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THE AMERICAN COLLEGE

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

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MADURAI

M.Sc., Biotechnology Programme

DEPARTMENT OF BIOTECHNOLOGY
Satellite Campus

Department of Biotechnology (PG)

Programme Specific Outcomes (PSOs)

On the successful completion of the Postgraduate programme, the students will be able to

PSO1 **Disciplinary Knowledge**	acquire advanced knowledge of biological systems, processes and practical skills sought after in Biotechnology field.
PSO2 **Communication Skills**	train to develop a strong verbal, non-verbal communication and collaboration skills to become successful professional experts.
PSO 3 **Problem Solving & Analytical Reasoning**	enhance the competence for innovative problem-solving by generating new ideas for interpreting data and proposing solutions
PSO 4 **Critical Thinking**	attain a keen capability to critically and systematically evaluate scientific data, resulting in the formulation of objective conclusions.
PSO 5 **Research Skills**	promote scientific exploration and innovative research across diverse areas of biotechnology and engage in the generation of significant and original research.
PSO 6 **Digital Literacy**	train to leverage digital tools, platforms, and technologies to excel in biotechnology relevant fields.
PSO 7 **Professional competencies**	develop entrepreneurial and employability skills necessary to guide diverse teams towards achieving organizational objectives.
PSO 8 **Moral and Ethical Awareness/Reasoning**	master the ethical codes governing the biotechnology field and demonstrate unwavering commitment to ethical practice.
PSO 9 **Multicultural Competence**	develop and enhance the multicultural aptitude across personal, professional, and social interactions to meet societal needs.
PSO 10 **Self-directed & Lifelong Learning**	cultivate professional skillsets through continuous learning for lifelong personal development and to be successful in society.

Department of Biotechnology (PG)

Learning Outcomes - Based Curriculum Framework (LOCF)
(w.e.f 2024-2025)

Sem	Category	Course Code	Course Title	Hours / Wk.	Credits	Marks
1	CC	24PBT4401	Biochemistry	5	4	80
1	CC	24PBT4503	Molecular Genetics	6	5	100
1	CC	24PBT4405	Molecular Cell Biology	5	4	80
1	CC	24PBT4407	Practical – I (A) Biochem. (B) Mol. Cell Biol. & Mol. Genet.	6	4	80
1	DSE	24XXXNNNN	*Discipline Specific Elective – I*	4	3	60
1	GE	24XXXNNNN	*Generic Elective – I*	4	3	60
	Total			**30**	**23**	**460**
2	CC	24PBT4302	Microbiology	4	3	60
2	CC	24PBT4404	Immunology	5	4	80
2	CC	24PBT4406	Genetic Engineering	5	4	80
2	CC	24PBT4608	Practical – II (A) Microbiol. (B) Immunol. (C) Genet. Eng.	8	6	120
2	DSE	24XXXNNNN	*Discipline Specific Elective – II*	4	3	60
2	GE	24XXXNNNN	*Generic Elective – II*	4	3	60
	Total			**30**	**23**	**460**
3	CC	24PBT5301	Bioinformatics and System Biology	4	3	60
3	CC	24PBT5503	Plant and Animal Biotechnology	6	5	100
3	CC	24PBT5305	Bioprocess Technology	4	3	60
3	CC	24PBT5307	Research Methodology & Biostatistics	4	3	60
3	CC	24PBT5609	Practical – III (A)Bioinform. (B)Pla.&Anim. Biotechnol. (C)Bioproc.Tech.	8	6	120
3	DSE	24XXXNNNN	*Discipline Specific Elective – III*	4	3	60

3	IS	24PBT5233	Internship*	-	2	40
	Total			**30**	**25**	**500**
4	CC	24PBT5502	Bioethics, Biosafety & IPR	6	5	100
4	CC	24PBT5504	Marine Biotechnology	6	5	100
4	CC	24PBT5506	Pharmaceutical Biotechnology	6	5	100
4	CC	24PBT5508	Project	8	5	100
4	DSE	24XXXNNNN	*Discipline Specific Elective – IV*	4	3	60
4	SEC	24PBT5244	Professional Competency Skill	-	2	40
	Total			**30**	**25**	**500**
Grand Total				**120**	**96**	**1920**

* Internship - First Year Vacation

Part III

Discipline Specific Elective (DSE)

Sem	Category	Course Code	Course Title	Hours / Wk.	Credits	Marks
1	DSE	24PBT4309	Bioinstrumentation	4	3	60
		24PBT4311	Medical Lab Technology	4	3	60
2	DSE	24PBT4310	Environmental Biotechnology	4	3	60
		24PBT4312	Agricultural Biotechnology	4	3	60
3	DSE	24PBT5311	Nanobiotechnology	4	3	60
		24PBT5313	Molecular Developmental Biology	4	3	60
4	DSE	24PBT5310	Stem Cell Biology	4	3	60
		24PBT5312	Enzymology	4	3	60

Generic Elective (GE)

Sem	Category	Course Code	Course Title	Hours/ Wk.	Credits	Marks
1	GE	24PBT4313	Introduction to Bioinformatics	4	3	60
		24PBT4315	Herbal Technology	4	3	60
2	GE	24PBT4314	Bioentrepreneurship	4	3	60
		24PBT4316	Food and Nutrition	4	3	60

Mapping with POs

PBT	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	3	3	2	2	2	2	2	2	1	2

Mapping of Courses with PSOs

Courses	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
24PBT4401	3	3	2	2	1	2	2	1	1	1
24PBT4503	3	3	2	2	3	3	2	2	3	1
24PBT4405	3	3	2	1	1	1	1	1	1	1
24PBT4407	3	3	3	3	2	2	1	2	1	2
24PBT4309/ 24PBT4311	3	3	2	2	2	2	2	2	1	2
24PBT4302	3	3	2	3	3	3	2	2	2	1
24PBT4404	3	3	2	2	2	2	2	1	1	1
24PBT4406	3	3	3	2	2	2	1	1	1	2
24PBT4608	3	3	3	3	3	2	2	2	1	3
24PBT4310/ 24PBT4312	3	3	2	2	2	3	2	2	2	1
24PBT5301	3	3	2	2	2	2	2	1	1	1
24PBT5503	3	3	2	2	2	2	2	2	1	1
24PBT5305	3	3	1	1	1	2	2	1	1	1
24PBT5307	3	3	2	2	3	3	2	2	1	2
24PBT5609	3	3	2	2	2	2	1	2	1	2
24PBT5311/ 24PBT5313	3	3	2	2	2	2	2	1	1	1
24PBT5233	3	3	3	3	3	3	3	2	2	3
24PBT5502	3	3	2	2	3	2	2	3	2	3
24PBT5504	3	3	1	1	2	3	1	2	1	1
24PBT5506	3	3	2	2	2	2	2	1	1	1
24PBT5508	3	3	3	3	3	3	3	2	2	3
24PBT5310/ 24PBT5312	3	3	3	2	2	1	2	2	2	2
24PBT5244	3	3	3	3	3	3	3	2	2	3
Average	3	3	2.2	2.1	2.2	2.2	1.9	1.6	1.3	1.6

Mapping of Courses with POs

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
24PBT4313/ 24PBT4315	3	3	3	2	2	2	2	1	1	1
24PBT4314/ 24PBT4316	3	3	2	2	1	3	3	2	2	2
Average	3	3	2.5	2	1.5	2.5	2.5	1.5	1.5	1.5

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4401	Biochemistry	Core	5	4

The paper imparts a thorough knowledge on the basics of all the Biochemical concepts, metabolic reactions and its regulation. The student will get to understand the core concepts of metabolism and physiological processes of the body in both healthy and disease state.

Course Outcomes:

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

CO1: state the basics of pH and related principles and carbohydrate metabolism.

CO2: update the knowledge on Amino acids, Protein and lipids.

CO3: assess and appraise the role of Nucleic acids.

CO4: enlighten the students on bio-energetics and biological oxidation pathways.

CO5: acquire basic knowledge about enzyme kinetics.

Unit I: 15 Hours

Water as elixir of life – acid and base – derivation of pH and pK - Buffers- Henderson- Hasselbalch equation, biological buffer system. Biomolecules - Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms - glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, glycolysis, citric acid cycle, cori cycle, glyoxylate pathway, Photosynthesis.

Unit II: 15 Hours

Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolisms, urea cycle, carbon skeleton of amino acids and over all in born error metabolisms.

Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycolipids, Eicosanoids, sphingolipids and steroid hormones. Cholesterol biosynthesis, bile acids and salt formation.

Unit III: 15 Hours

Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. In de novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolism of purines and pyrimidines bases, Synthetic analogues of nitrogenous bases.

Unit IV: 15 Hours

Bioenergetics – Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant – ATP as an energy

currency - Biological oxidation: Electron transport chain, oxidative phosphorylation, ATP synthase – chemiosmotic theory - Oxidation of fatty acids- mitochondrial and peroxisomal ß-oxidation, alpha and beta oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Hormonal regulation of fatty acids and Mineral metabolism.

Unit V: **15 Hours**

Enzyme kinetics - Kinetics of catalysed reaction: Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Hanes wolf equation, Eadiehofstee equation, Inhibition of enzyme activity.

Learning Resources:

Text Books

1. Jain, J. L. (2004). Fundamentals of biochemistry. S. Chand Publishing.
2. Mathews, C.K., Van Holde, K.E. & Ahern, K.G. (2000). Biochemistry. Benjamin Cummings
3. Rastogi, S.C. (2010). Biochemistry, 3rd Edition. Tata McGraw Hill Edition, New Delhi.

References

1. Berg, J. M., Tymoczko, J. L. &Stryer, L. (2010). Biochemistry. W. H. Freeman publisher
2. Kuchel, P.W., Easterbrook-Smith, S., Gysbers, V., Guss, J.M., Hancock, D.P., Johnston, J.M., Jones, A. & Matthews, J.M. (2009). Schaum's Outline of Biochemistry, 3rd Edition. McGraw Hill LLC.
3. Lehninger, A., Nelson, D. L., Donald, V., Voet, J. G. & Pratt, C. W. (2008). Principles of Biochemistry. John Wiley and sons, Inc., New Jersey.
4. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. W.H. Freeman.
5. Sathyanarayana, U & Chakrapani, U. (2011). Biochemistry. Books and Allied private limited, Kolkata.

Websites/ e-Learning Resources

- https://onlinecourses.nptel.ac.in/noc20_cy10/preview
- www.biochemweb.org

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	1	2	2	1	1	1
CO2	3	3	2	2	1	2	2	1	1	1
CO3	3	3	2	2	1	2	2	1	-	1
CO4	3	3	2	2	1	2	2	1	1	1
CO5	3	3	2	2	1	2	2	1	1	1
Average	3	3	2	2	1	2	2	1	1	1

High correlation – 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4503	Molecular Genetics	Core	6	5

The paper imparts a thorough knowledge on the basics of Genetics concepts, molecules and its regulations. The student will get to understand the core concepts of molecules and genetics.

Course Outcomes:

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

CO1: acquire good knowledge about the molecular mechanisms of gene expression and understand the theories behind the organization and functions of genetic material in the living world.
CO2: identify and distinguish genetic regulatory mechanisms at different levels and explain the processes behind mutations and other genetic changes and study various chromosomal abnormalities.
CO3: make the students understand different range of DNA damage and tools for their detection.
CO4: learn the concepts of the transposons and their applications.
CO5: detects the Allele frequencies and genotype frequencies in populations and describe the concepts behind the theory of evolution.

Unit I: **18 Hours**

Genes and chromosomes - Genetic codes - Colinearity of Genes and Proteins, Identification of DNA as the genetic material - Complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes) - DNA markers: VNTR, STR and their detection techniques.

Unit II: **18 Hours**

Replication of DNA - Gene expression – inducible and suppressible – lac operon – trp operon – gene regulation in prokaryotes and eukaryotes. Mutation and its types (Spontaneous mutation, virus induced mutation and Radiation induced mutation - Ionizing radiation, UV radiation). Chromosomal Abnormalities and associated genetic diseases – recombination.

Unit III: **18 Hours**

DNA Damage and Repair-Internal and external agents causing DNA damages, Types of DNA damages (Oxidative damages, Depurinations, Depyrimidinations, O6-methylguanines, Cytosine deamination, single and double strand breaks),Mechanisms of DNA damage (transition, transversion, frameshift, nonsense mutations),Repair mechanisms (Photo reactivation, excision repair, mismatch repair, post replication repair, SOS repair) - Insertion sequences in prokaryotes – transposable elements.

Unit IV: **18 Hours**

Allele frequencies and genotype frequencies, Random mating population, Hardy-Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked) in

breeding, genetics and evolution, random genetic drift, Karyotyping and usefulness of chromosomes in understanding Genetic variation, Genetics of eukaryotes - gene linkage and chromosome mapping.

Unit V: **18 Hours**

Extrachromosomal heredity: Biology of Plasmids, their discovery, types and structure off plasmid, r plasmid, *col* factors, Ti plasmid- replication and partitioning, Incompatibility and copy number control-natural and artificial plasmid transfer and their applications.

