, Northern blot, Western Blot.	To agree the difference between these techniques To choose the techniques To maximize the awareness about blotting	K4 K5 K6
5.3	Principles, types and applications of PCR.	To compare the Principle with amplifier To compare the types To agree the Disadvantages To list out the applications	K2 K2 K5 K1
5.4	DNA finger printing	To agree the DNA finger printing To apprise the importance To maximize awareness about this technology	K5 K4 K6
5.5	Restriction fragment length polymorphism (RFLP)	To apprise the RFLP To choose the importance of RFLP	K4 K5
5.6	Random amplified polymorphic DNA (RAPD)	To apprise the RAPD To determine the importance of RAPD	K4 K3
5.7	DNA foot printing.	To evaluate the foot printing To choose the importance To maximize awareness about technology	K5 K5 K6

4. Mapping Scheme

P20BT307	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	H	L	L	L	M	M	L	H	L	H	L
CO2	M	H	M	M	H	M	H	M	H	H	M	H	M
CO3	M	H	H	M	M	M	H	H	M	H	H	H	H
CO4	H	H	M	H	H	M	H	M	H	M	H	M	H
CO5	M	M	M	M	H	L	M	L	M	L	M	L	M
CO6	M	H	H	M	H	M	M	M	H	H	M	H	M

L: Low **M: Medium** **H: High**

5. COURSE ASSESSMENT METHODS

Direct
1. Continuous Assessment Test I,II
2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation
3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.C.Cynthia

Semester :3 **Course Code :P20BT308**
Credits : 5 **Total Hrs/ Week : 5**

Core Course: VIII - IMMUNOLOGY

1. Course Outcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Recall the role of immune cells, organs and their mechanism in body defense Mechanism	K1	I
CO2	Describe the cellular and resistance mechanisms against foreign bodies	K2	II
CO3	Demonstrate the association of immune system with allergic and infectious disease thereby developing vaccines	K3	III
CO4	Differentiate the defense mechanism of complicated immune diseases and disorders that can strategize remedies	K4	IV
CO5	Access the solutions to various infections and physiological problems	K5	V
CO6	Apply immune associated mechanisms in medical research to formulate design novel drugs and vaccine	K3	V

2. A. Syllabus

Unit –I **15hrs**

Introduction

Historical perspective and overview of Immune system, Haematopoiesis and differentiation; cells of immune system: Haematopoietic stem cells, T-cells, B-cells, Macrophages, Monocytes, Polymorphs, Platelets and Null cells. Immunity: Innate and acquired immunity. Lymphoid organs: Primary lymphoid organs (Thymus, Bone marrow), Secondary lymphoid organs (Spleen, Lymph node, MALT). Theory of clonal selection.

Unit – II **15hrs**

Cellular Responses

T- Cells and B- Cells: Development, maturation, activation and differentiation. Antigen: Properties and Biology. Immunoglobulin: Structure, functions and Classifications. Monoclonal antibodies - Principles and applications; APC's, MHC, antigen processing and presentation, regulation of T and B cell responses.

Unit – III **15hrs**

Infection and Immunity

Injury and Inflammation; Immune response to infections; Complement system; Immunity to - Bacteria, Virus, Fungi, and Parasites; Cytokines; Hypersensitivity; AIDS and Immunodeficiency, resistance and immunization; vaccines.

Unit – IV **15hrs**

Transplantation and Tumor Immunology

Transplantation: Mechanism, Graft rejection, General and specific immunosuppressive therapy; Clinical transplantation; Tumor immunology; Autoimmunity: Autoimmune diseases, diagnosis and treatment.

Unit – V **15hrs**

Immunotechniques

Immunization protocol and procedures, RIA, ELISA, Immuno electrophoresis, SDS- PAGE, FAC's, Immuno-flourescence, Western Blotting, Hybridoma technology - murine monoclonal antibody production and enrichment, Human monoclonal antibodies, T cell hybridomas;Abzymes;antibodyengineering;Chimericandhumanizedantibo diesandtheir applications.

B. Topics for self study

S.No	Topics	Weblinks
1	Immuno modulation and its clinical applications	Rajeev K. Tyagi (March 21st 2019). Introductory Chapter: Immunity and Immunomodulation, Immune Response Activation and Immunomodulation, Rajeev K. Tyagi and Prakash S. Bisen, IntechOpen, DOI: 10.5772/intechopen.85299.

S.No	Topics	Weblinks
2	Clinical tissue typing	Althaf MM, El Kossi M, Jin JK, Sharma A, Halawa AM. Human leukocyte antigen typing and crossmatch: A comprehensive review. World J. Transplant. 2017; 7: 339–48 Lee D, Kanellis J, Mulley WR. Allocation of deceased donor kidneys: A review of international practices. Nephrology (Carlton) 2019; 24: 591–8.
3	Antibody Engineering	https://www.atum.bio/assets/pdf/Antibody%20Engineering.pdf
4	Immunofluorescence	Babu, Arvind & Chandrasekar, P & Lalith, K & Chandra, Prakash & Reddy, G & Kumar, K & Reddy, Bvr. (2013). Immunofluorescence and its application in dermatopathology with oral manifestations: Revisited. Journal of Orofacial Sciences. 5. 2-8. 10.4103/0975-8844.113680.

C. Text Books

1. Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.
2. Kumar P. and Mina U. (2018) Life Sciences: Fundamentals and Practice, Part-I, 6th Edn., Pathfinder Publication. p.608.

D. Reference Books

1. Hardin J. and Bertoni G. (2017) Becker's World of the Cell. 9th Edn (Global Edition). Pearson Education Ltd., p. 923
2. Karp G., Iwasa J. and Masall W. (2015) Karp's Cell and Molecular Biology – Concepts and Experiments. 8th Edn. John Wiley and Sons. p.832.
3. Cooper G.M. (2019) The Cell – A Molecular Approach, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813
4. Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B. (2014) Campbell Biology in Focus. Pearson Education. p.1080.
5. Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018) Essential Cell Biology 5th Edn.,(paper back) W.W. Norton & Company p.864.
6. Mason K.A., Losos J.B. and Singer S.R. (2011) Raven and Johnson's Biology. 9th Edn. Mc Graw Hill publications. p.1406.

7. Alberts B., Johnson B., Lewis J., Morgan D., Raff M., Roberts K. and Walter P. (2015) Molecular biology of cell, 6th edn., Garland Science, Taylor and Francis, p. 1465
8. Challoner J. (2015) The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press Ltd., p.193

E. Web Links

1. https://www.classcentral.com/course/swayam-immunology-14117
2. https://alison.com/course/introduction-to-immunology-revised
3. https://www.mooc-list.com/tags/immunology

3. Specific Learning Outcomes (SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Introduction**		
1.1	Historical perspective and overview of Immune system, Haematopoiesis and differentiation	List out historical findings of immunology	K 1
1.2	Cells of immune system: Haematopoietic stem cells, T-cells, B-cells, Macrophages, Monocytes, Polymorphs, Platelets and Null cells.	Recall and compare the organization of the cells of immune system	K2
1.3	Immunity: Innate and acquired immunity.	Define Immunity Classify the types of Immunity and distinguish their functions	K 1 K 2
1.4	Lymphoid organs: Primary lymphoid organs (Thymus, Bone marrow), Secondary lymphoid organs (Spleen, Lymph node, MALT). Theory of clonal selection.	Identify the various parts related to the organs of immune system	K1
2	**Cellular Responses**		
2.1	T- Cells and B- Cells: Development, maturation, activation and differentiation. Antigen: Properties and Biology.	Compare the unique features and role of one organelle from the other.	K 2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2.2	Immunoglobulin: Structure, functions and Classifications. Monoclonal antibodies - Principles and applications; APC's, MHC, antigen processing and presentation, regulation of T and B cell responses.	Illustrate the morphological differences among organelles by pictorial representations.	K 3
3	**Infection and Immunity**		
3.1	1.Injury and Inflammation; Immune response to infections; Complement system	State the process of inflammation with response to injury Describe the working mechanism of complement system and classify the pathways of complement activation	K1 K2
3.2	2. Immunity to - Bacteria, Virus, Fungi, and Parasites; Cytokines; Hypersensitivity; AIDS and Immunodeficiency,	List out the pathogenic diseases Distinguish diseases based on their immune response Determine the disease using their symptoms	K3 K4 K5
3.3	Resistance and immunization; vaccines.	Interpret the mechanism of antigen resistance Develop strategies to formulate vaccine.	K5 K6
4	**Transplantation and Tumor Immunology**		
4.1	Transplantation: Mechanism, Graft rejection, General and specific immunosuppressive therapy;	Understand the mechanism of graft rejection Contrast graft acceptance and rejection	K1 K2
4.2	Clinical transplantation; Histocompatibility testing - HLA typing - HLA 1 and 2,)	Deduce clinical strategies for tissue typing and detecting sample identity.	K 3
4.3	Cross matching, serological, cellular and genomic typing. Tumor immunology; Autoimmunity: Autoimmune diseases, diagnosis and treatment.	Formulate therapies and treatments by justifying the impairment in the immune system	K 6

5	Immunotechniques		
5.1	Immunization protocol and procedures,RIA, ELISA, Immunoelectrophoresis, SDS-PAGE, FAC's, Immuno-flourescence, Western Blotting	Appraise the various techniques involved in immunology. Relate the immunotechniques to specific diseases based on their principle. Examine the immune samples to detect disease	K 5 K 2 K 3
5.2	Hybridoma technology - murine monoclonal antibody production and enrichment, Human monoclonal antibodies, T cell hybridomas; Abzymes; antibody engineering; Chimeric and humanized antibodies and their applications.	Design antidotes to enhance immunity by developing monoclonal antibodies.	K 6

4. Mapping Scheme

P20BT308	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	H	H	L	H	L	M	L	L	H	M	L	H
CO 2	H	H	H	L	M	H	M	L	L	H	M	L	H
CO 3	H	H	H	H	H	M	L	L	L	H	L	H	H
CO 4	H	H	H	H	H	H	H	H	H	H	M	H	H
CO 5	H	H	H	H	H	H	M	L	H	H	H	H	M
CO 6	H	H	H	H	H	H	M	H	M	H	H	H	H

L: Low M: Medium H: High

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II
2. Case study, Mini Project report, Poster presentation
3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.A.Anita Margret

Semester: 3 **Course Code: P20BT309**
Credits: 5 **Total Hrs/ Week : 5**

Core Course : IX - MEDICAL BIOTECHNOLOGY

1. Course Outcomes

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

CO. No	Course Outcomes	Level	Unit
CO1	Recognize the role of enzymes and nucleic acids in health sector	K1	I
CO2	Identify the various markers and techniques in cancer diagnosis	K2	II
CO3	Determine the safety measures on handling the clinical samples for diagnosis.	K4	III
CO4	Evaluate and analyze the disorders of carbohydrate metabolism and their detection	K5	IV
CO5	Appraise the novel drug application and approval in pharmaceutical industries	K5	V

2. A. Syllabus

Unit - I **15hrs**

Biotechnology in Health Care

Worldwide market – Enzymes Diagnostics, nucleic acid based diagnostics, PCR based diagnostics and Sequencing – Blood Products – Biosensors – types; Biochips

Unit – II **15hrs**

Cancer diagnostics

Molecular markers - Cancer phenotyping-molecular, immuno and fluorescent based diagnostics FACS- Cancer gene therapy - microsatellite and telomeric analysis-FISH-Vaccines-DNA Vaccines and synthetic Vaccines - novel routes of delivery.

