Academic Council Meeting No. and Date : 8 / September 04, 2023

Agenda Number :2 **Resolution Number : 34, 35 / 2.8, 2.29**

Vidya Prasarak Mandal's B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme code:BUBT
Programme : Bachelor of Science

Specific Programme : Biotechnology

[F.Y.B.Sc. Biotechnology]
Level - 4.5

CHOICE BASED GRADING SYSTEM

Revised under NEP and Autonomy

From academic year 2023-24

Preamble

Biotechnology is an applied branch of biology that includes the study that utilizes biological systems, to develop or create different products for betterment of society. Microbiology, biochemistry, immunology, genetics, molecular biology, medicine (drug development and personalized therapies), agriculture, marine, industrial biotechnology are among many other fields that form a beautiful collage of Biotechnology. With the goal of engaging the learners in biotechnological studies in the laboratory, and *in silico*, harnessing experimental approaches that can be correlated better with the theoretical learning, the syllabus was re-framed under autonomy. Continuing the Choice Based Credit System (CBCS) implemented by the esteemed University from the academic year 2016-2017, the restructured syllabus F.Y.B.Sc. Biotechnology has been implemented since 2021-22; with a purpose of maintaining the pace in concept building for better hierarchical learning as well as updating.

The present revision is related to restructuring of syllabus under the National Education Policy 2020, which aims at the holistic development of learner. With Biotechnology and Microbiology as major and minor subjects respectively, the students would also learn fundamental genetics, biostatistics and immunology as generic courses. To improve communication skills and scientific expression of the learner, a module covering English communication has been introduced. The syllabus has also included basics of yog, ayurved, meditation, traditional Indian diet and stress management as part of Indian Knowledge System. Role of Biotechnology on environment management would be dealt with as a part of 'Value education'.

Dr. Jayashree Pawar
Chairperson, BOS Biotechnology
VPM's B.N.Bandodkar College of Science (Autonomous), Thane

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B.Sc.)

The Undergraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instil ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behaviour in all aspects of life.

Eligibility: Passed 12th standard (HSC) of Maharashtra State Board / CBSE / ICSE board
Duration: 1 Year (Includes SEM I and SEM II)
Mode of Conduct: Offline Laboratory Practicals / Offline lectures / Online lectures
Specific Programme: F.Y.B.Sc. Biotechnology
Qualification Title: UG certificate

Discipline/Subject: **BIOTECHNOLOGY**

Program Specific Outcome

1	Recall and define fundamental concepts of biomolecules, cells, genes, enzymes, recombinant DNA technology, and basic molecular and cellular mechanisms underlying biotechnology.	L1
2	Explain the principles, workflows, and biosafety practices involved in standard biotechnological, molecular biology, biochemical, microbiological, and bioinformatics techniques.	L2
3	Apply biotechnological principles to industrial, medical, agricultural, environmental, and pharmaceutical contexts, demonstrating how biological systems are engineered for specific biotechnological applications.	L3
4	Analyze and interpret biological and experimental data related to health and disease, including diagnostic, immunological, genomic, and therapeutic aspects of clinical and biomedical	L4

	biotechnology.	
5	Evaluate biotechnological problems using critical thinking, data interpretation, and bioinformatic tools to propose feasible, evidence-based, and ethically sound solutions.	L5
6	Design and propose innovative biotechnological approaches to address societal, industrial, and environmental challenges, with emphasis on sustainability, public health, and community welfare.	L6

Specific Programme: F.Y.B.Sc. (Biotechnology)		
Assessment: Weightage for assessments (in percentage) For Major and Minor		
Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40 %	60 %

Curriculum Structure for the Undergraduate degree
F.Y.B.Sc. (Biotechnology)

	Course Code	Course Title	No. of lectures	Credits
Semester I				
Major	23BUBT1T01	Fundamentals of Life Sciences I	30	2
	23BUBT1T02	Fundamental Chemistry I	30	2
	23BUBT1P01	Practicals Based on 23BUBT1T01 & 23BUBT1T02	60	2
Minor	23BUBT1T03	Fundamentals of Microbiology I	30	2
	23BUBT1T04	Fundamentals of Microbiology II	30	2
	23BUBT1P02	Practicals Based on 23BUBT1T03 & 23BUBT1T04	60	2
Generic	23BUBT1T05	Fundamental Genetics and Evolution	30	2
	23BUBT1T06	Fundamental Biostatistics and Immunology	30	2
VEC	23BU1VEC01	Environmental Biotechnology I	15	1
		Practicals Based on 23BU1VEC01	30	1
AEC	23BUEN1T02	Communication skills I	30	2
IKS	23BUIK1T02	Principles of Yoga for Body and Mind Management	30	2
	Total		405	22

	Course Code	Course Title	No. of lectures	Credits
Semester II				
Major	23BUBT2T01	Fundamentals of Life Sciences II	30	2
	23BUBT2T02	Fundamental Chemistry II	30	2
	23BUBT2P01	Practicals Based on 23BUBT2T01 & 23BUBT2T02	60	2
Minor	23BUBT2T03	Industrial Microbiology	30	2
	23BUBT2T04	Fundamentals of Microbiology III	30	2
	23BUBT2P02	Practicals Based on 23BUBT2T03 & 23BUBT2T04	60	2
Generic	23BUBT2T05	Microbial Genetics and Cytoskeleton	30	2
	23BUBT2T06	Cytogenetics and Immunological Weapons	30	2
FP or CC	23BUBT2P03	Field Project in Biotechnology I	60	2
	OR			
	23BU2CC606	Departmental activities I	60	2
AEC	23BUEN2T02	Communication skills II	30	2
IKS	23BUIK2T02	Ayurveda for Healthy Lifestyle	30	2
	Total		420	22

