Savitribai Phule Pune University

(Formerly University of Pune)

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

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: The basic criteria for Under Graduate Degree (F.Y.B.Sc. Biotechnology) admission will be 10+2 criteria with Biology, Physics, Chemistry as principle subject Mathematics, Geography, crop sciences as optional subjects
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

Program: B.Sc. BIOTECHNOLOGY

First Year Biotechnology

SEMESTER -I				
Sr. No	**Course Category**	**Course code**	**Course Title**	**Credit**
1	**Subject 1**	BT-101- T	Biotechnology-I	2T
2		BT-102- P	Practicals in Biotechnology-I	2P
3	**Subject 2**	2T	----	2T
4		2P	----	2P
5	**Subject 3**	2T	----	2T
6		2P	----	2P
7	**GE/OE**	OE- 101-BT-T	Fundamentals of Environmental Biotechnology	2T
		OE- 102-BT-T	Fundamentals of Food Biotechnology	
		OE- 103-BT-T	Fundamentals of Agriculture Biotechnology	
8	**SEC**	SEC-101 BT-P	Bioinstrumentation	2P
		SEC-102 BT-P	Microscopic Techniques	
		SEC-103 BT-P	Aseptic Techniques	
9	**IKS**	IKS-101-T	Generic	2 T
10	**AEC**	AEC-101-T	English	2 T
11	**VEC**	VEC-101-T	Environmental awareness	2 T
Total Credit				**22**
SEMESTER -II				
Sr. No	**Course Category**	**Course code**	**Course Title**	**Credit**
1	**Subject 1**	BT-151-T	Biotechnology-II	2T
2		BT-152-P	Practicals in Biotechnology-II	2P
3	**Subject 2**	2T	---	2T
4		2P	---	2P
5	**Subject 3**	2T	---	2T
6		2P	---	2P
7	**GE/OE**	OE-151- BT-P	Practicals in environmental Biotechnology	2P
		OE-152- BT-P	Practicals in Food Biotechnology	
		OE-153- BT-P	Practicals in agriculture Biotechnology	
8	**SEC**	SEC-151 BT-P	Microbial culture techniques	2P
		SEC-152 BT-P	Separation techniques	
		SEC-153 BT-P	Computer in Biotechnology	
9	**AEC**	AEC-151-T	English	2 T
10	**VEC**	VEC-151-T	Environmental Biotechnology	2 T
11	**CC**	CC-151-T	PE/NSS	2 T
Total Credit				**22**

Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship

OR

Continue with Major and Minor

Continue option: Student will select one subject among the (subject 1 Biotechnology), and subject 3) as major and another as minor

SEM - I

SEM - I: Major Core
Course Code: BT-101-T
Course Name: Biotechnology-I
Credit: 2T
No. of lectures: 30

Course Objective:

1. To explain the basic biotechnological processes for utilization of living organisms for commercial use
2. To introduce basic concept of biotechnology, explaining the method/way people used living organism for human use in history of biotechnology

Course Outcomes (COs)

1. Student will understand basic concept of Biotechnology
2. Demonstrate knowledge of essential facts of the history of biotechnology and description of key scientific events in the development of biotechnology
3. Demonstrate knowledge of the definitions and principles of ancient, classical, and modern biotechnologies.
4. Describe the theory, practice and potential of current and future biotechnology
5. explain the use of biotechnology in industry
6. Define genetic engineering and mention its utility
7. Define transgenic organisms, mention the steps in their production and cite a few examples of transgenic plants and animals

Unit	Topic	No of lectures
I	Introduction to Biotechnology: • History of Biotechnology • Types of Biotechnology Applications of biotechnology in • Environment • Agriculture • Industry • Medicine	04
II	**Introduction to Plant Biotechnology:** • Importance of plants in ecosystems and human life, Basic plant structure and organization, A general account of different groups (Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and angiosperms), Overview of plant reproduction and their economic importance with example. • Biotechnological approach to improve crop productivity • Transgenic plants, applications of transgenic plants • Overview of plant tissue culture and its applications	8

	Plants as source of drugs, nutraceuticals	
III	**Introduction to Animal Biotechnology** Introduction to Kingdom Animalia • Outline classification & general characters of chordate non-chordates up to Phylum with examples • Animal models used to understand different aspects of animal biotechnology • Transgenic animals- Concept, basic method, applications • Introduction to animal tissue culture types of different cultures, applications of animal tissue culture	**8**
IV	**Introduction to Microbiology** • History and Evolution of Microbiology. • Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, • Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses. **Observation of Microorganisms:** • Bright field Microscope, • Wet Mount, hanging drop technique • Theory of staining: Classification of stains, Stain (Basic and Acidic), Fixative, Mordant, Decolorizer, Accentuator. Principles and methods of staining techniques for Monochrome, Negative, Differential (Gram, Acid fast), Specialstaining- Endospore, flagella)	**8**
V	• Scope of Biotechnology • Research- Biotechnology Institutions in India • Biotech Industry • Biotech Startup • Incubation centers for Biotech • Biotech Success Stories	**2**

