Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous)

Ganeshkhind, Pune 411 016

Three-Year BSc Biotechnology and

Four-Year BSc (Hons. With Research) Biotechnology

Degree Programs

Skeleton and Detailed Syllabus

(As per revised NEP pattern; to be implemented from 2024-25)

Introduction:

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 was 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 newly developed syllabus is a choice-based credit system with semester pattern. Biotechnology has grown extensively in last couple of decades. With the changing scenario at local and global level, 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 economic 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 college itself will be developing the trained and skilled man-power. Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of different 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 while postgraduate syllabus emphasizes on more applied courses. 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.

Program Objectives:

- To introduce the concepts in various allied subjects
- To enrich students' knowledge in basic and applied aspects of life sciences.
- To help the students to build interdisciplinary approach in teaching/learning & in research.
- To inculcate the sense of scientific responsibilities and social awareness
- To help the students build-up progressive and successful careers in academia and industry.

Program Specific Outcomes (PSOs):

Program Outcomes:

After successful completion of B.Sc. Biotechnology program, the students should be able:

PO1: to have competencies in the area of basic and applied biological sciences.

PO2: to learn and explore various fields and specializations of Biotechnology such as molecular biology, genetic engineering, large-scale manufacturing processes, environmental biotechnology and tissue culture

PO3: to get engaged and carry out biotechnological research independently and in team

PO4: to develop and explore the biotechnological tools with keeping in mind the social and ethical responsibilities

PO5: to prepare and pass competitive exams like GAT-B for higher studies

Examination Pattern

40:60 [Continuous Internal Evaluation: Formative, Summative and End semester exam (ESE)]

Evaluation of Students:

1) The Internal evaluation will be in form of continuous assesement format of 20 marks and End-Semester examinations will be of 30 marks making total to 50.

2) Student has to obtain 40% marks in the examination of In-Semester and End-Semester assessment. Separate passing is mandatory

4) Internal marks remain unchanged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal

departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.

In-semester Examination: Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department/ College Internal Assessment Committee will coordinate this activity.

Suggested internal assessment tools for courses:

The concerned teacher shall announce the units for which internal assessment will take place. A teacher may choose one of the methods given below for the assessment.

1. Students Seminar
2. Short Quizzes / MCQ Test
3. Home Assignments
4. Tutorials/ Practical
5. Oral test
6. Research Project
7. Group Discussion
8. Open Book Test
9. Study Tour
10. Written Test
11. PPT presentation
12. Field Visit
13. Industrial Visit
14. Viva

Teaching Methodology:

1. Classroom Teaching
2. Guest Lectures
3. Group Discussions
4. Surveys
5. Power Point Presentations
6. Visit to Institutions / Industries
7. Research Papers & Projects
8. E-content

Year 1

Semester I

Course Code	Theory/ Practical	Course Type	Course title	Credits	No. of Lectures/ Practical	Evaluation		
						Marks for CIE	Marks for ESE	Total Marks
24BIO11101	T	Major DSC	Biological Chemistry	2	30L	20	30	50
24BIO11102	P	Major DSC	Experiments in Biological Chemistry	2	15P	20	30	50
24BIO11103	T	Major DSC	Microbial Science	2	30L	20	30	50
24BIO11104	P	Major DSC	Experiments in Microbial Science	2	15P	20	30	50
24BIO11105	T	Major DSC	Bioinstrumentation	2	30L	20	30	50
24BIO11106	P	Major DSC	Experiments in Bioinstrumentation	2	15P	20	30	50
24BIO11408	P	VSC/SEC	Experiments in Computational tools for biotechnology	2	15P	20	30	50
24COB11301C	T	OE1	Banking Operations	2	30L	20	30	50
24ENG11506	T	AEC	Developing Communicative Competance in English	2	30L	20	30	50
24VEC11501	T	VEC	Environmental sustainability: principles and values	2	30L	20	30	50
24IKS11501	T	IKS	Foundation course on Indian Knowledge System	2	30L	20	30	50

Semester II

Course Code	Theory/ Practical	Course Type	Course title	Credits	No. of Lectures/ Practical	Evaluation		
						Marks for CIE	Marks for ESE	Total Marks
24BIO12101	T	Major DSC	Plant Science	2	30L	20	30	50
24BIO12102	P	Major DSC	Experiments in Plant Science	2	15P	20	30	50
24BIO12103	T	Major DSC	Animal Science	2	30L	20	30	50
24BIO12104	P	Major DSC	Experiments in Animal Science	2	15P	20	30	50
24BIO12105	T	Major DSC	Metabolism and Physiology	2	30L	20	30	50
24BIO12106	P	Major DSC	Experiments in Metabolism & Physiology	2	15P	20	30	50
24BIO12408	P	SEC	Experiments in Microscopy	2	15P	20	30	50
24SOC12303	T	OE2	Gender and Media	2	30L	20	30	50
24ENG12506	T	AEC	Mastering English for Professional Purposes	2	30L	20	30	50
24VEC12502	T	VEC	India’s Constitution, Democracy, Election and Governance	2	30L	20	30	50
-		CC1	Physical Education/ Cullinary/Animation/ Drama	2	30L	20	30	50

Year 2

Semester III

Course Code	Theory / Practical	Course Type	Course title	Credits	No. of Lectures/ Practical	Evaluation		
						Marks for CIE	Marks for ESE	Total Marks
24BIO23101	T	Major DSC	Cell Biology	4	60L	40	60	100
24BIO23102	P	Major DSC	Experiments in Cell Biology	2	15P	20	30	50
24BIO23103	T	Major-specific IKS	Biotech in Indian Perspective	2	30L	20	30	50
24BIO23205	T	Minor	Molecular Biology	2	30L	20	30	50
24BIO23206	P	Minor	Experiments in Molecular Biology	2	15P	20	30	50
24BIO23406	P	VSEC1	Histological Tools	2	15P	20	30	50
24BIO23301	T	OE-3	Open Elective	2	30L	20	30	50
24MAR235062 4HIN23506	T	AEC-3	Modern Indian Languages	2	30L	20	30	50
24CUL23601	P	FP-1	Field Project	2	15P	20	30	50
24BIO23602	P	CC-2	Culinary Arts / Web Design	2	30L	20	30	50

Semester IV

Course Code	Theory/ Practical	Course Type	Course title	Credits	No. of Lectures/ Practical	Evaluation		
						Marks for CIE	Marks for ESE	Total Marks
24BIO24101	T	Major DSC	Developmental Biology	4	60L	40	60	100
24BIO24102	P	Major DSC	Experiments in Developmental Biology	2	15P	20	30	50
24BIO24203	T	Minor	Genetics and Diagnostic Tools	2	30L	20	30	50
24BIO24204	P	Minor	Experiments in Genetics and Diagnostic Tools	2	15P	20	30	50
24BIO24405	T	SEC/ VSC2	Environmental Biotechnology	2	30L	20	30	50
24BIO24406	P	SEC/ VSC2	Experiments in Environmental Biotechnology	2	15P	20	30	50
24BIO24301	T	OE-4	Open Elective	2	30L	20	30	50
24MAR24506 24HIN24506	T	AEC-4	Modern Indian Languages	2	30L	20	30	50
24CEP24601	P	CEP	Community Engagement Project	2	15P	20	30	50
4CC24602	P	CC3	CC3	2	15P	20	30	50

Year 3

Semester V

Course Code	Theory/ Practical	Course Type	Course title	Credits	No. of Lectures/ Practical	Evaluation		
						Marks for CIE	Marks for ESE	Total Marks
24BIO35101	T	Major DSC	Animal and Plant Tissue Culture	4	60L	40	60	100
24BIO35102	T	Major DSC	Recombinant DNA Technology	4	60L	40	60	100
24BIO35103	P	Major DSC	Experiments in Recombinant DNA Technology	2	15P	20	30	50
24BIO35104	P	Major DSC	Experiments in Microbial Biotechnology	2	15P	20	30	50
24BIO35105	T	Major DSC	Immunology	2	30L	20	30	50
24BIO35106	P	Major DSC	Experiments in Immunology	2	15P	20	30	50
24BIO35407	T	VSEC	Microbial Biotechnology	2	30L	20	30	50
24BIO35408	P	VSEC	Experiments in Tissue Culture	2	15P	20	30	50
-	P	FP	Field Project/ Research Project	2	15P	20	30	50