Semester I

Course Code 23BUBT1T01	Course Title Fundamentals of Life Sciences I	Credits 2	No. of Lectures - 30

Course Outcomes

On completion of this course, students will be able to:

CO1	Explain features of different classes of microbes	L2
CO2	Analyze microbial diversity	L4
CO3	Compare different pathways of photosynthesis	L2
CO4	Explain cyclic and non-cyclic phosphorylation, energetics of photosynthesis, structure and functions of blood and other body fluids	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	1	1	0	0
CO2	2	0	1	1	0	0
CO3	2	0	1	1	0	0
CO4	2	0	1	0	0	0

Units	Description	No of lectures
Unit I: Biodiversity	**General classification:** a. Seven levels of classification b. Kingdoms: 6 kingdom classification (Plant, Animal, Protists, Fungi, Archaebacteria, Eubacteria; properties in brief **Introduction to Microbial diversity:** a. Rickettsia, Coxiella, Chlamydia, Mycoplasma: general features, medical significance b. Actinomycetes: General features; Importance: ecological, commercial and medical c. Archaea: Introduction- major Archaeal physiological groups, d. Ecological importance e. Eumycota (Fungi): Characteristics: Structure, reproduction, Cultivation of fungi, Biological and economic importance f. Protozoa: Ecology and Morphology of Protozoa; Major categories of Protozoa based on motility, reproduction; Medical importance of Protozoa g. Viruses: General properties and structure h. Algae – Characteristics of algae: morphology, Pigments,	**15**

	Reproduction; Cultivation of algae, Major groups of Algae –an overview, Differences between Algae and Cyanobacteria i. Fungi and Yeast- Characteristics: structure, Reproduction. Major fungal divisions- overview j. Slime molds and Myxomycetes	
Unit II: Plant and animal physiology	**Plant Physiology**: a. Photosynthesis b. Intracellular Organization of Photosynthetic Systems c. Fundamental Reactions of Photosynthesis d. Photosynthetic Pigments e. Role of light, Hill reaction and its Significance, Light Reactions f. Cyclic and Non-Cyclic Photo-induced electron flow, Energetics of Photosynthesis g. Photorespiration h. Dark phase of Photosynthesis, Calvin Cycle, C-3, C-4 pathways **Animal Physiology:** Blood composition, Structure, Function, Coagulation (Hemophilia), Anti- coagulants, body fluids and buffers	**15**

Course Code 23BUBT1T02	**Course Title Fundamental Chemistry I**	**Credits 2**	**No. of lectures-30**
Course Outcomes			
On completion of this course, students will be able to:			
CO1	Categorize various organic and inorganic compounds and catalysts for hydrogenation		L4
CO2	Explain various types of chemical bonds		L2
CO3	Apply the concepts of various concentration measures to effectively analyze and utilize acids, bases, and buffer solutions		L5
CO4	Explain principles of oxidation-reduction reactions and titrimetric analysis		L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	2	0	0	0	0	0
CO3	2	0	0	0	0	0
CO4	2	0	0	0	0	0

Units	Description	No of lectures
Unit I: Nomenclature, catalysts and chemical bonds	**Nomenclature and Classification of Inorganic Compounds:** Acids, bases and salts **Nomenclature and Classification of Organic Compounds:** a. Cyclic Hydrocarbons b. Alcohols and Ethers c. Carbonyl compounds and their derivatives d. Amines e. Amides f. Heterocyclic Compounds (Quinolines and isoquinolines) **Catalysts for hydrogenation:** a. Raney nickel, Pt and PtO_2 (C=C, C=N, NO_2 aromatic compounds) b. Pd /C: COCl→ CHO (Rosenmund) c. Lindlar catalyst: alkynes **Chemical bonds:** a. Ionic Bond: Nature of Ionic Bond, Structure of NaCl, Factors influencing the formation of Ionic Bond b. Covalent Bond: Nature of Covalent Bond, Structure of CH_4, NH_3, Shapes of $BeCl_2$, BF_3 c. Coordinate Bond: Nature of Coordinate Bond d. Non-covalent Bonds: Vander Waals force: dipole - dipole, dipole – induced dipole e. Hydrogen Bond: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with example of RCOOH).	**15**
Unit II: Basic concepts of physical chemistry and titrimetric analysis	**Preparation of solutions:** Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (concepts to be taught, problem solving during practical) **Acids and Bases:** a. Lowry-Bronsted and Lewis Concept b. Strong and Weak Acids and Bases - Ionic Product of Water - pH, pKa, pKb. Hydrolysis of Salts **Buffer solution:** a. Concept of Buffer b. Types of Buffers c. Derivation of Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity (Numericals expected) d. pH of Buffer Solution	**15**

	Principles of Oxidation & Reduction Reactions: a. Oxidizing and Reducing Agents b. Oxidation Number c. Oxidation d. Reduction e. Addition, Substitution & Elimination Reactions **Principles of Titrimetric Analysis:** a. Significance of Terms in Titrimetric Analysis b. Types of titrations: Acid-Base, Redox, Precipitation, Complexometric Titration; Strong Acid Vs Strong Base c. Theoretical aspects of Titration Curve and End Point Evaluation d. Theory of Acid –Base Indicators, Choice and Suitability of Indicators	

