Savitribai Phule Pune University

(Formerly University of Pune)

Three Year Degree Program in Biotechnology
(Faculty of Science & Technology)

S. Y. B.Sc. (Biotechnology)

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

(Based on Guidelines of NEP-2020)

To be implemented from Academic Year 2024-2025

Framed By

Boards of Studies (BOS) in Biotechnology

Savitribai Phule Pune University

Preamble of the Syllabus:

Biotechnology has expanded and established as an advanced interdisciplinary applied science. The study of Life itself is at the core of it and the interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted to not only current "Century of Knowledge" but also on to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work.

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on. The relevance and application of these studies on living organisms and their bioprocesses is extensively covered in this field with the help of technology. Green revolution and white revolution were possible in India thanks to the deeper and intrinsic understanding of biotechnology.

Economic and social renaissance is staged on biotechnology especially, since it' s biomedical and cutting-edge technological applications are tremendously powerful in shaping this century and exciting future. Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained work force to develop future generations of science leaders. Career opportunities for graduate students are created and expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.

The National Education Policy (NEP-2020), which is being adapted and implemented by the University Grants Commission (UGC) to all over India. The NEP offers a comprehensive, multidisciplinary education program that will support students' intellectual, scientific, social, physical, emotional, moral, and ethical growth to make their careers in industry and research and to compete in the globalized world. The new syllabus is prepared by Board of studies (BOS) in Biotechnology, to implement policies and procedure mentioned in NEP-2020. Biotechnology is a itself interdisciplinary applied science subject which more or less already implementing the purposes of NEP. Biotechnology has grown extensively in last couple of decades. The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, and to implements policies of NEP-2020, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of technological as well as the economical aspects of modern biology. The proposed credit based curriculum ensures the requirement of academia and industry. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions) without any additional training. Thus, the university/college itself will be developing the trained and skilled man-power. Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical,

chemical and biological sciences along with developing advanced technology. Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research. The basic aim of the revised course curriculum is to integrate various disciplines of life sciences which will cater the needs of human resources in academia and industry. The Overall objective of the Program is to promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in academics, government organization, biomedical sectors, health and nutrition settings for ultimate benefit of society and sustainable development.

1) **Eligibility:** Completion of at least 50% credit at F.Y. B.Sc. Level with Biotechnology as one of the major subject and/or as prescribed by the Savitribai Phule Pune University

2) **Exit options**

i)	Course Certificate Course	01year (Completion of 02 Semesters)
ii)	Diploma Course	02 years (Completion of 04 Semesters)
iii)	BSc Degree	03 years (Completion of 06 Semesters)
iv)	BSc Degree with Honours	04 years (Completion of 08 Semesters)

3) **Abbreviation:** VSC: Vocational Skill Course, IKS: Indian Knowledge System, FP: Field Project, OJT: On Job Training, CEP: Community Engagement and Service, GE/OE: Generic Elective / Open Elective, SEC: Skill Enhancement Course, AEC: Ability Enhancement Course, VEC: Value Education Course, CC: Cocurricular Courses

4) **Co-curricular Courses (CC)**

Co-curricular courses are credited for participation of students in various activities like Sports, NCC, NSS & allied activities

5) **Ability Enhancement Course:**

Students have option to choose second language from the Language Basket-5 (02 credits) each in semester-III (AEC-231-HIN: Hindi or AEC-232-MAR: Marathi) (and semester-IV (AEC-281-HIN: Hindi or AEC-282-MAR: Marathi)

6) **Field Projects (FP)**

Continuous assessment part (15 marks out of 50) of this course should be done by the mentor of the student. This should be based on the regularity, participation and performance of the students.
Semester End Assessment (35 marks out of 50) of this course should be done by a panel of examiners in two parts;

- Based on the work report submitted by the student (50% marks), and
- Remaining 50% marks should be based on his presentation and viva-voce on the work carried to be assessed by the panel of examiners.

7) Scheme of Examination

The total marks for a 2-credits course is 50.
Theory Paper of 02 Credits:
Internal Exam (15 M) + University Theory Exam (35 M) = Total 50 Marks.
Duration: For Internal exam = 40 Min. and for University Exam = 02 hours.
Practical Paper of 2 Credits:
Internal Exam (15 M) + University Practical Exam (35 M) = Total 50 Marks.
One Credit of Practical = 30 clock hours (2 Contact hours per credit per week)

- Practical for each course comprises of 02 Credits = 60 clock hours.
- Minimum 12 laboratory/ Filed sessions of 04 clock hours must be conducted in one semester.
- In case of short practical, two practical's should be conducted in one session.
- Each practical of 04 clock hours in the laboratory should consist of table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.

Pattern for Internal Theory Assessment: (15 Marks)

- Q-1: Choose correct option (5-MCQs with Multiple Options) - 5 marks
- Q-2: Answer the following questions (Short answer questions) (any 5 out of 7) - 5 marks
- Assignment/ presentation/ attendance/discipline -5 marks

Program: B.Sc. BIOTECHNOLOGY

Second Year Biotechnology

SEMESTER –III				
Sr. No	**Course Category**	**Course code**	**Course Title**	**Credit**
1	**Major Core**	BT-201- T	Cell Biology & Genetics	2T
2		BT-202- T	Molecular Biology & Metabolism	2T
3		BT-203- P	Practical in Cell Biology and Genetics	2P
4	**VSC**	VSC-201-BT-P	Practical in Molecular Biology & Metabolism	2P
5	**FP / OJT/ CEP**	FP-201-BT-P	Field Project	2P
6	**Minor**	MN-201-BT-T	Applied Biotechnology	2T
7		MN-201-BT-P	Practical in Applied Biotechnology	2P
8	**GE/OE**	OE- 201-BT-T	Wine Technology	2T
		OE- 202-BT-T	Dairy Technology	
9	**IKS**	IKS-201-T	Biotechnology in ancient India	2 T
10	**AEC***	AEC-231-HIN	Hindi	2 T
		AEC-232-MAR	Marathi	
11	**CC**	CC-201-T	PE/NSS	2 T
Total Credit				**22**
SEMESTER –IV				
Sr. No	**Course Category**	**Course code**	**Course Title**	**Credit**
1	**Major Core**	BT-251-T	Animal Development	2T
2		BT-252-T	Plant Development	2T
3		BT-253-P	Practical in Plant and Animal Development	2P
4	**VSC**	VSC-251- BT-P	Practical Biochemistry	2P
5	**FP / OJT/ CEP**	CEP-251-BT-P	CEP	2P
6	**Minor**	MN-251-BT-T	Fundamentals of Genetic Engineering	2T
7		MN-251-BT-P	Practical in Fundamentals of Genetic Engineering	2P
8	**GE/OE**	OE-251 BT-P	Practical in Wine Technology	2P
		OE-252 BT-P	Practical in Dairy Technology	
9	**SEC**	SEC-251-P	Practical in Agriculture Biotechnology	2 P
10		SEC-252-P	Practical in Environmental Biotechnology and Biodiversity	
11	**AEC***	AEC-281-HIN	Hindi	2 T
		AEC-282-MAR	Marathi	
12	**CC**	CC-251-T	PE/NSS	2 T
Total Credit				**22**