Semester VI

Course Code	Theory/ Practical	Course Type	Course title	Credits	No. of Lectures/ Practical	Evaluation		
						Marks for CIE	Marks for ESE	Total Marks
24BIO36101	T	Major DSC	Industrial Microbiology	4	60L	40	60	100
24BIO36102	T	Major DSC	Biostatistics and Bioinformatics	2	30L	20	30	50
24BIO36103	T	Major DSC	Enzyme Technology	2	30L	20	30	50
24BIO36104	P	Major DSC	Experiments in Industrial Microbiology	2	15P	20	30	50
24BIO36105	P	Major DSC	Experiments in Enzyme Technology	2	15P	20	30	50
24BIO36106	T	Major DSE	Bioanalytical Techniques	2	30L	20	30	50
24BIO36107	P	Major DSE	Experiments in Bioanalytical Techniques	2	15P	20	30	50
24BIO36407	P	VSEC4	Experiments in Biostatistics and Bioinformatics	2	15P	20	30	50
-	P	OJT	On-job Training	4	30P	40	60	100

Year 4

Semester VII

Course Code	Theory/ Practical	Course title	Credits	No. of Lectures/ Practical	Evaluation		
					Marks for CIE	Marks for ESE	Total Marks
24BIO47101	T	NanoBiotechnology	2	30L	20	30	50
24BIO47102	T	Introduction to OMICS approaches	2	30L	20	30	50
24BIO47103	T	Biotechnology and One Health Approach	2	30L	20	30	50
24BIO47104	P	Experiments in Nanobiotechnology	2	15P	20	30	50
24BIO47105	P	Experiments in OMICS	2	15P	20	30	50
24BIO47106	T	DSE- Agricultural Biotechnology	2	30L	20	30	50
24BIO47107	P	DSE- Experiments in Agricultural Biotechnology	2	15P	20	30	50
24BIO47208	T	RM – Research Methodology	2	30L	20	30	50
24BIO47208	P	RM – Experiments in Research Methodology	2	15P	20	30	50
RP	P	Research Project	4	30P	40	60	100

Semester VIII

Course Code	Theory/ Practical	Course title	Credits	No. of Lectures/ Practical	Evaluation		
					Marks for CIE	Marks for ESE	Total Marks
24BIO48101	T	Metabolic Engineering	2	30L	20	30	50
24BIO48102	T	Genome Editing	2	30L	20	30	50
24BIO48103	T	Data Science and Machine Learning in Biotechnology	2	30L	20	30	50
24BIO48104	P	Major DSC – Experiments in Metabolic Engineering and Genome Editing	4	30P	40	60	100
24BIO47105	T	DSE- Advanced Instruments	2	30L	20	30	50
24BIO47106	P	DSE- Experiments in Advanced Instruments	2	15P	20	30	50
RP	P	Research Project	4	30P	40	60	100
OJT	P	Research Project	4	30P	40	60	100

FYBSc

24BIO11101 Biological Chemistry [T, 2C, 30L]

On successful completion, the students should be able to:

CO1: Gain knowledge of the biochemical basis of life

CO2: Understand the importance of water as a universal solvent

CO3: Learn the different classes, structural and biochemical properties of basic biomolecules including carbohydrates, proteins, lipids, vitamins, enzymes, and nucleic acids

CO4: Know the functions of various vital biomolecules

Unit	Topic	Lectures
I	**Historical perspective of biochemistry** Atomic structures, molecules, valence and valence bond theory, chemical bonding (covalent, ionic, hydrogen)Origin of life, abiotic production of biomolecules, cellular and chemical foundation of life.	02
II	**Water** Properties of water, Hydrogen bonding, ionization of water, interaction of biological molecules in water, osmosis, pH, titration curves, buffers, biological buffers.	03
III	**Carbohydrates** Classification of carbohydrates, sugars and non-sugars, Monosaccharides, oligosaccharides, and polysaccharides. Functions of Carbohydrate Monosaccharides: Structure and properties, ketoses and aldoses, D and L configuration, chemical and physical properties. Polysaccharides and their classification based on function (Storage polysaccharide: eg starch, glycogen, Structural polysaccharides: eg. cellulose, chitin)	05
IV	**Lipid** Classification of lipids: Simple and complex lipids, fatty acids. Structure, chemical and physical properties complex lipids: Triacylglycerol, Sphingolipids, Phospholipids and Glycolipids, Steroids, Lipoproteins, Storage and structural lipids. Function of lipids	05
V	**Proteins:** Polymer of amino acids, Classification of amino acids, Chemistry of amino acids: Ionization of amino acid side chains, Configuration, zwitterion, reactions of amino acids, titration of amino acid, Isoelectric pH.	05

	Protein structure: Primary structure and peptide bond formation, Secondary structure, secondary repeats, Tertiary and Quaternary structure (eg. Haemoglobin). Protein denaturation and renaturation. Functions of proteins	
VI	**Enzymes**: General properties; classification of enzymes Concepts of Biocatalyst, Active site, Specificity, Energy of activation, Reaction Rate. Rate law for enzyme-catalyzed reaction Enzyme units, specific activity, turnover number. Lock and key, Induced fit hypothesis. Parameters affecting enzyme activity (temperature, pH, substrate, cofactor, enzyme concentration) Enzyme inhibition	06
VII	**Nucleic acids** Concepts of Purine, Pyrimidines, Nucleosides, Nucleotides, structure of DNA and RNA, Forces stabilizing nucleic acid structure Properties of Nucleic Acid. Denaturation & renaturation of Nucleic Acids. Different forms of DNA	04

Reference Books:

1. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA

2. Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet & Judith Voet , John Wiley and Sons, Inc. USA

3. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA

4. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY

5. Lehninger , Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.

BIO11102 Experiments in Biological Chemistry [P, 2C, 15P]

On successful completion, the students should be able to:

CO1: Gain knowledge of the preparation of solutions of various concentration

CO2: Understand the preparation of buffers and reagents pertaining to biochemistry

CO3: Learn the tests for estimation of biomolecules including carbohydrates, proteins, lipids, vitamins, enzymes, and nucleic acids

CO4: Know the extraction of biomolecules from various biological sources and quantitate them

UNIT	TITLE OF EXPERIMENT	No. of practical
1.	Numerical based on Molarity, Molality, Normality	1
2.	Handling of pipettes and micropipettes	1
3.	Preparation of biochemical reagents	1
4.	Preparation of buffer of desired pH and molarity	1
5.	Spot test for carbohydrates & amino acids	2
6.	Spectrophotometric analysis of nucleic acid	1
7.	Extraction of casein from milk	1
8.	Estimation of protein by Biuret method	1
9.	Estimation of protein by Lowry method	1
10.	Thin layer chromatography for amino acids	1
11.	Estimation of cholesterol by Zak’s method from given sample	1
12.	Estimation of sugar by DNSA method	1
13.	To perform enzymatic assay using amylase	1

References:

1.Principles and Techniques of Biochemistry and Molecular Biology" by Keith Wilson and John Walker

2.Walker, J. M. and Rapley, R. (2008) "Practical Biotechnology: Principles and Protocols".