Course Code **23BUBT1T03**	**Course Title** **Fundamentals of Microbiology I**	**Credits** **2**	**No. of lectures-30**
Course Outcomes			
On completion of this course, students will be able to:			
CO1	Explain the structure and functions of prokaryotic cell wall, cell membrane, cytoplasmic matrix, nuclear material		L2
CO2	Recall the structure and functions of components external to prokaryotic cell wall, storage bodies, endospore, magnetosomes, gas vesicles and difference between archaebacteria and eubacteria.		L1
CO3	Recall the structure and functions of eukaryotic plasma membrane, cytoplasmic matrix, cytoskeletal elements, organelles of biosynthesis, nucleus and centrioles and basal bodies		L1
CO4	Explain the structure and functions of eukaryotic lysosomes, glyoxysomes, peroxisomes, ribosomes, mitochondria, plastids, cilia and flagella and details about cellular internalization processes and difference between prokaryotic and eukaryotic cell structure.		L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	0	1	0	0	0
CO2	3	0	1	0	0	0
CO3	2	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	**Description**	**No of lectures**

Unit I: Ultra structure Of prokaryotic cells	**Bacterial cell shape, size and arrangement** **Detailed structure of:** a. Slime Layer, Capsule b. Flagella, pili and fimbriae c. Bacterial motility d. Cell Wall (Gram Positive and Gram Negative) e. Cell Membrane, mesosomes: structure and functions f. Cytoplasm, ribosomes g. Genetic Material h. Storage Bodies i. Endospores: structure and formation j. Magnetosomes, gas vesicles **Difference between eubacterial and Archaeal cell wall, lipids membranes and ribosomes**	**15**
Unit II: Ultrastructure of eukaryotic cells	**Ultra structure of Eukaryotic cells:** a. Plasma Membrane, The fluid mosaic model b. Cytoplasmic Matrix, Microfilaments, Intermediate Filaments andMicrotubules c. Organelles of biosynthesis: Endoplasmic reticulum (SER, RER) & Golgi apparatus: origin and significance in the cell d. Lysosomes, peroxisomes and glyoxysomes e. Endocytosis, Phagocytosis, Autophagy, Proteasomes f. Eukaryotic Ribosomes, Mitochondria and plastids, The endosymbiont hypothesis g. Nucleus- Nuclear structure, Nucleolus h. Cilia and flagella, difference between prokaryotic and eukaryotic flagella i. Centrioles and basal bodies **Comparison of Prokaryotic and Eukaryotic cells**	**15**

Course Code **23BUBT1T04**	**Course Title** **Fundamentals of Microbiology II**	**Credits** **2**	**No. of lectures-30**
Course Outcomes			
On completion of this course, students will be able to:			
CO1	Classify microorganisms based on nutritional requirements		L2
CO2	Choose appropriate methods of cultivation and preservation of microorganisms		L3
CO3	Describe physical methods of microbial control		L1

CO4	Explain mechanism, advantages, disadvantages and applications of chemical methods for microbial control	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	1	0	0
CO2	3	0	1	1	0	0
CO3	3	0	1	1	0	0
CO4	3	0	1	1	0	0

Units	Description	No of lectures
Unit I: Microbial Nutrition	a. Nutritional Requirements: Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth Factors (definition only) b. Classification of Different Nutritional Types of Organisms c. Design and Types of Culture Media d. Simple Medium, Differential, Selective & Enriched Media (with examples) e. Concept of Isolation & Methods of Isolation & Pure Culture Techniques f. Study of colony characteristics g. Culture of anaerobic microorganisms h. Preservation of microorganisms i. Culture Collection Centers	**15**
Unit II: Sterilization techniques	**Definition of frequently used terms**: Rate of microbial death, Factors affecting the effectiveness of antimicrobial agents & Properties of an ideal disinfectant **Physical methods of microbial control** a. Dry & moist heat – mechanisms, instruments used & their operations b. Electromagnetic radiations – Ionizing radiations, mechanisms – advantages & disadvantages c. Bacteria proof filters d. Low temperature e. Osmotic pressure f. Desiccation **Chemical methods of microbial control-mechanism & advantages & disadvantages (if any) applications** a. Phenolics b. Alcohols	**15**

	c. Heavy metals and their compounds d. Halogens e. Quaternary ammonium compounds f. Halogens g. Dyes h. Surfaces active agents/Detergents i. Aldehydes j. Peroxygens k. Sterilizing gases **Evaluation of a disinfectant:** Tube dilution & Agar plate techniques, Phenol coefficient, Tissue toxicity index	

Course Code **23BUBT1T05**	**Course Title** **Fundamental Genetics and Evolution**	**Credits** **2**	**No. of lectures-30**
Course Outcomes			
On completion of this course, students will be able to:			
CO1	Explain mendelian principles and their deviations		L2
CO2	Apply mendelian principles and their deviations using examples		L3
CO3	Summarise evolution and biogeography of islands		L2
CO4	Explain importance of biodiversity hotspots, methods of conservation and speciation.		L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	0	1	0	0	0
CO2	3	0	1	0	0	0
CO3	3	0	1	2	0	0
CO4	3	0	1	2	0	0