*as per guideline by SPPU

Second Year Biotechnology

SEM - III: Major Core
Course Code: BT-201-T
Course Name: Cell Biology and Genetics
Credit: 2T

Course Objective

- To provide basic knowledge of structure and diversity of eukaryotic cells
- To provide the basis of diversity and inheritance pattern of organism

Course Outcome

- Students learn ultra-structure of eukaryotic cells.
- Students will understand the mechanism of cell division and gamete formation
- Students learns signaling mechanism required to coordinate cell division and cell death
- Students learns genetic basis of inheritance pattern.
- Students will understand the chromosomal aberrations and Mutations are the cause of genetic disorder
- Students will also learn the mechanism of Sex Determination

Sr. No.	Topic	No. of lecture (30)
	Cell Biology	
1	Cell Theory; Types of Cell: i. Prokaryote & Eukaryotic Cell ii. Plant & animal cells iii. Cellular Diversity: Cell structure & related functions	2
2	Cell Membrane; Structure and Function • Structure, and function of cell Organelle i. Nucleus, ii. Mitochondria iii. Chloroplast iv. Lysosomes and Vacuoles v. ER & SER vi. Golgi Bodies vii. Cytoskeleton	6
4	Cell Cycle • Introduction to cell cycle • Phases and Check points of cell cycle	2
5	Cell Division in Plant & Animal • Mitosis • Meiosis	2
6	Cell Death • Introduction to cell signaling with example Aging, Apoptosis and Necrosis	3
	GENETICS	
7	• Mendelian Genetics Genetic basis of Inheritance, Heredity Importance of Genetics Mendel's Law: Law of Segregation, Mono Hybrid. Law Of Independent Assortment- Di Hybrid and Tri Hybrid	3
8	Chromosomal aberrations and Mutations.: i. Variation in chromosome number – types, dosage compensation and barr bodies (Human). ii. Variation in chromosome structure – types, generation of variation,	3
9	• Sex Determination and Recombination: Linkage and Recombination- Discovery of Linkage, Complete and incomplete linkage, crossing over, Two point & Three-point cross Cytological Proof of Crossing Over, • Mechanism of Sex Determination i. Homo and Heterogametic Theory, ii. Coincidence and interference iii. X-Linked Inheritance iv. Non Mendelian Inheritance v. Pedigree Analysis	6
10	• Genetic Disorders i) Sickle Cell Anemia, ii) Hemophilia,	3

	iii) Colour Blindness, iv) Albinism, v) Down's Syndrome	

Suggested readings

1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, 5th Edition (2007)BruceAlberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
5. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
6. 6. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
7. Genetics, by Strickberger M W (2006) (Prentice Hall, India)
8. Fundamentals of Genetics. B.D Singh
9. Genetics: analysis of genes and genomes by Hartl DL, Jones EW (2001) –(Jones and Bartlett, Massachusetts)
10. Introduction to genetic analysis by Griffiths AJ, Wessler SR, Carroll SB, Doebley J (Freeman & Co, New York) tenth edition.
11. Molecular genetics of bacteria (ASM Press, Washington) Snyder L, Champness W (2007)
12. Textbook of Cell Biology, Genetics, molecular biology , Ecology and Evolution.: P.S. Verma

SEM - III: Major Core

Course Code: BT-202-T

Course Name: Molecular Biology & Metabolism

Credit: 2T

Course Objective

- To provide an insight of basic organization and way of production of genetic material
- The course objectives cover topics such as gene expression, DNA replication, transcription, translation, and gene regulation, as well as the role of these processes in various biological systems.
- To provide the knowledge about, how energy is gathered? and reaction take place to keep cell working.
- The course on metabolism aims to provide students with a comprehensive understanding of metabolic pathways, their regulation, and their significance in various biological contexts.

Course outcomes:

1. Students learn about the structure, function, and importance of biomolecules like proteins and lipids
2. Students learn how to collect, analyze, and interpret experimental data Students learn how to use techniques to study molecular processes
3. Students learn how to locate, understand, and evaluate scientific information Students learn how to communicate their findings
4. Students learn how to analyze scientific information ethically

Unit	Title	L
	Molecular Biology	
1	**Basic Concepts of genome** Nucleic acid as the genetic material (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment), Importance of Molecular Biology, Central Dogma of Molecular Biology, Model organisms for studying Molecular Biology.	3
2	**Structure and functions of Nucleic acids:** Nucleosides & Nucleotides, purines and pyrimidines. Biologically important nucleotides, Watson and Crick model of DNA structure, A, B & Z forms of DNA, Supercoiled and relaxed DNA, denaturation and renaturation of DNA, melting temperature (Tm), hyperchromic effect.	3
3	**Genome and its organization:** (Idea about gene, coding sequence, regulatory sequence, intron, exon, Nucleosome structure and packaging of DNA into higher order structures, brief idea of chloroplast DNA and Mitochondrial DNA). Replication of DNA in prokaryotes Features of DNA Replication, Proof of semiconservative nature of DNA replication, Features of bidirectional DNA replication. Mechanism of bidirectional DNA replication Gene expression RNA structure and types of RNA,	2