Unit – III **15hrs**

Pathology Handling of clinical samples

Precautions and Safety measures Physical and Chemical examination of body fluids (Blood and Urine) Types - Colour, Transparency, P^H, Specific

gravity; Protein, Sugar, Ketone bodies, Bile pigment/salt, Chyle and Blood. Laboratory diagnosis of UTI.

Unit - IV **15hrs**

Clinical Biochemistry

Disorders of carbohydrate metabolism and their detection, measurement of glucose in plasma and urine, ADA classification of diabetes mellitus, glucose tolerance test, detection of gestational diabetes and self monitoring of blood glucose.

Unit – V **15hrs**

Clinical Research in Drug Discovery

New Drug Application and Approval - Pharmaceutical Industry – Global and Indian Perspective - Clinical trial market. Selection of drugs – Threats behind self medication- Monitoring the prescribed drug advised, Clinical data management, Ethical issue in clinical studies.

B. Topics for self study

S.No	Topics	Web Links
1.	Fetal Blood Sampling (FBS)	www.webmd.com
2	Thalassemia	www.cdc.gov› ncbddd› thalassemia› facts
3	Nanotechnology Cancer Therapy	www.cancer.gov› nano › treatment
4	Biorobotics-The next Generation of Medicine	www.biorobotics.com › biorobotics-next-generation

C. Text Books

1. Gupta S.K., Basic Principles of Clinical Research and Methodology, Jaypee Brothers Medical Publishers, 2007

D. Reference Books

1. Pillai., Biochemistry and Clinical Pathology, CBS Publications, 2012
2. Stephen Hulley., Outlines & Highlights for Designing Clinical Research: An Epidemiologic Approach, Academic Internet Publishers, 2011
3. Dan Wood., and Daron Smith., Research in Clinical Practice, \ Springer Publications, 2012

4. Robert J. Levine., Ethics and Regulation of Clinical Research: Second Edition, Yale University Press, 2010

E. Web Links

1. https://www.coursera.org/learn/cancer-metastasis
2. https://www.coursera.org/specializations/drug-development-product-management

3. Specific Learning Outcomes (SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Biotechnology in Health Care Worldwide market**		
1.1	- Enzymes Diagnostics, nucleic acid based diagnostics	State the scope of biotechnology in health sectors Discuss the various diagnosis method to detect the diseases Summarize the different types diagnostic techniques at molecular level	K2 K3 K4
1.2	Blood Products - Biosensors - types;Biochips	Evaluate and correlate test results with associated diseases at advanced technology level.	K5
2	**Cancer diagnostics Molecular markers**		
2.1	Cancer diagnostics Molecular markers	Analyse how cancer cells are diagnosed Explain the hallmarks of cancer cells	K4 K2
2.2	Cancer gene therapy – microsatellite and telomeric analysis	Applying the diagnostic method using molecular markers for cancer and its control measures	K5
2.3	Vaccines-DNA Vaccines and synthetic Vaccines - novel routes of delivery	Evaluate and produce DNA vaccines to control and prevent diseases with novel route of delivery	K6
3	**Pathology and Handling of clinical samples**		
3.1	Precautions and Safety measures	Acquire knowledge on handling the pathogenic clinical samples and its safety measures	K2
3.2	Physical and Chemical examination of body fluids (Blood and Urine) Types -Colour, Transparency,pH, Specific gravity; Protein, Sugar, Ketone bodies, Bile pigment/salt, Chyle and Blood	Formulate methods to examine the physical and chemical properties of body fluids.	K5

Unit/ Section	Course Content	Learning Outcomes	HBTLT
3.3	Laboratory diagnosis of UTI	Explain the symptoms tof UTI and its remedy to cure the infection Analyse the steps to diagnose UTI	K1 K4
4	**Clinical Biochemistry Disorders of carbohydrate metabolism and their detection**		
4.1	Clinical Biochemistry Disorders of carbohydrate metabolism and their detection	Analyse the and acquire knowledge on principle and detection of carbohydrate disorder	K4
4.2	Measurement of glucose in plasma and urine, ADA classification of diabetes mellitus, glucose tolerance test, detection of gestational diabetes and self monitoring of blood glucose.	Learn and importance of detecting the glucose level in blood and urine Apply and evaluate the level of diabetes by lab test and self monitoring	K2 K5
5	**New Drug Application and Approval**		
5.1	Pharmaceutical Industry - Global and Indian Perspective - Clinical trial market	Show the value of bioethics in formulating the novel drugs and the experiments performed in life science labs before marketing Evaluate the success of various applications for drug approval	K2 K5
5.2	Selection of drugs - Threats behind self medication- Monitoring the prescribed drug advised	Understand the consequence and side effects of self medication and prescribed drugs	K2
5.3	Clinical data management, Ethical issue in clinical studies	Analyse the methods and steps involved in Clinical data management Apply the value of ethics on clinical studies and management of clinical data	K4 K3

4. Mapping Scheme

P20BT309	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO 2	PSO3	PSO4
CO1	L	M	L	L	M	L	L	M	M	H	L	H	L
CO2	M	L	L	H	M	L	L	M	L	H	M	L	H
CO3	L	M	L	H	M	M	H	H	M	H	H	M	M
CO4	H	H	H	H	H	M	M	M	H	M	H	M	M
CO5	L	M	M	L	H	M	H	L	M	H	M	H	H
CO6	M	L	L	M	H	M	L	M	L	H	M	H	M

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation, Group discussion, seminars 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.R.Jasmine

Semester :3 **Course Code : P20BT3P4**
Credits: 3 **Total Hrs/ Week : 5**

Core Practical : IV - GENE TECHNOLOGY LAB

1. Course Outcomes

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

CO. No	Course Outcomes	Level	Experiments Covered
CO1	Comprehend the principles in PCR amplification for DNA fingerprinting analysis via RAPD and restriction digestion	K1	5,3,7
CO2	Apply skills on techniques of construction of recombinant DNA - Cloning vectors and isolation of gene of interest through restriction digestion and ligation methods	K2	3,4
CO3	Analyze gene amplification experiments by PCR analysis Purification of Protein through SDS and Native PAGE	K3	5,8,9
CO4	Identify the concept of integration of transgenes by Southern blot analysis	K4	10
CO5	Evaluate the importance of plasmids, cloning of gene and transformation into suitable bacteria for selection of recombinant clones	K5	11
CO6	Conclude with the introduction of rDNA into bacterial cells. Selection of transformants and recombinants (Blue and white screening)	K6	11

2. Syllabus

List of Experiments

1. Isolation of Genomic DNA frombacteria
2. Agarose gelelectrophoresis
3. Restriction digests ofDNA
4. Ligation- T DNALigase
5. Polymerase Chain Reaction(PCR)
6. RFLP

7. RAPD
8. SDS PAGE
9. NativePAGE
10. SouthernBlotting
11. Transformation- Blue and White method
12. Isolation of plasmidDNA

References

1. Brenda D.Spangler., Methods in Molecular Biologyand Protein Chemistry, John Wiley and Sons, Ltd.,2002.
2. Sambrook., Molecular Cloning: A Laboratory ManualVol. I – III, Cold Spring Harbor Laboratory,1989.
3. Ausbel M., and Roger Breut., Short Protocols in Molecular Biology,Vol-I&II,FifthEdition,FrederickJohnWileyandSons Inc.,2002

Web links

1. https://onlinecourses.nptel.ac.in/noc21_bt35/preview
2. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-bt32/

3. Specific Learning Outcomes (SLO)

Exercises	Course Content	Learning Outcomes	HBTLT
EX 1	Isolation of Genomic DNA frombacteria	Explain the Genomic DNA Show the Genomic DNA	K2
EX 2	Agarose gelelectrophoresis	Explain the agarose gel electrophoresis method	K2
EX 3	Restriction digests ofDNA	Choose restriction digestion enzymes & DNA Solve the Restriction digestion process	K3 K6
EX 4	Ligation- T DNALigase	Choose T DNALigase enzyme Predict the Ligation process	K3 K6
EX 5	Polymerase Chain Reaction(PCR)	Test the PCR technique Discuss with its advantages	K6
EX 6	RFLP	Predict the RFLP	K6
EX 7	RAPD	Compare with PCR Predict the RAPD	K2 K6

Exercises	Course Content	Learning Outcomes	HBTLT
EX 8	SDS PAGE	Relate with Native PAGE Analyze the SDS PAGE	K2 K4
EX 9	NativePAGE	Relate with SDS PAGE Analyze the Native PAGE	K2 K4
EX 10	SouthernBlotting	Test the Southern Blotting Discuss with its advantages	K6
EX 11	Transformation- Blue and White method	Construct the transformation method	K3
EX 12	Isolation of plasmid DNA	Explain the Plasmid DNA Show the Plasmid DNA	K2S