Units	**Description**	**No of lectures**
Unit I: Fundamental Genetics	**Mendel: The Father of Genetics** a. Mendel's success b. Genetic terminology **Monohybrid and Dihybrid crosses:** a. What does monohybrid crosses reveal? (Principle of segregation	**15**

	and concept of dominance) b. Punnett square c. Testcross d. Genetic symbols e. Dihybrid crosses f. Principle of independent assortment g. Applying probability and branch diagram to dihybrid cross h. Dihybrid testcross **Modifications of Dominance relationships:** a. Incomplete dominance b. Codominance c. Molecular explanations of incomplete dominance and codominance **Genes and the environment:** a. Penetrance and expressivity b. Effects of the environment (Age of onset, sex, temperature, chemicals) **Gene interactions and modified mendelian ratios:** a. Gene interactions that produce new phenotypes b. Epistasis (Recessive epistasis, dominant epistasis, epistasis involving duplicate genes) **Multiple alleles**	
Unit II: Evolution and Conservation of Biodiversity	**Evolution:** a. Concept, time line of evolution b. Origin of Life: Earliest life on Earth, RNA world Hypothesis, Endosymbiont theory, Unicellular to Multi cellular, Diversification of life. c. Concept of Species, Origin of Species (Speciation): Allopatric, Sympatric, Parapetric, Peripatric d. Concept of Molecular Evolution in brief e. Evolution and Biogeography of Islands – Dispersal, establishment and extinction, adaptive radiation **Conservation of Biodiversity:** a. Biodiversity Hot Spots b. Seed Banks & Artificial seeds in conservation, Significance of gene banks and germplasm conservation	**15**

Course Code **23BUBT1T06**	**Course Title** **Fundamental Biostatistics and Immunology**	**Credits** **2**	**No. of lectures-30**
Course Outcomes			
On completion of this course, students will be able to:			

CO1	Solve problems based on measures of central tendency, measures of dispersion of data and frequency distribution	L3
CO2	Explain the basic concepts of biostatistics including data types, population, sample, frequency distribution and statistical graphs, measures of central tendency, measures of dispersion	L2
CO3	Compare various types of immunity and their important components, antigen and antibody	L2
CO4	Illustrate structure and functions of various lymphoid organs and complement system	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	1	0
CO2	3	1	1	0	1	0
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No of lectures
Unit I: Fundamental Biostatistics	a. Introduction to biostatistics b. Types of data c. Population and sample d. Frequency distribution e. Visualizing data f. Central tendency g. Measures of variation h. Standard error of mean	**15**
Unit II: Fundamental Immunology	a. Overview of immune system b. Cells (T, B and NK cells) c. Organs - primary and secondary and their functional significance d. Innate immunity, acquired immunity e. Local and herd immunity f. Humoral and cell mediated immunity, factors influencing and mechanisms of each g. Antigens: Types and general properties h. Antibody: basic Structure, classes antibodies, Ig superfamily i. Complement: Nomenclature, activation pathways (Classical, alternative, lectin), biological function and regulation overview	**15**

Course Code 23BU1VEC01	Course Title Environmental Biotechnology I	Credits 1	No. of lectures-15

Course Outcomes

On completion of this course, students will be able to:

CO1	Explain air microbiology with respect to airborne pathogens, toxins, bioaerosols and sampling methods	L2
CO2	Outline the concepts associated with soil including its microorganisms and biogeochemical cycles	L2
CO3	Make use of enrichment and isolation technique to study soil ecosystem	L3
CO4	Inspect air and soil environment and microflora using microbiological techniques	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	2	0	0
CO2	3	0	1	2	0	0
CO3	3	0	0	2	0	0
CO4	3	0	0	2	0	0

Units	Description	No of lectures
Unit I: Microbes in the environment	**Air Microbiology** a. Important Airborne Pathogens, b. Important Toxins released by Airborne bacteria, c. Nature of Bioaerosols, d. Microbial survival in the air, e. Extramural and Intramural aeromicrobiology, f. Bioaerosol Control, g. Gravity sedimentation and air sampler (comparison of semi- quantitative and quantitative method for air sampling) h. Biosafety in the Laboratory **Soil Microbiology** a. Soil- definition, composition, textural triangle, Physicochemical characters of earth environment b. Types of soil organisms c. Microorganisms in soil d. Microorganism associations with vascular plants: e. Phyllosphere f. Rhizosphere & Rhizoplane g. Mycorrhizae	**15**

	h. Nitrogen Cycle; nitrogen fixation: Rhizobia, Actinorhizae, Stem Nodulating Rhizobia i. Fungal & Bacterial endophytes j. *Agrobacterium* & other plant pathogens	

Course Code 23BU1VEC01	**Course Title Practicals Based on 23BU1VEC01**	**Credit 1**	**No. of lectures in hrs-30**
Practical 1	Study of air microflora by Gravity Sedimentation Method		**3**
Practical 2	Determination of soil pH and moisture content		**3**
Practical 3	Visualizing soil micro-organisms using contact slide method		**3**
Practical 4	Study of following organisms from soil Nitrifying bacteria (enrichment) qualitative detection Cellulolytic bacteria (enrichment and isolation) qualitative detection		**5**
Practical 5	Enrichment and Isolation of *Rhizobium*		**3**
Practical 6	Winogradsky's column to study soil ecosystem		**6**
Practical 7	Visit to and report of biogas plant		**4**
Practical 8	Effect of heavy metals on growth of bacteria		**3**

Course Code 23BUIK1T02	Course Title Principles of Yoga for Body and Mind Management	Credits 2	No. of lectures-30

Course Outcomes

On completion of this course, students will be able to:

CO1	Apply basics of Gunas and Doshas to identify body type	L2
CO2	Summarize on Prana and its types	L2
CO3	Explain the importance of meditation and stress management	L3
CO4	Develop diet plan and habits in accordance with the principles of yoga	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	0	1	0	0	1
CO2	1	0	1	0	0	1
CO3	1	0	1	0	0	1
CO4	1	0	1	0	0	1