4	**Transcription in prokaryotes with *E.Coli* as model system:** Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains, Genetic code, properties of genetic code, Wobble hypothesis, hungry codon syndrome, codon usage bias	2
5	**Components of Protein synthesis machinery:** Messenger RNA, t RNA structure and function, Charging of tRNA, aminoacyl tRNA synthetases, ribosome structure and assembly, Mechanism of protein synthesis in prokaryotes: initiation, elongation and termination. Principles of gene regulation, negative and positive regulation, concept of operons,	2
6	**Regulation of gene expression in bacteria:** lac operon arabinose and tryptophan operon, lytic and lysogeny regulation. Damage, Repair and Mutation Causes (spontaneous, chemical agent, radiation) and types of DNA damage Mechanism of DNA repair: Direct repair, base excision repair, nucleotide excision repair, mismatch repair, recombination repair. Molecular basis of mutation, types of mutation (missense mutation, nonsense mutation, silent mutation, point mutation, frameshift mutation).	3
	Metabolism	
7	**Carbohydrate metabolism:** Aerobic & Anaerobic glycolysis, sequence of reactions in glycolysis, regulation in glycolysis, Pyruvate metabolism, citric acid cycle & its regulation, glycogenesis, glycogenolysis (sequence of reactions & regulation), Pentose-phosphate pathway (sequence of reactions & regulation),	4
8	**Lipid Metabolism** Fatty acid biosynthesis and degradation, Franz Knoop's experiment, β, α, ω, oxidation, trans fats. Synthesis and degradation of steroids and glycolipids	4
9	**Bioenergetics** Energetics, Redox reaction, mitochondrial structure and its role in energy metabolism, electron transport system. ATP synthesis and chemo-osmotic hypothesis of ATP generation.	2
10	**Photosynthesis:** Light reactions. Photosystem, z Scheme, Andre Jagendrofs experiment, carbon fixation and reduction, RUBISCO, its regulation, Photorespiration and CAM.	2
11	Introduction to secondary metabolites, such as alkaloids, non-protein amino acids, amines, cyanogenic glycosides, glucosinolates, lignin, suberin, terpenoids and phenolics and its benefits.	3

References:

1. Molecular biology and biotechnology Edition: 4th Walker, John M, Rapley, Ralph Molecular biology of the gene Edition: 5th Watson, James D
2. Molecular biology and biotechnology Meyers, Robert A
3. Principles of molecular biology Edition: Rev. & enl. 2nd Rastogi, Veer Bala Molecular Biology of the cell: Bruce Alberts
4. Molecular Biology of the cell: Harvey Franklin Lodish Biochemistry: Nelson and Cox
5. Biochemistry: Stryer Biochemistry: Voet and Voet
6. Outlines of Biochemistry: Conn and Stumph

SEM - III: Major Core
Course Code: BT-203-P
Course Name: Practical in Cell Biology and Genetics
Credit: 2P

Course Objective

- To develop the skill to observe the human eukaryotic cells and isolate the cell organelles
- To develop a skill to observe the division mechanism of cells
- To develop analytic skill to find the various inheritance pattern in organism

Course Outcome

- Students gets hands on training and learn technique to isolate and observe the various cell organelle likes mitochondria, chloroplast.
- Students learn to measure the size of various cells using micrometry
- Students learns the technique to observe the various stages of cell division
- Students learn to solve genetics problem regarding various inheritance pattern to learn theory behind it

Sr. No.	Topic	No. of Practical
1	Staining and Observation of human cheek epithelial cells	1
2	Micrometry- Measurement of cell size taking different types of cells.	1
3	Study of bacterial and fungal diversity of air/soil	1
4	Isolation and characterization of the following subcellular components, using appropriate samples, by differential centrifugation: ii. Mitochondria: Succinate Dehydrogenase assay iii. Chloroplast : Microscopic Observation	2
5	Study of different stages of Mitosis	1
6	Study of different stages of Meiosis in *Tradescantia*	1
7	Methods of cell lysis and confirmation	1
8	Problems set of Linkage and Pedigree analysis • Mendelian inheritance and Non Mendelian Inheritance Monohybrid cross. Dihybrid cross and Trihybrid cross • 2-point cross. 3-point cross and genetic mapping. • Tetrad analysis: Chromosome interference, analysis of ordered and unordered tetrads. • Sex linked inheritance	5
9	Studies on karyotype analysis	1

SEM - III: VSC
Course Code: VSC-201-BT-P
Course Name: Practical in Molecular Biology & Metabolism
Credit: 2P

Course Objective:

- A molecular biology course aims to provide students with a foundational understanding of the molecular mechanisms underlying biological processes, including how DNA, RNA, and proteins interact and are regulated within cells.

Course Outcome

- Students will isolate, characterize, estimate, and purify DNA, RNA, and proteins interact and are regulated within cells.
- Students will learn about the biochemical principles underlying energy metabolism, including the roles of macronutrients and micronutrients, and the interconnections between different metabolic pathways.
- The course also delves into the clinical implications of metabolic disorders and explore how metabolic pathways can be manipulated for therapeutic purposes.

Sr. No.	Title	No. of Practical
1.	Preparation of Buffer stocks (TBE, TE and TAE)	2
2.	Extraction of DNA from plant, animal and bacteria	2
3.	Assess purity of DNA by Agarose gel electrophoresis	1
4.	Determine Tm of DNA	1
5.	Estimate RNA and DNA by orcinol and DPA method	2
6.	Demonstration of native PAGE and staining	2
7	Demonstration of SDS PAGE	2
8	Extraction of cholesterol and lecithin from egg yolk and its estimation	1
9	Demonstrate the extraction and qualitative and quantitative estimation of secondary metabolites	2

SEM - III: Minor
Course Code: MN-201-BT-T
Course Name: Applied Biotechnology
Credit: 2T

Course Objective

- To build an awareness about the scope of biotechnology in various fields of Science and Technology
- To motivate the students to apply the knowledge and skills of Biotechnology for interdisciplinary research, innovation and entrepreneurship.