4. Mapping Scheme

P20BT3P4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	H	L	L	L	M	M	L	H	L	H	L
CO2	M	H	M	M	H	M	H	M	H	H	M	H	M
CO3	M	H	H	M	M	M	H	H	M	H	H	H	H
CO4	H	H	M	H	H	M	H	M	H	M	H	M	H
CO5	M	M	M	M	H	L	M	L	M	L	M	L	M
CO6	M	H	H	M	H	M	M	M	H	H	M	H	M

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.R.Sharmila

Semester : 3 **Course Code :P20BT3P5**
Credits : 3 **Total Hrs/ Week : 5**

Core Practical: V IMMUNOLOGY AND MEDICAL BIOTECHNOLOGY LAB

1. CourseOutcomes

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

CO.No	Course Outcomes	Level	Experiments Covered
CO1	Understand the key concepts in immunology through demonstration and visual examination.(K1)	K1	1,2
CO2	Comprehend the salient features of antigen antibody reaction and its application in disease diagnostics.(K2)	K2	3,4
CO3	Recognize the biochemical and genetic basis of immune response and disease resistance.(K3)	K3	7,8
CO4	Analyze the structural and physiological features of immune cells and organs.(K4)	K4	2,6
CO5	Apply advance immunological techniques to diagnose and procure remedies against various physiological ailments.(K5)	K5	2
CO6	Decipher the pathogenic mechanisms and develop skills to produce novel antidotes (K4)	K4	3,4

2. A. Syllabus

List of Experiments

IMMUNOLOGY

1. Antigen preparation and routes of Immunization
- Preparation of soluble antigen – human serum
- Preparation of cellular (particulate) antigen - bacterial antigen
- Immunization protocols
- Routes of antigen administration.

2. Identification of the cells and organs in immune system
- Visualization and study of Lymphoid Organs from mice and Chicken (Virtual Model)
- Determination of differential leukocyte count.

3. Isolation and characterizing lymphocytes and immunoglobins

- Isolation and enumeration of lymphocytes from human blood.
- Determination of lymphocyte viability by trypan blue exclusion test
- Purification & Estimation of IgG

4. Antigen-antibodyreactions and immunological techniques

- Direct agglutination to determine ABO blood grouping
- Immunoelectrophoretic and diffusion technique

a. RocketImmunoelectrophoresis.
b. Radialimmunodiffusion.

- Immunodiagnosis

a. Pregnancy test
b. HIV (Dot ELISA)
c. WesternBlotting

D. Reference Books

- A Handbook of Practical and Clinical Immunology, 2009,Vol. II , Second Edition. G.P. Talwar & S.K. Gupta (Eds). Published by CBS Publishers & Distributors Pvt. Ltd
- Practical Immunology, Frank C Hay; Olwyn M R Westwood; Paul N Nelson; Leslie Hudson2002,4th ed. Blackwell Scientific Publication.
- Pravash Sen. Gupta, Clinical Immunology.2003. Oxford University Press.
- Noel R. Rose, Herman Friedman, John L. Fahey.1986, 3rd ed., Manual of Clinical Laboratory Immunology. Amer Society for Microbiology (ASM)

Medical Biotechnology

5. Handling & Processing of a few Clinical Samples
6. Detection of drug resistant bacteria from clinical samples
7. Biochemical tests to differentiate various bacteria

References

1. "Medical Microbiology", Guide to the Laboratory Diagnosis & Control of Infection, Robert Cruickshank, Churchill Livingstone Publishers vol 1, 12th Edition 1973
2. "Laboratory Manual of Microbiology"-F.S Cheever, Pubmed Central 2006.

Web links

1. https://onlinecourses.nptel.ac.in/noc20_bt43/preview
2. https://www.digimat.in/nptel/courses/medical/microbiology/MB15.html

3. Specific Learning Outcomes(SLO)

Exercises	Course Content	Learning Outcomes	HBTLT
EX 1	**IMMUNOLOGY**		
1.1	Antigen preparation and routes of Immunization • Preparation of soluble antigen - human serum • Preparation of cellular (particulate) antigen - bacterial antigen • Immunization protocols • Routes of antigen administration.	Understand principles of antigen preparation and their recognition Employ the various immunization protocols and their administration	K1 K3
1.2	Identification of the cells and organs in immune system • Visualization and study of Lymphoid Organs from mice and Chicken (Virtual Model) • Determination of differential leukocyte count	Recall and compare the organization of the cells / organs of immune system Discriminate the molecular, metabolic and structural differences among immunological cells Apply their variations in disease diagnosis	K1 K4 K3
1.3	Isolation and characterizing lymphocytes and immunoglobins • Isolation and enumeration of lymphocytes from human blood. • Determination of lymphocyte viability by trypan blue exclusion test • Purification & Estimation of IgG	Identify the importance of analytical immunology. Estimate and measure the amount of immune cells and proteins present in a biological sample.	K2 K4

Exercises	Course Content	Learning Outcomes	HBTLT
1.4.	Antigen-antibodyreactions and immunological techniques • Direct agglutination to determine ABO blood grouping • Immuno electrophoretic and diffusion technique a. Rocket Immuno electrophoresis. b. Radial immuno diffusion. • Immunodiagnosis a. Pregnancy test b. HIV (Dot ELISA) c. Western Blotting	Appraise students with the various immunological techniques which includes quantitation and interactions of antigen-antibody reactions Evaluate and correlate test results with associated diseases or immunological ailments .	K5 K5
EX 2.	**MEDICAL BIOTECHNOLOGY**		
2.1	Handling & Processing of a few Clinical Samples	Identify the various bacterial pathogens from urine , blood and sputum samples.	K3
2.2	Detection of drug resistant bacteria from clinical samples	Distinguish drug sensitive and resistant bacteria	K4
2.3	Biochemical tests to differentiate various bacteria	Identify different bacterial species through Biochemical tests	K2

4. Mapping Scheme

P20BT3P5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	H	H	H	M	L	M	L	H	H	H	H
CO 2	H	H	H	H	M	H	L	M	L	H	H	H	H
CO 3	H	H	H	H	H	H	L	H	L	H	H	H	H
CO 4	H	H	H	H	M	M	L	M	L	H	H	M	M
CO 5	H	H	H	H	H	H	M	M	M	M	H	H	H
CO 6	H	H	H	H	H	H	M	M	M	M	H	H	H

L: Low M: Medium H: High

5. Course Assessment Methods

Direct
1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Mr.J.Dinesh Raja

Semester : 3 **Course Code :P20BT3:4**
Credits: 4 **Total Hrs/ Week : 4**

Elective III A : STEM CELL BIOLOGY

1. CourseOutcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Understand basic biology of stem cells, and cell cycle regulators in stem cells	K1	I
CO2	Describe the characteristics of stem cells and the different types of stem cells	K2	II
CO3	Apply the knowledge on the isolation process and cultivation of various stem cells and can learn the importance of preservation of stem cells	K3	III
CO4	Inspect the ethical and regulatory issues associated with use of stem cells	K4	IV
CO5	Integrate the application of stem cell therapy for various diseases	K5	IV
CO6	Review the Opportunities and Policy of Stem Cells	K6	V

2. A. Syllabus

Unit - I **15hrs**

Basics of Stem Cells: Concepts of stem cells and historical perspectives - Characteristic features- stem cell niche, stem cell plasticity, potency of stem cells: Unipotent-totipotent-multipotent-pluripotent. Mechanism of stem cell self renewal. Cell cycle regulators in stem cell. Differentiation and propagation of stem cells.

Unit -II **15hrs**

Types of Stem Cells: Embryonic stem cells & Germ stem cells -Fetal-adult's stem cells: Bone marrow stem cell, hematopoietic stem cell– Mesenchymal stem cell- Neural stem cells - Cancer stem cells Induced pluripotent stem cells & patient-specific stem cells -Genetically engineered stem cells.

Unit -III **15hrs**

Stem Cells isolation and culture: Isolation, characterization and maintenance of stem cells-stem cell markers, Fluoresence based cell sorting. Stem Cell banking-types: Public Bank &Private Bank. Methods involved in

stem cell banking and its importance. Stem cell preservation in cancer patients.

Unit -IV **15hrs**

Applications of Stem Cells: Stem cell therapy in neurodegenerative disorders: Spinal cord injury-Parkinson's disease, cardiovascular disorders, diabetes, autoimmune diseases, organ disorders, reproductive failures, stem cells in aging, baldness, stem cells and gene therapy. Ethical issues in the use of stem cells.

Unit – V **15hrs**

Opportunities and Policy of Stem Cells: Research scope and human resource development , National and global need for stem cell research-therapy & medical tourism, Institutions involved in stem cell research-therapy, Guidelines & SOPs on stem cell research-therapy, Informational resources on stem cells.

B. Topics for self study

S.No	Topics	Web Links
1.	Stem cell therapy for COVID-19: Possibilities and challenges.	https://doi.org/10.1002/cbin.11440
2	Umbilical cord blood research: current and future perspectives	https://pubmed.ncbi.nlm.nih.gov/17474296/
3	Amniotic fluid cells and human stem cell research: a new connection	https://pubmed.ncbi.nlm.nih.gov/12444390/
4	Stem cells: past, present, and future	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6390367/
5	Analysis of the Expectation of Stem Cell Therapy in Patients with Alzheimer's Disease	https://pubmed.ncbi.nlm.nih.gov/30906354/

C. Text Books

1. Kaushik D Deb ,Sathish M Totey " stem cell basics and applications "Tata McGraw Hill Education Private Limited,New Delhi,2009.
2. Marshak, "Stem Cell Biology", Cold Spring Harbar Symposium Publication. 2001.

3. Hossein Baharvand. Trends in stem cell biology and Technology. Humana Press, NY.2009.

D. Reference Books

1. Stewart Sell. "Stem Cells Handbook", Humana Press, NY ,2003. (Ed).
2. Robert Paul Lanza.. Essentials of Stem Cell biology. Elsevier Academic Press,2006.
3. Krusade Turksen. "Adult stem cells", Human press, USA, 2004.
4. Daniel Levitt and Ronald Mertelsmann. "Hematopoietic Stem Cells-Biology and Therapeutic application", Informal Health care, 1995.
5. Suzanna Holland, Karan and Lauria. "The Human Embryonic Stem Cell Debate", MIT Press, 2001.