Learning Resources:

Text Books

1. Alberts, B. (2017). Molecular Biology of the Cell. W.W. Norton publisher.
2. De Robertis, E.D.P., & De Robertis, E.M.F. (2017). Cell and Molecular biology. 8th Edition. Lippincott Williams & Wilkins
3. Karp, G., Iwasa, J., & Marshall, W. (2016). Karp's Cell and Molecular Biology: concepts and experiments. 8th Edition. John Wiley & Sons.

References

1. Ahluwalia, K.B. (2018). Genetics. New Age International Pvt Ltd.
2. Brooker, R. J. (2014). Genetics: analysis & principles. 4th Edition. McGraw Hill.
3. Goldberg, M.L., Hartwell, L.H., Fischer, J.A. & Hood, L.E. (2017). Genetics: From Genes to Genomes. McGraw-Hill Education
4. Rastogi, S. & Pathak, N. (2009). Genetic Engineering. Oxford University Press.
5. Verma, P. S., & Agarwal, V. K. (2009). Genetics, (Multicolour Edition). S. Chand Publishing.

Websites/ e-Learning Resources

- https://onlinecourses.nptel.ac.in/noc22_bt07/preview
- https://www.ncbi.nlm.nih.gov/books/NBK26887/
- https://www.ndsu.edu/pubweb/~mcclean/plsc431/mendel/mendel9.htm

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	3	2	1	2	-	1
CO2	3	3	3	2	3	3	2	3	2	1
CO3	3	3	2	3	3	3	2	2	-	1
CO4	3	3	2	2	3	3	1	1	-	1
CO5	3	3	3	3	3	3	2	3	3	1
Average	3	3	2.4	2.2	3	2.8	1.6	2.2	2.5	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4405	Molecular Cell Biology	Core	5	4

The paper imparts a thorough knowledge on the basics of all the Cell biology concepts, molecules and its regulation. The student will get to understand the core concepts of molecules and cell biology.

Course Outcomes:

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

CO1: explain the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.

CO2: identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism.

CO3: demonstrate knowledge and understanding of the principles and basic mechanisms of nuclear envelope and its functions.

CO4: underlining the metabolic pathways and the process of transmission of extracellular signals.

CO5: comprehend the basics of cancer, the process of carcinogenesis and importance of regulatory genes.

Unit I: **15 Hours**

Introduction to cell Biology- Basic properties of cells-Cellular dimension - Size of cells and their composition-Cell origin and Evolution (Endosymbiotic theory). Organelles of the eukaryotic cell and its functions; Biomembranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell-Cell adhesion - Cell junctions (Tight junctions, gap junctions, desmosomes, adherens); Extra cellular matrix (ECM)- components and role of ECM in growth.

Unit II: **15 Hours**

Structure of Nucleic acids - Synthesis, sorting and trafficking of proteins: site of synthesis of organelle and membrane proteins – transport of secretary and membrane proteins across ER – post-translational modification in RER – transport to mitochondria, nucleus, chloroplast and peroxisome - protein glycosylation – mechanism and regulation of vesicular transport – golgi and post-golgi sorting and processing – receptor mediated endocytosis; Synthesis of membrane lipids.

Unit III: **15 Hours**

Nucleus: Nuclear envelope – Nuclear pore complexes-nuclear matrix – organization of chromatin – supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome (Solenoid and Zigzag model)- Structure of chromosome – (Lamp brush and polytene chromosomes).

Unit IV: **15 Hours**

Molecular basis of eukaryotic cell cycle, Regulation and cell cycle check points; Programmed cell death (Apoptosis); Cell-Cell signalling - signalling molecules, types of signalling, signal transduction pathways (GPCR-cAMP, MAP Kinase).

Unit V: **15 Hours**

Cancer Biology: Multistage cancer development Mitogens, carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes - Rb, p53, Apoptosis and significance of apoptosis.

Learning Resources:

Text Books

1. Cooper, G. M., & Hausman, R. E. (2007). The cell: A Molecular Approach. 4th Edition. ASM Press
2. De Robertis.,& De Robertis Jr. (2020). Cell and Molecular Biology. 8th Edition, Wolters Kluwer, New Delhi.
3. Karp, G., Iwasa, J. & Marshall, W. (2016). Karp's Cell and Molecular Biology: Concepts and Experiments. 8th Edition. Wiley.

References

1. Alberts, B., Johnson, A., Lewis, J., Raff, M.C., Roberts, K. & Walter, P. (2007). Molecular biology of the cell. Garland Science, Taylor & Francis Group.
2. Cooper, G. M., & Hausman, R. E. (2004). The Cell: A Molecular Approach. 3rd Edition. ASM Press
3. Lodish, H. F., Berk, A., Kaiser, C. A., & Krieger, M. (2016). Molecular cell biology. W. H. Freeman and Company
4. Paul, A., (2001). Text book of cell and molecular biology, 2nd Edition, Niyogi Books.
5. Sadava, D. E. (2009). Cell biology: Organelle Structure and Function. CBS publishers and distributors, New Delhi.

Websites/ e-Learning Resources

- https://onlinecourses.nptel.ac.in/noc24_bt07/preview

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	1	2	1	1	1	1
CO2	3	3	2	2	1	1	2	1	1	1
CO3	3	3	2	2	2	1	2	1	1	2
CO4	3	3	3	1	1	1	1	1	1	1
CO5	3	3	2	1	1	1	1	3	1	1
Average	3	3	2.4	1.4	1.2	1.2	1.4	1.4	1	1.2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4407	Practical – I (A) Biochemistry (B) Molecular Cell Biology & Molecular Genetics	Core	6	4

The practical will establish a basic study skill on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: illustrate basic biochemistry procedures.

CO2: study the methods of estimation of biomolecules.

CO3: isolate & Analyse DNA, RNA & protein.

CO4: critically analyse the isolated biomolecules.

CO5: evaluate the quality and purity of DNA, RNA & Protein.

Experiments:

(A) Biochemistry – Practical

1. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v).
2. Calibration of pH meter and Preparation of biological buffer.
3. Extraction of Proteins from biological materials.
4. Protein separation methods: - Ammonium sulphate Precipitation.
5. Estimation of Proteins by Lowry's method/ Bradford method.
6. Estimation of lipid - Bligh and dyer method.
7. Estimation of Carbohydrate by Anthrone method.
8. Separation of amino acids by Paper Chromatography / Thin layer chromatography.
9. Separation of sugars by Paper Chromatography / Thin layer chromatography.
10. Column Chromatography.

(B) Molecular Cell Biology & Molecular Genetics

1. Isolation of DNA from bacteria.
2. Isolation of DNA from plants.
3. Isolation of DNA from blood.
4. Agarose gel electrophoresis of DNA.
5. Isolation of RNA.
6. Formaldehyde denatured Agarose gel electrophoresis of RNA.
7. Radiation induced genetic damage assessment.
8. Preparation of tissue culture medium and membrane filtration.
9. Preparation of single cell suspension from spleen and thymus.

10. Cell counting and cell viability.

Learning Resources:

Text Books

1. Jayaraman, J. (2011). Laboratory Manual of Biochemistry. 2nd Edition. New Age International Publishers.
2. Pattabiraman, T. N. (2015). Laboratory manual in biochemistry. 4th Edition. All India Publishers & Distributor.
3. Rajan, S., Christy, R. S. (2018). Experimental Procedures in Life Sciences. India: CBS Publishers & Distributors.

References

1. Sadasivam, S., & Manickam, A. (2018). Biochemical Methods. New Age International Publishers.
2. Jones, A. M., Weyers, J. D. B., Weyers, J., Reed, R. (2021). Practical Skills in Biology. Pearson.
3. Glick, B. R., Pasternak, J. J. (2003). Molecular biotechnology: principles and applications of recombinant DNA. ASM Press.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	2	1	2	1	2
CO2	3	3	3	3	2	2	1	2	1	2
CO3	3	3	3	3	2	2	1	2	1	2
CO4	3	3	3	3	2	2	1	2	1	2
CO5	3	3	3	3	2	2	1	2	1	2
Average	3	3	3	3	2	2	1	2	1	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4309	Bioinstrumentation	DSE	4	3

The paper imparts a thorough knowledge on the basics of all the instrumentation concepts, in biology. The student will get to understand the core concepts of biological instruments and their principles.

Course Outcomes:

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

CO1: explain the various types of microscopic techniques.

CO2: impart understanding on centrifugation instruments and techniques.

CO3: separation and quantification of biomolecules.

CO4: acquired the theoretical knowledge on electrophoresis analysis.

CO5: describe the application of radioactive molecules.

Unit I: **12 Hours**

Microscopic Techniques: Principles and applications of Light microscopy - Compound microscopy - Phase contrast microscopy - Fluorescent microscopy - Atomic force microscopy - Laser confocal microscopy– FRET – Scanning & Transmission electron microscopy.

Unit II: **12 Hours**

Centrifugation: Sedimentation coefficient - Svedberg unit - Relative centrifugal force - Principle and applications - Types of centrifuges - Preparative & Analytical centrifuges - Types of rotors - Centrifugation methods: Differential centrifugation - Density gradient centrifugation (Rate zonal & Isopycnic) and Ultra centrifugation - Flow cytometry.

Unit III: **12 Hours**

Chromatography Techniques: Principle and application of Paper chromatography - Thin layer chromatography - Column chromatography - Gel filtration chromatography - Ion exchange chromatography - Affinity chromatography - Gas chromatography and HPLC. Spectroscopic Techniques: Principle and application of UV-Vis spectroscopy - Fluorescence spectroscopy - Laser spectroscopy - Raman spectroscopy - X-ray spectroscopy - FT-IR - NMR – ESR – AAS - Mass spectroscopy.

Unit IV: **12 Hours**

Electrophoretic Techniques: Principle and application of agarose gel electrophoresis - SDS-PAGE - Native PAGE - 2D-gel electrophoresis - Iso-electric focusing, High resolution electrophoresis - Immuno electrophoresis – ELISA - RIA, Southern blotting – Northern blotting - Western blotting and Dot blotting – Polymerase Chain Reaction (PCR) - RT-PCR - Microarray.

Unit V: **12 Hours**

Radio-isotopic Techniques: Introduction to radioisotopes - Uses and their biological applications – Autoradiography - Radioactive decay – Types and measurement - Principles and applications of GM counter - Solid and liquid scintillation counter -Radiation dosimetry - Health effects of radiations.

Learning Resources:

Text Books

1. Chatwal, G. R. & Anand, S. K. (2014). Instrumental Methods of Chemical Analysis 5th Edition. Himalaya Publishing House.
2. Sharma, B. K. (2011). Instrumental Methods of Chemical Analysis. 1st Edition. Krishna Prakashan Media Publishers.
3. Veerakumari, L. (2009). Bioinstrumentation. MJP Publishers, Chennai, India.

References

1. Farrell, S. O., & Taylor, L. E. (2005). Experiments in biochemistry: A hands-on approach. Cengage Learning.
2. Holcapek, M., & Byrdwell, W. C. (Eds.). (2017). Handbook of advanced chromatography/mass spectrometry techniques. Elsevier.
3. Nelson, D. L., & Cox, M. M. (2008). Principles of Biochemistry, 5th Edition. W. H. Freeman, New York.
4. Veerakumari, L. (2019). Bioinstrumentation. MJP Publisher.
5. Wilson, K. & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press.

Websites/ e-Learning Resources

- https://www.excedr.com/resources/chromatography-techniques
- https://www.mrclab.com/ultracentrifuge-working-process-types-and-uses
- https://www.olympus-ims.com/en/knowledge/metrology/lextprinciples/basic/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	2	2	2	-	1	1
CO2	3	3	2	2	2	2	2	1	1	1
CO3	3	3	2	2	2	2	2	1	1	1
CO4	3	3	2	2	2	2	2	1	1	1
CO5	3	3	2	2	1	1	2	1	1	1
Average	3	3	2	1.8	1.8	1.8	2	1	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4311	Medical Lab Technology	DSE	4	3

The subject imparts with the knowledge and skills required to work in a medical laboratory setting. Programme aims to equip students to setup and manage specialized clinical laboratories and to deliver better health care system to the public and practice as specialized technologists in the concerned subject.

Course Outcomes:

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

CO1: gain knowledge on concept of health, quality of life and spectrum of disease.

CO2: demonstrate accurate quantitative analysis and help to solve biochemical problems.

CO3: learn the basic biological process essential for maintenance of homeostasis**.**

CO4: enhance understanding of biomedical waste management.

CO5: explain the chemistry of drugs with respect to their pharmacological activity.

Unit I: 12 Hours

Introduction to Health: Concept of health, Concept of well-being, the standard of living, quality of life, Hygiene, Dimensions of health, positive health, the spectrum of health, spectrum of disease, responsibility for health.

Unit II: 12 Hours

Clinical Biochemistry: Introduction and role of Medical Lab Technologist, Glassware & plastic wares used in the lab, calibration of volumetric apparatus. Sample collection techniques. General biochemical analysis and standards.

Unit III: 12 Hours

Anatomy: Blood, Muscle, Gastrointestinal Tract, Kidney, Endocrines, Reproduction, Cardiovascular System, Respiration, Central Nervous System. Diagnosis – Biochemical and Pathological analysis (Type 2 Diabetes Mellitus/ Autoimmune disorders).