Suggested Readings/Material:

1. Biotechnology: A Textbook of Biotechnology by U. Satyanarayana & U. Chakrapani (Books & Allied Publishers)
2. Biotechnology & Its Applications by R.C. Dubey (S. Chand Publishing)
3. A Textbook of Biotechnology by R.C. Gupta (Rastogi Publications)
4. Introduction to Biotechnology by H.K. Das (Academic Press)
5. Basic Concepts in Biotechnology by Keshav Kumar (New Age International Publishers)

6. Ganguli, Das Dutta (2011) – College Botany Vol I, II and III (New Central Book Agency, Kolkata)
7. Jordan, E.L. and VermaP.S. 1978, (i) Chordate Zoology S. Chand & Company Ltd. Ram Nagar. New Delhi.
8. Jordan, E.L. and VermaP.S. 1978 (ii) Invertebrate Zoology. S. Chand &Company Ltd. Ram Nagar. New Delhi.
9. Modern Text Book of Zoology: Invertebrates.,R.L.Kotpal. Publisher,Rastogi Publications

SEM - I: Major Core
Course Code: BT-101-P
Course Name: Practicals in Biotechnology-I
Credit: 2P

Course Objective:

1. To impart knowledge and skill on understanding the Concepts of Biotechnology.
2. To provide basic knowledge on various biotechnological practices in the laboratory
3. Develop basic laboratory skills relevant to biotechnology practices.

Course Outcomes (Cos):

1. Students will know and acquire practical knowledge about different plant groups and its importance in ecosystem and they will be able to identify different plant groups.
2. Students will study extraction and spectrophotometric estimation of leaf pigments.
3. Students will learn the effect of plant growth regulators on plants.
4. Students will preparation and importance of herbarium.
5. learn the concept of osmosis, diffusion pressure and turgor pressure using potato tubers.

Sr. No.	Title of the Experiment	No. of Practicals
1.	Laboratory safety – General rules and regulations Basic instruments required in Biotechnology Laboratory	**1**
2.	Study of different type of animal cells using permanent slide	**1**
3.	Study of Hydra: Permanent slides • Morphology • Reproduction	**1**
4.	Study of Drosophila: Characters, sexual dimorphism – eye & wing mutations Life cycle	**1**
5.	Observation of Microorganisms. Wet Mount- pond water, fungal staining	**2**
6.	Observation of Microorganisms: Monochrome staining technique	**1**
7.	Observation of Microorganisms: Gram's staining technique	**2**
8.	Study/collection and preservation of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.	**1**
9.	Study of typical plant/plant parts (Monocot and Dicot) and dissection of flower and study of parts of flower.	**1**
10.	Study of epidermal tissue system: stomata, trichrome and root hairs.	**1**
11.	Studies of economically important plants: Students should prepare herbarium specimens with their uses.	**1**

SEM - I: GE/OE

Course Code: OE-101-BT-T

Course Name: Fundamentals of Environment Biotechnology

Credit: 2T

Course Objectives:

1. Understand the fundamental concepts of biotechnology and its environmental applications.
2. Learn about the role of microorganisms in environmental processes.

Course Outcomes (COs)

1. Students will able to explore various biotechnological methods for pollution control and waste management.
2. Students will acquire insights into sustainable practices and their impact on the environment.
3. Students will understand the importance of microorganism in environmental process
4. Students are able explain the fundamental concepts of biotechnology and its environmental applications

Unit	Topic	No of lectures
I	**Introduction to Biotechnology:** • Concept of Biotechnology, Historical perspective and its evolution. • Core areas of Biotechnology: Microbiology, Molecular Biology, Genetic Engineering, Bioinformatics, Applications of Biotechnology. • Exploring the Microscopic World: The world of Bacteria, Protist, Fungi, and Viruses, Beneficial Microbes and their role. • Exploring the Plant and Animal World: The world of Plants and Animals, Role of Plants and animals in human life.	**5**
II	**Introduction to Environment:** • Ecology and Environment: Concepts of ecology and relevance of studying ecology. • Earth and its environment: (Atmosphere, Hydrosphere, Lithosphere, Biosphere) and its inter-relationships (effect of light, temperature, precipitation and topography on growth and development of organism). • Overview of Ecosystem and its structure (Concept, Types & components (biotic and abiotic components), trophic structure, food chain, food web. • Biodiversity: Concept and Definition of Biodiversity, levels or types of biodiversity, • Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.	**10**
III	**Threats to Environment and Role of Biotechnology in**	**10**