Course Outcome

- Student will acquire a multifaceted knowledge in the area of Biotechnology
- Student will develop an understanding about the applications of Biotechnology in different fields of science
- Student can apply knowledge in the field of food, environmental and agricultural biotechnology
- Student will acquire knowledge about various new concepts in the field of Biotechnology.
- Student can apply knowledge in the field of nanotechnology

Sr. No.	Topic	No. of lecture (30)
1.	**Biotechnology in Environment:** Generation of alternate fuels: ▪ 1st Generation Biofuels: Bio-alcohol (Corn, sugarcane). Syngas, Biodiesel, Biogas ▪ 2nd Generation Biofuels: Cellulosic Biofuel, Biohydrogen, Bioethanol ▪ 3rd Generation Biofuels: Algae fuel Biotransformation of recalcitrant xenobiotics (with example), Waste water treatment Green technology: Definition, concepts and implication, role of green technologies towards a sustainable development	4
2.	**Biotechnology in Agriculture:** Introduction, Scope, Importance and role of Agricultural Biotechnology in India, concept of Urban agriculture Classical vs modern Agricultural biotechnology Biofertilizers and Biopesticides- Definition, scope and importance Concept of genetic manipulations to develop new plant varieties (Case study- Bt Cotton)	4
3.	**Food Biotechnology:** Macro-and micro nutrients and its role in human nutrition Introduction to food additives, Prebiotics, Probiotics and Nutraceuticals	5

	Food contaminants and adulterants and their effects on human health Food waste management and development of value added products Use of microbes in the production of alcohols (Beer, Wine), bread, dairy products Food safety and standards, HACCP System to food protection	
4.	**Biotechnology in human Health:** Applications of Biotechnology in- Disease diagnosis, prevention and treatment - Significance, Scope with suitable example Drug discovery- Concept, Significance and Scope	4
5.	**Marine Biotechnology:** Marine Biotechnology: Significance Marine bio-resource, its applications and their pharmacological potential Concept of barophilic organisms & their applications Seaweeds for removal of metal pollutants Microalgae- Importance, Biotechnology approach for production.	4
6.	**Nano biotechnology:** Introduction to Nano biotechnology Concept of bio fabricated nano-particle and their characterization Different nanostructure (Nano spheres, Nano capsules, dendrimers) and its significance in biological applications Applications of nano-materials in environment, agriculture and biomedicine	6
7.	**Systems and Synthetic Biology in Biotechnology:** Principles of Systems Biology, applications of systems Biology in Biotechnology. Principles, applications and scope of synthetic Biology	3

Suggested Readings:

1. Biotechnological Applications in Environmental Management: Author: TrivedyR. K., Sadhana Sharma
2. Principles and Applications of Environmental Biotechnology for a Sustainable Future Editors Ram Lakhan Singh Springer
3. Textbook of Agricultural Biotechnology. 2008 by Nag and Ahindra
4. Anthony Pometto (2005). Food Biotechnology, 2nd Edition. CRC Press
5. Byong H Lee (2014). Fundamentals of Food Biotechnology, 2nd Edition, Wiley Blackwell
6. Marine Biotechnology. 2021 by Shubha Agarwal Govil (Author)
7. Essentials of Marine Biotechnology. 2019. By Se-Kwon Kim
8. Nanobiotechnology: Concepts, applications and Perspectives, Christof M.Niemeyer (editor), Clad AMirkin (Editor), Wiley VCH, First edition, 2004.
9. Systems and synthetic Biology by Vikram Singh and Pawan K.Dhar, Springer Publication. 2015

SEM - III: Minor

Course Code: MN-201-BT-P
Course Name: Practical in applied Biotechnology
Credit: 2P

Course Objectives:

- To develop an understanding of importance of Biotechnology applications in various sectors of Science.
- To impart the practical knowledge and skills of Biotechnology for interdisciplinary research.

Course Outcomes:

- Students will learn basic techniques and applications of Biotechnology through hands-on training.
- Students will be able to demonstrate and apply the skills acquired in different sectors of Biotechnology for human health and sustainable development.
- Students will be able to solve problems using biotechnology principles.

Sr. No.	Topic	Practical (15P)
1	Introduction to Biotechnology Laboratory and study of common Biotechnology laboratory instruments	**1**
2	Study of pollution indicator plants (morphology and anatomy of any 5plants)	1
3	Qualitative detection of biotransformation of pollutant/ pesticide	1
4	Qualitative detection of adulterants in different food samples	1
5	Detection of Carbohydrates in food sample	1
6	Qualitative analysis of proteins in food sample	1
7	Quality assessment of pasteurized milk by MBRT method	1
8	Demonstration of determination of Standard Plate Count of Milk and Food samples	1
9	Production of wine / alcohol using fermentation technique and detection of the product.	1
10	Production of Spirulina/ Azolla culture	1
11	Demonstration of effect of Biofertilizer on plant growth using pot culture	2
12	Bioactive compound / chitin isolation and identification from marine bio-resource	1
13	Synthesis of metal/metal oxide Nanoparticles by Microbial /Plant based method and its Spectrophotometric analysis (UV/ IR)	1
14	Biological activities of nanoparticles- Antibacterial activity of synthesized nanoparticles	1

SEM - III: GE/OE
Course Code: OE-201-BT-T
Course Name: Wine Technology
Credit: 2T

Course Objective

- Understand the history, classification, and global significance of wine.
- Explain the wine production process from grape harvesting to aging and bottling.
- Analyze the economic impact, trade dynamics, and marketing strategies of the wine industry
- Explore emerging trends, sustainability practices, and career opportunities in wine making.

Course Outcomes (COs):

- Students will demonstrate knowledge of winemaking techniques- fermentation and maturation.
- Students will assess grape varieties, wine quality, flavor profiles used in different wine types.
- Students will evaluate wine business strategies, tourism models, and consumer preferences.

Sr. No.	Topic	No. of lecture (30)
I	**Introduction to Wine, Winemaking and viticulture** • Introduction to different beverages, concept of wine, • Health benefits of wine, • History & Evolution of Winemaking • Major Wine-Producing Regions • Wine Classifications & Types (Red, White, Rosé, Sparkling, Fortified) • Basic Winemaking Process and important terminologies of wine • Importance of Grapes in Winemaking • Grape Varieties & Their Impact on Wine Quality • Global Wine Industry Overview	15
II	**Wine Production & Technology** • Wine Making Process-I (Pre-fermentation): Harvesting of grapes, crushing, preparation and extraction of must, maceration • Wine Making Process-II (Fermentation process): Concept of fermentation, types and parts of fermenter, parameters affecting fermentation • Wine Making Process-III (Post-fermentation): Flavour enhancement and aging of wine, barrel ageing and maturation in bottle, quality control, bottling and cellar system.	10
III	**Wine Economics & Trade** • Role of Wine in Hospitality & Tourism	5

	• Wine Tourism Destinations & Business Models • Global Wine Market Trends • Career Opportunities in the Wine Industry	

Suggested Readings:

1. Ronald S. Jackson (2002) Wine Testing a professional handbook
2. Ron s. Jockson (2000) Wine science principles practices & perception
3. Vine, Richard p (1997) Wine Appreciation
4. Emile Peynavd (1997) The taste of wine
5. Brue W. Zoecklein, Kenneth Fugelsang, Barry H. Gump Fred S. Nury (1999) Wine Analysis and Production

SEM - III: GE/OE
Course Code: OE-202-BT-T
Course Name: Dairy Technology
Credit: 2T

Course Objective

- To equip the students with the knowledge and professional skills necessary to understand and apply principles of milk and milk processing in Dairy industry
- To inculcate the knowledge and importance of quality control and preservation in Dairy industry.