Unit IV: 12 Hours

Bio medical waste management: Biomedical waste: Sources, Sample collection and storage – Management of Biomedical waste – Methods of Disposal for Biomedical waste.

Unit V: 12 Hours

Pharmacology: Concepts, source of drugs, routes of drug administration – advantage disadvantages of Drugs – Pharmacokinetics.

Learning Resources:

Text Books

1. Chatterjea, M. N., & Shinde, R. (2011). Textbook of Medical Biochemistry. JP Medical Ltd.
2. Godkar, P. B., &Godkar, D. P. (2014). Textbook of medical laboratory technology. Bhalani publishing house.
3. Ochei, J. O., & Kolhatkar, A. A. (2000). Medical laboratory science: theory and practice. McGraw Hill Education.

References

1. Satyanarayan, U. & Chakrapani, U. (2007). Biochemistry, 3rd Edition, Books & Allied Pvt Ltd. Kolkatta.
2. Varley, H. (1967). Practical clinical biochemistry. 4th Edition. Heinemann Medical.
3. Vasudevan, D. & Sreekumari, S. (2005). Textbook of Biochemistry. 4th Edition. Jaypee Publishers.
4. Wilson, K. & Walker J., (2000). Practical Biochemistry: Principles & Technique, 5th Edition. Cambridge University Press.

Websites/ e-Learning Resources

- https://www.betterhealth.vic.gov.au/health/ConditionsAndTreatments/infections-bacterialand-viral
- https://www.healthline.com/health/bacterial-vs-viral-infection
- https://www.webmd.com/a-to-z-guides/bacterial-and-viral-infections

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	1	1	1	2
CO2	3	3	2	1	2	1	1	2	1	2
CO3	3	3	2	1	-	1	1	2	1	2
CO4	3	3	2	1	1	1	1	1	1	2
CO5	3	3	2	1	1	1	1	2	1	2
Average	3	3	2	1.2	1.2	1.2	1	1.6	1	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4313	Introduction to Bioinformatics	GE	4	3

The paper imparts a thorough knowledge of the basics of bioinformatics tools. The student will get to understand the basic concepts of data processing and analysis relate with the various biological data banks and their usage.

Course Outcomes:

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

CO1: explain the basic concepts, history, scope and importance of Bioinformatics and biological data analysis.

CO2: perceive the details about the different types of biological databases in Bioinformatics.

CO3: introduction to the basics of sequence alignment and analysis.

CO4: acquire knowledge to interpret the characteristics of phylogenetic methods.

CO5: apply the scientific foundation of drug design and computational modelling to predict how molecules interact.

Unit I: **12 Hours**

Central dogma of biology - Introduction to Bioinformatics – Definition and History, Applications of computer in biological research – Introduction to genomic research, data generation and analysis – Human Genome Project – Importance of bioinformatic in various field.

Unit II: **12 Hours**

Information Resources: NCBI & SRS System - Nucleotide sequence databases: EMBL, NCBI GenBank - Protein amino acid sequence &structure databases: UniProt Knowledgebase (SwissProt/TrEMBL). CATH - Protein function and pathway database: ENZYME & KEGG - Visualization of molecular structures tool: RasMol – protein-protein interaction: STRING.

Unit III: **12 Hours**

Primer Designing, PCR, sequencing - Sequence alignment: global vs local alignments - Dot Plot scoring matrices: PAM- Dynamic programming: Needleman and Wunsch algorithm, Smith–Waterman algorithm - Nucleotide scoring matrices, gap & gap penalties – Similarity search engine: BLAST & FASTA - Multiple sequence alignment - CLUSTAL W - Protein structure alignment methods – DALI.

Unit IV: **12 Hours**

Phylogenetic analysis - Construction of phylogenetic tree - Distance based method: UPGMA, NJ, ME - Character based method: maximum parsimony, maximum likelihood – Evaluation of phylogenetic trees: skewness test-permutation test - Bootstrapping –PHYLIP.

Unit V: **12 Hours**

Medical application of Bioinformatics: Disease genes, Drug Discovery. Target Identification. Target Validation – QSAR - Preclinical pharmacology and toxicology – ADMET - Drug designing: Rational drug design, Computer aided drug design (Ligand based approach, Target based approach) - Molecular Docking.

Learning Resources:

Text Books

1. Attwood, T.K., Smith, P.D.J. & Phukan S, (2007). Introduction to Bioinformatics. 1st Edition. Pearson Education Pvt. Ltd.
2. Baxevanis, D. & Francis, B.F. (2004). Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins. 3rd Edition. John Wiley & Sons Inc.
3. Lesk, A. M. (2003). Introduction to Bioinformatics, Oxford University Press.

References

1. Mount, D. W. (2001). Bioinformatics: Sequence and genome analysis. Cold Spring Harbour Laboratory Press, New York.
2. Baldi, P., & Brunak, S. (2001). Bioinformatics: the machine learning approach. MIT press.
3. Orpita, B., & Thukral, S.K. (2007). Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
4. Rastogi, S.C., Mendiratta, N., & Rastogi, P. (2004). Bioinformatics methods and applications, Prentice-Hall of India private limited, New Delhi.
5. Misener, S. & Krawetz, S. A. (2000). Bioinformatics methods and protocols, Humana press Inc, New Jersey.

Websites/ e-Learning Resources

- www.ncbi.nlm.nih.gov/
- www.Bioinformatics.org
- https://blast.ncbi.nlm.nih.gov/Blast.cg

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	2	1	1	2
CO2	3	3	2	1	3	2	2	1	1	2
CO3	3	3	3	1	3	2	2	1	1	1
CO4	3	3	3	2	3	2	2	1	1	1
CO5	3	3	3	2	3	2	2	1	1	1
Total	15	15	13	8	14	10	10	5	5	7
Average	3	3	2.6	1.6	2.8	2	2	1	1	1.4

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4315	Herbal Technology	GE	4	3

The subject imparts knowledge on the fundamentals of herbal technology. The student will gain a basic knowledge and understanding about the identification, cultivation, application and conservation of herbal plants.

Course Outcomes:

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

CO1: provide the basic knowledge about systems of medicine.

CO2: explain the basics about herbal remedies.

CO3: discuss about the methods of cultivation and harvesting.

CO4: acquire the basics about herbal medicine and its formulations.

CO5: assess and appraise the conservation strategies.

Unit I: **12 Hours**

Systems of medicines **–** Indian system of medicine (AYUSH) – Concepts and significance of Siddha – Unani - Ayurveda – Homeopathy. Historical perspectives of herbal medicine – Indigenous knowledge - Traditional herbal medicine – World, Indian - Concepts of herbs and herbal medicine.

Unit II: **12 Hours**

Herbal plants in traditional remedies– Need and significance of herbal plants – Identification and health benefits of Common herbal plants *Allium sativum* (Garlic) - *Piper methysticum* (pepper) - *Mentha piperita* (Peppermint) - *Curcuma longa* L (Turmeric) - *Withaniasomnifer* **(**Ashwagandha) - *Zingiber officinale* **(***Ginger)* - *Silybum marianum* (Milk thistle) - *Jasminum officinale* (Jasmine). Medicinally used plant parts: Roots, Stem, Barks, Leaves, Flowers, Fruits & Seeds.

Unit III: **12 Hours**

Cultivation, harvesting and processing of herbal plants - Common cultivation methods for local & rare herbal Medicinal Plants – Mass production of crude drugs – Standard operating procedures for cultivation, environmental condition for ideal cultivation of plants – Harvest of medicinal plant parts – Storage & preservation.

Unit IV: **12 Hours**

Preparation, formulation and marketing of herbal plants: Ayurvedic preparation of herbal plants - Raw materials of herbal origin - Herbal product development - Methods involved in monohedral and polyherbal formulations with their merits and demerits - Quality control of finished herbal plant products – Indian and global marketing management.

Unit V: **12 Hours**

Conservation of herbal plants – Need and significance of conservation of herbal plants. Methods of Conservation practice: In-situ practices: Medicinal Plants conservation Areas and Ex-situ practices: Field Gene Bank - Botanic Gardens - Cryopreservation - Micropropagation. Centres of medicinal plant conservation in India.

Learning Resources:

Text books

1. Bhattacharjee, S.K. (2004). Handbook of Medicinal Plants. 4th Edition. Pointer
2. Kameswara Rao, C. (2000). Database of medicinal plants. KSCST, Bangalore. Publishers and Distributors, Jaipur.
3. Trivedi, P.C. (2004). Medicinal Plants: Utilization and Conservation. Aavishkar

Reference books

1. Faroogi, A. A., & Sreeramu, B. S. (2004). Cultivation of Medicinal and Aromatic Crops. University Press (India) Pvt. Ltd., Hyderabad.
2. Sinha, R. K. & Sinha, S. (2001). Ethnobiology, Surabhi Publications. Jaipur.
3. Stace, C.A. (1985). Plant Taxonomy and Biosystematics, Edward Arnold, London.
4. Cutler, S.J. & Cutler, S.H.G. (2000). Biologically active natural Products – Pharmaceuticals. CRC Press, USA.
5. Hartmann, H.T., Kester, D.E., Davies, F.T. & Geneva, R.L. (2004). Plant Propagation: Principle and Practice. Prentice-Hall of India, New Delhi.

Websites/ e-Learning Resources

- https://www.researchgate.net/publication/344349369_Text_book_of_Herbal_Drug_Technology
- https://www.scribd.com/document/689951082/Herbal-Drug-Technology-PV-Publication
- https://dattanibookagency.in/products/herbal-drug-technology-second-edition-by-s-s-agrawal

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	1	1	2	1	1	1
CO2	3	3	2	2	1	2	2	1	1	1
CO3	3	3	2	2	1	2	2	1	1	1
CO4	3	3	2	2	1	2	2	2	1	1
CO5	3	3	2	2	1	2	2	2	1	1
Average	3	3	2	2	1	1.8	2	1.4	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4302	Microbiology	Core	4	3

To provide a comprehensive knowledge on taxonomy and microbial diversity, growth, their harmful effects and beneficial role of microorganisms in agriculture and environment.

Course Outcomes:

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

CO1: state the major discoveries of microbiology and describe microbial diversity, microbial growth and metabolism.

CO2: provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques.

CO3: enlighten the students on host microbe interaction and epidemiology of microbial disease.

CO4: update the knowledge on epidemic and pandemic diseases.

CO5: assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.

Unit I: **12 Hours**

History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek and Edward Jenner. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial diversity: Biovars, Serovars and Prions, Microbial metabolism- Methanogenesis, acetogenesis and auxotrophs - Secondary metabolites.

Unit II: **12 Hours**

Microbial culture, identification, preservation and control: Nutritional requirements for growth - Identification of bacteria – Biochemical – IMViC, 16s rRNA sequencing - Microscopy: principles and applications – Methods of storage and preservation - Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods.

Unit III: **12 Hours**

Host microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases.

Unit IV: **12 Hours**

Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Cholera, COVID-19, Influenza, Ebola, Malaria, Filariasis, Candidiasis, Superficial mycosis.

Unit V: **12 Hours**

Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, Biofertilizers - types and applications; Rhizosphere effect. Biogeochemical cycles - Carbon, Nitrogen, Sulphur and Phosphorous; Extremophiles - Thermophiles, Acidophiles, Halophiles and alkaliphiles; Biotechnological application of extremophiles.

Learning Resources:

Text Books

1. Ananthanarayan and Paniker's (2017). Textbook of Microbiology. 10th Edition. The Orient Blackswan.
2. Maheshwari, D. K, &Dubey, R. C. (2013). A Textbook of Microbiology.4th Edition. S Chand Publishing India.
3. Willey, J., Sherwood, L., & Woolverton, C. J. (2017). Prescott's Microbiology. 10th Edition. McGraw-Hill Education.

References

1. Benson, H. J. (1999). Microbiological Applications: A Laboratory manual in General Microbiolog.7th Edition. McGraw Hill.
2. Gillespie, S., &Bamford, K. (2012). Medical Microbiology and Infection at a Glance. 4th Edition. John Wiley &Son.
3. Managing epidemics- Key facts about major deadly diseases, World Health Organization (WHO) 2018.
4. O'Flaherty, V. I. N. C. E. N. T., Collins, G., & Mahony, T. (2010). Environmental microbiology, 259-279.
5. O'Flaherty, V., Collins, G.,& Mahony, T. (2010). Environmental Microbiology, 2nd Edition. Wiley.

Websites/ e-Learning Resources

- https://doi.org/10.3389/fmicb.2020.631736
- https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf
- https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf ISBN 978-92-4-156553-0.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	3	2	1	1	1	1
CO2	3	3	2	3	3	3	2	2	1	2
CO3	3	3	3	3	3	3	2	2	3	1
CO4	3	3	3	3	3	2	2	2	3	1
CO5	3	3	2	3	3	3	3	3	2	1
Average	3	3	2.4	2.8	3	2.6	2	2	2	1.2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4404	Immunology	Core	5	4

The paper imparts a thorough knowledge on the basics of immunology. The student will get to understand the core concepts of immune systems and their non-specific and specific mechanisms, vaccine, etc.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: illustrate various mechanisms that regulate immune responses and maintain tolerance.