	Environmental Protection • Population explosion and environment (Pollution, deforestation, biodiversity loss, waste management etc.). • Environmental pollution: Concept of pollution, types of waste or pollutants (biodegradable, non-bio-degradable, Toxic/non-toxic, biomedical etc.) • Types of pollution: Concept of air, water and soil pollution, sources of air, water and soil pollution (natural and anthropogenic), consequences of air, water and soil pollution • Methods of Environmental Protection: Physical methods, Chemical methods/approaches used to reduce environmental pollution • Biotechnology to address environmental challenges: Bioremediation-Cleaning up pollution with the help of use of microorganisms (bacteria and fungi algae) and plants, • Biofuels-Alternative energy sources derived from biological sources, Biotechnology for biodiversity conservation	
IV	Global environmental issues: • Ozone layer depletion (Montreal protocol), El Nino, • Acid rain - causes and effects, • Global climate change • Greenhouse gases and their impact on the environment • Global warming – effect on oceans, coastline and marine	**5**

Suggested Readings/Material:

1. Biotechnology Laboratory Manual by R.S. Gaud and A.D. Deshpande (Jaico Publishing House, 2010)
2. Practical Biotechnology: Techniques and Experiments by S.K. Singh (Rastogi Publications, 2013)
3. Manual of Microbiology by R.C. Dubey and D.K. Maheshwari (S. Chand Publishing, 2017)
4. Laboratory Manual of Biochemistry by P. Jayaraman (New Age International Publishers, 2018)
5. Plant Biotechnology: Practical Manual by H.S. Chawla (CBS Publishers & Distributors Pvt. Ltd., 2002
6. Elements of Biotechnology by P.C. Joshi (Publisher: PHI Learning Private Limited, 2017)
7. Ecology and environment (2005) Sharma PD Rastogi Publication, New Delhi
8. Environmental Biology (2000) Varma & Agarwal S. Chand Limited, New Delhi
9. Environmental biotechnology (2010) Rana Rastogi Publications, New Delhi

SEM - I: GE/OE
Course Code: OE-102-BT-T
Course Name: Fundamentals of Food Biotechnology
Credit: 2T

Course Objectives

1. To provide the knowledge of various concepts/ methods/ processes of biotechnology used to make food.
2. To impart use of living organism in food transformation to make functional food/ nutraceuticals

Course outcomes:

1. Student will acquire a multifaceted knowledge in the area of Food Biotechnology
2. Student will develop an understanding about the role of diet in human health
3. Student will understand the role of microbes in food biotechnology
4. Student will acquire knowledge about various food borne diseases.
5. Student will understand the significance of food preservation and food analysis
6. Student will learn the importance of food hygiene and food safety

Unit	Topic	No. of Lectures
I	**Basics of Food and Human Nutrition:** • Macro-and micro nutrients and its role in human nutrition • **Carbohydrates-** Dietary sources, Functional properties of dietary carbohydrates • **Amino acids and Proteins-** Important protein sources, Functions of proteins in food • **Lipids-** Definition and classification, biological role and uses of lipids • **Vitamins-** Definition, Classification, general sources, functions and dietary requirements. Deficiency symptoms of vitamins • **Introduction to-** Food additives, Prebiotics, Probiotics and Nutraceuticals • Food contaminants and adulterants and their effects on human health Food allergens	6
II	**Microorganisms in Food Biotechnology:** • Fermentation Technology- Use of microbes in the production of alcohols (Beer, Wine), bread, Yogurt, dairy products • Role of Probiotics in food processing and human nutrition Food spoilage • Food waste management and development of value added products	6
III	Non-Alcoholic Beverages: • Definition of non-alcoholic beverages, current trends of	4

	nonalcoholic beverages (use in health benefits, stress reliever, immune system booster) • Juice based beverages (coconut water, sweet toddy, sugar cane juice, coconut milk, flavored syrups), fruit beverages, tea (Kombucha) coffee, cocoa, spices, plant extract etc.,	
IV	**Food borne diseases:** • Food allergy, Food poisoning, Food intoxication, Food borne infections (Any two examples)	3
V	**Food preservation:** • Shelf life of food • Spoilage of food • Methods of food preservation- Pasteurization, preservation with sugars and salt, chemical preservation, freezing, drying, tetra packing, carbonation • Canning and bottling of fruits and vegetables, Process of canning • Methods and Importance of Packaging in food preservation	6
VI	**Quality assurance and Certification:** • Introduction to quality, Concept of TQM (Total Quality Management) • National and International food laws • Food safety and standards authority of India (FSSAI), Duties and responsibilities of Food Safety Authorities Accreditation and certification • Certification bodies in India BIS, AGMARK	5

Selected Readings:

1. Anthony Pometto (2005). Food Biotechnology, 2nd Edition. CRC Press
2. Fundamentals of Foods and Nutrition by R. Madambi & M.V. Raj gopal.
3. Byong H Lee (2014). Fundamentals of Food Biotechnology, 2nd Edition, Wiley Blackwell
4. Food Preservation by Sandeep Sareen Girdharilal, Siddappaa, G.S and Tandon, G.L., Preservation of fruits &Vegetables, ICAR, New Delhi, 1998
5. Aluko, R.E. (2012). Functional Foods and Nutraceuticals. Springer
6. Ronald H. Schmidt and Gary E Rodrick. 2003. Food Safety Handbook. John Wiley & Sons, Inc.,Hoboken. New Jersey, USA.
7. Gordon L. Robertson Food Packaging principles & practice, Newyork, Marcell Dekker Inc.
8. Bureau of G and Multon J.K Food Packaging technology, (Vol.1 and 2) – VCH publishers, INC, New York.
9. Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.
10. Robinson, R.K. Ed. 1983. Dairy Microbiology. Applied Science, London.
11. A. V. Sathe, A First Course in Food Analysis, New Age International Pvt. Ltd. 1999
12. S. S. Nielsen, Food Analysis Laboratory Manual, Kluwer Academic Publishers,

SEM - I: GE/OE
Course Code: OE-103-BT-T
Course Name: Fundamentals of Agriculture Biotechnology
Credit: 2T

Course Objectives: This course is designed to impart knowledge and skill on understanding the Concepts of Agriculture, crop improvement, Bioinoculants and to understand its association with Biotechnology.

Course Outcomes

1. Students will learn concept of Agriculture Biotechnology.
2. Students will understand the concepts of Biofertilizer, Bioinsecticides, Gene manipulations
3. Students will study role of Bacteria, Fungi and Cyanobacteria in plant growth and development.
4. Students will understand concept of bioinoculant and will study development and formulation of bioinoculants.

Unit	Topic	No. of Lectures
I	**Introduction to Agriculture Biotechnology:** • Effect of climate change on crop productivity • Sustainable Agricultural practices • Beneficial Microbes in Agriculture: Bacteria, Fungi and Cyanobacteria • Role of microbes in soil fertility and crop production, Biological nitrogen fixation, phosphate and zinc solubilization • Concept of Biofertilizer and Bioinsecticides • Use of Biotechnological methods for pest and disease control in plants • Concepts of e-agriculture, Urban agriculture	10
II	**Crop improvement:** • Plant Genetic Engineering – crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Genetic modification in Agriculture – transgenic plants, genetically modified foods. • Concept, methods and role of Tissue culture in agriculture • Greenhouse Technology and Protected Cultivation, Hydroponics, Aquaponics.	8
III	**Bioinoculants for improving crop productivity:** Development and formulation • Production of carrier-based formulation • Liquid formulations CRISPR technology as a genome editing tool.	8

IV	**Examples of Agriculture Biotechnology products:** • Bt Cotton • Golden rice • FlavrSavr tomato **Applications of Agriculture Biotechnology**	4

Suggested Books:

1.Microbiology. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R, 2009, McGraw Hill Publishers

2. Microbiology. Prescott, L.M, Harley, J.P. and Klein, D.A., 2008, McGraw Hill Publishing Ltd

3. Brock Biology of Microorganisms. Madigan, M., Martinko, J.M. and Parker, J. 2009, . Prentice Hall of India Pvt. Ltd.

4. Soil Microbiology: Subba Rao, N.S.(4th Ed.) 2014. Oxford & IBH Publishing Co.Pvt. Ltd.

5. Naveen Kango, 2010, Text Book of Microbiology , I.K. International Publishing House Pvt.Ltd

6. G. Rangaswami, D.J. Bagyaraj , 2016 , Agricultural Microbiology, PHI Learning Pvt.Ltd

7. Shiva Aithal, Nikhilesh Kulkarni , 2010, Modern Approaches Soil Agriculture & Environmental Microbiology , Himalaya Publishing House

8. Ahindra Nag , 2008 , Text Book Of Agricultural Biotechnology, PHI Learning

9. Alexander N. Glazer, Hiroshi Nikaido , 2008 , Microbial Biotechnology Fundamentals Of Applied Microbiology , Cambridge University Press

SEM - I: SEC
Course Code: SEC-101-BT-P
Course Name: Bioinstrumentation
Credit: 2P

Course Objective

1. Develop basic laboratory skills relevant to biotechnology practices.
2. Enhance critical thinking and observation skills through experimentation and data analysis.