Course outcomes:

- Student will acquire the knowledge about the opportunities in dairy field.
- Student will develop skills of milk and milk product processing
- Student will understand the causes of milk spoilage and prevention of milk and milk products from spoilage
- Student will develop skills required in the various sectors of dairy industry.
- Student will acquire the knowledge about the pathogen and milk borne diseases.
- Student will develop income generating potential

Unit	Topic	No. of Lectures (30)
I	**Livestock diversity and its Management:** Livestock diversity in India and its importance Role of livestock in Agriculture Selection of elite animals Characteristics of ideal dairy farm Management of milking animals Animal health management and its impact on milk quality Milking systems and hygienic milk production	**10**
II	**Milk Process Technology:** Nutritional importance of milk and its constituents Collection methods of raw milk and its impact on milk quality Method of Sampling of raw milk. Quality assessment of raw milk Processing of milk and its significance: cooling, separation, standardization, homogenization and pasteurization and its types Types of milks and its production- pasteurized, standardized, toned, double toned, flavored milk. Production of milk products- Yogurt, butter, buttermilk, paneer, Dairy plant hygiene and sanitation, disposal of dairy waste	14
III	**Quality Assurance of Milk** Spoilage of milk and milk products by microorganism and its control.	6

	Different packaging Materials, importance of packaging in milk and milk product preservation Quality assurance of dairy products: Quality assurance (ISO 9001:2000) and food safety system (HACCP) Quality assessment of milk- detection of adulteration	

Selected Readings:

1. Outline of Dairy Technology - Sukumar De, Oxford University Press 2008
2. Technology of Milk processing- Khan QA and Padmanabhan, ICAR, New Delhi.
3. Principle of Dairy Processing- J. N. Warner, Wiley Eastern Ltd. New Delhi.
4. A Text Book of Dairy Engineering, C.N. Hall
5. Engineering for Dairy and Food Products, E.M. Farral
6. Food Engineering and Dairy Technology, Ing. H.G. Kessler
7. Modern Dairy Technology Vol I & II, R.K. Robinson
8. Dairy Technology and Engineering, Harpar and Hall
9. Dairy Processing Technology. Sangu, K.P.S (2002)
10. Robinson, R.K. (1991) Dairy Microbiology, The microbiology of milk, Applied Science publisher, London.
11. Pasteurized Milk Ordinance (PMO), Potter, N., Hotchkiss, J. H., 1995 Milk and milk products. In: Food Science, 5th Edition, Chapman
12. Fundamentals of Dairy Microbiology, J.B. Prajapati

SEM - III: IKS

Course Code: IKS-201-T

Course Name: Biotechnology in ancient India

Credit: 2T

Unit	Topic	No. of Lectures (30)
I	Definition, Scope of subject specific IKS IKS based approaches on Knowledge Paradigms IKS in ancient India and in modern India Introduction to the historical context of ancient Indian biotechnology Earliest example of biotechnology	**2**
II	**Ayurveda** • Introduction to Ayurveda, the ancient Indian system of medicine • Ayurvedic preparation of herbal medicine • Ayurvedic pharmaceutical formulations • Modern herbal medicines • Methods of extraction of bioactive compounds from plants and other sources • Ancient Indian example of Nanotechnological intervention in medicine • Preparation of Ayurvedic medicines and cosmetics • Preparation of Aasav, Arishta using fermentation technology • Concept of 'sookshma' • Concept of dosages	8
III	**Indian traditional food & Biotechnology in preparation and preservation food** • Traditional probiotic foods and their importance in human health • Understanding rich sources of nutrients • Concept of Microbiology practices in food preparation such as fermentation, starter culture and preinoculum, food spoilage. • Fermented food, drink, fermented dairy products • Methods of food preparation and preservation, drying, pickling • Traditional Alcoholic Beverages • Water purification - Boiling, alum treatment	8
IV	**Indian Agriculture** • Agricultural heritage – early history & its importance • Ancient agricultural practices • Indus civilization and relevance of heritage to present day agriculture • Plant protection through indigenous traditional knowledge during harvesting, threshing and storage	8

	• Indigenous & introduced crops: rice, sugarcane and cotton. • Plant and animal breeding techniques • Development of new plant varieties and animal breeds • Chimeric grafting technique • Selection & preservation of seeds, concept of seed bank	
V	**Indian medicinal plants** • Medicinal plants traditionally used for treatment of diseases • Use of herbal medicine, and its links to cultural practice • Religious importance of plants • Religious culture linked to science	4

1. Biotechnology in India: The beginnings, Pushpa M. Bhargava 2009
2. Drumavicitrikaranam -Plant Biotechnology in Ancient India, Dr. Shakuntala Gawde 2024
3. Science and Civilization in India" by D.P. Chattopadhyaya
4. "Indian Alchemy: Soma in the Veda" by J.N. Banerjee
5. "Ayurveda: The Science of Self-healing" by Dr. Vasant Lad
6. "Agricultural Techniques in Ancient India: Origins and Practices" by Vidula Jayaswal
7. "Ancient Indian Agriculture: Genesis, Geography, and Practice" by Dilip K. Chakrabarti
8. "The Ancient Heritage of India: An Introduction" by Upinder Singh
9. "Fermented Foods of the World: A Dictionary and Guide" by Geoffrey Campbell-Platt