3.Practical biochemistry by Sadashivam and Manicckam

4.Biochemical Techniques: Theory and Practice" by John F. Robyt and Bernard J. White

5."Laboratory Manual for Principles of Biochemistry" by Albert L. Lehninger, David L. Nelson, and Michael M. Cox

24BIO11103 Microbial Science [T, 2C, 30L]

On successful completion, the students should be able to:

CO1: Understand the different classes of microorganisms

CO2: Know the various structural aspects of different microbes

CO3: Understand the various approaches of microbial cultivation and observation

CO4: Get familiar with the concept of disinfectants and antibiotics

Unit	Topic	No.of Lectures
I	**Introduction to Microbial World:** • History of Microbiology, Abiogenesis vs Biogenesis, Discovery of Microorganisms, Germ theory of diseases, Koch's postulates, Pre golden era, Golden Era, post golden Era, Contributions of various scientists in path breaking discoveries, inventions and Product Development. • General Characters and their importance of Prokaryotes, Eubacteria, Archaebacteria, Eukaryotic Microorganisms- (Fungi, Algae, protozoa), Viruses, viroid and prions. • Importance of study of Microbiology and relevance in Biotechnology (Brief discussion of application of Microbiology invarious fields) **Classification of Microorganisms:** • All 5 major groups of microorganisms, Similarities and dissimilarities in relation to evolution. • Difference between Prokaryotic and Eukaryotic organisms. • Bacterial Classification: Bergey's Manual of Systemic Bacteriology	6
II	**Bacterial cell structure:** Ultrastructure of Bacteria- Cell wall (Gram Positive and Gram negative), Cell Membrane,	5

	Capsule, Flagella, Pili, slime layer, Ribosome, Nucleoid, Mesosomes, Endospore, Cell inclusions (Gas vesicles, carboxysomes,magnetosomes, PHB granules, Glycogenbodies, metachromatic granules)	
III	**Observation of Microorganisms:** • Theory of staining: Classification of stains, Stain (Basic and Acidic), Fixative, Mordant, Decoloriser, Accentuator Principles and methods of staining techniques for following (Monochrome, Negative, Differential (Gram, Acid fast), Specialstaining-Endospore, flagella, cell wall, nucleic acid, capsule)	5
IV	**Cultivation 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 of microorganisms: Concept of Pure culture, co-culture and Mixedculture, Colony characteristics. • Reproduction in microorganisms: Binary Fission and other asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate. • Isolation of microorganisms and pure culture techniques: Streak, Spread, Serial Dilution, Pour plate, Enrichment, Singlecell isolation Colony • Preservation and Maintenance methods	8
V	**Control of microbial growth:** • Definition: Sterilization and Disinfection. • Physical Agents – Heat (Dry and Moist heat), pasteurization, Radiation, Filtration • Principle and working of Autoclave and Hot air oven. • Sterilization Efficiency • **Chemical Agents and their Mode of Action** - Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents **Disinfectant**-Characteristics of an Ideal disinfectant**,** Examples of Disinfectants and Evaluation of Disinfectant	5

Recommended References

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology.3rdEdition.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, 6thEdition.MacGraw Hill Companies Inc.

4. Salle A.J. (1971) Fundamental Principles of Bacteriology.7th Edition. Tata MacGraw 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.

24BIO11104 Experiments in Microbial Science [2C,15P]

Course outcome

CO1: Learn the basic technique of aseptic handling

CO2: Get hands-on experience in sterilization, media preparation, and glassware preparation

CO3: Get hands-on experience in microbial isolation, culture purification, and enumeration

No.	Title of experiment	No. of practical
1	**Introduction to Microbiology Laboratory and common microbiology laboratory instruments** (Incubator, Hot Air Oven, Autoclave, Distillation Unit, Chemical Balance, Laminar air flow hood, Centrifuge, Handling of Microorganisms and Biosafety measures)	01
2	**Observation of Microorganisms** (Use and Care of Compound Microscope, Wet Mount- pond water, Fungal staining, Monochrome staining, Negative staining, Gram staining, Spore staining, Motility: Hanging drop technique)	08
3	**Aseptic transfer techniques**	01
4	**Preparation of Media and Glassware** (Bacterial growth media: Nutrient broth, Nutrient agar plates, butts, and slants, Fungal growth media: Potato dextrose agar plates)	01
5	**Demonstration of microbes in the air, on the table surface, fingertips on nutrient media.**	01
6	**Isolation and enumeration of bacteria** (Streak plate technique, Serial dilutions, Spread plate and pour plate technique, Yeast cell counting using Neubauer's chamber)	05

BIO11105 Bioinstrumentation [T, 2C, 30L]

On successful completion, the students should be able to:

CO1: Get knowledge of the principles behind the working of various instruments

CO2: Learn the basics of pH metry and buffers

CO3: Understand the theory of spectroscopy

CO4: Familiarize with the concept of planar and column chromatography **Bioinstrumentation**

Unit	Topic	Lectures
I	**Biophysics and biophysical properties** (Adsorption, absorption, diffusion, osmosis, surface tension, colloidal properties and dialysis)	02
II	**Biophysical properties and cell membrane** Organization of plasma membrane, Passive and active transport. Membrane potential, Passive and active electrical properties of cell, Depolarization, hyperpolarization of membrane (neuronal), Generation of action potential	03
III	**Introduction to bioinstrumentation**, techniques for analysis of biomolecules	02
IV	**Spectroscopy** Definition, Electromagnetic wave and spectrum, Applications of each region of electromagnetic spectrum for spectroscopy Lambert-Beer's Law, types of sources, Instrumentation of single beam and double beam instrument. Introduction to molecular energy levels. Excitation. Absorption. Emission. Rotational spectra. Energy levels of rigid diatomic molecules. Electron spectroscopy. UV-visible spectroscopy. Principle, construction and working of colorimeter, Spectrophotometer. Application to biomolecules (proteins, DNA, Hb, chlorophyll).	05
V	**Chromatography** Concept, planar chromatography and types, column chromatography and types, applications of chromatography	05
VI	**Microscopy** Concepts - Resolving power, Construction and working principles of the following microscopes: Stereo zoom (Dissecting), Compound, Light microscopy, Bright and Dark Field microscopy, Inverted, Phase contrast, Fluorescence microscopy and Electron microscopy	05

VII	**pH meter** Principle, construction and working, concept of pH, isoelectric pH, buffers	03
VIII	**Centrifuge** RCF, sedimentation concept, different types of centrifuges. different rotors, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications	03
IX	**Mass spectroscopy** (Bainbridge mass spectrometer) Principle and applications	01
X	**Atomic absorption spectrometer** (AAS) Principle and applications	01

References

1. Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and SonsLtd., USA

2. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer AcademicPublisher, USA.

3. Textbook of optics and atomic physics, 8th edition (1989) P.P. Khandelwal,Himlaya Publishing House, India.

4. Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata McGraw Hill, India.

BIO11106 Experiments in Bioinstrumentation [P, 2C, 15P]

On successful completion, the students should be able to:

CO1: Calibrate and use the pH meter, colorimeter

CO2: Use the centrifuge machine for the separation of components

CO3: Gel hands-on training of using UV-Vis spectrophotometer

CO4: Separate the different components using chromatography

No.	Title of experiment	No. of practical
1	Calibration of weighing balance and its working for micro measurements	01
2	Calibration of pH meter and estimation of pH of unknown solutions	01
3	Prepare acidic and basic buffers and adjust the pH	01
4	Handling, calibration, and maintenance of micropipettes	01
5	Separation of mixtures using different types of centrifuge	01
6	Separation of a mixture of *E. coli* and Yeast using sucrose density gradient	01
7	Study the components and working of the colorimeter	01
8	Measure the absorbance of a given solution using a colorimeter and spectrophotometer.	01
9	Determination of lambda max and molar extinction coefficient using a spectrophotometer. Validate the beer-lamberts law.	03
10	Determination of the unknown concentration of the sample using a colorimeter/spectrophotometer	02
10	Separation of dyes using paper chromatography	01
11	Demonstration of ELISA reader	01

References:

1.Veerakumari, L. (2015). Bioinstrumentation. C. jamarthanan, MJ publishers:Triplicane.

2.Arumugam, N. and Kumaresan, V. (2015). Biophysics and Bioinsturmentation. SarS Publications.