E. Web Links

1. https://www.coursera.org/learn/stem-cells
2. https://nptel.ac.in/courses/102/106/102106036/
3. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-bt35/

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Basics of Stem Cell**		
1.1	Concepts of stem cells and historical perspectives - Characteristic features- stem cell niche, stem cell plasticity, potency of stem cells: Unipotent-totipotent-multipotent-pluripotent.	Define the Basic Concepts of stem cells. Discuss the various characteristics of stem cells.	K1 K2
1.2	Mechanism of stem cell self renewal. Cell cycle regulators in stem cell. Differentiation and propagation of stem cells.	Illustrate general mechanism of stem cell self renewal. Explain the principles of cell cycle regulators. Recognize main differentiation and propagation of stem cells.	K3 K4 K5

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Types of Stem Cells**		
2.1	Embryonic stem cells & Germ stem cells -Fetal-adult's stem cells:	Classify the stem cells based on the sources cells. Differentiate embryonic stem cell with adult stem cell. Discuss the importance of stem cell for therapeutic purpose.	K1 K2 K2
2.2	Bone marrow stem cell, hematopoietic stem cell	Recognize the concept of Bone marrow stem cells.. Illustrate methods of isolation of hematopoietic stem cell. Evaluate different types of eggs and formation.	K3 K3 K5
2.3	Mesenchymal stem cell- Neural stem cells - Cancer stem cells	Illustrate how the Mesenchymal stem cells are isolated and cultured for medical applications. Explain the neural stem cells isolation and its uses. Distinguish between stem cell and cancer stem cell.	K3 K4 K4
2.4	Induced pluripotent stem cells & patient-specific stem cells - Genetically engineered stem cells.	Explain the mechanism of iPSC and its development pattern. Analyze the applications of genetically engineered stem cells	K2 K4
3	**Stem Cells isolation and culture**		
3.1	Isolation, characterization and maintenance of stem cells-stem cell markers, Fluoresence based cell sorting.	Report how the stem cells are isolated from the normal cell population.. Interpret the concept of stem cell markers. Record the availability of stem cells by fluoresence based cell sorting.	K1 K2 K3
3.2	Stem Cell banking-types: Public Bank &Private Bank. Methods involved in stem cell banking and its importance.	Describe the importance of stem cell banking. List the different banking of stem cells. Explain the protocols and procedures involved in stem cell banking.	K4 K4 K3
3.3	Stem cell preservation in cancer patients.	Analyze the significance of Stem cell preservation in cancer patients	K4

Unit/ Section	Course Content	Learning Outcomes	HBTLT
4	**Applications of Stem Cells**		
4.1	Stem cell therapy in neurodegenerative disorders: Spinal cord injury-Parkinson's disease,	Analyze various applications stem cells. Describe how stem cells are used for the treatment of neurodegenerative disorders: Spinal cord injury-Parkinson's disease, Develop new methods for the treatment of Spinal cord injury-Parkinson's disease with stem cells.	K4 K4 K4
4.2	Cardiovascular disorders, diabetes, autoimmune diseases,	Comprehend the treatment of cardiovascular disorders, diabetes by stem cells. Apply the knowledge of stem cells in the treatment of autoimmune diseases.	K5 K5
4.3	Organ disorders, reproductive failures, stem cells in aging, baldness,	Create the idea about organ disorders treatment, reproductive failures treatment by stem cells. Explain how the stem cells are used for baldness and aging problems.	K6 K2
4.4	Stem cells and gene therapy. Ethical issues in the use of stem cells.	Describe the methods of gene therapy and how the stem cells used gene therapy. Conclude various ethical issues in the use of stem cells.	K5 K5
5	**Opportunities and Policy of Stem Cells**		
5.1	Research scope and human resource National and global need for stem cell research-therapy & medical tourism,	Describe about Opportunities and Policy of Stem Cells. Illustrate research scope and human resource National and global need for stem cell research. Discuss about medical tourism with its significance.	K3 K4
5.2	Institutions involved in stem cell research-therapy, Guidelines & SOPs on stem cell research-therapy, Informational resources on stem cells.	List the different Institutions involved in stem cell research-therapy. Review the Informational resources on stem cells. Explain the Guidelines & SOPs on stem cell research-therapy,	K3 K3 K6

4. Mapping Scheme

P20BT3:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	L	M	M	L	-	-	-	-	H	L	L	M
CO2	L	M	M	M	H	M	-	-	-	H	M	-	-
CO3	H	M	M	H	M	M	-	-	-	H	H	M	H
CO4	M	H	M	M	L	M	-	-	H	M	H	M	H
CO5	M	H	M	L	H	L	-	-	-	H	M	L	H
CO6	M	L	H	M	H	H	-	-	H	H	M	M	L

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation 3. End SemesterExamination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.R.Sharmila

Semester : 3 **Course Code :P20BT3:A**
Credits: 4 **Total Hrs/ Week : 5**

Elective IV B – DEVELOPMENTAL BIOLOGY

1. CourseOutcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Defining the general concepts of organisms developement. general principles of cell and cell communication in development	K1	I
CO2	Illustration of fertilization, development and sex determination in humans and their germ layers	K2	II
CO3	Inference on organogenesis-I of central nervous system and the epidermis and the formation of neural tube	K3	III
CO4	Explaination on organogenesis-II of mesoderm and endoderm layers	K4	IV
CO5	Medical implications of developmental biology, determine the infertility, and diagnosis infertility of IVF	K5	V
CO6	Enumerating the mechanisms of evolutionary changes	K6	V

2. A. Syllabus

Unit - I **15hrs**

Basic Concepts

General concept of organisms development: Potency, commitment, specification, induction, competence, determination & differentiation; morphogenetic gradients; cell fate & cell lineages; genomic equivalence and cytoplasmic determinants; imprinting. General principles of cell and cell communication in development: cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, paracrine factors.

Unit – II **15hrs**

Fertilization, Development and Sex Determination in Humans

Fertilization, Development and Sex Determination in Humans. Gametogenesis and Sperm & Egg formation; Ultra structure of sperm and ovum, Egg types, egg membrane. Fertilization,Cleavage, Morula, Implantation, Blastulation, Gastrulation, Formation of germ layers, Axis formation - Anterior and Posterior. Sex determination, Chromosomes and Environment.

Unit-III **15hrs**

Organogenesis - I

Organogenesis: Central nervous system and the epidermis and Formation of neural tube, Differentiation of the neural tube, Tissue architecture of the central nervous system, Origin of cutaneous structures. Neural crest cells and axonal specificity, Trunk neural crest, Pattern generation in the nervous system.

Unit-IV **15hrs**

Organogenesis - II

Paraxial and intermediate mesoderm, Somites formation, Osteogenesis, Urogenital system. Lateral plate mesoderm and endoderm-Heart formation, Digestive tube and its derivatives.

Unit - V **15hrs**

Implications of Developmental Biology

Medical implications of Developmental Biology and Genetic disorders, Environmental assaults on human development, Environmental regulation of animal development and environment as a part of normal development, Polyphenisms and plasticity, Learning system. Mechanisms of macro evolutionary change, Heterotrophy, Heterochrony and Heterometry.

B. Topics for self study

S.No	Topics	Web Links
1	Production of gametes	https://www.ncbi.nlm.nih.gov/books/NBK10005/
2	Sex Determination in Human	https://www.researchgate.net/publication/265092990_A_novel_method_for_sex_determination_by_detecting_the_number_of_X_chromosomes

S.No	Topics	Web Links
3	cell fate and cell lineages	https://ebook.vip-files.de/cell-lineage-and-fate-determination-moody-sally-a.pdf
4	Production of gametes	https://embryology.med.unsw.edu.au/embryology/index.php/Ovary_Development

C. Text Books

1. Gilbert S.F., Developmental Biology, Sinauer Associates Inc. Pub., Sunderland, Massachusetts, 2010

D. Reference Books

1. Alberts B., Molecular Biology of the Cell, Garland Science, New York, 2002
2. Lodish H., Molecular Cell Biology, W.H. Freeman, New York, 2000.

E. Web Links

1. https://nptel.ac.in/courses/102/106/102106084/
2. https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/
3. https://bit.ly/2YHJvRO

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Basic Concepts General concept of organisms development**		
1.1	Potency, commitment, specification, induction, competence, determination& differentiation; morphogenetic gradients; cell fate & cell lineages; genomic equivalence and cytoplasmic determinants; imprinting.	Basic Concepts of Developmental Biology. Get the Knowledge in Organogenesis Recognize Cell Linages and Cytoplasmic determinants	K1 K2 K3

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1.2	General principles of cell and cell communication in development: cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, paracrine factors.	Illustrate General principles of cell and cell communication in development. Recognize main difference between cell factors and molecules.	K1 K2
2	**Fertilization, Development and Sex Determination in Humans**		
	Fertilization, Development and Sex Determination in Humans	Understand the Basic Concepts of Fertilization, Development and Sex Determination in Humans	K1
2.1	Fertilization, Development and Sex Determination in Humans. Gametogenesis and Sperm & Egg formation	Recognize the concept of fertilization. Illustrate methods of sex determination in Humans. Evaluate different types of eggs and formation.	K1 K2 K2
2.2	Ultra structure of sperm and ovum, Egg types, egg membrane. Fertilization, Cleavage, Morula, Implantation, Blastulation, Gastrulation, Formation of germ layers, Axis formation - Anterior and, Posterior. Sex determination, Chromosomes and Environment.	Illustrate how sperm and ovum interacts each other Understand the different steps in fertilization. Apply how the germs layers are forming in determination of sex.	K1 K2 K4
3	**Organogenesis – I**		
3.1	Central nervous system and the epidermis and Formation of neural tube, Differentiation of the neural tube, Tissue architecture of the central nervous system,	Understand how the formation of neural tissues organogenesis. Understand the concept of Central Nervous System.	K1 K2
3.2	**Organogenesis - I** Origin of cutaneous structures. Neural crest cells and axonal specificity, Trunk neural crest, Pattern generation in the nervous system.	Illustrate the concept of neural crest cells, axonal specificity. Apply Pattern generation in the nervous system.	K1 K2
4	**Organogenesis – II**		
4.1	Paraxial and intermediate mesoderm, Somites formation, Osteogenesis, Urogenital system.Lateral plate mesoderm and endoderm-Heart formation	Write the mechanism of various organ formation and the concept Design different organ formation structures.	K1 K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
4.2	Digestive tube and its derivatives.	Comprehend chirality of Digestive tube and its derivatives.	K1
5	**Implications of Developmental Biology**		
5.1	Medical implications of Developmental Biology and Genetic disorders, Environmental assaults on human development, Environmental regulation of animal development and environment as a part of normal development.	Predict the Medical implications of Developmental Biology and Genetic disorders. Substantiate based on evidences the factors causes genetic disorders.	K5 K3
5.2	Polyphenisms and plasticity, Learning system. Mechanisms of macro evolutionary change, Heterotrophy, Heterochrony and Heterometry.	Comprehend the role of the Polyphenisms and plasticity Substantiate based on evidences in macro evolutionary change	K1 K3