SEMESTER-IV

SEMESTER-IV

SEM - IV: Major Core
Course Code: BT-251-T
Course Name: Animal Development
Credit: 2T

Course Objective:

- To provide basics knowledge of animal development and its significance in research and in medical biotechnology

Course Outcome

- Students learn theory behind development of embryo to organism.
- Students will understand the mechanism of tissue organization and pattern of arrangement various organ in specific manner.
- Students will understand the theory of development of embryo to adult and aging
- Students will learn the theory of ageing and concepts of apoptosis and its significance

Unit	Topic	No. of Lectures
1	History of developmental biology, Model organisms in study of developmental biology: frog, chick, mouse, Drosophila, Sea urchin, Zebra Fish , *Caenorhabditis elegans*	3
2	Reproduction and Development: • Basics of gametogenesis: Oogenesis, spermatogenesis and spermiogenesis • Detailed structure of gametes • Fertilization process in sea urchin and mammals • Types of eggs, types and patterns of cleavage • Morphogenetic movements	10
3	Gastrulation • In *Amphioxus*, chick up to formation of three germinal layers	5
4	Basics of neurulation	2
5	Concept of pattern formation • Maternal effect genes and their role in Drosophila pattern formation	2
6	Concept of Stem cells, Progenitor cells, cell lineages, determination, commitment and differentiation, re differentiation and trans-differentiation	2
7	Different types of regeneration with one example of each type Theories of ageing	3
8	Apoptosis during Embryonic development, intrinsic an extrinsic pathway Abnormal development and teratogenesis in animals	3

Suggested Readings

1. Development Biology, 9th edition, (2010), Gilbert S.F.(Sinauer Associates, USA)
2. Principles of Development, 5thedition (2018), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.
3. An introduction to embryology, 5th edition, B. I. Balinsky, B.C. Fabian (2012) Cengage Learning India

SEM - IV: Major Core
Course Code: BT-252-T
Course Name: Plant Development
Credit: 2T

Course Objective:
- Explain the unique features of plant development at the cellular, organ, and whole-plant levels.
- Describe the phases of sexual reproduction in plants, including gametophyte development and fertilization.
- Analyse the major phases of plant development, from embryogenesis to reproductive maturity.
- Understand the applications of plant development in biotechnology, including parthenogenesis and molecular regulation.

Course Outcomes (COs):
- Students will demonstrate knowledge of competence, differentiation, and developmental plasticity in plants.
- Students will interpret the role of plant growth regulators in vegetative and reproductive development. Students will explain pattern formation in flowering plants using ABC models.
- Students will apply concepts of plant development to biotechnology, including seed dispersal, parthenocarpy and model organisms.

Unit	Topic	No. of Lectures
I	**Plant as a living system** • Unique features of plant development, Plant development at Cellular, organ and whole-plant levels, • Concept of competence, Determination, Commitment, Differentiation, De-differentiation and Re-differentiation (partial/terminal) in vivo.	5
II	**Phases of Sexual Reproduction in plant** • Microsporogenesis-development of male gametophyte and male gamete, Megasprogenesis-development of female gametophyte and female gamete, • Double fertilization and triple fusion, • Development of endosperm and its types	5
III	**Major phases of plant development** • Vegetative development: Zygote to seed embryo (monocot and dicot), embryo to seedling till vegetative maturity, Pattern formation in plants, • Role of plant growth regulators Reproductive development: Shift from vegetative to reproductive phase, • Induction- perception of inductive stimuli and subsequent changes, Pattern formation in flowering (ABCDE model),	11

	• Role of plant growth regulators Developmental plasticity, Programmed Cell Death- ageing, senescence and necrosis	
IV	**Plant development in Biotechnology** • Model systems to understand plant development - Arabidopsis, Molecular regulation of development in Arabidopsis • Parthenogenesis- Haploid and Diploid;Parthenocarpy – Natural , Induced; Importance of seed and seed dispersal; • Applications of Plant development in Biotechnology	9

Suggested Readings:

1. Development Biology, 9th edition, (2010), Gilbert S. F. (Sinauer Associates, USA)
2. Principles of Development, 4th edition (2010), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.
3. Bhojwani S.S. and Bhatnagar S.P. (2009) – Embryology of Angiosperms (Vikas Publ House, New Delhi) 5.
4. Burgess J. (1985) An Introduction to Plant Cell Development (Cambridge Univ Press, UK)
5. Taiz L, Zeiger E (2010) – Plant physiology (Sinauer Associates, USA).
6. Sharma HP (2009) – Plant embryology: Classical and experimental (alpha sci)
7. Steeves TA & Sussex IM (2004) – Patterns in plant development. (Cambridge Univ Press, Cambridge, New York)
8. The molecular life of plants by Jones et al Wiley Publivations
9. Biochemistry and Molecular Biology of Plants, 2nd Edition - Bob Buchanan et al Wiley
10. Plant Physiology, Taiz and Zeiger Sixth edition Sinaeur

SEM - IV: Major Core
Course Code: BT-253-P
Course Name: Practical in Plant and Animal Development
Credit: 2P

Course Objective:

- To aware the students the development of embryo, regeneration of organism and thereby its importance in biotechnology research
- Demonstrate proficiency in dissection, sectioning, staining, and mounting techniques for studying plant development.
- Identify and analyze the structure and function of root apical meristem (RAM), shoot apical meristem (SAM), and florally induced meristem.
- Understand the processes of microsporogenesis and gametophyte development through practical observation.
- Examine the stages of plant embryogenesis in monocots and dicots and their significance in plant development.

Course outcome:

- Students will learn the technique to observe the different stages of chick embryo development.
- Students will understand the concept of regeneration using hydra as model
- Students will apply microscopic techniques to study plant developmental structures, including meristems and gametophytes.
- Students will perform anther squash techniques to observe microsporogenesis and pollen development.
- Students will analyze the developmental stages of plant embryos in monocot and dicot species.
- Students will gain practical exposure to nursery/agricultural practices through field visits and observations.