BIO11408: Computational Tools for Biotechnology [T, 1C,15L]

On successful completion, the students should be able to:

CO1: Understand the basic hardware and operating systems in computers

CO2: Concept of computer viruses

CO3: Learn the concept of the internet and different databases

CO4: Introduce to the concept of bioinformatics

Unit	Topics	No. of Lectures
I	**Introduction to computers:** Overview and functions of a computer system, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP devices, Digital tape, CD-ROM, DVD (capacity and access time) **Introduction to the operating system:** Operating system concept-Windows and UNIX/Linux **Data processing & presentation:** Introduction: MS Office (Word, Excel & PowerPoint) **Computer viruses:** An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted?, General Precautions **Internet searches:** Concepts in text-based searching, Searching Medline. PubMed, bibliographic database	05
II	**Databases** Introduction & need of databases, Types of databases Basic concepts in: Data Abstraction, Data Models, Instances & Schemes, E-R Model (Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables), Network Data Model: Basic concepts, Hierarchical Data Model: Basic concepts Multimedia Database: Basic concepts and Applications, Indexing and Hashing, B + Tree indexed files, B Tree indexed files, Static Hash functions, Dynamic Hash functions Text Databases: Introduction & Overview of Biological database, Types of Biological Database	08
III	**Bioinformatics:** Introduction to bioinformatics, History, Goals, Relation to other fields.	02

BIO11408 Experiments in Computational Tools for Biotechnology Lab [P, 1C, 15P]

On successful completion, the students should be able to:

CO1: Learn the basics of operating system (DOS), Microsoft Word

CO2: Learn different methods to represent and process the data in digital form

No.	Title of experiment	No. of Practical
1	Tutorials operating systems: DOS File handling: copy, rename, delete, type Directory structure: make, rename, and move directory	01
2	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)	03
3	Introduction to the use of Wizards & Templates, Working with Graphics (Word Art), Working with Tables & Charts, Inserting Pictures	01
4	Spreadsheet Applications (Microsoft Excel): Worksheet Basics: Entering information in a Worksheet, Saving & Opening a Worksheet, Editing, Copying & Moving Data, Inserting, Deleting & Moving Columns & Rows, Clearing	02
5	Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files. Access Modes: Updating Records, Querying, Reports, Forms & sub forms	03

SEMESTER II

BIO12101 Plant Science [T, 2C, 30L]

On successful completion, the students should be able to:

CO1: Gain knowledge of different classes of plants

CO2: Learn the structural and functional aspects of various plant tissue types and organs

CO3: Understand the water and photosynthate conduction in plants

CO4: Understand the basics of growth and development in plants

Unit	Topic	Lectures
I	**Introduction to plant kingdom, Classification of plants** (General & Unique features of plants, Principles/Basis of plant classification, Outline of the classification with example: Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms, Characteristic features of Dicot and Monocot)	03
II	**Structure of plant Cell** (characteristic features of plant cells and cell wall)	02
III	**Plant tissues and tissue systems** (Meristematic tissues and Permanent tissues: Simple and complex)	03
IV	**Vegetative and reproductive organs of plants** (structure, function and modifications of root, shoot and leaves, structure of flower, primary and secondary growth, growth ring formation)	04
V	**Plant water relationship** (Cell permeability, diffusion, imbibition, Osmosis & its types, relation between osmotic pressure (OP), turgor pressure (TP) and wall pressure (WP), DPD (Suction pressure), Absorption and transport of water, mechanism of Ascent of sap: transpiration and guttation, translocation via capillarity action, Cohesion-tension theory)	05
VI	**Translocation in phloem** (phloem as the site of sugar translocation, Pressure–Flow Model, Phloem loading and unloading, Source-sink relationship.)	04
VII	**Photosynthesis** (Photosynthesis pigments, concept of two photo systems, photophosphorylation, Calvin cycle, CAM plants, photorespiration)	03
VIII	**Respiration** (Glycolysis, Krebs's cycle and ETS)	03
IX	**Growth and development of plant** (macro and micro elements, plant growth regulators, photoperiodism, nitrogen fixation)	02
X	**Economic importance of plants**	01

References:

1. Dutta A.C. (2000) A Classbook of Botany (Oxford University Press, UK)

2. Ganguli, Das Dutta (2011) – College Botany Vol I, II and III (New Central BookAgency, Kolkata)

3. Esau K. (1977) Anatomy of seed plants (Wiley, USA)

4. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.

24BIO12102 Experiments in Plant Science lab [2C - 15P]

No.	Title of experiment	No. of practical
1	Study of algae, fungi, bryophytes, pteridophytes, gymnosperms, angiosperms with one example each	02
2	Microscopic observation of various types of plant cells	01
3	Study of anatomy of plant organs using tissue sectioning and staining	02
4	Study of various plant tissues using maceration	02
5	Study of stomata and rate of transpiration	01
6	Study of osmotic potential using incipient plasmolysis	01
7	Determination of Diffusion Pressure Deficit (DPD)	01
8	Study of rate of respiration	01
9	Study of Hill's reaction using isolated chloroplasts	01
10	Preparation of plant growth media, effect of plant growth regulators, mineral deficiency of rate of seed germination	03

24BIO12103 Animal Science [T, 2C, 30L]

On successful completion, the students should be able to:

CO1: Understand the basis of animal classification, different classes and examples

CO2: Learn the structural and functional aspects of animal tissues and organs

CO3: Know different model systems used in animal science

CO4: Understand animal physiological processes including digestion, respiration, circulation, excretion, and reproduction along with different systems

CO5: Learn the lifecycles of different animal parasites

Unit	Topic	Lectures
I	**Introduction to Kingdom Animalia** (Outline classification of non-chordates and chordates with examples)	02
II	**Animal Tissues** (Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nerve tissue)	04
III	**Introduction to Invertebrate model system** a) Hydra b) *C. elegans* c) *Drosophila* d) Honey bee (*Apis* sp. i. Morphology ii. Mouthparts, sting apparatus iii. Social organization iv. Communication in bees)	04
IV	**Animal Physiology I** Digestion: Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins Respiratory: Physiology, External and internal respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases. Circulation: Structure of heart, Physiology of circulation, Pulmonary and systemic circulation Excretion: Physiology of excretion and osmo- regulation (Water and Salt Balance)	07
V	**Animal Physiology II** Functioning of Excitable Tissue (Nerve and Muscle) Structure of neuron, Propagation of nerve impulse (myelinated and nonmyelinated nerve fibre); Muscle Physiology:Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction Endocrine Physiology: Brief overview on: Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Reproductive Physiology Brief account of spermatogenesis and oogenesis	07
VI	**Parasitology**	04

	Introduction to Host-parasite Relationship Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism Parasitic Protozoa Life history and pathogenicity of *Plasmodium vivax* Parasitic Helminths Life history and pathogenicity of *Fasciola hepatica, Taenia* sp	
VII	**Economic Zoology** An overview on Vermiculture, Aquaculture, Sericulture, Apiculture	02

Reference books:

1. Jordan, E.L. and Verma P.S. 1978, (i) Chordate Zoology S. Chand & Company Ltd. Ram Nagar. New Delhi.

2. Jordan, E.L. and Verma P.S. 1978 (ii) Invertebrate Zoology. S. Chand & Company Ltd. Ram Nagar. New Delhi.

3. Modern Text Book of Zoology: Invertebrates., R.L.Kotpal. Publisher, Rastogi Publications, 2012.

4. Economic Zoology, Shukla & Upadhyaya, 4th Edition., Rastogi Publications, 2009.

5. Modern Parasitology: A Textbook of Parasitology, 2nd edition, (1993) F. E. G. Cox, Wiley & Sons, USA

24 BIO 12104 Experiments in Animal Science [2C - 15P]

On successful completion, the students should be able to:

CO1: Learn the structural aspects, and lifecyle of animals from different classes

CO2: Understand the concept of the vital capacity of the lungs

CO3: Learn the method for the collection, classification, and preservation of Insects

No.	Title of experiment	No. of practical
1	Study of *Paramoecium* (Morphology, Reproduction: Binary fission & Conjugation, culturing of *Paramoecium*)	02
2	Study of Hydra (Permanent slides) (Morphology, Reproduction, Regeneration)	02
3	Study of Drosophila (Characters, sexual dimorphism eye & wing mutations, Life cycle, Culturing Drosophila using standard methods)	03
4	Study and Dissection of Honey Bee (Mounting of Mouth parts, pollen basket, Antenna Cleaner, Sting apparatus, legs and wings)	02
5	Experiment on squamous epithelium	01
6	Experiment on Skeletal (Voluntary) Muscle	01
7	Experiment on Human Sex Chromatin	01
8	To find the vital capacity of the lungs Collection	01
9	Collection, Classification and preservation of Insects	02

24BIO12105: Metabolism and Physiology [T, 2C, 30L]

Upon successful completion of this course, student should be able to:

CO1: Students will gain the knowledge about various metabolic pathways

CO2: Students will learn the energy dynamics with relation to the different metabolites

CO3: Students will understand the concepts of plant, animal, and microbial physiology

CO4: Students will gain knowledge about adaptations of plant, animal and microbes in extreme environmental conditions