4. Mapping Scheme

P20BT3:A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	M	L	M	L	-	-	-	-	H	L	L	M
CO2	L	M	M	M	H	M	-	-	-	H	M	-	-
CO3	H	M	L	M	M	L	-	-	-	H	H	H	H
CO4	M	H	M	M	L	M	-	-	H	M	H	M	M
CO5	M	H	L	L	H	L	-	-	-	H	M	H	H
CO6	M	M	H	M	H	H	-	-	H	H	M	M	M

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Projectreport, Poster presentation 3. End SemesterExamination
Indirect
1. Course-end survey

GENERIC COURSES FOR POST GRADUATE PROGRAMMES (2022-2024)

Total Hours : 15 Hours
Course Type : Generic Course1

Course Code : P22BT3G1

Semester III	**Scientific Writing and Research Publication Ethics**	**Code: GC**
Credits: 1		**Hours Per Week: 1**

Course Outcomes

On Completion of the Course, the students will be able to:

Sl.No	Course Outcomes	Level	Unit
1	Describe the fundamentals of Scientific writing	K1	I
2	Identify the different resources & search engines in research	K2	II
3	Explain the concept of Plagiarism and the consequences of violating plagiarism.	K3	III
4	Identify and make use of various software tools	K2	IV
5	Identify the quality journals from the appropriate data base according to their field of interest	K3	IV
6	Evaluate the quality of journals based on various Bibliometrics	K4	V

UnitI :

Fundamentals of Scientific Writing : Introduction to different kinds of publications, specialized journalsin Biotechnology and Bioinformatics; Types of papers – Short communications, Research articles, Review articles, Systematic Review and Meta-analysis. Barriers to Scientific writing, Grammarly, Paraphrasing tools

Unit II :

Literature Review -Article finding : Conducting article search using search tools/resources-UGC care, Googles cholar, PubMed, Cochrane database, Science direct, ProQuest, Embase, Web of Science, ERIC, DOAJ, JSTOR, Biological Abstracts, BioOne, CINAHL, IndexCopernicus, Scopus. Referencing – EndNote, Mendeley

Unit III:

Publication ethics: Plagiarism – concept and problem that leads to unethical behaviour – violation of publication ethics- predatory publishers and journals- redundant publications–overlapping publications

UnitIV:

Open access publishing – initiatives–software tool to identify predatory publications-Journal finder – journal suggestions – journal suggestor-Publication misconduct – specific ethical issues – authorship – conflicts of interest – complaints and appeals - examples of fraud – use of plagiarism software – URKUND –TURNITIN.

Unit V: Databases and Research Metrics – Indexing databases – Citation databases: Web of Science,

Scopus – Impact Factors of journal as per Journal Citation Report, SNIP, SJR, IPP. Cite Score – Metrics: h-index, g index, i10 index, altmetrics.

References

1 . Bairagi, Vinayak, and Mousami V. Munot, eds. Research methodology: A practical and scientific approach. CRCPress, 2019.Guidelines for Safety Assessment of Foods Derived from Genetically EngineeredPlants.2008.

2. Kothari, Chakravanti Rajagopalachari. Research methodology: Methods and techniques.New Age International, 2004.

3. Kuhse, H. (2010). Bioethics: An anthology. Malden, MA: Blackwell.Kumar, Ranjit. Research methodology: A step-by-step guide for beginners. Sage, 2018. National Biodiversity Authority. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry ofScience and Technology, Govt. of India. Richard, Pring. Philosophy of Educational Research. Continuum, 2000.

4. Surbhi Jain, Research Methodology in Arts, Science and Humanities. Society Publishing, 2019.

5. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for geneticallymodified plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9

Semester: 4 **Course Code: P20BT410**
Credits: 4 **Total Hrs/ Week : 5**

Core Course : X - ENVIRONMENTAL BIOTECHNOLOGY

1. CourseOutcomes

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

CO. No	Course Outcomes	Level	Unit
CO1	Remember and list the types of pollutions and environmental issues	K1	I
CO2	Describe and compare the methodologies of waste water treatment	K2	II
CO3	Apply the strategies of waste water treatments and recycle pollutants into bioenergy	K3	II
CO4	List out the diversity of life forms and develops the methodologies for biodiversity conservation	K3	III
CO5	Apply genetic engineered microbes in the field of agriculture and bioremediation for sustainable growth	K3	IV
CO6	Analyze the environmental toxicity using different parameters and predict the safe limits of drugs	K4	V

2. A. Syllabus

Unit –I **15hrs**

Ecology and ecosystem

Global environmental changes: Global warming, Green house effect, acid rain, ozone depletion, thermal inversion and photochemical smog. Sources, types, effects of Environmental Pollutions - Water, Air, Thermal, Industrial, oil, Metal Toxic Hazardous wastes and radiation environmental issues, management strategies and safety biotechnological approach for management, Biomagnifications.

Unit –II **15hrs**

Waste water treatment

Aerobic and anaerobic methods of waste water treatment (Primary, Secondary and Tertiary) use of aquatic plants in waste water treatment. Solid waste management, Bio-energy and SCP from waste, microbial desulphurization of coal recycling and processing of organic residues.

Unit –III **15hrs**

Xenobiotics

Ecological considerations - decay behavior and degradative plasmids, Biotransformation of xenobiotics - Detoxification, Surfactants, Pesticides. Biopesticides integrated pest management. Biodiversity -treaties and protocols for Biodiversity Conservation, Biodiversity - definition, hot spots of Biodiversity, strategies for Biodiversity Conservation.

Unit –IV **15hrs**

Bioremediation

Biosensors in Bioremediation- Biotechnology in pulp and paper industry, Advanced and emerging Biotechnological applications for industrial effluent (tannery and distillery). Pesticide waste disposal, oleophilic fertilizers and use of genetically engineered microbes. Principles of Biosorption and Bioaccumulation. Giant bacteria and their ecological significance. Sea weeds for removal of heavy metal pollutants. Hazards of genetically engineered microbes plants and animals to the environment.

Unit V **15hrs**

Environmental toxicology

Toxicology – Basic probit analysis concepts – Toxicants – Toxicity, Acute, sub acute, chronic, dose effect, LD 50 and response safe limits. Dose response safe limits. Dose response relationship, graphs, concentration response relationship. Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.

B. Topics for self study

S.No	Topics	Web Links
1.	Solid waste management-Composting, Vermiculture	Introduction to Environmental Biotechnology by A. K Chatterji, PHI Learning Publishers, 2011
2	Genotoxicity	Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter. Winter-VCH. 2005
3	Microbial biosensor	Environmental Biotechnology, Concepts and Applications. Hans-JoachinJordening and Josef Winter. Winter-VCH. 2005
4	Theory of island biogeography	Introduction to Environmental Biotechnology by A. K Chatterji, PHI Learning Publishers, 2011

C. Text Books

1. Alan S., Environmental Biotechnology, Pearson Education Limited, England, 1999.

D. Reference Books

1. Eugene P.ODUM., Fundamentals of Ecology, W.E. Saunders Company, London, 1972.
2. Metcalf and Eddy, Waste water engineering –Treatment Disposal and Reuse, Tata McGraw Hill, New Delhi,1979.
3. Donald G. Crosby., Environmental Toxicology and Chemistry, Oxford University Press, 1998.

E. Web Links

1. https://onlinecourses.nptel.ac.in/noc21_bt41/preview
2. https://onlinecourses.nptel.ac.in/noc19_ge23/preview

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Ecology and ecosystem**		
1.1	Global environmental changes: Global warming, Green house effect, acid rain, ozone depletion, thermal inversion and photochemical smog.	Understand and explain the human activities and sources involved in global changes	K2
	Sources, types, effects of Environmental Pollutions - Water, Air, Thermal, Industrial, oil, Metal Toxic Hazardous wastes and radiation	Summarize the sources involved in various type of environmental pollutions.	K2
1.2	Environmental issues, management strategies and safety biotechnological approach for management	Develop new ways needed for efficient management of environmental issues through biotechnological approach	K5
2	**Waste water treatment**		
2.1	Aerobic and anaerobic methods of waste water treatment (Primary, Secondary and Tertiary)	Describe the various methods involved in the waste water treatment using microbes	K2
	Use of aquatic plants in waste water treatment. Solid waste management	Apply the aquatic plant as a source to treat manage waste water and solid waste	K3
	Bio-energy and SCP from waste	Formulate protocols for the production of bioenergy and SCP from waste.	K5