CO2: describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses.

CO3: learn the concepts of cellular and molecular processes that represents the human immune system.

CO4: elucidate the role of immunological regulation and tolerance at a cellular and molecular level.

CO5: compile concepts on immunological principles and diagnosis.

Unit I: **15 Hours**

History and overview of the immune system - Types of immunity: Innate – Acquired - Passive and active - Self vs non-self-discrimination - Physiology of immune response: HI and CMI specificity and memory - Cells and organs of the immune system - Lymphoid tissue - Origin and development - Hematopoiesis and differentiation of lymphocytes.

Unit II: **15 Hours**

Lymphocyte-sub-populations of mouse and man - APC cells, lymphokines - Phagocytic cells – Macrophage - Dendritic cells - K and NK Cells - Nature and biology of antigens – Epitopes – Haptens - Adjuvents. Immunoglobulins: Structure - Distribution and function - Immunoglobulin super family Isotypic - Allotypic - Idiotypic variants - Generation of antibody diversity.

Unit III: **15 Hours**

Monoclonal antibody production and its applications - Types of vaccine and vaccination schedule - Role of MHC antigens in immune responses - Structure and function of class I and class II MHC molecules - MHC antigens in transplantation - HLA tissue typing - Transplantation immunology - Immunological basis of graft rejection - Clinical transplantation - Immunosuppressive therapy - Tumour immunology - Tumour antigen - Immune response to tumours.

Unit IV: **15 Hours**

Effector mechanisms in immunity - Macrophage activation -Cell mediated cytotoxicity - Cytotoxicity assay - Hypersensitivity reactions and types - The complement system - Mode of activation - Classical and alternate pathway - Biological functions of C proteins.

Unit V: **15 Hours**

Immunotechniques - Principle and Applications - Immunodiffusion - Immuno fluorescence – *In situ* localization technique - FISH - GISH - RIA – ELISA – FACS - Western blotting, ELISPOT assay - Agglutination tests - VDRL test – Purification of antibodies - Quantitation of immunoglobulin by RID, EID and nephelometry - CMI techniques - Immunotherapy.

Learning Resources:

Text Books

1. Kannan, I. (2010). Immunology. MJP Publishers, Chennai.
2. lanTizard, (1995). Immunology: An Introduction, Thomson Learning.
3. Roitt. S. (2011). Essential Immunology, 12th Edition, Wiley-Blackwell. USA.

References

1. Abbas, A. K., Lichtman, A.H.L. & Pillai, S. (2010). Cellular and Molecular Immunology. 6th Edition. Saunders Elsevier Publications, Philadelphia.
2. Bashir, S. G. (2009). Text Book of Immunology, PHI Learning Pvt. Ltd. New Delhi.
3. Hay F.C., & Westwood O.M.R. (2002). Practical Immunology, 4th Edition, Blackwell Publishing, London.
4. Kindt, T.J., Osborne, B. A., & Goldsby, R. A. (2006). Kuby Immunology, 6th Edition, W. H. Freeman & Company.
5. Shetty, N. (1996). Immunology: introductory textbook - I. New Age International, New Delhi.

Websites/ e-Learning Resources

- http://www.wiley.com/college/bio/karp12791/weblinks.html
- https://www.efis.org/public-outreach/immunology-learning-tools/immunology-learning.html
- https://www.ibiology.org/educators-resources/flipped-courses/immunology-flipped-course/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	2	2	2	1	1	1
CO2	3	3	3	2	2	2	2	1	1	1
CO3	3	3	3	2	2	2	2	1	1	1
CO4	3	3	1	2	2	2	2	1	1	1
CO5	3	3	1	1	2	2	2	1	1	1
Average	3	3	2.2	1.8	2	2	2	1	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4406	Genetic Engineering	Core	5	4

The paper imparts a thorough knowledge on the basics of all the versatile tools and techniques employed in genetic engineering and recombinant DNA technology. The student will get to understand the core concepts of biotechnology.

Course Outcomes:

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

CO1: underlining the basic steps of gene cloning and the role of enzymes responsible for gene manipulation, transformation and genetic engineering.

CO2: getting detailed information of cloning vectors and identifying suitable hosts for cloning.

CO3: acquiring theoretical acquaintance about basics of cloning strategies, gene transfer methods and genome mapping.

CO4: describes the PCR techniques and sequencing methods for gene therapy.

CO5: elucidate different techniques involved in genetic engineering.

Unit I: **15 Hours**

Impact of genetic engineering - Gene cloning - Genetic engineering tools: Nucleic acid manipulating enzymes, Promoters, Selectable markers and reporters used in rDNA technology, Restriction digestion, Ligation, Transformation - Screening and selection of Recombinants - Construction of gene libraries.

Unit II: **15 Hours**

E. Coli vectors: pBR322 and its derivatives - Cloning vectors for gram negative bacteria: ColE1, pSC101, Lambda bacteriophage vectors, filamentous phages (M13 phage) – Cosmids - Phasmids/ Phagemids - BAC, PAC vectors YAC vectors, MAC vectors - Expression and shuttle vector - Cloning in gram-positive bacteria (*Bacillus subtilis*) - Cloning in yeast *Saccharomyces cerevisae*: Life cycle and types of vectors.

Unit III: **15 Hours**

Eukaryotic vectors - Plant and animal viruses as vectors – SV40 (molecular genetics and expression) - Specialized cloning vector for cDNA - Synthesis of specific RNA in vitro - Vectors for cloning promoters and terminators - Vectors with adjustable copy number - Gene transfer methods: *Agrobacterium* mediated transformation, Electroporation and Electrofusion – Genome mapping.

Unit IV: **15 Hours**

Nucleic acid hybridization techniques - Molecular probes (Types of probes and its construction) -Probe labelling: Nick translation, End labelling and Random primer labelling - Polymerase chain reaction, types and its applications – PCR based Cloning - DNA fingerprinting - DNA sequencing methods: First generation sequencing methods (Maxam and Gilbert sequencing, Sangers Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing) and Second-generation sequencing methods.

Unit V: **15 Hours**

Gene downregulation using antisense RNA, dsRNA and cosuppression – Gene editing: TALENS, Zinc finger nuclease and CRISPR-Cas9 technology - Site directed mutagenesis (PCR based methods) - Transgenic animals (knockout mice) and plants (Flavrsavr tomato) - Recombinant pharmaceutical products (insulin and somatostatin) - Crop improvement: Pesticide resistance, herbicide resistance - DNase foot printing - Gene therapy (*in vitro* and *in vivo* methods).

Learning Resources:

Text Books

1. Brown, T. A. (2020). *Gene cloning and DNA analysis: an introduction*. John Wiley & Sons.
2. Nicholl, D. S. (2023). *An introduction to genetic engineering*. Cambridge University Press.
3. Primrose, S. B., & Twyman, R. (2006). Principles of gene manipulation and genomics. John Wiley & Sons.

References

1. Goeddel, D.V. (2002). Gene Expression Technology- Methods in enzymology. Academic Press.
2. Krebs, J. E., Lewin, B., Goldstein, E. S., & Kilpatrick, S. T. (2013). *Lewin's essential genes*. Jones & Bartlett Publishers.
3. Rodriguez, R.L. and Denhardt, D.T. (2003). Vectors: A Survey of Molecular Cloning Vectors and Their Uses. Butterworths.
4. Winnacker, E. L. (1987). From genes to clones: introduction to gene technology. VCH Publisher.
5. Wu, W., Zhang, H.H., Welsh, M.J. & Kaufman, P.B. (2003). Gene Biotechnology. CRC Press.

Websites/ e-Learning Resources

- https://archive.nptel.ac.in/courses/102/103/102103013/
- https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Bruslind)/18%3AGeneticEngineering
- https://www.britannica.com/recombinant-DNA-technology

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	1	1	1	1
CO2	3	3	3	2	2	2	1	1	1	2
CO3	3	3	3	2	2	2	1	1	1	2
CO4	3	3	2	2	2	2	2	2	1	2
CO5	3	3	3	2	2	2	2	2	2	2
Average	3	3	2.6	2	2	2	1.4	1.4	1.2	1.8

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4608	Practical – II (A) Microbiology (B) Immunology (C) Genetic Engineering	Core	8	6

The practical will establish a basic study skill on the subject and will improve the student's ability to have a hands-on experience on the above core subjects.

Course Outcomes:

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

CO1: isolate and identify microbes from various sources.

CO2: characterize microbes.

CO3: isolate, identify & enumerate immune cells.

CO4: demonstrate the technique of immunodiagnostics.

CO5: assess extracted DNA, RNA and protein for rDNA technology.

(A) Microbiology-Practical

1. Sterilization techniques and preparation of agar slants.
2. Isolation of endophytic fungi from plants.
3. Isolation of pure culture of *E. coli*.
4. Isolation of pure culture of *Aspergillus niger*.
5. Negative staining of bacteria.
6. Isolation of bacterial pigments.
7. Characterization of bacterial pigments.
8. Microbial antibiosis (giant colony technique).
9. Screening for biofilm producing bacteria from water.
10. Screening for extracellular enzymes producing bacteria – Amylase and Caseinase.

(B) Immunology - Practical:

1. Identification of various immune cells from human peripheral blood.
2. Lymphocyte separation and identification.
3. Determination of lymphocyte viability by trypan blue method.
4. Immunodiagnostics: Widal.
5. Immunodiagnostics: Blood grouping and typing.
6. ELISA.
7. Radial Immunodiffusion.
8. Ouchterlony Immunodiffusion.
9. Immunoelectrophoresis.
10. Rocket electrophoresis.

(C) Genetic Engineering – Practical

1. Preparation of plasmid DNA by alkaline lysis method.
2. Agarose gel electrophoresis.
3. Determination of molecular weight of DNA.
4. Restriction enzyme digestion.
5. Competent cell preparation.
6. Transformation and selection of recombinants.
7. Insertional inactivation/ Blue White screening.
8. Amplification of DNA – PCR.
9. RFLP.
10. SDS PAGE (Demo)

Learning Resources:

Reference Books

1. Cappuccino, J.H. & Sherman, N. (2014). Microbiology – A Lab Manual. 10th Edition. The Benjamin Publishing Company, Singapore.
2. Green,M. R.(2012). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbor Laboratory Press
3. Rajan, S., & Selvi Christy, R. (2015). Experimental Procedures in Life Sciences. CBS Publishers & Distributors Pvt Ltd.

References

1. Gunasekaran, P. (2007). Laboratory manual in microbiology. New Age International.
2. Brown. T. A. (2016). Gene Cloning & DNA Analysis, 7th Edition, Wiley-Blackwell.
3. Jones, A. M., Weyers, J. D. B., Weyers, J., Reed, R. (2021). Practical Skills in Biology. Pearson.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	2	2	1	3
CO2	3	3	3	3	3	2	2	2	1	3
CO3	3	3	3	3	3	2	2	2	1	3
CO4	3	3	3	2	3	2	2	2	1	3
CO5	3	3	3	3	3	2	2	2	1	3
Average	3	3	3	2.8	3	2	2	2	1	3

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4310	Environmental Biotechnology	DSE	4	3

The subject imparts knowledge on the fundamentals of ecology and pollution. The student will be provided with a basic knowledge and understanding about the functions of ecosystem and reduction of pollution by biotechnological tools.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: learn the basic concept of ecosystem.

CO2: classify potential methods of biodegrading organic pollutants in water.

CO3: illustrate the basic concept of waste management plan.

CO4: learn the mode of entry of toxic substance.

CO5: compile biotechnological approaches to degrade xenobiotic compounds.

Unit I: **12 Hours**

Environment: Basic concepts - Biotic and abiotic factors - Environmental management and Conservation - Environmental laws and agencies involved in conservation. Environmental pollution: Types of pollution and its control strategies - Air pollution - Soil pollution - Water pollution - Oil pollution - Heavy metal pollution and Radioactive pollution. Environmental issues - ozone depletion and greenhouse effect.

Unit II: **12 Hours**

Biofilms in waste water treatment - Biofilm Kinetics: Aerobic biofilms - Completely mixed biofilm reactor - Soluble microbial products and inert biomass - Special-case biofilm solution. Bioreactors for waste water treatment - Reactor types: Batch reactor - Continuous reactor - Flow stirred reactor - Tank reactor - Plug-flow reactor - Engineering design of reactors - Reactors in series.

Unit III: **12 Hours**

Waste water management: Source of waste water - Waste water treatment: Physical - Chemical and Biological treatment. Microbiology of waste water - Aerobic and anaerobic process - BOD and COD.

Solid waste management: Composting - Industrial waste - Municipal solid waste - Biomedical waste - Treatment methods of solid waste materials - Biogas production.

Unit IV: **12 Hours**

Environmental toxicology: Environmental toxicants – Toxic agents - Sources – Toxicant uptake – Bio transformation and elimination – Toxicological risk assessment – Human toxicology and medicinal ethics - Test for evaluating

toxicity - Biomagnification - Biomining - Biofuels – Biosensors - Biomonitoring of toxic materials.