Course Outcomes (Cos)

1. Student will able know the basic knowledge about safety to follow during any type of instrumentation laboratory
2. Students will get skill to use various instruments used in biotechnology laboratory
3. Students are able to observe the microorganism from various source.
4. Students are able find concentration of unknown sample using colorimeter or spectrophotometer.
5. Students will able to separate the chemicals using technique like centrifuge, chromatography

Sr. No.	Topic	Practical (15P)
1	Understanding Laboratory Signs and Safety: Familiarize students with common laboratory safety symbols and their meanings, writing log book	**1**
2	Study of component, working and use of Incubator, Distillation Unit, Laminar air flow, water-bath, vortex mixture and other miscellaneous instruments	**2**
3	Study the working and calibration of Electronic Balance	1
4	Handling and calibration of micropipettes	1
5	Study the principle and working of pH meter. Preparation of buffers and measurement of pH	1
6	Study the working and components of various types of Centrifuges.	1
7	Study the construction and working of Bright field compound microscope, simple microscope. Observation of basic cell structures using prepared slides.	1
8	Study the construction and working of Dark field/ phase contrast/ fluorescence microscope. (Demonstration)	1
9	Study the principle, construction and working of autoclave and hot air oven. Sterilization of glassware and reagents using moist heat.	1
10	Component & Working of Colorimetry and preparation of standard graph	1
11	Study the principle, components and working of Spectrophotometer. Verification of Beer and Lamberts law	1
12	Determination of Absorption spectra and lambda max of the given sample	1
13	Separation and identification of amino acids / sugars by paper chromatography / TLC	1
14	Visit to Instrumentation facility of National/ State Institute study the construction and working instruments.	1

SEM - I: SEC
Course Code: SEC-102-BT-P
Course Name: Microscopic Techniques
Credit: 2P

Course Objective:
To develop a skill to handle and caring of a various type of microscope.
To develop a skill to observe/ enumerate various types of microorganism, blood cells using specific microscope

Course Outcome (Cos)

1. Students will be able to operate a compound microscope, prepare and observe biological samples.
2. Students are able choose type of staining technique, mounting method to observe specific organism
3. Students are able to measure the size of microorganism
4. Students are able to count, blood cells, microorganism, animal cells.
5. Students are able to observe live organism using microscope

Sr. No.	Topic	Practical (15P)
1	Study the construction and working of Bright field compound microscope, simple microscope. Observation of basic cell structures using prepared slides.	2
2	Care and maintenance of microscope, maintaining logbook	1
3	Study the construction and working of Dark field/ phase contrast/ fluorescence microscope. (Demonstration)	1
4	Dry mounts: Observing pollen, dust, dead matter such as insect aphid legs or antennae, hair, feather	1
5	Wet mounting: Observation of pond water under simple and compound microscope	1
6	Hanging drop technique: Observation of motility in bacteria	1
7	Preparation of bacterial smear and monochrome staining and observation bacterial cells	1
8	Sectioning of stigma, plant root, stem, staining and observation	1
9	Staining and observation of fungal spores and mycelia	1
10	Stereo zoom microscope: Construction, working and observation of fungal colony, hydra	1
11	Measure the dimensions (Length, Diameter) of microscopic objects using stage micrometer & Ocular Micrometer	1
12	Principle, Construction, working of inverted microscope and observation of animal cells	1
13	Hemocytometer: Observation, enumeration of blood cells/ yeast cells	1
14	Visit to Electron Microscope/ phase contrast microscopy facility	1

SEM - I: SEC
Course Code: SEC-103-BT-P
Course Name: **Aseptic Techniques**
Credit: 2P

Course Objective

1. To develop a skill to work in pathology laboratory
2. To develop skill to handle a microorganism maintenance and preservation skill.

Course Outcome (Cos)

1. Students will understand the importance of aseptic technique in research, in laboratory
2. Student will able to isolate pure culture, handle pure culture
3. Students will understand the importance of hygiene/ cleanliness and aseptic condition while working with organism.
4. Students will able to disinfect a room/ laboratory by fumigation technique.
5. Students able to carry out sterilization process to make glassware, instruments sterile primary requirement in nay biological laboratory

Sr. No.	Topic	Practical (15P)
1	Study the principle, Construction and working of Laminar Air Flow	1
2	Study the principle, Construction and working of Autoclave and Hot Air Oven	1
3	Preparation of material (glassware and plasticware) for sterilization	1
4	Preparation of sterile glassware and reagents (solutions/media) using moist and dry heat	2
5	Preparation of sterile solutions/ media using membrane filtration technique	1
6	Hand hygiene and Personal Protective Equipment to maintain aseptic conditions	1
7	Study different disinfectants used to create aseptic working environment/ surface disinfection	2
8	Use of open flame /Bunsen burner in aseptic technique	1
9	Carry out aseptic transfer of solutions / buffers / chemicals	1
10	Cultivation of bacteria / cell subculture in aseptic conditions	2
11	Treatment and disposal of infectious material	1
12	Study of fumigation process	1

SEM - II

SEM - II: Major Core
Course Code: BT-151-T
Course Name: Biotechnology-II
Credit: 2T

Course Objectives

1. To explain the importance of basic science required to develop biotechnological process
2. To provide the knowledge of importance of microorganism in various process of biotechnology

Course Outcomes (COs):

1. Students will get the knowledge of microbial world, its importance and how it discovers?
2. Students learn, how to cultivate the microorganism? and learn the theory behind designing the microbial foods
3. Students will understand basic evolutionary process and formation of life on earth
4. Students will understand the building block of life its diversity