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2.2	Microbial desulphurization of coal recycling and processing of organic residues.	Apply microbes for bioenergy production by recycling organic residues	K3
3	**Xenobiotics**		
3.1	Ecological considerations - decay behavior and degradative plasmids	Develop the genetically engineered microbes to clean up the environmental issues	K5
3.2	Biotransformation of xenobiotics - Detoxification, Surfactants, Pesticides. Biopesticides integrated pest management	Formulate genetically engineered microbes as a solution of controlling pest wastes	K4
3.3	Biodiversity -treaties and protocols for Biodiversity Conservation, Biodiversity - definition, hot spots of Biodiversity, strategies for Biodiversity Conservation	Understand the concepts of biodiversity and list out the endangered species for conservation Develop strategies for Biodiversity Conservation	K2 K5
4	**Bioremediation**		
4.1	Biosensors in Bioremediation- Biotechnology in pulp and paper industry	Adapt safe and effective measures in biotechnology	K5
	Advanced and emerging Biotechnological applications for industrial effluent (tannery &distillery).	Describe the methods and apply knowledge to treat industrial effuluents	K3
4.2	Pesticide waste disposal, oleophilic fertilizers and use of genetically engineered microbes.	To understand the use and role of genetically engineered microbes	K2
4.3	Giant bacteria and their ecological significance. Sea weeds for removal of heavy metal pollutants.	Analyze the importance of giant bacteria and sea weeds to clean the ecosystem	K5
4.4	Hazards of genetically engineered microbes plants and animals to the environment.	Analyze the disadvantage and hazards on usage of engineered microbes in the environment	K3
5	**Environmental toxicology**		
5.1	Toxicology - Basic probit analysis concepts - Toxicants	Understand the concept of toxicology and toxicants	K2
5.2	Toxicity, Acute, sub acute, chronic, dose effect, LD 50 and response safe limits. Dose response safe limits. Dose response relationship, graphs, concentration response relationship.	Analyze the effect of toxicity on human, Minimum dose and safe limit of toxicants usage in environment	K4

Unit/ Section	Course Content	Learning Outcomes	HBTLT
5.3	Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity	Analyze the role of chemicals which causes carcinogenicity in air	K4
5.4	Environmental carcinogenicity testing.	Assess and detect the level of carcinogens in environment	K4

4. Mapping Scheme

P20BT410	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	L	-	L	M	-	-	M	H	L	M
CO2	L	-	L	-	-	-	L	-	-	M	L	L	M
CO3	H	H	L	-	M	H	M	M	L	M	L	L	H
CO4	H	M	-	L	M	H	M	M	L	M	L	M	M
CO5	L	-	L	-	-	L	L	-	M	L	M	-	M
CO6	M	M	H	L	M	H	M	L	L	L	M	L	M

L: Low M: Medium H: High

5. COURSE ASSESSMENT METHODS

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation, Group discussion, seminars 3. End Semester Examination
Indirect
1. Course-end survey

Name of the Course Coordinator: Dr.S.Sriram

Semester : 4 **Course code : P20BT4:5**
Credits : 4 **Total Hrs/ Week : 5**

Elective : V A - BIOTECHNOLOGY MANAGEMENT

1. Course Outcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Build a foundation in mangement and main business processes needed within the biotechnology field and plan to develop the strategies, project management, risk and entrepreneurship	K2	I
CO2	Correlate the ideas of biotechnology in safety and hazard management especially using timely techniques like nanotechnology	K3	III
CO3	Specify the basic processing methods followed in food and such related industries and manage to integrate them	K2	II
CO4	Trace the pollution preventive measures, develop and adher to the procedures wherever necessary	K4	IV
CO5	Practice and prioritize life science industry customs including ethical practices, laboratory guidelines and other standards followed in research	K5	V
CO6	Display both leadership skills as well as neccessary knowledge of biotechnology to help in career advancement	K4	I

2. A. Syllabus

Unit –I **15hrs**

Emerging trends in Biotechnology industries.

Strategies for research and development, business/maintenance expansion, licensing, generic versus brand-name proprietary drug business. Production management – fundamentals of production planning and control for Biotechnology. Innovation and knowledge management for Biotechnology. IPR and technology transfer. Entrepreneurship within the biotechnology and biopharma industries.

Unit -II **15hrs**

Food safety management

Management of Food and other Industrial Wastes. Processing of Fruit and Vegetable wastes, Dairy products, Meat, Poultry and Sea food, Beverage and Fermentation of Industrial wastes. Processing and Utilization of Grain milling industries, Spices and Condiments, Sugar and Paper Industrial wastes.

Unit -III **15hrs**

Safety and hazard management in Biotechnology

Waste Management by NanotechnologyNanotechnology for waste minimization, Nanofiltration, Nanocatalysts, Magnets and Detectors, Electro spinning nanofibres for Water Treatment and Potential risks.

Unit -IV **15hrs**

Environmental Impacts

Environment management systems. Regulatory affairs and biosafetyregulations. Pollution prevention, Measurement-COD, BOD, DOC; Control measures, Legal and environmental issues. Ecosystem managements-Biodiversity conservation using Biotechnological principles.

Unit - V **15hrs**

Bioethics

Methods in bioethics, Autonomy Organ transplantation, Biobanking, Morality of human embryos and stem cell research; Therapeutic cloning; Genetic screening and enhancement; Animal experimentation; International guidelines. Quality management and accreditation of biotechnology laboratories. Guidelines and Standards followed in India and globally.

B. Topics for self study

S.No	Topics	Web Links

C. Text Books

1. Sangita Malvee., Biotechnology Management,Astral International Pvt. Ltd.,2014.
2. Joshi V.K., and Sharma S.K., Food Processing Waste Management, New India Publishing Agency, New Delhi, 2011

D. Reference Books

1. Shaleesha A Stanley., Bioethics, Wisdom Educational Services, Chennai, 2008
2. Bonnie Steinbock., The Oxford Handbook of Bioethics, Oxford University Press, New Delhi, 2007
3. Lewis Vaughn., Bioethics, Principles, Issues and Cases, Oxford University Press, New Delhi, 2012
4. Pete Harpum.,Portfolio, Program, and Project Management in the Pharmaceutical and Biotechnology Industries, Wiley; 1 edition. 2010

E. Web Links

1. https://nptel.ac.in/courses/102/104/102104082/
2. https://nptel.ac.in/courses/102/105/102105058/
3. https://nptel.ac.in/courses/102/105/102105088/

3. Specific Learning Outcomes(SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Emerging trends in Biotechnology industries**		
1.1	Emerging trends in Biotechnology industries.	Explain the recent developments in Biotechnology in industrial sector	K2
1.2	Strategies for research and development, business/maintenance expansion, licensing, generic versus brand-name proprietary drug business.	Illustrate the plans or ideas practiced in Biotechnology management	K3
1.3	Production management – fundamentals of production planning and control for Biotechnology.	Summarize the basic workplan followed in production area	K2
1.4	Innovation and knowledge management for Biotechnology.	Develop new ways which are needed for efficient management in Biotechnology industries	K3
1.5	IPR and technology transfer. Entrepreneurship within the biotechnology and biopharma industries.	Discuss and describe the importance of IPR in Biotechnology industry	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2	**Food safety management**		
2.1	Management of Food and other Industrial Wastes.	Indicate how food waste can be controlled and managed	K2
	Processing of Fruit and Vegetable wastes, Dairy products, Meat, Poultry and Sea food, Beverage and Fermentation of Industrial wastes.	Report the methods which operate to process various waste	K3
	Processing and Utilization of Grain milling industries, Spices and Condiments, Sugar and Paper Industrial wastes.	Apply different successful processing methods to manage other than main food wastes	K3
3	**Safety and hazard management in Biotechnology**		
3.1	Safety and hazard management in Biotechnology	Record the nature of waste widely prevalent and also consider the safety measures	K3
3.2	Waste Management by Nanotechnology Nanotechnology for waste minimization, Nanofiltration, Nanocatalysts, Magnets and Detectors, Electro spinning nanofibres for Water Treatment and Potential risks.	Formulate methods to clean waste using nanotechnology	K6
4	**Environmental Impacts- Environment management system**		
4.1	Environmental Impacts- Environment management systems	Adapt safe and effective measures to manage waste	K6
4.2	Regulatory affairs and biosafety regulations.Pollution prevention, Measurement-COD, BOD, DOC; Control measures, Legal and environmental issues.	Devise methods based on the quality of waste	K4
4.3	Ecosystem managements-Biodiversity conservation using Biotechnological principles.	Choose apt biotechnology methods/techniques to clean the ecosystem	K3
5	**Bioethics**		
5.1	Methods in bioethics,Autonomy Organ transplantation, Biobanking, Morality of human embryos and stem cell research; Therapeutic cloning; Genetic screening and enhancement; Animal experimentation; International guidelines.	Show the importance of bioethics	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
5.2	Quality management and accreditation of biotechnology laboratories.	Formulate guidelines based on the nature of experiments performed in lifescience labs	K6
5.3	Guidelines and Standards followed in India and globally.	Assess the guidelines followed in laboratories	K5

4. Mapping Scheme

P20BT4:5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	M	M	L	H	M	L	H	-	L	M	M	M
CO2	L	M	L	M	-	L	L	M	-	L	L	L	L
CO3	L	M	L	M	-	L	L	M	-	L	L	L	L
CO4	L	M	L	M	-	L	L	M	-	L	L	L	L
CO5	M	L	-	-	-	L	L	-	H	L	L	L	L
CO6	M	M	M	M	L	M	H	M	M	M	M	M	M

L: Low **M: Medium** **H: High**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review 3. Group discussion, Poster presentation, oral presentations/seminars 4. End Semester Examination
Indirect
1. Report and group assignments of industrial visits

Name of the Course Coordinator: Mr.J.Dinesh Raja

Semester : 4 **Course code : P20BT4:A**
Credits : 4 **Total Hrs/ Week : 5**

Elective : VB. FOOD BIOTECHNOLOGY

1. CourseOutcomes

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

CO.No	Course Outcomes	Level	Unit
CO1	Remember and recognize sources of microorganisms and food borne illness	K1	II
CO2	Learn and understand a new dimension in food industry	K2	IV, I
CO3	Apply concepts related to food technology in a fundamental way and it can be applied to in a professional domain. Apply the principles of food science to control and assure the quality of food products	K6	V
CO4	Analyze the chemistry underlying the properties and reactions of various food components	K4	III, I
CO5	Evaluate the food Processing industries and preservation techniques	K5	IV
CO6	Demonstrate practical proficiency in a food analysis laboratory	K3	III, II

2. A. Syllabus

Unit – I **15hrs**

Food chemistry

Constituents of food - contribution to texture, flavor and organoleptic properties of food; food additives - intentional and non-intentional and their functions; enzymes in food processing.