Units	Description	No of lectures
Unit I: Know Your Body	a. Three Gunas & Mental Nature b. The Three Doshas c. The Seven Dhatus d. The Five Pranas	**15**
Unit II: Meditation & Stress Management	a. Concept of Stress b. Stimulation - Relaxation for Stress Management c. Dinacharya d. Balancing the female cycle e. Pranayama & Its forms f. Meditation & The Mind g. Resolving inner conflict & limiting beliefs ‘The Enquiry’, Accomplishing goals	**15**

Course Code 23BUBT1P01	Course Title Practicals Based on 23BUBT1T01 & 23BUBT1T02	Credits 2	No. of lectures-60

Course Outcomes

On completion of this course, students will be able to:

CO1	Interpret the results of various blood tests, including blood cell counts and blood group classifications	L5
CO2	Identify different microscopic structures and organisms based on morphological study	L3
CO3	Demonstrate ability to perform titration experiments, characterise organic compounds (chemical tests) and use colorimeter	L2
CO4	Solve problems based on concentration measures to prepare solutions	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	2	0
CO2	3	1	0	0	2	0
CO3	2	0	0	0	0	0
CO4	3	2	0	0	0	0

Practical 1	Construction and working of simple and compound microscope	**2**
Practical 2	Study of fungi by staining using lactophenol cotton blue	**3**
Practical 3	Study of Permanent slides of Protozoa	**2**
Practical 4	Study of microalgae and cyanobacteria using permanent slides	**2**
Practical 5	Wet mount of lichens	**2**
Practical 6	Slide Culture technique to study Actinomycetes (demonstration)	**3**
Practical 7	Study of Hill reaction	**3**
Practical 8	Colorimetric study of Absorption Spectrum of Photosynthetic Pigments	**3**
Practical 9	Determination of RBC count using hemocytometer	**4**
Practical 10	Differential staining of WBCs using Romanowsky Stains: Field's staining	**2**
Practical 11	Study of human blood groups	**4**
Practical 12	Safety Measures and Practices in Chemistry Laboratory, Working and use of a Digital Balance, Functioning and Standardization of pH Meter	**2**
Practical 13	Qualitative Analysis of Inorganic Compounds	**4**
Practical 14	Preparation of 0.1 N succinic acid and standardize the NaOH of two different concentrations	**3**
Practical 15	Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions	**5**

Practical 16	Characterization of Organic Compounds containing only C, H, O, N, S elements (element tests to be done)- Compounds belonging to the following classes: Carboxylic Acid, Phenol, Aldehyde/Ketone, Alcohol and Haloalkane	**13**
Practical 17	Dissociation Constant of Weak Acids by Incomplete Titration Method using pH Meter and determination of Acetic acid in Vinegar by Titrimetric Method	**3**

Course Code **23BUBT1P02**	**Course Title** **Practicals Based on 23BUBT1T03 & 23BUBT1T04**	**Credits** **2**	**No. of lectures-60**

Course Outcomes

On completion of this course, students will be able to:

CO1	Estimate the effect of antimicrobial compounds	L5
CO2	Distinguish microorganisms based on their microscopic morphologies using different staining techniques	L4
CO3	Demonstrate aseptic technique	L2
CO4	Recall principles of different microbiological media and lab equipments	L1

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	0	0	2	0
CO2	3	1	0	0	2	0
CO3	3	0	0	0	2	0
CO4	3	1	0	0	0	0

Practical 1	Study of shape of different bacteria by monochrome staining	**4**
Practical 2	Study of Gram nature of different bacteria by Gram staining	**4**
Practical 3	Cell wall staining	**4**
Practical 4	Capsule staining	**4**
Practical 5	Study of bacterial motility: Hanging drop method (demonstration); TTC agar	**5**
Practical 6	Vital staining of mitochondria using Janus green B	**4**
Practical 7	Aseptic transfer	**3**
Practical 8	Sterilization equipment: Principle, Construction and Working of Autoclave & Hot Air Oven	**4**
Practical 9	Methods of preparation of glassware for Sterilization (Pipettes, Petri Plates, Flasks)	**1**

Practical 10	Effect of UV light on micro-organisms (Qualitative)	**4**
Practical 11	Study of antimicrobial effect of dyes, phenolics and heavy metals	**4**
Practical 12	Preparation of culture media: liquid and solid	**2**
Practical 13	Preparation of slant, butts and plates	**3**
Practical 14	Study of general-purpose medium	**2**
Practical 15	Study of selective and differential media (MacConkeys and Sabourauds' media)	**2**
Practical 16	Isolation of organism and study of colony characteristics	**4**
Practical 17	Study of enriched media: superimposed blood agar	**2**
Practical 18	Study of enrichment media: Enrichment and isolation of *Azotobacter*	**4**

Course Code 23BUIK1T02	Course Title Principles of Yoga for Body and Mind Management	Credits 2	

Course Outcomes

On completion of this course, students will be able to:

CO1	Apply basics of Gunas and Doshas to identify body type	L2
CO2	Summarize on Prana and its types	L2
CO3	Explain the importance of meditation and stress management	L3
CO4	Develop diet plan and habits in accordance with the principles of yoga	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	0	1	0	0	1
CO2	1	0	1	0	0	1
CO3	1	0	1	0	0	1
CO4	1	0	1	0	0	1