Sr. No.	Topic	No. of Practical
1	**Animal Development** Study of amphioxus development, observation of different development stages (Permanent slides)	1
2	Study of staging & staining of Chick embryos (24 h, 48h, 72 h)	3
3	Effect of teratogen on development of chick embryo by window technique	1
5	Demonstration of regeneration in *Hydra*	1
6	Study of development stages and culturing drosophila	2
	Plant Development	
7	Methods of studying plant development (using suitable plant material) a) Dissection b) Sectioning c) Staining d) Mounting	1
8	Study of apices and meristem –Root apical meristem (RAM), shoot apical meristem (SAM), florally induced meristem	2
9	Microsporogenesis- anther squash technique	1

10	Development of male and female gametophytes	1
11	Study of developmental stages during plant embryogenesis in dicot and monocot.	2
12	Visit to agricultural university/nursery	1

SEM -IV: VSC
Course Code: VSC-251-BT-P
Course Name: Practical Biochemistry
Credit: 2P

Course Objectives:

- The main objectives of a practical biochemistry course are to equip students with laboratory skills, enhance their understanding of biochemical principles, and enable them to apply these skills in research and problem-solving.
- Specifically, students learn to perform common biochemical techniques, analyze data, and critically evaluate research findings.

Course Outcomes

- In essence, a practical biochemistry course aims to bridge the gap between theoretical knowledge and practical application, preparing students for careers in research, industry, and healthcare.
- Students are trained in safe laboratory practices and the importance of meticulous record-keeping and data integrity.
- Students gain practical experience with various biochemical techniques, such as preparing solutions, running assays, using spectrophotometers, and performing chromatography

Sr. No.	Topic	No. of Practical
1	Qualitative Analysis of Carbohydrates	1
2	Isolation of starch from potatoes	1
3	Isoelectric Precipitation of Proteins: Casein from Milk	1
4	Quantitative Estimation of Amino Acids by Ninhydrin	2
5	Estimation of Saponification Value of Fats/Oils	2
6	Estimation of blood glucose by Glucose oxidase method	2
7	Determine the concentration of SGPT and SGOT	2
8	Estimate the concentration of cholesterol	2
9	Separation of Amino Acids by Thin Layer Chromatography	2

SEM - IV: Minor

Course Code: MN-251-BT-T
Course Name: Fundamentals of Genetic Engineering
Credit: 2T

Course Objective:

- A genetic engineering course aims to familiarize students with the fundamental principles and techniques of recombinant DNA technology and its applications.
- It also aims to equip students with the knowledge of various approaches to conducting genetic engineering, its applications in biological research, and the biotechnology industries

Course outcome:

- Students learn about techniques such as gene cloning, PCR amplification, protein purification, and basic culture handling
- Students learn how to design and conduct genetic engineering experiments
- Students learn how to analyze and interpret data from genetic engineering experiments
- Students learn how genetic concepts affect societal issues such as health, disease, food, and the environment
- Students learn about the role of genetic mechanisms in evolution

Unit	Topic	No. of Lectures
1	Genes, genetic code and factors that control gene expression	2
2	Enzymes in Genetic engineering, exo, endo nucleases, restriction endonucleases, Ligases, Phosphatases, Polymerases.	3
3	Isolation of Nucleic acids genomics, plasmid, and RNA, methods of its detection	3
4	Vectors: Plasmids, Bacteriophage λ and M13, Cosmid, Phagemid, BAC, YAC Insertional, replacement, expression.	4
5	Gene transfer techniques: Biological, physical, mechanical, and Chemical methods	5
6	PCR: Introduction, PCR Cocktail, Reactions, Primer designing, primer purchasing, PCR variants, Medical, Infectious disease, Forensic, Research and diagnostic applications, variants, and limitations	3
7	Transgenic science in animal and plant improvement, transgenic animals, RNAi, Embryonic stem cell technology, DNA microinjection, Sperm mediated gene transfer, characterization of Transgenic animals, Plant Bioreactors, Pharming,	5
8	Engineering Microbes for production of inclusion bodies, antibiotics, hormones, monoclonal antibodies, clearing oil spills, and enzymes	3
9	Gene therapy: methods, challenges, and applications, Crispr CAS 9 system	2

Suggested Readings

1. Molecular Cloning: A Laboratory Manual by Joseph Sambrook and David Russell

2. Gene Cloning and DNA Analysis by TA Brown
3. DNA Technology by Alcamo
4. Principles of Gene Manipulation and Genomics by Sandy B. Primrose and Richard Twyman

SEM - IV: Minor

Course Code: MN-252-BT-P

Course Name: Practical in Fundamentals of Genetic Engineering

Credit: 2P

Course Objective:

- A practical genetic engineering course aims to provide hands-on experience with techniques and applications, focusing on developing skills in genetic manipulation and analysis.
- Students learn to apply theoretical knowledge to real-world scenarios, exploring applications in various fields like agriculture, medicine, and biotechnology.
- The course emphasizes practical skills like DNA isolation, cloning, transformation, and analysis of results.

Course outcome:

- Understanding the basics of genetic engineering:
- This includes the fundamentals of DNA, genes, and inheritance, as well as the history and development of genetic engineering.
- Students will learn about techniques like restriction enzymes, ligases, and cloning vectors, and how they are used to manipulate DNA.
- This may involve hands-on laboratory work, such as DNA manipulation, cloning, and gene expression analysis.

Unit	Topic	No. of Practical
1	Plasmid Isolation and Purification	1
2	Competent Cells Formation and Transformation of Competent Cells with recombinant plasmid DNA	2
3	Extraction of RNA from baker's yeast	2
4	Perform restriction digestion of λ DNA	2
5	Ligate the digested sample	2
6	Colony PCR	1
7	Demonstrate the Crispr Cas-9 by paper model	1

SEM - IV: GE/OE
Course Code: OE-251-BT-P
Course Name: Practical in Wine Technology
Credit: 2P

Course Objective:

- Understand the function and application of key laboratory instruments used in wine technology.
- Analyze the grapevine life cycle, grape berry structure, and its role in winemaking.
- Perform sensory evaluations to detect sweetness, acidity, bitterness, and saltiness in wine.
- Develop practical skills in wine tasting, quality assessment, and sensory analysis.

Course Outcomes:

- Students will demonstrate proficiency in measuring sugar content (°Brix), pH, and total dissolved solids in wine.
- Students will identify different wine glasses, bottles, and their impact on wine presentation.
- Students will apply fundamental wine production techniques and fermentation processes through hands-on demonstration.
- Students will analyze and report insights from winery visits, wine tasting, and industry practices.