Unit V: **12 Hours**

Bioremediation: *In-situ and Ex-situ* Bioremediation of contaminated soils and waste land -Microbiology of degradation of Xenobiotics in environment – Pesticides – Surfactants - Degradative plasmids - Phytoremediation - Genetically Engineered Microorganisms (GEMs) in environment - Role of superbug in oil - Petroleum degradation in soil and water - Green audit - carbon credit.

Learning Resources:

Text Books

1. Dubey, R. C. (2010). A textbook of Biotechnology, S. Chand and Company Ltd, New Delhi.
2. Jordening, H.J., &Winter, J. (2005). Environmental Biotechnology. Wiley-VCH Verlag & Co.
3. Wang, L.K. (2010). Environmental Biotechnology, 1st Edition, A Product of Humana Press.

References

1. Agarwal, S.K. (2002). Environmental Biotechnology. APH Publishing Corporation.
2. Evans, G. M., Evans, G. G. & Furlong, J. (2011). Environmental biotechnology: theory and application. John Wiley & Sons, Ltd.
3. Manahan, S. E. (2009). Environmental Chemistry. 9th Edition, CRC Press.
4. Moo-Young, M., Anderson, W.A., & Chakrabarty, A. M. (2010). Environmental Biotechnology: Principles and Applications. Springer.
5. Rittmann, B. E. & McCarty, P. L. (2001). Environmental Biotechnology: Principles and applications. McGraw Hill, Newyork.

Websites/ e-Learning Resources

- http://lbe.epfl.ch
- https://delhigreens.com/2020/08/20/5-uses-of-biotechnology-in-environmental-protection/
- https://www.britannica.com/science/environmental-toxicology

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	2	2	2	1	1	1
CO2	3	3	2	1	2	2	2	2	1	1
CO3	3	3	2	2	2	2	2	2	1	1
CO4	3	3	2	2	2	2	1	1	1	1
CO5	3	3	2	1	2	2	1	2	1	1
Average	3	3	1.8	1.4	2	2	1.6	1.6	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4312	Agricultural Biotechnology	DSE	4	3

To provide a comprehensive knowledge on taxonomy and microbial diversity, growth, their harmful effects and beneficial role of microorganisms in agriculture and environment

Course Outcomes:

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

CO1: state the basics of Agriculture and its history.

CO2: clarify the role of soil microorganisms in agriculture.

CO3: identify diseases & pests that affects the plants and solutions.

CO4: explain about the genetically modified crops and crop improvement.

CO5: gain knowledge on post harvesting technology and marketing.

Unit I: **12 Hours**

History of Agriculture - Crop production – food scarcity – green revolution - loss of soil fertility – drought and flood – demand – crop varieties – global warming – climate – smart agriculture - Biotechnology in Agriculture.

Unit II: **12 Hours**

Soil parameters - Soil health and nutrition – plant nutrition requirements - soil microbes – nitrogen fixation - plant growth regulation and promotion - Biofertilizers: Azolla, Rhizobium, Azotobacter, Azospirillum, Mycorrhiza - cellulose based nanofibres – Irrigation methods.

Unit III: **12 Hours**

Stress management –Disease and Pest management in crops – fungal, bacterial and viral diseases – common pests –fungicide, pesticide and insecticide - PGPR – bio control agents. Modern Agriculture – Hydroponics, Aquaponics, Aeroponics – Organic and Natural Farming.

Unit IV: **12 Hours**

Genetically modified crops for crop improvement, herbicide resistance, insect resistance, virus resistance, quality modifications – Starch, Oil and Protein. Plants as bioreactors. Current status of transgenics, Biosafety norms and controlled field trails and release of transgenics. Advantages and applications of transgenic plants.

Unit V: **12 Hours**

Post Harvest technology, Post harvest losses in different farm produce, Cleaning, grading and drying of farm produce, Farm storage structures and storage of farm produce, Principles of processing of farm produce, Value addition. Quality control and packaging.

Learning Resources:

Text Books

1. Joshi, R. (2006). Agricultural Biotechnology, Isha Books, Delhi.
2. Kumar, H. D. (2005). Agricultural Biotechnology, Daya Publishing house.
3. Nag, A. (2008). Text book of Agricultural Biotechnology, PHI Learning Private Limited, New Delhi.

References

1. Chakraborty. U, & Chakraborty, B. (2005). Stress biology, Narosa Publishing House.
2. Gupta, P. K. (2010). Plant Biotechnology, Rastogi Publication, Meerut, India.
3. Jaiwal, P. K & Singh, R. P. (eds). (2006). Plant Genetic Engineering. Studium Press, USA.
4. Murphy, D. (2007). Plant Breeding and Biotechnology: Societal Context and the Future of Ariculture, Cambridge University Press.
5. Slater, A., Scott, N., & Fowler, M. (2003). Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press.

Websites/ e-Learning Resources

- https://archive.nptel.ac.in/LocalChapter/statistics/937/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	3	1	1	1	1	1	1	3	1
CO2	2	3	1	1	2	2	1	1	3	1
CO3	3	3	2	1	2	2	2	2	2	1
CO4	3	3	2	2	3	3	2	2	1	1
CO5	3	3	2	2	1	3	1	1	3	1
Average	2.6	3	2	1.8	1.8	2.8	2.3	1.4	2.4	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4314	Bioentrepreneurship	GE	4	3

This course is framed to provide thorough knowledge about concepts in entrepreneurship, entrepreneurship opportunities in biotechnology sector, commercialization process and strategies of various kinds of bioproducts

Course Outcomes:

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

CO1: know about entrepreneurship, types of Entrepreneurs and Entrepreneurship in the context of Biotechnology.

CO2: provide information about Bioentrepreneur, Types of Enterprises and Commercialization Process and Strategic management of biotechnological products.

CO3: bring out complete skill about different entrepreneurship ideas and to achieve sustainable development.

CO4: give industrial skill about mushroom culture.

CO5: deliver technical knowledge on single cell protein production.

Unit I: **12 Hours**

Entrepreneurship – Enterprise - Startups - Competencies of an Entrepreneur - Types of Entrepreneurs - Advantages and Disadvantages of Entrepreneurship - Characteristics of Biotechnology Industry - Entrepreneurship in the context of Biotechnology - comparison between the biotechnology and IT industries – Funding agencies for bio entrepreneurs.

Unit II: **12 Hours**

Technopreneurs - Profiling the Bioentrepreneur - Types of Enterprises - Private sector enterprises - Public sector enterprises - Joint sector - Commercialization Process & Strategy - Management of Intellectual Property Rights – Patents – Trademarks – Copyrights - Geographical Indications - Trade Secrets.

Unit III: **12 Hours**

Introduction and commercial practicing of Composting, Apiculture, Sericulture, Floriculture, Horticulture, Silviculture, Aquaculture and their contribution to sustainability.

Unit IV: **12 Hours**

Introduction to mushrooms: Non-edible mushrooms - Mushroom poisoning. Edible mushrooms – Oyster, button, milky mushrooms. Nutritional value. Medicinally important mushrooms. Mushroom cultivation techniques – spawn preparation, bed preparation, growth and harvest. Value addition. Product formation and marketing.

Unit V: **12 Hours**

Single Cell Protein Production - Source: Yeast, Spirulina. Applications – marketing. Sea weeds – medicinal and nutritional importance. Commercial value of Azolla and Azospirillum.

Learning Resources:

Text Books

1. Kumaresan. V., (2015). Biotechnology. Saras Publication.
2. Patzelt, H., & Brenner, T., (2008). Handbook of Bioentrepreneurship. 1st Edition. Springer-Verlag, New York.

References

1. Agarwal, S., Kumari, S., & Khan, S. (2021). Bioentrepreneurship and Transferring Technology into Product Development. IGI Global.
2. Satyanarayana, U. & Chakrapani, U. (2019). Biotechnology, 12thEdition, Books & Allied (P) Ltd.

Websites/ e-Learning Resources

- https://www.biotech.co.in/sites/default/files/2020-01/Bioentrepreneurship-Development.pdf
- https://www.researchgate.net/publication/352413541_Introduction_to_Bioentrepreneurship

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	1	3	3	1	1	1
CO2	3	3	2	1	1	3	3	2	2	2
CO3	3	3	2	2	1	3	3	1	2	3
CO4	3	3	1	1	1	3	3	1	2	2
CO5	3	3	1	1	2	3	3	1	2	1
Average	3	3	1.4	1.2	1.2	3	3	1.2	1.8	1.8

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT4316	Food and Nutrition	GE	4	3

The paper imparts a systematic knowledge of basic and applied aspects in food processing & to enable the student to understand food composition and its physiochemical, nutritional and sensory aspects. To gain in depth knowledge about processing and preservation techniques of different food products.

Course Outcomes:

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

CO1: remember and understand the basic concepts/Principles of Food Processing.

CO2: analyse the various concepts on food composition and its physicochemical, nutritional and sensory aspects.

CO3: apply the knowledge in understanding the practical problems in food processing.

CO4: execute/create the project or field assignment as per the knowledge gained.

CO5: understanding of emerging areas of nutrition**.**

Unit I: 12 Hours

Cereal and cereal products technology: Cereals - Wheat, rice, maize, barely, oat, rye-Structure, cultivation, harvesting, properties, composition and commercial value. Milling process Complete milling process, milled products and their nutritive value and applications - scoring of quality parameters.

Unit II: 12 Hours

Meat, fish, egg and its products technology: Meat - Composition, variety, handling, grading, ageing, curing, smoking and tenderizing of meat, meat pigments and colour changes, cooking, storage, methods of preservation for value addition and spoilage. Eggs-Composition, quality factors, storage, bacterial infection and pasteurization, freezing, drying and egg substitutes. Fish - Composition, onboard handling & preservation, drying and dehydration, salt curing, smoking, marinades, fermented products, canning, Modified Atmosphere Packaging and quality factors.

Unit III: 12 Hours

Milk and milk products technology: Milk - composition, factors affecting milk quality, physical and chemical properties. Milk processing: Separation, centrifugal process, natural creaming, pasteurization, sterilization, homogenization, effect of processing on nutritive value. Milk products: Khoa, Chinna, butter, butter oil, margarine, cheese, ice cream - Commercial processing, BIS Standards, packaging and distribution.

Unit IV: **12 Hours**

Fruits and vegetable technology: Principles of fruits and vegetables preservation, Processing Technologies - Freezing, dehydration/ during, canning, preserves: jam, jelly, marmalade, pickle, sauce, squash, chutney.

Unit V: **12 Hours**

Advances in nutrition: Effect of processing, preservation and storage on nutritional quality of foods, nutrient interactions, food fortification, nutritional labelling, nutraceuticals, functional foods and introduction to nutrigenomics.

Learning Resources:

Text Books

1. Gibney, M.J., et al., (2009). Introduction to Human Nutrition. 2nd Edition. Blackwell.
2. Mann, J. & Truswell, S. (2007), Essentials of Human Nutrition. 3rd Edition. Oxford University Press.
3. Salikhe, D. K., & Kadam, S. S. (1995), Handbook of fruit science and technology. CRC Press.

References

1. Kent, N. L. (1993). Technology of Cereals. 4th Edition. Pergamon Press.
2. Olson, V. M., Shemwell, G. A., & Pasch, S. (1998). Egg and Poultry Meat Processing, VCH Publisher, NewYork.
3. Siddapa, G. S. (1986). Preservation of Fruits and Vegetables, ICAR Publication.
4. Van Loesecke, H.W. (1998). Production Composition, Storage and processing. Marcel Decker inc, NewYork.
5. Winton & Winton (1991). Techniques of Food Analysis. Allied Scientific Publishers.

Websites/ e-Learning Resources

- http://www.fao.org/3/V5030E/V5030E00.htm
- https://fmtmagazine.in/fruits-vegetables-processing-technologies
- https://www.nutsforlife.com.au/resource/nuts-and-processing/

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	2	2	3	1	3
CO2	3	2	2	1	1	2	3	2	2	2
CO3	3	1	2	1	1	2	2	2	2	1
CO4	3	3	2	2	2	2	2	2	1	2
CO5	3	2	2	3	2	3	1	1	1	2
Average	3	2	2	2.3	1.4	2.2	2	2	1.4	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5301	Bioinformatics and System Biology	Core	4	3

This subject imparts a thorough knowledge of the basics of bioinformatics tools also it aims to bridge the gap between computational tools and biological knowledge allowing to apply mathematical and computation concept to synthetic biology**.**

Course Outcomes:

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

CO1: introduced to the basic concepts of Bioinformatics and its significance in biological data analysis.

CO2: describe the basics of sequence alignment and analysis.

CO3: explain about the methods to characterize and manage the different types of biological data.

CO4: introduction to the basic concepts of systems biology software project.

CO5: equipped with the necessary mathematical instruments and methods to address biological issues.

Unit I: 12 Hours

Introduction to bioinformatics - Protein and nucleotide databases - Information retrieval from biological databases - Sequence alignment and database searching: similarity searches using BLAST and FASTA: Introduction to biological neural network, motivation for artificial neural network (ANN) - Big data analysis: DNA/RNA/protein sequence or structure data, gene expression data, protein-protein interaction (PPI).