Units	Topic	No. of Lectures (30)
1	Introduction to Metabolism • Biochemistry-Definition, scope & importance in Biotechnology • Chemistry of Metabolism: Oxidation–reduction reaction, Grouptransfer reactions etc, • Concept of Bioenergetics, ATP & Phosphoanhydride bond.	2
2	Carbohydrate Metabolism – • Aerobic & Anaerobic glycolysis, sequence of reactions in glycolysis, regulation in glycolysis, • Pyruvate metabolism, citric acid cycle & its regulation, Electron transport Chain, & oxidative phosphorylation, chemiosmotic hypothesis • glycogenesis, glycogenolysis (sequence of reactions& regulation), • Pentose-phosphate pathway (sequence of reactions & regulation, significance),	5
3	Amino acid Metabolism – • Essential & non-essential amino acids, Brief outline of amino acid synthesis, • General reactions of amino acid metabolism- Transamination, deamination & decarboxylation. • Urea Cycle- reactions, energetics & regulation • Disorders related to amino acid metabolism-Phenylketonuria, albinism, Maple syrup urine disease, Tyrosinemia, Homocystinuria with reactions. • Metabolic network – Interrelationship of metabolisms, Krebs	5

	cycle, amino acid synthesis	
4	Lipid Metabolism – • Outline of lipid synthesis, • Catabolism of Fatty acid: beta oxidation, Oxidation of unsaturated fatty acids, Oxidation of odd chain fatty acids, Cholesterol, ketone bodies.	4
5	Nucleotide Metabolism – • Biosynthesis of purine & pyrimidine (de novo & salvage pathway); Degradation of purine & pyrimidine.	4
6	Plant, Animal, and Microbial Physiology • Introduction and scope • Physiology with respect to growth and development • Physiology of stress (abiotic and biotic) responses in plants, animals, and microbes • Physiology of adaptive responses to climate change and environmental challenges	10

Reference Books :

1. Conn EE and Stump PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.

2. Voet D and Voet JG. 2011. Biochemistry. 4th Ed. John Wiley and Sons, Inc. NY, USA .

3. Nelson DL and Cox MM. 2012. Lehninger‟s Principles of Biochemisry, 6th Ed . Macmillan Learning, NY, USA.

4. Berg JM, Tymoczko JL, Stryer L and Gatto GJ. 2002. Biochemistry, 7th Ed. W.H. Freeman and Company, NY, USA.

5. Stryer, L., “Biochemsitry”, 4th Edition, W.H. Freeman & Co., 2000. 6. Murray, R.K., et al “Harper’s Biochemistry”, 23rd Edition, Prentice Hall International, 1993.

6. DP Singh, New Age International Publishers, 2003 “Stress Physiology”.

24BIO12106: Experiments in Metabolism and Physiology [2C, 15P]

Upon successful completion of this course, student should be able to:

CO1: Students will learn the nature and importance of enzymes in living systems

CO2: Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell

CO3: Students will gain hands on to design experiments on plant, animal, and microbial physiology

Sr. No.	Title	No. of Practical (15)
1	Estimation of glucose by Benedict's method	1
2	Estimation of amylase activity from given sample	1
3	Estimation of reducing sugar by DNSA (dinitrosalicylic acid) method	1
4	Estimation of alkaline phosphates activity from given sample	1
5	Estimation of creatinine in urine or Preparation of lactalbumin from milk or Chlorophyll from plant source	1
6	Estimation of cholesterol by ZAK's method	1
7	Bacterial growth curve	2
8	Effect of pH/Temperature on bacterial growth	2
9	Effect of salt stress on bacterial growth	1
9	Physiological parameters in plants/animals pertaining to growth and development (biomass production/ relative water content, root-shoot ratio	2
10	Physiological parameters in plants/animals pertaining to biotic/abiotic stress (ROS generation, Lipid peroxidation)	2

References

1. Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.

2. Principles of Biochemistry (2013) 4th ed., Voet, Donald,Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.

3. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.

24BIO12408: Experiments in Microscopy [2C, 15P]

On successful completion, the students should be able to:

CO1: Understand the basic principles of microscopy, working of different types of microscopes

CO2: Evaluate the cell morphologies under microscope

CO3: Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules

No.	Title of experiment	No. of practical
1	Construction, working, and principle of different types of microscopes: light, compound, and inverted microscope	04
2	Handling, maintenance and troubleshooting of compound microscope	01
3	Visualization of bacteria using bright and dark field microscopy	01
4	Visualization of animal cell culture using an inverted microscope	01
5	Determination of cell size using micrometry	01
6	Examine microscopic specimens to determine cell shape and arrangement.	01
7	Preparation of permanent slides	03
8	Visit the central instrumentations facility (SEM and TEM)	02
9	Study of electron micrographs	01

Recommended References:

- David L., Spector. and Robert D., Goldman. (2006). Basic Methods in Microscopy, Protocols and Concepts from Cells: A Laboratory Manual. *Northwestern University Medical School, Chicago.*
- Bradbury, S. and Bracegirdle, B. (1998). Introduction to light microscope: microscopy handbooks. BIOS Scientific Publishers – Springer, oxford, UK. Volume 42;69-76.
- Inoue, S. and Oldenbourg, R. (1995). Handbook of optics. Nass, M. (ed), McGraw-Hill, New York. Volume 2:17.

SY BSc Biotechnology SEM III (2025-26)

24BIO23101 Cell Biology (T, 4C, 60 L)

On successful completion, the students should be able to:

CO1: Know different cell types and cellular organelles and their functions.

CO2: Understand the structure of Plasma membrane, types of membrane transport mechanisms and cell signalling pathways.

CO3: Learn the concept of cell cycle and regulation in plant and animal cells.

CO4: Understand the phenomenon of cell death and its various types.

Unit	Topic	Lecture (60)
I	**Introduction to Cell**: Cell theory, cellular diversity and cell structure. **Types of cells and functions**: Prokaryotic & Eukaryotic cells, Plant & Animal cells, and Yeast (as a unicellular model organism).	5
II	**Structure and Functions of Cell Organelles:** Nucleus, Mitochondria, Chloroplast, Endoplasmic Reticulum, Golgi Bodies, Vacuoles, Peroxisome, and Lysosome. **Cell junctions and functions:** Types of cell junctions, Extracellular matrix, and Cytoskeleton.	10
III	**Concept and Organization of Genome** : Chromosomal organization and structure, Chromatin structure: Euchromatin, Heterochromatin (nucleosomes)- histone, non-histone proteins, Organelle DNA – mitochondria and chloroplast DNA	10
IV	**Genetic Code** • Concept of codon, reading frame, frame shift, Major scientific contributions to decipher genetic code • Properties of genetic code	5
IV	**Protein Trafficking:** Overview of Cellular Protein Transportation Systems. Proteins Targeted to a Cell Organelle: Nucleus, Mitochondria, Lysosomes Proteins Targeted to the Endoplasmic Reticulum and Secretory Pathway. Vesicular transport	10
V	**Plasma membrane:** Organization, Properties and Functions. **Transport Mechanisms:** Active & Passive Transport, Endocytosis, Exocytosis, and Bulk transport (phagocytosis and pinocytosis).	10

	Cell Signalling: Signalling molecules and receptors, Autocrine, Paracrine & Syncrine signalling, and G-protein mediated signalling.	
VI	**Cell cycle and Regulation:** Mitosis & Meiosis in Plant and animal cells, Phases and Check points of cell cycle.	5
VII	**Introduction to Cell death and Types:** Aging, Apoptosis, Necrosis, Neoplasia, Autophagy, Ferroptosis, Pyroptosis and Necroptosis.	5

Reference books:

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) Bruce Alberts, 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. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
7. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
8. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition.

24BIO23102 Experiments in Cell Biology (P, 2C, 15)

On successful completion, the students should be able to:

CO1: Know different cell types, and cell dimensions.

CO2: Learn centrifugation techniques for studying and characterization of cell organelles.

CO3: Learn slide preparation to study different stages of mitosis and meiosis and effect of colchicine.

CO4: Learn slide preparation to study polytene chromosomes of *Drosophila*/*Chironomus* larva.

CO5: Get familiar with the structure, and properties of Barr bodies and human epithelial cells.

CO6: Understand the phenomenon of cell lysis.