Units	Description	No of lectures
Unit I: Know Your Body	e. Three Gunas & Mental Nature f. The Three Doshas g. The Seven Dhatus h. The Five Pranas	**15**
Unit II: Meditation & Stress Management	h. Concept of Stress i. Stimulation - Relaxation for Stress Management j. Dinacharya k. Balancing the female cycle l. Pranayama & Its forms m. Meditation & The Mind n. Resolving inner conflict & limiting beliefs ‘The Enquiry’, Accomplishing goals	**15**

Course Code 23BUEN1T02	Course Title Communication skills I	Credits 02	No. of Lectures 30

Course Outcomes

On completion of this course, students will be able to:

CO1	Explain the concepts and rules related to sentences and their kinds, parts of speech, infinitives and participles, commands, requests, and questions, and punctuation (full stop, comma, colon, semicolon, dash) with appropriate examples.	L2
CO2	Describe and discuss the usage of verbs and their kinds, articles, prepositions, conjunctions, tenses and their kinds, and the use of correct verb forms in English grammar.	L2
CO3	Explain the concepts, rules, and usage of sentence transformation, antonyms, synonyms, homophones, homonyms, collocations, active and passive voice, and degrees of comparison with suitable examples.	L2
CO4	Describe and discuss the principles and techniques of reading comprehension, vocabulary learning, conversation skills, essay writing, short speeches, dialogue writing, and mock interview preparation for effective communication.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	0	1	0	0	0
CO2	0	0	1	0	0	0
CO3	0	0	1	0	0	0
CO4	0	0	1	0	0	0

Units	Description	No of lectures
Unit I: Basic English	1.1 Sentence, kind of Sentence 1.2 Parts of speech 1.3 Infinitive and participles 1.4 Commands, Requests and questions 1.5 Punctuation: Full stop, comma, colon, semicolon, dash Verbs, Kind of verbs 1.6 Articles, prepositions, conjunctions 1.7 Tenses, Kinds of senses, Use of correct verb forms	**15**
Unit II: Speech, Communication and	2.1 Transformation, Antonyms, Synonyms 2.2 Homophones, Homonyms, Collocation 2.3 Active and passive voices, Degree of comparison 2.4 Reading, Vocabulary learning, Conversation, Essay	**15**

Comprehension	writing, Short speeches, Dialogue writing, Mock interview	

Semester II

Course Code 23BUBT2T01	Course Title Fundamentals of Life Sciences II	Credits 2	No. of lectures-30

Course Outcomes

On completion of this course, students will be able to:

CO1	Enlist the structural and functional features of various macromolecules such as carbohydrates, proteins,amino acid and lipids	L1
CO2	Enlist the structural and functional features of nucleic acids and water in biological system	L1
CO3	Illustrate the structure of eukaryotic chromosomes and its variation	L2
CO4	Explain the concept of sex determination using suitable examples	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	0	0	0
CO2	3	0	1	0	0	0
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No. of Lectures
Unit I: Macromolecules	**Water Structure, properties in brief** **Carbohydrates:** a. Definition, Classification, Biological role b. Monosaccharides, oligosaccharides (maltose, cellobiose, sucrose, lactose) c. Polysaccharides (starch, glycogen, peptidoglycan, cellulose) **Amino acids & Proteins:** a. General structure and features of amino acids (emphasis on amphoteric nature) Classification by R-group b. Uncommon amino acids and their functions c. Peptides & proteins- Definition; general features & examples with biological role d. Primary, secondary, tertiary, quaternary structures - Brief outline **Nucleic acids:** a. Nitrogenous bases- Purines, Pyrimidines, Pentoses - Ribose, Deoxyribose b. Nomenclature of Nucleosides and nucleotides, N-β-glycosidic	**15**

	bond, polynucleotide chain to show bonding between nucleotides (Phosphodiester bonds) c. Basic structure of RNA and DNA **Lipids:** Classification, Properties of Saturated & Unsaturated Fatty Acids	
Unit II: Chromosome structure and variations	**Eukaryotic chromosomes**: Structure of chromatin; Euchromatin and Heterochromatin **Variations in chromosome structure:** a. Deletion (Details of Drosophila not required) b. Duplication c. Inversion d. Translocation **Variations in chromosome number:** a. Changes in one or a few chromosomes b. Changes in complete sets of chromosomes **Sex chromosomes and sex determination:** Genotypic sex determination (mammals, *Drosophila* and *Caenorhabditis*, other organisms); Genetic sex determination	**15**

Course Code 23BUBT2T02	**Course Title Fundamental Chemistry II**	**Credits 2**	**No. of lectures-30**
Course Outcomes			
On completion of this course, students will be able to:			
CO1	Recall various name reactions and transition rate theory		L1
CO2	Explain principles and use of green chemistry		L2
CO3	Derive integrated rate equation of first and second order equation		L4
CO4	Determine order of reaction		L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	0	0	0	0	0
CO2	2	0	0	0	0	0
CO3	2	0	0	0	0	0
CO4	2	0	0	0	0	0