Unit II: 12 Hours

Sequence alignment basics, Dot-matrix alignment, pairwise alignment. Global and local alignment algorithms, multiple sequence alignment - progressive alignment algorithms, consensus sequence, patterns and profiles, Database searching: Pairwise alignment based rigorous algorithm (Smith and Waterman) and Heuristic algorithms (FASTA and Blast). Multiple sequence alignment-based database searching.

Unit III: 12 Hours

Bioinformatics for genome sequencing, EST Clustering and analyses, finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation -Visualization of molecular structures: RasMol and Pymol - Protein secondary structure prediction, Fold Recognition.

Unit IV: **12 Hours**

Introduction to Systems Biology - Types of data used in modelling - Types of models - Types of modelling frameworks - Robustness and Stability of systems - Databases and software's for Systems Biology.

Unit V: **12 Hours**

Methods used in systems biology - Ordinary differential equations (ODE): Linear ODEs, Non-linear ODEs - Stability analysis: Linear and Non-linear systems, Phase plane Analysis – Regression techniques (maximum likelihood, least squares methods) - Michaelis-Menten and Hill functions.

Learning Resources:

Text Books

1. Bosu, O., & Thukral, S. K. (2007). Bioinformatics: databases, tools, algorithms. Oxford University Press.
2. Rastogi, S. C., Rastogi, P., & Mendiratta, N. (2022). Bioinformatics: Methods and Applications-Genomics, Proteomics and Drug Discovery. PHI Learning Pvt. Ltd.
3. Choi, S. (2007). Introduction to systems biology (p. 542). Humana press.

References

1. Lohar, P. S. (2021). Bioinformatics. MJP Publisher.
2. Misener, S., & Krawetz, S. A. (2000). Bioinformatics methods and protocols (Vol. 132). Totowa, NJ, USA: Humana Press.
3. Thiagarajan, B. & Rajalakshmi, P. (2019). Computational Biology. Germany: MJP Publisher.
4. Dassanayake, R. S., Gunawardene, Y. I. N. S. (2011). Genomic and Proteomic Techniques: In Post Genomics Era. India: Alpha Science International.
5. Singh, V. & Dhar, P.K. Systems and Synthetic Biology. (2014). Germany: Springer Netherlands.

Websites/ e-Learning Resources

- https://blast.ncbi.nlm.nih.gov/Blast.cgi
- www.Bioinformatics.org
- www.ncbi.nlm.nih.gov/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	1	1	1
CO2	3	3	2	1	2	2	2	1	1	1
CO3	3	3	2	1	2	2	2	1	1	1
CO4	3	2	2	2	2	2	2	1	1	1
CO5	3	2	2	2	2	2	2	1	1	1
Average	3	2.6	2	1.6	2	2	2	1	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5503	Plant and Animal Biotechnology	Core	6	5

The subject imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals. The student will get to understand the core concepts of biotechnology.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation and their application in industries.

CO2: importance of secondary metabolites and production in plants.

CO3: develop concepts, principles and processes in animal biotechnology.

CO4: concept and different types in Animal Cell Culture and animal cell lines.

CO5: use of molecular biology techniques genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical and industrial applications.

Unit I: **18 Hours**

Introduction of plant tissue culture, Composition of media, Micropropagation, Organogenesis, Somatic embryogenesis, Haploid and triploid production, Protoplast isolation and fusion, Hybrid and cybrid, synthetic seed production. Secondary metabolites - Phenols, Alkaloids, Flavonoids, Anthocyanins, Terpenes and Lignans. Production from Secondary metabolites suspension culture, Bioreactors – Photo bioreactor. Biogenesis and therapeutic applications.

Unit II: **18 Hours**

Plant transformation direct transformation by electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards the development of enriched food products, plant growth regulators; Molecular marker aided breeding: RFLP maps, Linkage analysis, RAPD markers, STS mirco satellite, SCAR, SSCP, QTL, Map based cloning and Molecular marker assisted selection.

Unit III: **18 Hours**

Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Prophylaxis - Vaccines, Oral vaccines DNA Vaccines in animal disease. Cell culture: Culture media, types of media, primary and established culture; organ culture; tissue culture**.**

Unit IV: **18 Hours**

Disaggregation of tissue and primary culture - cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, Cryopreservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays.

Unit V: **18 Hours**

Nuclear magnetic resonance methods of monitoring cell metabolism culturing animal cells in fluidised bed reactors. Application of animal cell culture for *in vitro* testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Culture Scale up and mass production of biologically important compounds. Harvesting of products, purification and assays. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases; Stem Cells-Properties, Types, Therapy, Prospects and Ethics in stem cell research.

Learning Resources:

Text Books

1. Ignacimuthu, S. (2004). Plant Biotechnology. New Delhi: Oxford and IBH Publishing House.
2. Slater, A., Scott, N.W., & Fowler, M. R. (2008). Plant Biotechnology. Oxford: Oxford University Press.
3. Stewart, N.C. (2016). Plant Biotechnology and Genetics. 2nd Edition. New Jersey: John Wiley & Sons, Inc

References

1. Chawla. H. S., 2010. Introduction to plant biotechnology. Oxford and IBH publishing company pvt. Ltd, New delhi.
2. Ian Freshney, 2010. Culture of animal cells. 6th edition, Wiley-Blackwell publishers.
3. Portner, R. (2014). Animal Cell Biotechnology: Methods and Protocols. 3rd edition. New York: Springer-Verlag
4. Ranga, M. M. (2007). Animal Biotechnology. (3rd ed.). Jodhpur: Agrobios.
5. Razdan. M. K., 2011. Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New Delhi.

Websites/ e-Learning Resources

- https://onlinecourses.swayam2.ac.in/cec22_bt07/preview
- https://ihas.its.edu.in/Home/E-Resources-for-Biotechnology.aspx

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	1	1	1
CO2	3	3	2	2	2	2	2	1	1	1
CO3	3	3	2	2	1	2	2	1	1	1
CO4	3	3	2	1	1	2	2	1	1	1
CO5	3	3	2	1	2	2	2	2	2	1
Average	3	3	2	1.6	1.6	2	2	1.5	1.2	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5305	Bioprocess Technology	Core	4	3

The paper imparts a thorough knowledge on the basics of bioprocess and industrial fermentation. The student will get to understand the core concepts of fermentation and its commercial application.

Course Outcomes:

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

CO1: outline the basis of Bioprocess Engineering.

CO2: relate reactors in fermentation.

CO3: differentiate fermentation processes.

CO4: assess scale up and scale down processes.

CO5: compile the output of fermentation processes.

Unit I: 12 Hours

Introduction to fermentation - General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes. Food Safety: Introduction to food safety aspects and food related hazards – HACCP and ISO.

Unit II: 12 Hours

Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermenters, body construction. Production of citric acid, penicillin and insulin. Isolation and improvement of Industrially important Micro-organisms, Media for Industrial fermentation and Sterilization.

Unit III: 12 Hours

Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration: Principles, Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid liquid extraction, aqueous two phase extraction, supercritical fluid extraction.

Unit IV: 12 Hours

Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying- Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing.

Unit V: **12 Hours**

Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites, Effluent Treatment and Fermentation Economics.

Learning Resources:

Text Books

1. Shuler, M. L., Kargi, F. (2003). Bioprocess Engineering. PHI publishers.
2. Liong, M. (2011). Bioprocess Sciences and Technology. United States: Nova Science Publishers.

References

1. Belter, P. A., Cussler, E. L., Hu, W. (1988). Bioseparations: downstream processing for biotechnology. Wiley.
2. Harrison, R. G., Todd, P., Rudge, S. R., Petrides, D. P. (2015). Bioseparations Science and Engineering. Oxford University Press.

Websites/ e-Learning Resources

- web.mit.edu/professional/short.../fermentation_technology.html
- www.wildfermentation.com/John Schollar and Benedikte Watmore, Practical Fermentation-a technicalguide

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	2	2	1	1	1
CO2	3	3	1	1	1	2	2	1	1	1
CO3	3	3	1	1	1	2	2	1	1	1
CO4	3	3	1	1	1	2	2	1	1	1
CO5	3	3	1	1	1	2	2	1	1	1
Average	3	3	1	1	1	2	2	1	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5307	Research Methodology & Biostatistics	Core	4	3

This course aims to inculcate a clear idea of research among students, understand the existing social issues in research, design the wet lab procedures and interpret the results.

Course Outcomes:

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

CO1: understand the bases of research.

CO2: apply appropriate statistical tests based on study question, study type and type of data.

CO3: gain new insights to data collection, analysis and presentation. select an appropriate research, experiment and sample design.

CO4: discuss the components of research paper and methods of the significance of Research report writing and publishing.

CO5: acquire the knowledge on usage of software in presenting research insights.

Unit I **12 Hours**

Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals.

Unit II **12 Hours**

Scope of Biostatistics, Tabulation of data, Graphical representation, Frequency distribution. Measures of central tendency and dispersion: Mean, Median, Mode, Range, Standard deviation, variance, coefficient of variation. Probability analysis, axiomatic definition, axioms of probability, addition theorem, multiplication rule, conditional probability and application in biotechnology.

Unit III **12 Hours**

Standard Deviation - T test. Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking. Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two factor factorial design.

Unit IV **12 Hours**

Spreadsheet Tool: Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Presentation Tool: Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool.

Unit V **12 Hours**

Review of literature, Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography.

Learning Resources:

Text Books:

1. Arora, P.N., Malhan, P.K. (2006). Biostatstics. 2nd Edition. Himalaya Publishing House.
2. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. India: New Age International (P) Limited.
3. Sridhar, M. S. (2010). Introduction to Research Methodology: Problem Selection, Formulation and Research Design. United States: M. S. Sridhar, Lulu.

Reference Books:

1. Bell, J., Waters, S. (2018). Doing Your Research Project: a Guide for First-Time Researchers. United Kingdom: McGraw-Hill Education.
2. Daniel, W. W., Cross, C. L. (2014). Biostatistics: Basic Concepts and Methodology for the Health Sciences. India: Wiley.
3. Holmes, D., Moody, P., Dine, D., Trueman, L. (2017). Research Methods for the Biosciences. United Kingdom: Oxford University Press.
4. Jaype Brothers (2011). Methods in Biostatstics for Medical Students and Research Wokser (English). 7th Edition. Publishing. 270p.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog

Websites/ e-Learning Resources

- https://explorable.com/quantitative-research-design
- www.ask.com/Methodology+Research
- www.qmethod.org/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	3	1	1	1	1
CO2	3	3	3	3	3	3	2	1	1	2
CO3	3	3	3	3	3	3	3	1	1	2
CO4	3	3	1	2	3	3	3	2	1	2
CO5	3	3	2	2	3	3	3	1	1	2
Average	3	3	2	2.2	2.6	3	2.4	1.2	1	1.8

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5609	Practical – III (A) Bioinformatics (B) Plant and Animal Biotechnology (C) Bioprocess Technology	Core Course	8	6

The practical will establish a basic study skill on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: learn the Bioinformatics tools for sequence retrieval and alignment.

CO2: apply the learned tools for various applications.

CO3: comprehend the procedures for media preparation and sterilization.

CO4: analyse the functioning of the cells in plants and animals.

CO5: identify the techniques of upstream & downstream process.

(A) Bioinformatics – practical

1. Sequence retrieval from Genbank & Uniprot.
2. Sequence identity search- Sequence similarity search using BLASTN & BLASTP.
3. Accessing Structural Database and Download the Protein Structure.
4. Working with Ensembl.
5. Multiple Sequence Alignment and Phylogenetic Analysis.
6. Predicting Physiochemical properties of protein sequence.
7. Predicting secondary structure using SOPMA tool.
8. Predicting secondary structure using CFSSP tool.
9. Multiple Sequence.
10. Gene Prediction.

(B) Plant and Animal Biotechnology - Practical:

1. Plant tissue culture - sterilization techniques and media preparation.
2. Generation of Callus from leaf /root/bud & shoot apex.
3. Isolation of plant protoplast.
4. Mass culture of Chlorella /Spirulina.
5. Introduction to Animal Cell culture: Procedure for handling cells and medium.
6. Animal tissue culture - sterilization techniques and media preparation..
7. Trypsinization of established cell culture.
8. Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue, Erythrosin (b) Giemsa staining.

9. MTT Assay (Demonstration).

(C) Bioprocess Technology – Practical

1. Parts and design of fermenter.
2. Media preparation and sterilization.
3. Isolation of industrially important microorganisms for microbial processes.
4. Production and estimation of protease.
5. Production and estimation of amylase.
6. Aqueous Two Phase Extraction of enzymes.
7. Citric acid production.
8. Use of alginate for cell immobilization.
9. Media standardization (C:N ratio) for maximum biomass production of an industrially important microorganism.
10. Production of wine using grapes.

Learning Resources:

Text Books

1. Agostino, M. (2012). Practical Bioinformatics. Garland Science.
2. Adhav M, (2009). Practical Biotechnology and Plant Tissue Culture, S. Chand & Company Ltd.
3. Rajan, S., Christy, R. S. (2018). Experimental Procedures in Life Sciences. India: CBS Publishers & Distributors.