S. No.	Title of the experiment	No. of Practical
1	Study of Electron Micrographs of cell organelles	1
2	Micrometry: Measurement of various types of cells size	1
3	Observation of Barr bodies	1
4	Study of human cheek epithelial cells: preparation of slides	1
5	Isolation and characterization of the organelles using centrifugation technique: i. Cytosol: Isocitric acid dehydrogenase assay ii. Nucleus: Staining and Counting using hemocytometer iii. Mitochondria: Succinate Dehydrogenase assay iv. Chloroplast: Staining and microscopic observation v. Lysosomes: Acid Phosphatase assay	5
6	Methods of cell lysis and confirmation	1
7	Study of different stages of mitosis (*Allium cepa* root tip) and meiosis (grasshopper testis/ *Tradescantia*): preparation of slides and observation of permanent slides of Mitosis and Meiosis.	4
8	Study of polytene chromosomes (*Drosophila*/*Chironomus* larva): preparation of slides	2

Reference Books:

1. Cell biology and genetics lab manual Boğaziçi University Department of Molecular Biology and Genetics 2007-2008.

2. Cell Biology Laboratory the University of Toledo Department of Biological Sciences/Natural Sciences and Mathematics.

24BIO23205 Molecular Biology (Theory, 2C, 30L)

On successful completion, the students should be able to:

CO1: Students will understand the fundamental principles of molecular biology including DNA and RNA structure and the central dogma of molecular biology

CO2: The students will gain the knowledge about vital processes such as replication, transcription and translation.

CO3: The students will learn the regulation of genes in prokaryotes and the repair mechanisms of DNA.

Units	Topics	Lectures
I	**Introduction to Molecular Biology** • Central dogma of Molecular Biology, • Nucleic acids- structure, properties and function, Nucleoside and nucleotide • Structure of DNA: DNA forms; A, B & Z • Salient features of double helix, Chargaff's rule • Types and structure of RNA: tRNA, rRNA, mRNA and non-coding RNA (miRNA, SiRNA)	2
II	**Replication of DNA** • DNA synthesis: general principles, bidirectional replication, Semiconservative nature of DNA replication, Rolling circle replication • The replication complex: Enzymes involved in DNA replication, Unique aspects of eukaryotic & prokaryotic DNA replication, Fidelity of replication. • Inhibitors of Replication	7
III	**DNA damage and repair** • Causes and types of DNA damage • Mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, SOS repair, recombination repair	3
IV	**Synthesis of RNA: Transcription** • Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination • Transcription in Eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation	8

	• RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing.	
V	**Synthesis of Protein: Translation** • Structure of ribosome and assembly • Protein Synthesis in Prokaryotes: properties of the prokaryotic Initiator tRNA-fMet, Charging of tRNA, amino acyl tRNA synthetases • Protein Synthesis in Eukaryotes: Mechanism of initiation, elongation and termination of polypeptides, • Fidelity of translation, Inhibitors of translation.	6
VI	**Gene Regulation** • General aspects of gene Regulation: inducible and repressible system • The lactose operon: Catabolite repression • The Arabinose operon: Positive, negative regulation • The Tryptophan operon: Regulation by attenuation.	4

Reference Books:

1. Genes X, 10th edition (2009), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc. USA

2. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education,Inc. and Dorling Kindersley Publishing, Inc. USA

3. Molecular Biology, 5th Edition (2011), Weaver R., Publisher-McGrew Hill Science.USA

4. Fundamentals of Molecular Biology, (2009), Pal J.K. and SarojGhaskadbi, Oxford University Press. India

5. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. JohnWiley & Sons. Inc.

6. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology.VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

7. Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

24BIO23205 Experiments in Molecular Biology (P, 2C, 15)

On successful completion, the students should be able to:

CO1: Students will learn basic micropipette handling and buffers as well as reagent preparations.

CO2: Students will gain hands on experience on Isolation of DNA from various sources (Bacteria, Plant and animal).

CO3: The students will able to estimate the nucleic acids quantitatively and qualitatively.

CO4: The students will acquire knowledge about agarose gel electrophoresis.

Sr. No.	Title of Experiment	No. of Practical
1.	Handling Micropipettes	1
2.	Reagent and Buffer Preparation	1
3.	Bacterial DNA isolation by alkaline lysis/lysozyme method and analysis by agarose gel electrophoresis	2
4.	Isolation of Plant DNA and analysis by agarose gel electrophoresis	2
5.	Isolation of Animal DNA and analysis by agarose gel electrophoresis	2
6.	Estimation of nucleic acids by UV-VIS spectrophotometry	1
7.	Estimation of DNA by Diphenylamine method	1
8.	Determination of melting temperature of DNA	1
9.	Isolation of RNA from Yeast/Yeast tablets	1
10.	Estimation of RNA by Orcinol method	1
11.	Estimation of proteins by Bradford method	1
12.	Estimate the concentration of protein by using UV-VIS spectrophotometer	1

Recommended References:

1. Lab manual on molecular biology January 2016 Edition: First Edition, Media Associates Delhi-53Editor: Ruhi Dixit, KartikayBisen, Ashwani Kumar, Ashim Borah, Chetan Keswani ISBN: 978-81-909182-7-5
2. Molecular Biology Practical HandbooK: Dr. S. Sivaranjani, Dr. S. Ramadevi, V. Ramabhai, P. Everest Helen Rani and A. Gejalakshmi ISBN 978-93-5570-639-3
3. Surzycki, S. (2012). *Basic techniques in molecular biology*. Springer Science & Business Media.

VSC1

24BIO23406: Histological Tools [2C, 15P]

On successful completion, the students should be able to:

CO1: Understand the basic principles basic histological techniques

CO2: Understand the importance of histological preparations in biology

CO3: Students will independently make a tissue sections using histological techniques

No.	Title of experiment	No. of practical
1	Construction, working, and principle of Microtome	01
2	Handling, maintenance and troubleshooting of Microtome	01
3	Sectioning: • Cutting tissue using microtome.	02
4	Fixation of tissues • Paraffin technique / Frozen Section Technique / Semithin Section Technique	02
5	Dehydration and Embedding • Dehydration and clearing of the tissue. • Impregnation of the tissue. • Embedding of tissue.	03
6	Histological localization • H&E (Haematoxylin and eosin) stain / Mucin stain / Trichrome stain • Histological staining of reactive oxygen species in plant tissues • Histochemical staining of plant cell death (Evans blue)	05
7	Observation of permanent slides	01

Recommended References:

1.Anthony L. Mescher (2018) Junqueira's Basic Histology, Text and Atlas. 15th edition. McGraw-Hill Education, USA

2.Kim S. Suvarna, Christopher Layton, John D. Bancroft (2018) Bancroft’s Theory and Practice of Histological Techniques. 8th edition. Elsevier

3.Kević N. (2019): Basic Histological Techniques

Open Electives (OE)

OE1: Introductory Biotechnology [T, 2C, 30L]

Unit	Topic	Lectures
1	Biotechnology – Definition, scope and potentials	02
2	Types of Biotechnology: Blue Biotechnology, Green Biotechnology Red Biotechnology, White Biotechnology, Nanobiotechnology	05
3	Plant tissue culture and Plant Biotechnology and their applications	03
4	Environmental Biotechnology and its applications, with case studies	03
5	Animal biotechnology and its applications, with case studies	03
6	Microbial biotechnology and its applications, with case studies	03
7	Biotechnology in: 1. Medicine and health care 2. Crop production and agriculture 3. Food processing 4. Environmental protection	06
8	Biotechnology based industries (Agriculture, Diagnostics and Therapeutics, Food and Pharmaceuticals)	05

OE2: Biotechnology for Environment and Agriculture [T, 2C, 30L]

Unit	Topic	Lectures
1	Biotechnology – concept and scope in environmental and agricultural sectors	02
2	Major environmental calamities and accidents (e.g. Chernobyl, Sea oil spills, etc.)	03
3	Biotechnological tools useful for environmental protection, conservation, pollution abatement and restoration of degraded environments	06
4	Bioremediation of contaminated sites using biotechnological approaches – ex situ and in situ, with case studies	04
5	Biotechnology for conservation of biodiversity	02
6	Biotechnological tools used in agriculture – Crop improvement	06

	Development of biotic and abiotic stress tolerant crops Animal husbandry and allied fields	
7	Biofertilizers their production and applications	03
8	Genetically modified crops, their advantages, biosafety issues and ethical concerns related with them	04

SY BSc Biotechnology SEM IV

24BIO24101: Developmental Biology (4C) (T)

On successful completion, the students should be able to:

CO1: Gaining knowledge about model organisms to understand the concepts of embryology.
CO2: Understanding the basic concepts of steps in the development of plants and animals.
CO3: Understanding the patterning in model organisms like Drosophila / *Araboidiopsis*
CO4: Students will apply about role of teratogens on abnormal development of an embryo.
CO5: Understanding the mechanisms on the concept of regeneration and gaining knowledge on Important concepts like differentiation, trans differentiation, commitment., developmental plasticity.