Unit	Topic	No. of lectures
I	• Origin of life, Origin of amino acids, nucleotides, Urey Miller's expt., Unicellular organism, multicellular organisms. Concept of biomolecules, polymerization, formation of polymers i.e. proteins, nucleic acids, Molecular interactions, biological functions.	2
II	**Biomolecules** • Carbohydrates: Introduction, biological importance. Definition, Classification, Monosaccharides other than glucose, glycosidic bond, disaccharides, polysaccharides [starch, glycogen, peptidoglycan] • Lipids: Introduction, Classes, Fatty acids [Physical & Chemical properties]. Glycerolipid, Sphingolipid, Lipid derived from isoprene, Bile acids, bile salts, plasma lipoproteins, Vesicles, membrane transport	8

III	Amino acids & Proteins: Structure & Function. • Structure and properties of Amino acids, • Types of proteins and their classification, • Forces stabilizing protein structure and shape. • Different Level of structural organization of proteins • Denaturation and renaturation of proteins. • Fibrous and globular proteins. Nucleic acids: • Nucleosides, nucleotides, Polynucleotide, DNA and its different forms [A, B, C, D, E and Z], • RNA and its types. Forces stabilizing nucleic acid structure.	**8**
	Cultivation, growth and isolation of microorganisms: • Basic Nutritional (Macro and micro), and environmental requirements (Hydrogen ion concentration, Temperature and Oxygen and other), Nutritional classification of bacteria • Design of media (Bacterial and Fungal): Types of media and Composition: Liquid, semi-solid and solid media, Selective media, Enrichment media, Enriched media, differential media,selective and differential media, Minimal media and thereuses. • Cultivation –Concept of Pure culture, co-culture and Mixed culture, Colony characteristics. • Isolation of microorganisms and pure culture techniques: Streak, Spread, Serial Dilution, Pour plate, Enrichment, • Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria	**10**
VII	**Microbial Interactions** (Any 2 examples each) • Microbe-Plant, • Microbe-Animal • Microbe-Microbe interaction • Handling of microorganisms and Biosafety measures.	**2**

Recommended Textbooks and References

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology.3rd Edition. Thomson Brooks / Cole.
2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
3. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.
4. Salle A.J. (1971) Fundamental Principles of Bacteriology.7th Edition. TataMacGraw Publishing Co.
5. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
6. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.

SEM - II: Major Core
Course Code: BT-152-P
Course Name: Practicals in Biotechnology-II
Credit: 2T

Course Objective

3. Develop basic laboratory skills relevant to biotechnology practices.
4. Enhance critical thinking and observation skills through experimentation and data analysis.

Course Outcome

1) Students are able to calculate and prepare various buffers and molar solutions
2) Able to quantitate the amount of sugar, protein from the given sample
3) Students understand the concept of aseptic transfer technique and sterilization
4) Students are able to isolate pure culture of microorganism from various sources
5)

Sr. No.	Title of Experiment	No. of practical
1	Preparation of solutions, buffers – sensitivity, specificity, accuracy	**1**
2	Estimation of reducing sugars by Benedict's Method/DNSA	**2**
3	Spot tests for Amino Acids (Qualitative analysis)	**3**
4	Quantitative methods for Amino acids	**4**
5	Protein estimation by Bradford and lowry method	**5**
6	**Preparation of Media and Glassware** Bacterial growth media- Nutrient broth, Nutrient agar plates, butts and slants	**6**
7	**Cultivation of microorganisms:** • Aseptic transfer techniques • Isolation and purification of bacteria by steak plate technique • Spread plate • Serial dilution and Pour plate • Study of colony characters	**5**

SEM - II: GE/OE
Course Code: OE-151-BT-P
Course Name: Practicals in Environmental Biotechnology
Credit: 2P

Course Objectives:

5. Develop basic laboratory skills relevant to biotechnology practices.
6. Enhance critical thinking and observation skills through experimentation and data analysis.
7. Promote safe and responsible laboratory practices.

Course Outcomes (Cos)

6. Students will be able to operate a compound microscope, prepare and observe biological samples.
7. Students will be able to find the chemical and physical characteristics of soil and its relation to product yield
8. Students will be able to follow aseptic techniques for culturing microorganisms and analyze their growth patterns.
9. Students will be able to demonstrate safe handling of laboratory materials and proper waste disposal procedures.