Unit – II **15hrs**

Food Microbiology

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases - infections and intoxications, food spoilage - causes.

Unit – III **15hrs**

Food processing

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

Unit – IV **15hrs**

Food preservation

Use of high temperatures – sterilization, pasteurization, blanching, canning - concept, procedure & application; Low temperature storage - freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods

Unit – V **15hrs**

Manufacture of food products

Bread and baked goods, dairy products – milk processing, cheese, butter, ice cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

B. Topics for self study

S.No	Topic	Web links
1.	Plant derived vaccines	https://www.slideshare.net/Lee-Ann786/plant-derived-vaccines
2.	Safety evaluation of novel food products	https://www.eufic.org/en/food-production/article/safety-evaluation-of-novel-foods-a-european-and-international-perspective
3.	Genetically manipulated food products	https://www.motherjones.com/environment/2013/08/what-are-gmos-and-why-should-i-care/ https://www.fda.gov/food/agricultural-biotechnology/gmo-crops-animal-food-and-beyond
4.	Putrescine fermentation	https://www.academia.edu/8822257/Formation_Degradation_and_Detoxification_of_Putrescine_by_Foodborne_Bacteria_A_Review

C. Text Books

1. Gupta S.K., Basic Principles of Clinical Research and Methodology, Jaypee Brothers Medical Publishers, 2007

D. REFERENCE BOOKS

1. Pillai., Biochemistry and Clinical Pathology, CBS Publications, 2012
2. Stephen Hulley., Outlines & Highlights for Designing Clinical Research: An Epidemiologic Approach, Academic Internet Publishers, 2011
3. Dan Wood., and Daron Smith., Research in Clinical Practice, \ Springer Publications, 2012
4. Robert J. Levine., Ethics and Regulation of Clinical Research: Second Edition, Yale University Press, 2010

E. Web Links

1. https://nptel.ac.in/courses/126/105/126105015/
2. https://nptel.ac.in/courses/126/105/126105011/
3. https://nptel.ac.in/courses/126/105/126105013/

3. Specific Learning Outcomes (SLO)

Unit/ Section	Course Content	Learning Outcomes	HBTLT
1	**Food chemistry**		
1.1	Constituents of food - contribution to texture, flavor and organoleptic properties of food.	Explain and understand the constituents of food and properties of food in industrial sector	K2
1.2	Food additives - intentional and non-intentional and their functions; enzymes in food processing.	Illustrate the role of additives in various food products and to understand the importance of enzymes in food processing.	K4
2	**Food Microbiology**		
2.1	Sources and activity of microorganisms associated with food	Indicate the route cause and activity of microbes on food and its control measures	K2
2.2	Food fermentation	Understand the mass production of food products through fermentation	K2

Unit/ Section	Course Content	Learning Outcomes	HBTLT
2.3	Food chemicals; food borne diseases - infections and intoxications, food spoilage - causes.	Evaluate the transmission of food borne diseases through spoiled food and preventive measures to overcome the infection.	K6
3	**Food processing**		
3.1	Raw material characteristics; cleaning, sorting and grading of foods	To produce and operate methods to process various raw materials based on the characteristics	K5
3.2	Physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.	To apply and formulate different processing methods of various foods	K5
4	**Food preservation**		
4.1	Use of high temperatures - sterilization, pasteurization, blanching, canning concept, procedure & application; Low temperature storage	To adapt safe protocols and effective measures to preserve and storage of foods using temperatures	K5
4.2	Factors affecting quality of frozen foods; irradiation preservation of foods	Gain knowledge on various physical and chemical factors affecting the preserved foods	K2
5	**Manufacture of food products**		
5.1	Bread and baked goods, dairy products	Develop the production of various food products	K6
5.2	Milk processing, cheese, butter, ice cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages	To create a good nutritional value dairy products and other food products	K5

4. Mapping Scheme

P20BT4:A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO 2	PSO3	PSO4
CO1	H	M	L	M	L	H	L	M	L	H	L	M	M
CO2	L	L	M	H	H	M	L	M	L	H	M	H	H
CO3	M	L	H	L	M	M	M	H	M	H	H	H	H
CO4	M	L	H	M	H	M	M	M	H	M	H	M	M
CO5	M	M	M	H	M	L	M	L	M	L	M	M	H
CO6	H	H	H	M	M	H	L	M	H	H	M	H	H

L: Low M: Medium H: High

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test, Assignment, Journal paper review, Case study, Mini Project report, Poster presentation, Group discussion, seminars 3. End Semester Examination
Indirect
1. Course-end survey

Value Added Courses For M.Sc. Students

Course Code

Logical Reasoning And Analytical Ability For Competitive Exams

Course Objectives

- To Enhance the Problem Solving Skills and Analytical Skills
- To help students especially in Non Mathematics platform to clear any Indian Govt Examinations
- To ensure that students learn to think critically about mathematical models for relationship between different quantities and use those models effectively and accurately to solve problems and reach sound conclusions about them.
- To Comprehend work with and apply general mathematical techniques and models to different situations ,not just plug problem specific data into a given formula.
- To prepare the students to become Efficient Government Officers for serving the Society

Unit -I :

Basic Aptitude and Mental Ability (6Hrs)

(i) Simplification – Percentage - Highest Common Factor (HCF) - Lowest Common Multiple (LCM).

(ii) Ratio and Proportion.

(iii) Simple interest - Compound interest - Area - Volume – Time and Work.

(iv) Logical Reasoning - Puzzles-Dice - Visual Reasoning – Alpha numeric Reasoning- Number Series

Unit – II

Logical Thinking (6Hrs)

(i) Basic Concept of Logic – types of propositions – methods and rules for reducing propositions – inference – inductive, deductive inference – methods and rules for solving inferences.

(ii) Rules and concept of inversion

Unit – III

Critical Thinking (6Hrs)

(i) Statement argument – Fallacies in argument – Deciding and strong and weak arguments – statements

(ii) Assumption – difference between assumptions and implications – Extraction the assumption hidden in the statement.

(iii) Course of action – finding a suitable course of action – punchlines – judging the statement qualifies as a punchline – deriving inference from passages – deleting inference from passages

Unit – IV

Analytical Thinking (6Hrs)

(i) Input/Output Problems – Problems dealing with recording – problems involving mathematical operations.

(ii) Concept of Binary Number – convert binary to decimal – decimal to binary numbers

Unit – V

Data Sufficiency (6Hrs)

(i) Introduction – Problems dealing with day and date – relationship and ages – analysis of the situation

(ii) Syllogistic Problems – Rules and methods to solving Problems.

Reference Books

1. Analytical Reasoning – MK Pandey -BSc Publishing Pvt Ltd ,5th Edition (2019)
2. Logical and analytical Reasoning – R.Guptha's Ramesh Publishing House , Delhi – 4th Edition 2019.
3. A Modern Approaches to Logical Reasoning -RS Aggarwal – S Chand Publishing – Delhi – 1 (Edition -2018)
4. Non Verbal Reasoning - RS Aggarwal – S Chand Publishing – Delhi – 1 (Edition - 2018)
5. UPSC Indian Civil Services (Prelims CSAT Paper II)Arahant Publishing(P) Ltd (2018)- Dhiraj Pandey

Evaluation Methods : (ONLINE & OFFLINE MODE)

Tests based on Govt Exam Levels : Short Time Negative Marking, Survey Based Calculations Tests based on Previous years Govt Exam Question Papers.

Value Added Course Effective Communication Skills

Course Code Total Hours

Course Objectives:

1. To acquire knowledge about the fundamentals of communication and to improve the vocabulary, reading and writing skills.
2. To learn how to frame a grammatically correct sentence.
3. To understand and apply vocabulary in the right sense while communicating effectively.
4. To develop effective writing skills and avoid errors.
5. To improve their presentation skills and gain confidence in public speaking.
6. To critically use the language skills for effective communication.

Unit - I: Grammar

Articles, Tenses- Past, Present, Future & Continuous Tenses, Active & Passive Voice.

Unit – II : Understanding and Applying Vocabulary

Vowel and consonant – Useful Vocabulary for Everyday Conversation, Synonyms and Antonyms, Word formation : Prefixes and Suffixes

Unit - III : Introduction to Writing Skills

Effective Writing Skills, Avoiding Common Error, Paragraph Writing

Unit - IV : Letter Writing

Letter Types & Format, Resume Writing

Unit - V : Public Speaking

Pronunciation, Guidelines to an Effective Presentation, Group Discussion, Effective Public Speaking.

Text Book

Wren, P.C., and H. Martin.High School English Grammar & Composition. Pub: S Chand, 2017.

Reference Book

Hargie, Owen. The Handbook of Communication Skills. Pub: Routledge, 2006.

Evaluation Pattern (MARKS: 100)

Writing Exam	:	50 Marks
Oral Exam	:	50 Marks
Total	:	100 Marks

VALUE ADDED COURSE

"EFFECTIVE PRESENTATION USING ONLINE AND OFFLINE TOOLS"

Course Code: Total Hours

Course objectives

After completion of the programme, students will be able to

- Design different types of powerpoint presentation slides (K5)
- Demonstrate the online tools used for presentations (K3)
- Categorize different tools used for presentations (K4)
- Describe the tricks for effective presentations (K1)
- Compare various online and offline powerpoint presentation tools (K2)

1. Introduction to Presentations
2. Types of Presentations
3. Inserting Pictures, Audio and Video
4. Inserting Charts, SmartArts, Shapes
5. Transitions and Animations
6. Tricks in Slideshow, Exporting in different formats
7. Introduction to LibreOffice Impress
8. Merits and Demerits of LibreOffice Impress
9. Introduction to Powtoon
10. Animations using Powtoon
11. Basics of renderforest
12. Basic Features of Canva
13. Animations using Canva
14. Exploring features of Canva
15. Overview of Google Slides and Addons

Reference links:

1. https://www.youtube.com/watch?v=ag8pSTF-Lao
2. https://www.youtube.com/watch?v=lxcHLxjkcXQ
3. https://www.customguide.com/cheat-sheet/powerpoint-quick-reference.pdf
4. http://index-of.co.uk/OFIMATICA/Wiley%20PowerPoint%202013%20for%20Dummies.pdf

SELF-STUDY 1
SELECTED TOPICS FOR COMPETITIVE EXAM-1

Course Code : Total Hours : 30

Course Objectives:

- To learn about biomolecules and its metabolism
- To learn about cell cycle and its regulation
- To understand the concepts of replication, transcription and translation
- To know about the immune system and cancer
- To understand the development of fertilization and embryo

Unit-I : Molecules and their Interaction Relavent to Biology

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Bioenergetics, glycolysis, oxidative phosphorylation Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins. Enzyme Kinetics

Methods in biology : In vitro mutagenesis and deletion techniques, gene knocks out in bacterial and eukaryotic organisms. Protein sequencing methods, detection of post translation modification of proteins.DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques. Isolation, separation and analysis of carbohydrate and lipid molecules. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors.