Units	Topics	No. of Lectures
Animal Development		
1	• History of developmental biology • Problems of developmental biology • Model organisms in study of developmental biology: frog, chick, mouse, Drosophila, Sea urchin, Zebra fish, *Caenorhabditiselegans*	2
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	8
3	Gastrulation • In Frog, Chick, Drosophila up to formation of three germinal layers	6
4	Basics of neurulation; Primary neuralation	2
5	Concept of pattern formation • Maternal effect genes and their role in Drosophila pattern • Molecular mechanism in Drosophila patterning	5
6	• Concept of Stem cells, Progenitor cells, Cell lineages, determination, commitment and differentiation, re-differentiation and trans-differentiation	1
7	Different types of regeneration with one example of each type	2
8	Theories of ageing	1
9	Programmed cell death and apoptosis during embryonic development	2
10	Environmental challenges, its implications: Abnormal development and teratogenesis in animals	1

Plant Development		
1	Plant as a living system • Principles and Unique features of plant development • Comparison of Plant and animal development	2
2	Plant development at: • Cellular, organ and whole-plant levels • Whole plant as an interacting dynamic system(Effect of biotic and abiotic factors on plant development).	2
3	Major phases of plant development i) Vegetative development: • Zygote to seed embryo to seedling till vegetative maturity • Pattern formation in plants- vegetative • Hormones as mediators of development ii) Reproductive development: • Shift from vegetative to reproductive phase • Structure of flower • Induction- perception of inductive stimuli and subsequent • changes, • Pattern formation in plants- flowering	8
4	Microsporogenesis, development of male gametophyte and male gamete, Megasprogenesis, development of female gametophyte and female gamete, Double fertilization and triple fusion, Development of endosperm	8
5	Concept of competence, Determination, Commitment, Differentiation, De-differentiation and Re-differentiation (partial/ terminal) in vivo with one example each	3
6	Model systems to understand plant development: Arabidopsis Molecular regulation of development in Arabidopsis Effect of environmental factors on plant development and their solutions	4
7	Parthenogenesis • Haploid, Diploid • Parthenocarpy – Natural, Induced • Importance of seed and seed dispersal • Applications of Plant development in Biotechnology	3

References:

1. Development Biology, 9th edition, (2010), Gilbert S. F. (Sinauer Associates, USA)
2. Principles of Development, 5th edition (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
4. Development Biology, 9th edition, (2010), Gilbert S. F. (Sinauer Associates, USA)
5. Principles of Development, 4th edition (2010), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.

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

24BIO24102: Experiments in Developmental Biology (2C) (P)

Upon successful completion of this subject student should be able to:

CO1: Hands-on training on different methods of isolation and culturing the plant/animal embryo.
CO2: Hands-on training like dissection, and staining of different stages of plant and chick embryo.
CO3: Students will understand the different developmental stages of animal and plant development.

Sr.no	Title	No. of Practical
Animal Development		
1	Study of frog development, observation of different development stages (Permanent slides or fixed embryos Early and Late stages of embryogenesis)	2
2	Study of staging of chick embryo (Slides) Staining of Chick embryos developmental stages (24 h, 48h, 72 h)	2
3	Effect of teratogen on development of chick embryo by window technique	1
4	Demonstration of any one technique of chick embryo culturing	2
Plant Development		
1	Methods of studying plant development (any suitable plant material) a) Dissection b) Sectioning c) Staining d) Mounting	1
2	Study of apices and meristem RAM, SAM, florally induced meristem (using permanent slides)	2

3	Microsporogenesis- anther squash technique	1
4	Development of male and female gametophytes	1
5	Developmental stages during plant embryogenesis in dicots and monocots	1
6	Dissection of seed and excision of young embryo and endosperm (one dicotyledon and monocotyledon example each)	2

References:

1. Burgess J. (1985) An Introduction to Plant Cell Development (Cambridge Univ Press, UK)
2. Taiz L, Zeiger E (2010) – Plant physiology (Sinauer Associates, USA).
3. Sharma HP (2009) – Plant embryology: Classical and experimental (alpha sci)
4. Development Biology, 9thedition, (2010), Gilbert S. F. (Sinauer Associates, USA)
5. Principles of Development, 5thedition (2018), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.
6. An introduction to embryology, 5th edition, B. I. Balinsky, B.C. Fabian (2012) Cengage Learning India

24BIO24203: Genetics and Diagnostic Tools (2C) (T)

Upon successful completion of this subject student should be able to:

CO1: Understand the basic concept of transmission genetics.
CO2: Understand the concepts of gene interactions and its applications in knowing genetic Disorders.
CO3: Comprehend the phenomenon of extra nuclear inheritance and SexDeterminationand Recombination
CO4: Understand and analyse Genetic disorders and syndromes.
CO5: Gain knowledge about diagnostic molecular testing and genetic counseling.

Sr.No	Topics	Lectures
I	**Introduction to Classical and Modern genetics** Mendel's Law: MonoHybrid, DiHybrid and TriHybrid Deviation From Mendel's Law-Partial or Incomplete Dominance, CoDominance, Epistasis Penetrance and expressivity-Pleiotropism Gene Interaction- Modified DiHybrid Ratio, Multiple Allele, Lethal genes Extra nuclear and polygenic traits. **Introduction to Eugenics**	**4**
II	**Chromosomal aberrations and Mutations:** Variation in chromosome number–types,dosage compensation and Barrbodies (Human). Variation in chromosome structure–types, generation of variation, Mutations Classification and types, molecular basis of mutations.	**5**

III	**Genetic Diseases and Inheritance Pattern:** Linkage and Recombination-Discovery of Linkage, Complete and incomplete linkage, crossing over, Cytological Proof of Crossing Over, three-pointcross, Recombination Frequency and Map Distance. Autosomal inheritance- Dominant (Eg. Adult polycystic kidney and Neurofibromatosis) Autosomal inheritance- Recessive (Eg. Albinism, Sickle cell anemia) X-linked – Recessive: (Eg. Duchene muscular dystrophy) X-linked Dominant- (Eg. Hypophosphatemia) Y-linked inheritance Holandric gene (E.g. Testes determining factor - TDF) Multifactorial inheritance: (Eg. Congenital malformations: Cleft lip and palate, Rheumatoid arthritis and Diabetes) Mitochondrial diseases: (Eg. Leber's hereditary optic neuropathy).	**7**
IV	**Genetic diagnostic tools :** Introduction, Types and application Example: Cancer and environment: physical, chemical and biological carcinogens. Familial cancers, Genetic predisposition to sporadic cancer, Chromosomal aberrations in neoplasia, Tumor specific markers.	**7**
V	**Diagnostic Molecular Genetics:** Molecular methods: chromosomal anomaly Inborn errors of metabolism and their genetic bases,- Adult/Prenatal/Newborn screening. Genetic basis of male and female infertility: Diagnostic Molecular Genetics. Introduction to Karyotyping with case studies of genetic disorders/ syndromes Sickle Cell Anemia, Hemophilia, Color Blindness, Albinism, Down's and Kleinfelter's Syndrome. Introduction to Genetic Counseling.	**7**

ReferenceBooks:

1. Genetics,byStrickbergerMW(2006)(PrenticeHall,India)
2. FundamentalsofGenetics. B.DSingh
3. Genetics: analysis of genes and genomes by Hartl DL, Jones EW (2001) –(Jones and Bartlett,Massachusetts)
4. Introductiontogeneticanalysis byGriffiths AJ,WesslerSR, CarrollSB,DoebleyJ(2012)– (Freeman&Co,NewYork)tenthedition.
5. Moleculargeneticsofbacteria(ASMPress,Washington)SnyderL,ChampnessW(2007)
6. TextbookofCellBiology,Genetics, molecularbiology,EcologyandEvolution.:P.S.Verma AndV.K Agarwal(2001)
7. PrincipalsofGenetics:RobertH.Tamarin,7thEdition.
8. GENESIX(2006):BenjaminLewin.
9. Gardner, A. and Davies, T. (2017). Human Genetics. Viva Books, New Delhi, published by arrangements with Scion Publishing Limited, 2nd Ed.
10. Gibson, G. (2015). A Primer of Human Genetics.
11. Harper, P. (2010). Practical genetic counselling. CRC Press.