References

1. Baxevanis, A. D., Ouellette, B. F. F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley.
2. Harisha, S. (2008). Biotechnology Procedures and Experiments Handbook. India: Laxmi Publications Pvt Limited.
3. Masters J. R. W. (2004). Animal cell culture practical approach. Oxford.

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	2	2	3	1	2	1	2
CO2	3	3	2	2	2	3	1	2	1	2
CO3	3	3	2	2	2	2	1	2	1	2
CO4	3	3	2	2	2	2	1	2	1	2
CO5	3	3	2	2	2	2	1	2	1	2
Average	3	3	2	2	2	2.4	1	2	1	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5311	Nanobiotechnology	DSE	4	3

The subject imparts knowledge on the fundamentals of nanoparticles. The student will be provided with a basic knowledge and understanding about the role of nanoparticles in biotechnology.

Course Outcomes:

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

CO1: learn the bases for Introduction to Nanotechnology.

CO2: discuss about the basic concept on preparation and characterization of the nanomaterials.

CO3: explain the potential application of nanoparticles in various field.

CO4: gain the knowledge on nanoparticle-based drug delivery.

CO5: describe the impact of nano particles in humans.

Unit I: **12 Hours**

Introduction to Nanotechnology - Scientific revolution, Feynman's vision - Classification of nanobiomaterials - Types of nanomaterials (nanoparticles, nanotubes, nanowires, nanofibers) - Size dependent variation in the properties of Nanomaterials - Nature's Nanophenomena.

Unit II: **12 Hours**

Preparation of Nanomaterials: Top-down and bottom-up approaches – Biosynthesis of Nanomaterials – Nanobiomaterials: Polymer, Ceramic, Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Quantum dots, Magnetic Nanoparticles, Nanofibres, Hydrogels, Films and Scaffolds.

Unit III: **12 Hours**

Application of Nanomaterials in Bone substitutes and Dentistry - Food and Cosmetic applications - Bio-sensors and Lab-on-a-chip - Bio-devices and implantable devices – Bioremediation - Nanomaterials for anti-microbial coating (medical implants and paints) - Application of Nanotechnology in textile industry.

Unit IV: **12 Hours**

Nanomaterials for diagnosis and therapy - Targeted drug delivery - Drug release mechanism – Nanoparticle as drug carrier: Dendrimers, liposomes, polymeric nanoparticle - Nanoparticle technologies for cancer therapy and diagnosis - Point of Care Test - Magnetic nanoparticles for imaging– Biofunctionalization and biocompatibility of nanoparticle.

Unit V: **12 Hours**

Nanotoxicology - Portals of Entry of the nanoparticles into the Human Body - Bio-toxicity of Nanoparticles - Nanoparticles in Mammalian systems and Health threats -Biological response and cellular interaction of nanoparticle - Risk assessment and Safety Regulation of nanoparticles.

Learning Resources:

Text Books

1. Shanmugam, S. (2019). Nanotechnology. MJP Publisher.
2. Niemeyer, C.M. & Mirkin, C.A. (2004). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley.
3. Geckeler, K. E., & Nishide, H. (Eds.). (2009). Advanced nanomaterials. John Wiley & Sons.

References

1. Laurencin, C. T. (2008). Nanotechnology and Tissue Engineering: The Scaffold. CRC Press.
2. Shoseyov, O. & Levy, I. (2008). NanoBioTechnology: BioInspired Devices and Materials of the Future. Netherlands: Humana Press.
3. Hull, M., & Bowman, D. (2018). Nanotechnology environmental health and safety: risks, regulation, and management. Elsevier Science
4. Cao, G., Wang, Y. (2011). Nanostructures and Nanomaterials: Synthesis, Properties, and Applications. World Scientific.
5. Jain, K. K. (2006). Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications. United Kingdom: Horizon Bioscience.

Websites/ e-Learning Resources

- http://www.zyvex.com/nano
- www.fda.gov/nanotechnology/
- www.nature.com/nnano/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	2	1	1	1	1
CO2	3	3	2	1	2	2	2	1	1	2
CO3	3	3	2	2	2	2	2	1	1	1
CO4	3	3	2	2	2	2	2	1	1	1
CO5	3	3	2	2	2	2	2	1	1	2
Total	15	15	9	8	9	10	9	5	5	7
Average	3	3	1.8	2	1.8	2	1.8	1	1	1.4

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5313	Molecular Developmental Biology	DSE	4	3

The subject imparts knowledge on the fundamentals of developmental biology. The student will be provided with a basic knowledge and understanding about the molecular aspects of developmental biology.

Course Outcomes:

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

CO1: illustrate the structure and function of developmental biology, Gametogenesis.

CO2: discuss basic fertilization process of animals.

CO3: demonstrate the functions of embryonic development process.

CO4: illustrate the organ development of vertebrate animals.

CO5: demonstrate the impact of gene in developmental biology and developmental disorders.

Unit I: **12 Hours**

Definition and scope of developmental biology. Gametogenesis - Spermatogenesis and Oogenesis. Structure of Sperm and oocyte. Instructive and permissive interactions, competence, epithelial - mesenchymal interactions. Important signalling pathways in vertebrate development.

Unit II: **12 Hours**

Fertilization - Definition, mechanism of fertilization in mammal & sea urchin. Types of fertilization. Nieuwkoop centre, Molecular role of organizer.

Unit III: **12 Hours**

Cleavage in Xenopus, Chick and mammals, Regulation of cleavage cycle. Morphogenetic movements, Gastrulation in Xenopus, Chick and mammals. Fate Maps.

Unit IV: **12 Hours**

Vertebrate Development: Formation of the neural tube, myogenesis, and haematopoiesis. Mechanism of vertebrate eye development.

Unit V: **12 Hours**

Drosophila Maternal effect genes, induction at single cell level - differentiation of photoreceptors in ommatidia - Developmental disorders: Spina bifida, Anencephaly, craniorachischisis, Cyclopia and Thanotrophic dysplasia.

Learning Resources:

Text Books

1. Gilbert, S. F. (2010). Developmental Biology. United States: Sinauer Associates.
2. Subramaniam, T. (2002). Developmental Biology. United Kingdom: Alpha Science International.
3. Sastry, K. V. (2010). Developmental Biology. India: Rastogi Publications.

References

1. Twyman, R. M. (2001). Developmental Biology. 2nd Edition, Viva Publications, New Delhi.
2. Carlson, B. M. (2018). Human Embryology and Developmental Biology - Inkling Enhanced E-Book. Elsevier Health Sciences.
3. Willey, J. M., Sherwood, L. M., Woolverton, C. J. (2019). Prescott's Microbiology. McGraw-Hill Education.

Websites/ e-Learning Resources

- www.sackler.tufts.edu/.../Cell-Molecular-and-Developmental-Biology
- www.devbio.com/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	1	2	1	1	1	2
CO2	3	3	2	2	1	2	1	1	1	1
CO3	3	3	1	1	1	1	1	1	1	1
CO4	3	3	1	2	1	1	1	1	1	1
CO5	3	3	2	2	1	1	1	1	1	1
Average	3	3	1.6	1.8	1	1.4	1	1	1	1.2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5233	**Internship**	**IS**	**-**	**2**

To gain hands on training and expertise in handling sophisticated instruments and acquire in depth knowledge in their applications.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: understand working principles and the techniques of various processes.

CO2: apply standard operating procedures followed in industries.

CO3: prepare to face challenges & gain confidence in the field of study.

CO4: critically assess the utilization of sophisticated instruments and expensive consumables.

CO5: develop work ethics to be followed in a scientific laboratory.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	2	2
CO2	3	3	3	3	3	3	3	2	2	2
CO3	3	3	3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	3	2	2	3
Average	3	3	3	3	3	3	3	2	2	2.6

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5502	Bioethics, Biosafety & IPR	Core	6	5

This course provides the guidelines and regulations governing research; evaluate ethical conduct and social responsibilities; to adhere to safe working practices; to appreciate the need for protection of human subjects; to recognize the potential harms in research and show sensitivity to cultural and ethical issues; to create a general awareness about IPR.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: understand the basics of biosafety and bioethics and its impact on biological sciences and the importance of human life.

CO2: apply the knowledge to recognize the importance of bioethics in research and good clinical practices.

CO3: acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.

CO4: evaluate the importance of IPR.

CO5: analyse the importance of protection of new knowledge and innovations and its role in business and entrepreneurship.

Unit I: 18 Hours

Introduction to Bioethics - Need for bioethics in social and cultural issues. Bioethics & GMO's Issues and concerns pertaining to Genetically modified foods & food crops, Organisms and their possible health implications - Containment facilities for genetic engineering experiments, regulations on field experiments, release of GMO`s and labelling of GM foods - Bioethics in Medicine - Protocols of ethical concerns related to prenatal diagnosis, gene therapy, Organ transplantation, and Xenotransplantation.

Unit II: 18 Hours

Clinical trials –Regulations. Bioethics & Cloning Permissions and Procedures in Animal Cloning, Human cloning, Risks and hopes. Bioethics in Research Stem cell research, Human Genome Project, Use of animals in research, human volunteers for Clinical research, Studies on Ethnic races. Ethics in patient care, Informed consent.

Unit III: 18 Hours

Biosafety – Biological risk assessment. Biological agents and Hazard groups. Criteria in biological risk assessment. Guidelines for categorization of genetically modified plants for field test. Regulation, national and international guidelines of Biosafety, rDNA guidelines, Regulatory requirements for drugs and Biologics GLP. Biosafety levels. Safety equipments and Biological Safety cabinets.

Unit IV: **18 Hours**

IPR: Introduction to Intellectual Property rights, Patenting – Factors for patentability – Procedures for registration of Patents. Copyright works, ownership, transfer and duration of Copyright. Renewal and Termination of Copyright. Industrial Designs - Need for Protection of Industrial Designs. Procedure for obtaining Design Protection. Infringement, Right of Goodwill, Passing Off. Trademarks - Introduction to Trademarks. Need for Protection of Trademarks. Classification of Trademarks. Indian Trademarks Law. Procedural Requirements of Protection of Trademarks.

Unit V: **18 Hours**

Geographical Indications - Indication of Source and Geographical Indication. Procedure for Registration, Duration of Protection and Renewal. Infringement, Penalties and Remedies. Layout- Designs of Integrated Circuits: Conditions and Procedure for Registration. Duration and Effect of Registration Protection of Plant variety and Plant breeders' rights in India. Protection of traditional knowledge, Bioprospecting and biopiracy. India's new IP Policy (2016), Govt of India's steps to promote IPR.

Learning Resources:

Text Book

1. Sibi. G. (2020). Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology. India: I.K. International Publishing House Pvt. Limited.
2. Srivasta, A. K., Das, P., & Sharma, P. (2024). Intellectual Property Rights, Biosafety and Bioethics (Ethical Frontiers). Namya Press.
3. Sateesh, M. K. (2013). Bioethics and Biosafety. India: I.K. International Publishing House Pvt. Limited.

References

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
2. Chandra, R. (2004). Issues Of Intellectual Property Rights. Isha Books.
3. Erbisch, F.H. & Maredia, K.M. (2000). Intellectual Property Rights In Agricultural Biotechnology. (2000). Universities Press (India) Pvt. Limited.
4. Singh, S.S. (2004). The Law of Intellectual Property Rights: Introductory, WTO, Patent Laws, Copyright Law, Commercial Domain. Deep & Deep Publications (p) Ltd.
5. Subbian, A. (2007). Intellectual Property Rights: Heritage Science and Society Under International Treaties. India: Deep & Deep Publications.

Websites/ e-Learning Resources

- USPTO Web Patent Databases at: www.uspto.gov/patft
- Government of India's Patents Website: www.patinfo.nic.in
- Intellectual property India: www.ipindia.nic.in

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	3	2	2
CO2	3	3	2	2	3	2	2	3	2	2
CO3	3	3	2	2	3	2	2	3	2	3
CO4	3	3	2	2	3	2	2	3	2	3
CO5	3	3	2	2	3	2	2	3	2	3
Average	3	3	2	2	2.8	2	2	3	2	2.6

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5504	Marine Biotechnology	Core	6	5

The subject imparts knowledge on the fundamental concepts of marine ecosystem and its microbial diversity. The student will be able to understand marine ecosystem and its importance to humans in biotechnology perspectives.

Course Outcomes:

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

CO1: explain the principle features of marine ecosystems and the microbial diversity in oceans.

CO2: illustrate about the bioremediation of marine pollution and controlling measures of biofouling.

CO3: apply the knowledge on the development of disease resistant marine organisms.

CO4: comprehend the uses of marine organisms and their significance.

CO5: deliver applications of marine products.

Unit I: **18 Hours**

Classification of the Marine Environment. Marine Biodiversity. Marine microbial habitats. Diversity of marine microorganisms: Archae, Fungi, Bacteria, Cyanobacteria, Algae, Viruses, Viroids and Prions. Sampling techniques in marine microbiology: water, sediments.