Sr. No.	Title of practical	Number of Practicals
1.	Understanding Laboratory Signs and Safety: Familiarize students with common laboratory safety symbols and their meanings. Conduct a mock safety inspection to identify potential hazards and proper responses.	1
2.	Study of soil by: Physical properties: Colour, Texture, Water holding capacity	2
3.	Study of soil by: Chemical properties: pH, chlorides and alkalinity	2
4.	Study of community by Quadrate method for plants/point count method for animal and analysis of community for- Percentage of frequency, density, abundance.	2
5.	Microorganism Culture: Inoculate agar plates with different samples (e.g., soil, polluted water) and observe microbial growth.	2
6.	Demonstration of water conservation techniques.	1
7.	Quantitative analysis of Water dissolved oxygen (DO) and COD/BOD	2
8.	To prepare a report on various types of local fresh water ecosystem/ local industrial effluents	1

Suggested Readings/Material:

1. Biotechnology Laboratory Manual by R.S. Gaud and A.D. Deshpande (Jaico Publishing House, 2010)
2. Practical Biotechnology: Techniques and Experiments by S.K. Singh (Rastogi Publications, 2013)
3. Manual of Microbiology by R.C. Dubey and D.K. Maheshwari (S. Chand Publishing, 2017)
4. Laboratory Manual of Biochemistry by P. Jayaraman (New Age International Publishers, 2018)
5. Plant Biotechnology: Practical Manual by H.S. Chawla (CBS Publishers & Distributors Pvt. Ltd., 2002
6. Elements of Biotechnology by P.C. Joshi (Publisher: PHI Learning Private Limited, 2017)
7. A Practical Guide to Environmental Biotechnology (Learning Materials in Biosciences) by Jayant Kumar Patra.
8. Fundamentals of Ecology and Environment Book (Practical Manual) by B. L. Chaudhary & Jitendra Pandey.
9. Environmental Biotechnology Lawrence K. Wang, Volodymyr Ivanov Joo-Hwa Tay 2010

SEM - II: GE/OE

Course Code: OE-152-BT-P

Course Name: Practicals in Food Biotechnology

Credit: 2P

Course Objectives

1. To develop basic skill of biotechnological technique used in food
2. To teach various biotechnological approach used in preparation of foods

Course outcome (Cos)

1. Students will understand the type of food prepared using biotechnological approach
2. Students understand the need/ applications of food biotechnology for increasing human populations
3. Students are able to produce wine, curd like fermented foods at laboratory level
4. Students are able to identify any adulteration in market food
5. Students are able to quantitate chemical like protein, sugar from food sample

Sr. No.	Topic	Practical (15P)
1	Physical examination of various food preparations	1
2	Production of wine using fermentation technique	2
3	Analysis of wine i) Alcohol ii) pH and Total acidity iii) Reducing sugar	3
4	Production of fermented food curd/idli batter using pure culture of LAB and analysis of pH, acidity & physical characteristics	2
5	Qualitative detection of adulterants in different food samples (Flours/ Ghee/ Chilli Powder/ Honey/ Tea/ Turmeric powder/ soft drinks etc.)	1
6	Detection of Adulterants and preservatives in milk	1
7	Detection of Carbohydrates in food sample	1
8	Qualitative analysis of proteins in food sample	1
9	Osmotic dehydration of fruits / vegetables by sugar and salt solution/ pickling.	1
10	Preparation of squash and concentrates using preservation by sugar/chemicals.	1
11	Visit to the fermentation/food/wine industry & report writing	1

SEM - II: GE/OE

Course Code: OE-153-BT-P

Course Name: Practicals in Agriculture Biotechnology

Credit: 2P

Course Objectives: This course is designed to inculcate necessary practical knowledge and skill for understanding the concept of Biotechnological applications in the field of Agriculture

Course Outcomes

1. Students will learn the concept of Agriculture Biotechnology.
2. Students will understand the concept of Biofertilizer formulation.
3. Students will study role of Rhizobacteria in plant growth and development.
4. Students will understand concept of bioinoculant and will study the development and formulation of bioinoculants.

S.No.	Title of Experiment	No. of Practicals
1	Production of Spirulina/Azolla culture	2
2	Estimation of protein from Spirulina/Azolla culture	1
3	Culture media preparation for Isolation of Beneficial bacteria (Rhizobacterium, Azotobacter)	1
4	Isolation of Rhizobium & from root nodules of leguminous crop and development of Rhizobium Biofertilizer	1
5	Isolation of Azotobacter from soil and development of Azotobacter Biofertilizer	1
6	Formulation of Bioinoculant/ Biofertilizer from isolated Rhizobacteria & azotobacter	1
7	Demonstration of effect of Biofertilizer (above prepared Rhizobium or Azotobacter) on plant growth using pot culture	2
8	Preparation of compost from vegetable/leaf /fruit wastes	2
9	Bio- pesticide production: Production of Neem pesticide/Nano- pesticide to control the insects and pest.	2
10	Cultivation of medicinal plants nearby college	1
11	Visit to functional greenhouse/ Composting Unit/Mushroom cultivation unit/ and report writing	1

SEM - II: SEC

Course Code: SEC-151-BT-P

Course Name: Microbial Culture Techniques

Credit: 2P

Course Objective

1. To develop a skill of microbial culture technique
2. To develop a skill to isolate, grow, maintenance & preservation of microorganism.