24BIO24204: Experiments in Genetics and Diagnostic Tools

Upon successful completion of this subject student should be able to:

CO1: Understand the Mendel's laws and its deviations.

CO2 Solve genetic problem based on linkage and crossing overs

CO3: Prepare and analyze the karyotype of normal and syndromic individuals.

CO4: Perform biochemical test to detect inborn errors and RBC anamolies.

S. No.	Title of the experiment	No. of Practical
1	Problem based on: 1. Mendelian inheritance with test of significance (Chi square test) 2. Problem sets on Linkage and crossing overs 3. Construction and analysis of Pedigree 4. Problems based on Recombination Frequency and Map Distance	4
2	Demonstration of Preparation of metaphase spread, Staining, Banding	2
3	Detection of inborn errors of metabolism PKU.	1
4	Measurement of RBC indices and morphology	2
5	Human Karyotyping (Genetic disorder case study)	2
6.	Study of drum sticks in Neutrophils of Blood smear	1
7.	Study of pollen grains for viability and identify any abnormalities	1
8	Study effect of a known mitotic inhibitor on the cell division of onion roots.	1
9	Detection and measurement of Coenzyme Q 10 in human blood/plasma/tissue homogenate and biological relevance.	1

Reference Books:

1. Mendelian Inheritance in Man: A Catalogue of Human Genes and Genetic Disorders, Victor A. McKusick,2Vol I & II

2. Harper, P. (2010). Practical genetic counselling. CRC Press.

3. Moat SJ, Schulenburg-Brand D, Lemonde H, et al. (2020) Performance of laboratory tests used to measure blood phenylalanine for the monitoring of patients with phenylketonuria. J Inherit Metab Dis. doi:10.1002/jimd.12163.

24BIO24405: Environmental Biotechnology (2C, 30 L)

On completion of the course, student will be able to

CO1: Build awareness about environment, scope, and importance of Biotechnology in sustainable development.

CO2: Acquire knowledge about the concept of pollution, its impact on environment, ecosystem and on climate change.

CO3: Understand the current global environmental threats, global priorities and sustainable development**.**

CO4: Acquire an insight about different environmental monitoring systems for the control of environmental pollution.

CO5: Explore the application of Biotechnology in environmental analysis and value addition to global economy

CO6: Focus on the utilization of microbial processes in waste and water treatment, and bioremediation and to develop bioremediation and phytoremediation techniques.

Unit	Environmental Biotechnology Topic	No. of Lectures
I	**Foundations of Environment** Environment: Definitions, Components-Atmosphere, Hydrosphere, Lithosphere, Biosphere) and Inter-relationships **Ecosystem:** Introduction, Characteristics, Components of ecosystem and Homeostasis	2
II	**Threats to Environment and Ecosystem** Concept of pollutant, contaminant and xenobiotics Environmental pollution: Types, sources and consequences of Air, Water, Soil, radiation and noise pollution with reference to human health and epidemiological issues (suitable examples) Causes and consequences of climate change with reference to global warming, Ozone depletion, Sea level rise and species extinction Global threats to the environment in current scenario (Antibiotics, Microplastics, nanoparticles as a pollutant and their potential impact) Future scenarios of the global environment **Environmental Toxicology:** Impact of activation of oxygen due to xenobiotics (biochemical processes that results in reactive oxygen compounds like free radicals) Long-term harmful effects of xenobiotics on gene activity, cell differentiation, embryo development, reproduction, and behaviour.	5
III	**Environment Monitoring** • Biotechnological approaches for pollution control • Biomonitoring: Bioindicators, Biomarkers, Biosensors • Pollution impact Assessment: Ecological footprints, Carbon Footprints and Carbon Credits	3

	• Remote sensing and GIS **:** Principal, objectives, Energy sources for remote sensing, Types of remote sensing and Applications	
IV	**Waste management** • Waste water treatment technology and recycling, Secondary treatment of waste water, Tertiary treatment of waste water (BNR, BPR) • Water quality assessment by estimation of DO, BOD and COD • Solid waste management: Biotechnology recovery solutions	3
V	**Biotechnology for sustainable development** Introduction to use of biological agents in pollution control-biosensors in environmental analysis, molecular biology applications in environmental engineering Bioremediation: Principle, types, advantages, limitations and applications Genetic engineering of organisms for bioremediation Bioleaching of metals, Biomethanation, biofilms/biofilters for vapor-phase wastes, composting Microbially enhanced oil recovery (MEOR) Concept of Biofertilizers, Biopesticides, Bioherbicides, Biofungicides Bioinsecticides: Bacillus thuringienis, Baciloviruses, uses, genetic modifications and aspects of safety in their use Use of microorganisms for Bioremediation of - i) Plastic (**micro-plastic and nano-plastic**) ii) Hydrocarbons iii) Dyes (Biosorption) iv) Pesticides / insecticides and herbicides Phytoremediation technology (terrestrial and aquatic), development of stress tolerant plants	6
VI	**Biotechnology and value addition** Bio processes in production of value added products from waste – Biofuel technology, Enzyme/ protein and bioplastic production technology. Biofertilizer production, production of biosurfactants/ bioemulsans	4
VII	**Global Environmental Priorities** i) Global approach for environment management (Earth summit, Stockholm convention) ii) Indian environment policies: Important objectives of The Environment Protection Act 1986 iii) Sustainable Development Goals	3
VIII	**Analytical techniques in Environmental studies** Principle and application of i) Atomic absorption spectrophotometry, Flame photometry ii) Chromatographic techniques- Gas-liquid chromatography, GC-MS, High performance liquid chromatography iii) Metagenomics	4

Reference Books:

1. Ecology and environmental biology (2011) SahaTK Books & Allied (p) Ltd edition, PrenticeHall, Inc.
2. Environmental Science(2011) Santra S.C. NewCentralBookAgency
3. Environmental Biology (2000) Varma & Agarwal S.Chand Limited
4. Environmental risks and hazards (1994) SusanCutterPrenticeHall,Inc.
5. Environmental Biotechnology(2010) Rana Rastogi Publications
6. Bioremediation (1994)Baker,K.HandHerson,D.S.McGrawHill,Inc.NewYork
7. Biotreatment of Industrial & Hazardous Waste (1993) M.V.Levinand Gealt, M.AMcGrawHill. Inc
8. Environmental Protection and Laws(1995) Jadhav and Bhosale V.M. Himalaya publishing House.
9. Soil and Water Conservation Engineering (1981) G. O. Schwab, Richard K. Frevert,TalcottW. Edminster,and KennethK. Barnes
10. Waste Water Engineering: Treatment and Reuse (2002) MetCalf & EddyI NC, TatamcGrawHilledition, Prentice-Hall
11. Remote sensing of the environment (2000) John R. Jensen Dorling Kindersley India Pvt. Ltd
12. Concepts and Techniques of Geographic Information Systems (2009) C.P.Lo.Albert and K.W.Yeung 2nd

24BIO24406: Experiments in Environmental Biotechnology (2C, 15P)

Sr. No.	Topic	No. of practicals
1	Study of pollution indicator plants in terms of morphology and anatomy (any 5-7plants)	1
2	**Soil analysis: Determination of effect of pollution by using** Chemical properties: pH, Organic content, Chloride contents and Alkalinity	2
3	**Waste water / Sewage analysis:** Determination of dissolved oxygen concentration and BOD of water sample	1
4	Microbial (Bacterial and Fungal) community estimation	1
5	Molecular fingerprinting techniques for estimation of microbial diversity (demonstration)	1
6	Detection of pollution induced biomarker	1
7	DNA extraction from environmental samples	1
8	Determination of Genotoxicity of pollutant using Onion root tip model	1

9	Determination of Cytotoxicity of pollutant	1
10	Determination of Mutagenicity of pollutant (Ames Test)	1
11	Qualitative determination of biodegradation of pesticide / insecticide/ xenobiotic.	1
12	Determination of enzymatic activity of microbes in bioremediation process	1
13	Qualitative determination of heavy metal pollutants (Lead) from soil / water.	1
14	Biosorption technique for removal of dyes in the effluent treatment processes	1