Unit II: **18 Hours**

Causes and consequences of Marine Pollution. Red Tide, Ballast water. Biofouling and Control technology - Biofouling organisms - Problems due to biofouling - Antifouling paints and its environmental pollution - Biotechnological approach to biofouling control. Bioremediation - Aerobic and anaerobic bioremediation in the marine environment. Seaweeds for removal of metal pollutants.

Unit III: **18 Hours**

Genetic engineering and ploidy manipulation to enhance growth of marine organisms - reproduction and development of disease resistance in aquacultural species crustaceans, molluscans, fin fishes and algae.

Unit IV: **18 Hours**

Applications of Marine Organisms: Giant bacteria and their significance. Occurrence, characteristics and exploitation of unculturable bacteria. Barophilic organisms and their applications. GFP, RFP characteristics and their applications. Green mussel adhesive protein. Chitosan products and application. Biomimetics.

Unit V: **12 Hours**

Prospective resources of marine ecosystem. Marine natural products. Marine organisms: an alternative source of potentiality valuable natural products Pharmaceuticals from marine organisms: anti - cancer, diagnostic and therapeutic, bioadhesives and thermostable enzymes.

Learning Resources:

Text Books

1. Kim, S. (2015). Springer Handbook of Marine Biotechnology, Springer Publication.
2. Kim, S. (2020). Encyclopedia of Marine Biotechnology: 5 Volumes. Wiley Publication.
3. Kirchman, D.L., Gasol, J.M. (2018). Microbial ecology of the oceans, (3rdedition), Wiley –Blackwell.

References

1. Attaway, D.H. (2001). Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
2. Nybakken, J.W., Bertness, M.D., (2005). Marine biology: An ecological approach. 6th ed. Benjamin Cummings, San Francisco.
3. Sanchez, G., Hernandez, E. (2019). Environmental Biotechnology and cleaner Bioprocess, (1st edition). CRC Press, ISBN 9780367455552

Websites/ e-Learning Resources

- https://onlinecourses.swayam2.ac.in/cec23_bt22/preview
- https://www.coursera.org/learn/marine-biology
- https://www.course-bookings.lifelong.ed.ac.uk/courses/SN/science-and nature/SN125/marine-biology-and-ecology-online/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	2	1	1	1	1
CO2	3	3	2	1	2	3	1	1	1	1
CO3	3	3	1	1	2	3	2	2	1	1
CO4	3	3	1	1	2	3	1	2	1	1
CO5	3	3	1	1	3	3	2	1	1	1
Total	15	15	6	5	10	14	7	7	5	5
Average	3	3	1.2	1	2	2.8	1.4	1.8	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5506	Pharmaceutical Biotechnology	Core	6	5

The subject imparts knowledge on the fundamentals of pharmaceutical biotechnology. The student will be provided with a basic knowledge and understanding about the pharmaceutical products produced based on biotechnological methods and its biomedical applications.

Course Outcomes:

CO1: explain the basic components of pharmaceutical and biotechnology industry and methods and applications of biosensor.

CO2: describe the scientific, technical and economic aspects of vaccine & rDNA technology.

CO3: describe the basic concepts of protein engineering, therapeutic proteins and enzyme immobilization techniques.

CO4: describe the concepts of hybridoma technology, microbial biotransformation and microbial bio-transformed products.

CO5: explain the basic components of somatic gene therapy, Xeno-transplantation and fermenter and bio safety methods.

Unit I: **18 Hours**

Introduction to concepts and technologies in pharmaceutical biotechnology and industrial applications, Biosensors – working and applications of biosensors in pharmaceutical Industries – Pharmacology and Ethnopharmacology: Scope, applications and Importance.

Unit II: **18 Hours**

Scientific, technical and economic aspects of vaccine research and development, Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Storage conditions and stability of vaccines, Recombinant DNA technology, Application of rDNA technology and genetic engineering in the production of: (i) Interferon (ii) Vaccines - hepatitis B (iii) Hormones – Insulin, Brief introduction to Protein Engineering, Therapeutic proteins, Production of Enzymes – General consideration – Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillinase, Methods of enzyme immobilization and applications.

Unit III: **18 Hours**

Hybridoma technology - Production, Purification and Applications, Formulation of biotech products - Rituximab, Introduction to Microbial biotransformation and applications, Study of the production of penicillin, citric acid, Vitamin B_{12}, Glutamic acid and Griseofulvin, Somatic gene therapy, Xenotransplantation in pharmaceutical biotechnology, Large scale production fermenter design and its various controls, Bio safety in pharmaceutical industry.

Unit IV: **18 Hours**

Pharmacological activity of Plant drugs, Plant Chemicals in modern pharmacology; biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, vinca alkaloids, synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and bio-transformation. Criteria for pharmacological evaluation of drugs.

Unit V: **18 Hours**

Clinical Pharmacology, Drug therapy, therapeutic situation, benefits and risk of use of drugs, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug action, factors affecting drug action; Adverse Drug reactions and drug poisoning - classification and causes of ADR; principle clinical manifestations and treatment of ADR, General principles of management of drug poisoning; antidotes, classification of drugs.

Learning Resources:

Text Books

1. Kokate, C. (2011). Textbook of pharmaceutical biotechnology. Elsevier India.
2. Vyas, S. P. & Dixit, V. (2018). Pharmaceutical Biotechnology. CBS Publishers & Distributors
3. Walsh, G. (2013). Pharmaceutical biotechnology: concepts and applications. John Wiley & Sons

References

1. Figeys, D. (2005). Industrial proteomics: applications for biotechnology and pharmaceuticals. Wiley.
2. Guzmán, C. A., & Feuerstein, G. Z. (Eds.). (2010). Pharmaceutical Biotechnology (Vol. 655). Springer Science & Business Media.
3. Kayser, O., & Müller, R. H. (2004). Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley.
4. Lal, H. (2011). Essentials of Pharmaceutical Biochemistry. CBS Publishers & Distributors.
5. Shargel, L., Wu-Pong, S. & Yu, A. (2004). Applied Biopharmaceutics & Pharmacokinetics. McGraw-Hill Education.

Websites/ e-Learning Resources

- http://library.nuft.edu.ua/ebook/file/Gad2007.pdf
- https://oasis.iik.ac.id:9443/library/repository/a932eb462c49885a2c72755977036b81.pdf
- https://tugasakhirsttifbogor.files.wordpress.com/2018/08/pharmaceutical-biotechnology.pdf

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	1	2	1	1	1
CO2	3	3	2	2	2	2	2	1	1	1
CO3	3	3	2	2	2	2	2	1	1	1
CO4	3	3	2	2	2	2	2	1	1	1
CO5	3	3	2	2	2	2	2	1	1	1
Average	3	3	2	2	2	1.8	2	1	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5508	**Project**	**Core**	**8**	**5**

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of pursuing research.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: understand working principles and the techniques of various processes in the field of research work.

CO2: design experiments to solve/answer a problem identified in the field of study.

CO3: prepare to face challenges & gain confidence in the field of study.

CO4: develop work ethics to be followed in a scientific laboratory.

CO5: seek advanced research-based knowledge, professional employment, or entrepreneurship in diverse fields of Biotechnology.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	2	3
CO2	3	3	3	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	2.4	2.2	3

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5310	Stem Cell Biology	DSE	4	3

The subject imparts knowledge on the fundamentals of stem cells. The student will be provided with a basic knowledge and understanding about the application of stem cell biology.

Course Outcomes:

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

CO1: learn the major discoveries of stem cell biology.

CO2: explain about the stem cell niche and functions.

CO3: illustrate basic stem cell isolation and culture techniques.

CO4: describe the signalling pathways and cell cycle checkpoints regulates stem cell fate.

CO5: assess and appraise the applications of embryonic stem cells.

Unit I: **12 Hours**

Stem cells: Definition, Characterization, Pluripotency, Self-renewal and differentiation - Types of stem cells: Embryonic stem cells, adult stem cells, mesenchymal stem Cells, Adipose stem cells.

Unit II: **12 Hours**

Stem cell niche - Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells

Unit III: **12 Hours**

Embryonic and Adult stem cell isolation and culture techniques - Characterization of stem cells - Preservations of Stem cell.

Unit IV: **12 Hours**

Stem cell cycle: Chromatin modification and transcriptional regulation - chromatin modifying factors - Chromosomal inactivation - JAK -STAT pathway - Ras\Raf pathway - PI3K cell signalling - p53 check points - Role of LIF pathway in cell cycle control.

Unit V: **12 Hours**

Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells – Ethical issues in human stem cell research.

Learning Resources:

Text Books

1. Battler, A. & Leor, J. (2007). Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine. United Kingdom: Springer.
2. Marshak, D.R. and Gardner, R.L. & Gottlieb, D.I. (2001). Stem Cell Biology. Cold Spring Harbor Laboratory Press.
3. Sullivan, S. and Cowan, C.A. & Eggan, K. (2007). Human Embryonic Stem Cells: The Practical Handbook. Wiley.

References

1. Bertolotti, R. and Parvez, S.H. & Nagatsu, T. (2000). Progress in Gene Therapy, Volume 1 Basic and Clinical Frontiers. Taylor & Francis.
2. Bongso, A., Lee, E. H. (2011). Stem Cells: From Bench to Bedside. Singapore: World Scientific.
3. Lanza, R. & Klimanskaya, I. (2011). Essential Stem Cell Methods. Elsevier Science.
4. Quesenberry, P.J. & Stein, G.S. & Forget, B.G. and Weissman, S.M. (1998). Stem Cell Biology and Gene Therapy. Wiley.
5. Sell, S (2013). Stem Cells Handbook. Springer New York.

Websites/ e-Learning Resources

- https://stemcells.nih.gov/
- www.nature.com/subjects/stem-cells
- www.eurostemcell.org

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	1	1	1	1	1	2
CO2	3	3	2	2	2	1	1	1	1	2
CO3	3	3	2	3	3	1	2	2	2	2
CO4	3	3	2	3	2	1	2	1	2	2
CO5	3	3	2	2	2	1	3	3	2	2
Average	3	3	2	2.2	2	1	1.8	1.6	1.6	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5312	Enzymology	DSE	4	3

The subject helps the students to render immense knowledge about the fundamentals of enzyme structure and its kinetics. Industrial application of enzymes it also deals about the various biological compounds and their uses

Course Outcomes:

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

CO1: explain the basics of enzyme nomenclature and properties.

CO2: classify and cognize the native and immobilized enzyme.

CO3: examine the equations of steady state kinetics.

CO4: assess extraction and downstream processing of enzymes.

CO5: compile the uses of enzymes and design enzymes for Industrial and Clinical application.

Unit I: **12 Hours**

Introduction to enzymes: Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions – Extraction, Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis and liquid-liquid extraction methods.

Unit II: **12 Hours**

Kinetics of catalysed reaction: Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Hanes wolf equation, Eadie hoofstee equation, Inhibition of enzyme activity

Unit III: **12 Hours**

Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis

Unit IV: **12 Hours**

Theories on mechanism of catalysis - Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex.

Unit V: **12 Hours**

Coenzyme action - Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological

significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications. Clinical and industrial applications of enzymes, Enzyme Engineering.

Learning Resources:

Text Books

1. Lehninger, A. L., Nelson, D. L., Cox, M. M. (2005). Lehninger principles of biochemistry. United Kingdom: W. H. Freeman.
2. Garrett, R. H., Grisham, C. M. (2002). Principles of Biochemistry: With a Human Focus. Singapore: Harcourt College Publishers.
3. Price, N. C., & Stevens, L. (2010). Fundamentals of Enzymology. Oxford University Press.

References

1. Zubay, G. L. (1998). Biochemistry. India: Wm.C. Brown Publishers.
2. Voet, D., Voet, J. G., Pratt, C. W. (2000). Fundamentals of Biochemistry. United States: Wiley.
3. Murray, R. K., Harper, H. A., Granner, D. K., Mayes, P. A., Rodwell, V. W. (2000). Harper's Biochemistry. 25th Edition, Appleton and Lange Publishers.

Websites/ e-Learning Resources

- www.lsbu.ac.uk/biology/enztech/
- www. lsbu.ac.uk/biology/enzyme/
- http://www.aetlted.com/tech/applications.html

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	1	1	1	1	2
CO2	3	3	2	2	2	1	1	2	1	1
CO3	3	3	2	1	2	1	1	2	1	1
CO4	3	3	3	2	2	1	1	2	1	1
CO5	3	3	3	2	1	1	1	2	1	1
Average	3	3	2.6	1.8	2	1	1	1.8	1	1.2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PBT5244	**Professional Competency Skill**	**SEC**	**-**	**2**

This course enables to acquire thorough knowledge, practical skills, research abilities and social competences for their lifelong career management.

Course Outcomes:

On successful completion of the course the students will be able to

CO1: aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development.

CO2: apply educational and collaborative technologies that foster learning and prepare learners for professional environments.

CO3: prepare to face challenges & gain confidence in the biotechnology and its allied field.

CO4: set high personal standards of performance in the Competitive Examinations viz, CSIR NET, GATE, IIT JAM, UPSC, Banking Services, TNPSC group services, etc.

CO5: seek advanced research-based knowledge, professional employment, or entrepreneurship in diverse fields of Biotechnology.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	2	3
CO2	3	3	3	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	2.4	2.4	3

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'