Unit	Topic	No. of Practical
1	Introduction to Wine technology laboratory and study of common Wine technology laboratory instruments e.g. Refractometer, Hydrometer, Colorimeter, pH Meter, Distillation Unit, Balance etc.	**1**
2	Study of grapevine and its life cycle	**1**
3	Study of grape berry	**1**
4	Determination of total dissolved solids (sugar content in degree Brix) grapes/fruits juice and wine	**1**
5	Determination of pH of grapes/fruits juice and wine	**1**
6	To study threshold detection of acid taste.	**1**
7	To study threshold detection of sweet taste.	**1**
8	To study threshold detection of bitter taste.	**1**
9	To study threshold detection of salt taste.	**1**
10	Types of wine glasses and bottles	**1**
11	Demonstration of wine production and qualitative detection of alcohol in wine sample	**2**
12	Introduction to Wine Tasting • Five steps of wine tasting (See, Swirl, Sniff, Sip, Savor) • Differentiation of basic wine types & styles. • Evaluation of wine quality, aroma, and taste.	**2**
13	Virtual visit to winery and report writing	**1**

Suggested Readings:

1. Ronald S. Jackson (2002) Wine Testing a professional handbook
2. Ron s. Jockson (2000) Wine science principles practices & perception
3. Vine, Richard p (1997) Wine Appreciation
4. Emile Peynavd (1997) The taste of wine
5. Brue W. Zoecklein, Kenneth Fugelsang, Barry H. Gump Fred S. Nury (1999) Wine Analysis and Production

SEM - IV: GE/OE
Course Code: OE-252-BT-P
Course Name: Practical in Dairy Technology
Credit: 2P

Course Objectives:

- To impart the practical knowledge and skills required to become a professional in the dairy industry.
- To enhance understanding of importance of safety and quality in Dairy industry.

Course Outcomes:

- Students will learn basic milk processing techniques through hands-on training.
- Students will develop the ability to apply skills for processes and practices used in the dairy industry.
- Students will be able to analyze and report the quality of milk and dairy products.
- Students will be equipped to be a professional in Dairy industry.

Sr. No.	Topic	Practical (15P)
1	Introduction to dairy/ milk laboratory and study of common dairy laboratory instruments	**1**
1	Study of various platform test on receiving of milk such as 1) organoleptic evaluation verification of container, 2) temperature, 3) odour, dirt & dust, taste, 4) COB test 5) Milk lactometer	2
2	Determination of pH/ acidity of milk	1
3	Determination of fat and SNF of milk	1
4	Detection of adulterants in milk samples (starch, urea, sugar)	2
5	Detection of presence of Skimmed milk powder /gelatin in milk	1
6	Qualitative analysis of proteins in milk sample	1
7	Determination of efficiency of pasteurization by Alkaline Phosphatase test	1
8	Microbial analysis of milk- Dye reduction test	1
9	Manufacturing of fermented milk product	1
10	Production of paneer	1
11	Manufacturing of flavored milk	1
10	Virtual visit to modern milk processing plant to study various operations.	1

SEM - IV: SEC
Course Code: SEC-251-P
Course Name: Practical in Agriculture Biotechnology
Credit: 2P

Course Objectives:

- To inculcate necessary practical knowledge and skill for understanding the concept of Biotechnological applications in the field of Agriculture

Course Outcomes

- Students will learn the concept of Agriculture Biotechnology.
- Students will understand the significance of Bio fertilizer
- Students may inspire to start mushroom production unit/ bio pesticide production
- Students will understand concept of bio inoculant and formulation of bio inoculant

Sr. No.	Topic	No. of Practical
1	Production of Spirulina/Azolla culture	2
2	Estimation of chlorophyll and protein from Spirulina/Azolla culture	1
3	Isolation of *Rhizobium* from root nodules of leguminous crop and development of Rhizobium m Bio fertilizer	1
4	Isolation of *Azotobacter* from soil and development of *Azotobacter* Bio fertilizer	1
5	Formulation of Bio inoculant/ Bio fertilizer from isolated *Rhizobacteria* & *Azotobacter* and demonstration of effect on plant growth using pot culture	2
6	Production of Neem pesticide/Nano- pesticide/ parasite and demonstration of its effect on plant using pot culture	2
7	Preparation of compost from vegetable/leaf /fruit/ agriculture wastes	2
8	Cultivation of mushroom using agriculture waste	2
9	Cultivation of medicinal plants nearby college	1
10	Visit to functional greenhouse/ Composting Unit/Mushroom cultivation unit and report writing.	1

SEM - IV: SEC
Course Code: SEC-252-P
Course Name: Practical in Environmental Biotechnology and Biodiversity
Credit: 2P

Course Objectives:

- To understand key ecological concepts, ecosystem structures, and biotic community development.
- To learn about environmental pollution, biodiversity loss, and biotechnological methods for environmental protection.
- To develop practical skills in ecological sampling, soil and water analysis, and bioremediation techniques.

Course Outcomes

- Students will explain the structure and function of natural and artificial ecosystems and the processes of ecological succession.
- Students will identify sources and impacts of different types of pollution and evaluate biotechnological solutions for remediation.
- Students will analyze environmental challenges and assess the effectiveness of sustainable development initiatives.
- Students will apply field and laboratory techniques to assess ecosystem health, microbial diversity, and environmental toxicity.

Sr. No.	Topic	No. of Practical
1	Study the map of India/Maharashtra to locate: a) major sanctuaries, national parks. Botanical Gardens b) Reserve forest/protected areas of S.P. Pune University jurisdiction (Ahmednagar, Nashik and Pune district)	01
2	Study of Biodiversity Hotspots and Biodiversity conservation measures in India	01
3	Field visit to study different types of ecosystems and sample collection	01
4	Study of the field collection specimens, preservation and identification	01
5	Study of community by quadrat/transect methods.	01
6	Study of community by point count method for animal.	01
7	Analysis of terrestrial community for-Percentage of frequency, density, abundance.	01
8	Frequency class diagram and comparison with Raunchier frequency chart	01
9	Study of Physical (Colour, Texture, Water holding capacity) and Chemical (pH, Organic matter content, and alkalinity) properties of soil	02
10	Microbial (Bacterial/Algal/Fungal) community estimation	02
11	Testing cyto/geno toxicity of soil sample	02
12	Report Writing based on field visit data analysis	01