Course Outcomes

1. Students understand the importance of aseptic technique and sterilization.
2. Students are able prepare sterile media in various forms
3. Students are able to isolate pure culture of industrially important organism from soil
4. Students are able to cultivate and grow the virus.
5. Students will able to perform bioassay require for isolation and identification of unknown organism.

Sr. No.	Topic	Practical (15P)
1	Preparation of Sterile Media and Glassware: • Bacterial growth media- Nutrient broth, Nutrient agar plates, Nutrient agar butts and slants, Semi-solid Media • Selective and Differential Media- MacConkey's agar plates • Minimal medium • Enriched medium • Fungal growth media- potato dextrose agar plates	3
2	Isolation and purification of bacteria by Steak plate technique	1
3	Cultivation and enumeration of bacteria by Spread plate technique	1
4	Preparation of Serial dilutions. Cultivation and enumeration of bacteria by Pour plate technique	1
5	Cultivation of bacteria in broth culture (under different growth conditions of temperature, pH, aeration) and determine cell density	1
6	Cultivation of bacteria for transport and short term preservation using stab cultures	1
7	Cultivation of bacteria for specific purpose (sporulation/ enzyme production) / Cultivation of fastidious organisms	1
8	Cultivation of bacteria / fungi using Slide culture technique	1
9	Study of enrichment technique	1
10	Cultivation of anaerobic bacteria	1
11	Cultivation of Fungi from soil	1
12	Cultivation of bacteriophages and determine number of infectious phage particles (Demonstration)	1
13	Cultivation of viruses in an embryonated eggs (Demonstration)	1

SEM - II: SEC
Course Code: SEC-152-BT-P
Course Name: Separation Technique
Credit: 2P

Course Objective

1. To tell importance of separation of biomolecules/ compounds from mixture
2. To develop skill of separation of biomolecules compounds from mixture

Course outcome

1. Students will understand the basic concept of separation on which separation methods are designed
2. Student will able to separate various organics/ inorganic biomolecules from mixture
3. Students are able separate small quantity molecules from mixture
4. Students able isolate DNA and able separate DNA, Protein from mixture
5. Students will understand the working, principal, and operation of various instruments used in separation process.

Sr. No.	Topic	No. of Practical
1	Study of filtration technique using various types of filters	2
2	Study the operation of separating funnel	1
3	Study the working and components of various types of Centrifuges. Separation of analyte by differential centrifugation.	1
4	Study of the Distillation process	1
5	Separation of chemical / proteins using precipitation technique	2
6	Casting gel for electrophoresis	2
6	Separation of proteins using PAGE (Demonstration)	1
7	Separation of DNA using agarose gel electrophoresis (Demonstration)	1
8	Separation and identification of amino acids by paper chromatography.	1
9	Separation and identification of pigments / sugars by TLC	1
10	Study of Column chromatography (Demonstration of any two techniques). Preparation of column.	2

SEM - II: SEC
Course Code: SEC-153-BT-P
Course Name: Computer in Biotechnology
Credit: 2P

Course Objectives

1. To develop the basic skill required for presentation, data analysis, calculations and data maintenance.
2. To develop a basic skill to require for the Bioinformatics, and clinical data analysis
3. To develop skill, require for calculations and statistical methods

Course outcome

1. Students will get basic knowledge (handling devices, role of operating system etc.) of computers.
2. They will also familiar with how data gets stored through Database Management System. They will capable to create documentation, budgets and mathematical calculations and also make attractive presentations using ms word, excel and Power point respectively
3. Students will able to make power point present for presentation
4. Students understand the basic concept of computers, its applications in Biotechnology,
5. It is a foundation course for higher studies subjects like, bioinformatics, clinical analysis.

Sr. No.	Topic	No. of Practical
1	Operating systems: DOS, Windows. File handling: copy, rename, delete, type Directory structure: make, rename, move directory	2
2	Use of internet – Downloading & Installing software/plug-ins on Windows, Any-desk software	1
3	Use of Anti-virus programs	1
4	Word Processing (Microsoft Word): Creating, Saving & Operating a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text, Find & Replace, Spell Checker & Grammar Check, Document Enhancement (Borders, Shading, Header, Footer), Printing Document (Page Layout, Margins). Introduction to use of Wizards & Templates, Working with Graphics (Word Art), Working with Tables and Charts, Inserting Files	2
5	Spreadsheet Applications (Microsoft Excel): Worksheet Basics: Entering information in a Worksheet, Saving & Opening a Worksheet, Editing. Data organization and analysis using scientific / mathematical functions.	2

6	Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files. Access Modes: Updating Records, Querying, Reports, Forms & sub forms.	2
7	Scientific Presentations with graphics (Microsoft Power Point): Creation of slides, Rapid Presentation design using wizards	2
8	Biological databases: Searching Medline, PubMed, bibliographic databases.	2
9	Introduction to Bioinformatics: Searching Bioinformatics Resources	1