Unit-II : Cellular Organization and Communication

Membrane structure and function : Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Structural organization and function of intracellular organelles : Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Organization of genes and chromosomes: Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and

chromosomes, heterochromatin, euchromatin, transposons. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

Cellular Communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Programmed cell death, aging and senescence-Apoptosis, DNA repair enzymes, Insulin signaling pathway, Chromatin deacytylase mTOCR1 gene

Unit-III: Fundamental Processes

DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

Protein synthesis and processing : Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.

Control of gene expression at transcription and translation level: Regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing

Unit-IV : Immunology

Innate and adaptive immune system : Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses,

primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines. Signal Transduction.

Unit- V: Developmental Biology

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*

References

1. Geoffrey M Cooper., and Robert E Hausman., The Cell-A Molecular Approach, Sixth Edition, ASM Press, Washington, 2013
2. Harvey Lodish., Arnold Berk., Paul Matsudaira., Chris A. Kaiser., Monty Krieger., Matthew
3. P. Scott., Lawrence Zipursky., James Darnell., Molecular Cell Biology, Sixth Edition, 2008
4. Gerald K., Cell and Molecular Biology, Third edition, John Wiley & Sons, New York, 2001
5. Alberts et al. Essential Cell Biology: An Introduction to the Molecular Biology of the Cell, Second Edition, Garland Science Taylor & Francis Group, New York, 2003
6. Benjamin A. Pierce., Genetics-A Conceptual Approach, W.H.Freeman & Company, New York, Second Edition, 2006.
7. Deb A.C., Fundamental of Biochemistry, New Central Book Agency, Calcutta, Seventh Edition, 2001
8. David Rawn J., Biochemistry, Neil Patterson Publications, 2005

9. Nelson L. D., and Cox M. M., Lehninger's Principle of Biochemistry, Macmillan, Worth Publication Inc., Sixth Edition, 2013
10. Berg J.M., and Stryer L., Biochemistry, W.H. Freeman & Co. New York, Seventh Edition, 2007
11. Thomas M. Devlin., Biochemistry with Clinical Correlation, Wiley-Liss Publication, Fifth Edition, 2002
12. Satyanarayana U., Biochemistry, Books and Allied Pvt. Ltd. Calcutta, 1999.
13. Janis Kuby J., Immunology, Fourth Edition, W. H. Freeman & Co., 2000
14. Abul K. Abbas., Andrew K. Lichtman., and Jordan S. Pober., Cellular and Molecular Immunology, Third Edition, W.B. Saunders Company, 1997
15. Weir D.M. Ann., and Stewart J., Immunology, Eight Edition, Churchill Livingston, New York, Tizzard, 1997
16. Ivon Roitt., Essential Immunology, Eight Edition, Blackwell Scientific Publication, 1994.

Evaluation Method

Multiple Choice Questions

SELF-STUDY 2

COURSE TITLE: SELECTED TOPICS FOR COMPETITIVE EXAM-2

Course Code : Total Hours : 30

Course Objective:

- To learn about the photosynthesis and plant hormones
- To understand the respiratory, digestive and excretory system
- To know about the mendalian inheritance principles
- To understand the ideology in ecology
- To study about evolutionary concepts

Unit-1 : System Physiology - PLANT [6Hrs]

Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways.

Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.

Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks

Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

Unit-2 : System Physiology - Animal [6Hrs]

Blood and circulation - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.

Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above

Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

Sense organs - Vision, hearing and tactile response.

Excretory system - Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Digestive system - Digestion, absorption, energy balance, BMR.

Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation

Unit-3 : Inheritance Biology [6Hrs]

Mendelian principles: Dominance, segregation, independent assortment.

Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests

Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. **Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping. **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Recombination: Homologous and non-homologous recombination including transposition.

Unit-4 : Ecological Principles [6Hrs]

The Environment: Physical environment; biotic environment; biotic and abiotic interactions. **Habitat and Niche**: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population Ecology: Characteristics of a population; population growth curves;population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Community Ecology: Nature of communities; community structure and attributes;levels of species diversity and its measurement; edges and ecotones.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax. **Ecosystem Ecology:** Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water,marine, eustarine).

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

Unit-5 : Evolution and Behaviour [6Hrs]

Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.

Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

The Mechanisms: Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

Brain, Behavior and Evolution: Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care;Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

References

1. Lincoln Taiz and Eduardo Zeiger Plant Physiology, 3rd edition, Publisher: Sinauer Associates (2002).
2. Guyton and Hall Textbook of Medical Physiology 12th edition, Elseiver (2011).
3. Misra S.P., and Pandey S.N., Essential Environmental Studies, Anne Books Pvt.,Ltd., New Delhi, 2008
4. Chapman J.L., and Reiss, M.J., Ecology, Principle and Applications, Cambridge University Press,1995
5. Kormondy E.J., Concept of Ecology, Prentice-Hall of India Pvt. Ltd., 1989.
6. Agarwal V.K., and Verma P.S., Basis of Evolution, S. Chand Publishing, New Delhi, 1995.
7. Benjamin A. Pierce., Genetics-A Conceptual Approach, W.H.Freeman & Company, New York, Second Edition, 2006.

Evaluation Method:

Multiple Choice Questions

ADD-ON COURSE
SCIENTIFIC WRITING

Credit 2
Course Code : Total Hours : 30

Course Objectives

- To introduce scientific writing to young minds and to train them to write well-styled, properly referenced, plagiarism-free manuscripts/scientific papers
- To combine practical journal club classes (once/twice a week) with the course modules and thereby, to train students how to read and understand scientific papers of the highest quality
- To inculcate the unique practice of augmenting students' writing skills through practical training and innovative assignments

Unit 1

Fundamentals of scientific writing – Introduction to different kinds of publications/ scientific documents; Types of papers – Full-length research articles, review articles, short communications, monographs, systematic reviews & meta-analyses and books/book chapters, dissertations/theses: Structure and layout of each document. Authorship – criteria and hierarchy. Specific journals for Biotechnology and Bioinformatics.

Unit 2

Overcoming the difficulties and constraints in scientific writing- tackling barriers like language, time, Lack of knowledge/reading**,** Document preparation and formatting. How to write the contents- Abstract, Introduction/background, materials and methods, results and discussion, conclusion and conflicts of interest statement. Usage of MS Word. Other practical writing skills needed for Biotechnology and Life Science based papers.

Unit 3

Collecting information for review of literature - various online search tools/resources – Google Scholar, PubMed, Cochrane database, ScienceDirect, ProQuest, Embase, Web of Science, ERIC, DOAJ, JSTOR, Biological Abstracts, BioOne, CINAHL, Index Copernicus, SCOPUS, etc.; **Abstract writing**, preparation of index cards, **Systematic review article search tools**, PRISMA and SPIDER approaches, inclusion and exclusion criteria, clinical trials design and methodology – PRISMA, research design, Cochrane database CASP tools, **data extraction and synthesis**.

Unit 4

Article structuring to meet the specific requirements of the journal- Summarising and Paraphrasing; Reference styles – quotations, referencing styles – APA, Harvard, IEEE, Vancouver, Chicago, MLA styles; Introduction to use of Endnote and Mendeley (reference managers); Use of Review Manager (RevMan); Use of journal finder & journal scoping; following journal-specific author guidelines, article image-making/processing tool, Poster making tools, making journal- specific article templates, use of statistical software for data presentation -graphing-MS Excel and GraphPad Prism.

Unit 5

Ethics in scientific writing and communication- Journal author agreements, conflicts of interest and ethics violations–legal issues; unintentional plagiarism, fabrication, multiple submissions, and salami slicing. Cover letter writing; rebuttal writing to specific comments from the journal editors and reviewers; confidentiality agreements, collaboration. Creating account in journals and article submission process for various journals (practical demonstration).

References

1. Abbey, Edward. 1968. Desert Solitaire. McGraw-Hill. Baldwin, Bruce G. 2014. Origins of Plant Diversity in the California Floristic Province. Annual Review of Ecology, Evolution and Systematics 45: 347-369.
2. Coley, P.D., J.P. Bryant, F.S. Chapin, III. 1985. Resource availability and plant anti-herbivore defense. Science. 230:895-899. Greene, Anne E. 2013. Writing Science in Plain English. University of Chicago Press.
3. Janzen, D.H. 1979. How to be a fig. Annual Review of Ecology and Systematics. 13-51. Leopold, Aldo. 1949. A Sand County Almanac. Oxford. McKibben, Bill (Editor). 2008.
4. American Earth: Environmental Writing Since Thoreau. Library of America. Wallace, David Rains 2015. Mountains and Marshes: exploring the Bay Area's Natural History. Counterpoint.
5. Wiens, **J.J.,** and M.D. Donoghue. 2004. Historical biogeography, ecology, and species richness. Trends in Ecology and Evolution 19: 639-644.

Evaluation

MAJOR TASK: Student must write his/her article on their own (review and/or paper)

They should transform their MSc/BSc project dissertation research into a peer review jounal paper format.

Minor Task : ASSIGNMENTS – Topic relevant to each unit

1. Collecting different kinds of scientific documents and categorizing them with justification
2. Sample full article on their field of interest to judge their language, grammar, vocabulary, style and formatting
3. Sample article on a assigned topic to evaluate their structuring and worth of the entire manuscript
4. Presenting effectively the given sample scientific data using various computer tools
5. A sample paper with flaws will be given- the students will reconstruct, correct and do all necessary changes and submit an appealing research article