Units	**Description**	**No. of lectures**

Unit I: **Name Reactions & Green Chemistry**	**Basic Organic reactions** a. Nucleophilic substitution reaction: SN1 and SN2 b. Elimination reactions (E1 and E2 mechanism) **Name reactions** a. Aldol condensation b. Cross- Aldol Condensation c. Wolf kishner reduction d. Clemmensen reduction e. Perkin reaction f. Hydroboration g. Friedal Craft's Reaction h. Knoevenagel reaction, Witting reaction i. Cannizzaroreaction **Introduction to Green Chemistry** a. Need and Relevance b. Principles of Green Chemistry c. Use of the following in green synthesis with suitable examples: ● Green reagents: dimethylcarbonate, polymer supported reagents ● Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts ● Green solvents: water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide ● Comparison of traditional processes versus green processes: Synthesis of Adipic acid	**15**
Unit II: **Chemical Kinetics**	a. Order & Molecularity of Reaction b. Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected) c. Determination of Order of Reaction by Integration Method, Graphical Method, Ostwald's Isolation Method, Half Time Method (Numericals expected) d. Transition state theory: Collision theory, Transition state theory (Derivation not expected) Arrhenius equation and calculation of activation energy	**15**

Course Code 23BUBT2T03	Course Title Industrial Microbiology	Credits 2	No. of lectures-30

Course Outcomes

On completion of this course, students will be able to:

CO1	Explain the concept of components and range of fermentation process, strain improvement and methods of improving yield of primary and secondary metabolites	L2
CO2	Describe feedback inhibition for industrial application, high throughput screening, microbial culture preservation methods and types of fermentation	L4
CO3	Recall basic components of fermenter, and fermenter sterilization	L1
CO4	Determine composition of fermentation media, inoculum development, downstream processing, extraction and purification for Penicillin and Ethanol Production	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	0	0
CO2	3	0	1	0	0	0
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No. of lectures
Unit I: An Introduction to Fermentation	**An introduction to fermentation processes:** a. The range of fermentation processes b. The components of a fermentation process **Screening methods:** a. Primary and secondary screening b. High throughput screening methods **Strain improvement:** a. Selection of induced mutants synthesizing improved levels of primary metabolites b. The isolation of induced mutants producing improved yields of secondary metabolites c. The improvement of strains by modifying properties other than the yield of product **Preservation of cultures and Quality control of preserved stock** **Types of fermentations:** Surface and Submerged; Batch and Continuous, Aerobic and anaerobic	**15**
Unit II: Fermenter, fermentation media and sterilization	**2.1 Design of a fermenter:** Stirred Tank Fermenter- Basic Design; Parts of a Typical Industrial Fermenter. 2.2 **Composition of Media for industrial fermentations** 2.3 **Sterilization:** Batch and continuous sterilization 2.4 **Study of Representative Fermentation Processes:** Penicillin production and Ethanol Production by Fermentation along with a flow-diagram (study with respect to Inoculum development, downstream processing extraction and purification)	**15**

Course Code 23BUBT2T04	Course Title Fundamental Microbiology III	Credits 2	No. of lectures-30

Course Outcomes

On completion of this course, students will be able to:

CO1	Compare different methods of bacterial enumeration	L2
CO2	Analyze different factors that influence microbial growth, concepts of biofilm, quorum sensing	L4
CO3	Relate basic concepts of microbial growth in food spoilage and food preservation	L1
CO4	Summarize major chemical conversions in production of various fermented foods	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	1	0	0
CO2	3	1	1	1	0	0
CO3	3	0	1	1	0	0
CO4	3	0	1	1	0	0

Units	Description	No. of lectures
Unit I: Microbial growth	1.1 Definition of growth, Mathematical Expression, Growth curve 1.2 Measurement of growth 1.3 Direct microscopic count – Breed's count, Petroff –Hausser counting chamber- Haemocytometer 1.4 Viable count – Spread plate and Pour plate technique 1.5 Measurements of cell constituents 1.6 Turbidity measurements – Nephelometer & spectrophotometer techniques 1.7 Synchronous growth, Continuous growth (Chemostat and Turbidostat) 1.8 Influence of environmental factors on growth: Solutes and Water Activity, pH, Temperature, Oxygen Concentration, Pressure, Radiation 1.9 Biofilm formation and quorum sensing	**15**

Unit II: Food Microbiology	2.1 **Microbial growth in foods**: intrinsic factors and extrinsic factors 2.2 **Microbial growth and food spoilage:** a. Controlling food spoilage: Homeostasis and hurdle technology b. Antimicrobial chemicals: organic acids, nitrites, parabenzoic acid, sodium chloride, phosphates, sulfites c. Naturally occurring antimicrobials: lysozyme, lactoferrin and other Fe binding proteins, avidin, spices and essential oils, onions and garlic, isothiocyanates, phenolic compounds 2.3 **Bio preservation:** controlled acidification, bacteriocins, probiotics, prebiotics and symbiotic 2.4 **Physical methods of food preservation:** a. Drying, freeze-drying, cold storage (Overview) b. Heat treatment: concept of TDP and TDT c. Preservation by irradiation: UV and ionizing radiations (Overview) **2.5 Microbiology of fermented foods:** a. Overview of fermented foods: importance & major chemical conversions b. Chocolate: The sweet side of fermentation! c. Fermented Milks: Lactic Acid Bacilli; mesophilic and thermophilic milk fermentations d. Yeast lactic fermentation: Kefir e. Meat and fish fermentation f. Production of bread g. Other fermented foods Alkaline fermentation: alkali-fermented vegetables	**15**

Course Code 23BUBT2T05	Course Title Microbial genetics and Cytoskeleton	Credits 2	No. of lectures-30

Course Outcomes

On completion of this course, students will be able to:

CO1	Recall the experiments conducted to search for genetic material and conjugation	L1
CO2	Illustrate transformation, transduction and transposable elements	L2
CO3	Compare the structure and composition of various cytoskeletal elements	L4
CO4	Explain the assembly, disassembly and motor proteins of various cytoskeletal elements	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	0	0	0
CO2	3	0	1	0	0	0
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No. of lectures
Unit I: **Microbial genetics**	**The search for genetic material:** a. Griffith's transformation experiment b. Avery's transformation experiment c. Hershey and Chase Bacteriophage experiment **Genetic analysis of Bacteria:** a. Minimal medium, complete medium, auxotroph, prototroph b. Conjugation: Discovery of conjugation in bacteria, Thesex factor F, High frequency recombination strains of *E. coli*, F' factors, Natural gene transfer and antibiotic resistance, concept of horizontal and vertical gene transfer c. Transformation (Only process) d. Transduction: Bacteriophages, Generalized transduction (Only process), Specialized transduction **Transposable elements in bacteria:** Insertion sequences and transposons	**15**

Unit II: Cytoskeleton	**Overview of Major Functions of Cytoskeleton** **Microtubule:** structure and composition, MAPs Function-Role in Mitosis, Structural support and Cytoskeleton Intracellular motility. Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic properties of Microtubule. Microtubules in Flagella and Cilia **Microfilament:** Structure, Composition, Assembly and Disassembly Motor Protein: Myosin, Muscle contractility: Sliding Filament. Actin Binding Proteins: Examples of Non-Muscle Motility **Intermediate Filament:** Structure and composition; Assembly and Disassembly; Types and Functions	**15**

Course Code 23BUBT2T06	Course Title Cytogenetics and Immunological Weapons	Credits 2	No. of lectures-30

Course Outcomes

On completion of this course, students will be able to:

CO1	Solve problems based on genetic linkage, crossing over, genetic mapping in bacteria and eukaryotes	L3
CO2	Outline conventional karyotyping, related legal-ethical issues and pedigree analysis	L2
CO3	Illustrate the structural details, functional significance of immune cells, cytokines and their receptors, structure and importance of immunological receptors	L2
CO4	Explain the antigen processing pathways, structure, functions and significance of components involved.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	0	1	0
CO2	3	0	1	0	0	1
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No. of lectures
Unit I: Cytogenetics	**Genetic linkage, Crossing Over and Mapping:** a. Conjugation, transformation, transduction mapping. b. Two-point testcross c. Tetrad analysis **Conventional karyotyping e.g., CML** **Pedigree** **Legal and ethical issues**	**15**
Unit II: Immunological Weapons	a. Hematopoiesis; Cells of the Immune System: T, B, NK, DC, Granulocytes. b. TCR CD3 Complex. c. Cytokines and its receptors d. B cell Receptor e. MHC Classes - General Organization and Inheritance; Structures and Peptide Interactions; Class I and II Diversity and Polymorphism f. Antigen Presentation - Endocytic and Exocytic Pathways g. MHC Restriction	**15**

Course Code 23BUBT2P03	Course Title Field Project in Biotechnology I	Credits 2	No. of lectures-60
Course Outcomes			
On completion of this course, students will be able to:			
CO1	Apply basic academic and field-based skills to plan and execute a structured project or activity.		L3
CO2	Analyze information or data gathered during the activity to identify relevant patterns, issues, or insights.		L3
CO3	Interpret findings logically and connect them to the objectives of the project or activity.		L4
CO4	Communicate outcomes clearly through written reports, visual displays, or oral presentations.		L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	2	1
CO2	2	3	2	2	3	2
CO3	2	3	2	3	2	2
CO4	2	2	3	1	3	2

Description

The learner can take a field project as one of the options as CC for 2 credits. In this course, the learner can participate in activities that are based on biotechnology and help acquire field-based skills through planning and execution of activities of 60 Hrs. duration. The learner would be required to qualify the assessment where he / she would be required to communicate outcomes clearly, interpret findings logically through written reports, visual displays, or oral presentations.

Course Code 23BU2CC606	Course Title Departmental activities I	Credits 2	No. of lectures-60
Course Outcomes			
On completion of this course, students will be able to:			
CO1	Participate actively in academic, laboratory-based, outreach, or skill-oriented departmental activities.		L2
CO2	Demonstrate teamwork, time management, and organizational skills while performing assigned activities.		L3
CO3	Relate the experience gained from departmental activities to fundamental concepts of biotechnology and allied sciences.		L2
CO4	Communicate and reflect on learning experiences through presentations, reports, or creative academic outputs.		L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	3	2
CO2	2	1	1	1	3	2
CO3	3	2	2	2	2	2
CO4	2	1	3	1	3	3

Description

The learner can take departmental activity as one of the options as CC for 2 credits. In this course, the learner can participate in activities that are based on basic academics and help acquire field-based skills through planning and execution of activities of 60 Hrs. duration. The learner would be required to qualify the assessment where he / she would be required to communicate outcomes clearly, interpret findings logically through written reports, visual displays, or oral presentations.

Course Code 23BUEN2T02	Course Title Communication Skills II	Credits 2	No. of lectures-30

Course Outcomes

On completion of this course, students will be able to:

CO1	Elaborate on different types of articles and IMRaD pattern of Research article	L2
CO2	Explain the importance of aesthetics of research article	L2
CO3	Describe interpretation and explain report writing	L2
CO4	Identify and practice use of ICT, websites and softwares used in research.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	1	2
CO2	3	2	1	0	1	1
CO3	3	2	1	0	1	1
CO4	3	2	2	0	1	1

Units	Description	No. of lectures
Unit I: **Scientific Writing**	1.1 **Types of research articles:** 8L 1.Review article 2. Original research article 3. Book chapter 4. Book review 5. Conference abstract 6. Short communications/note 7. case study 1.2 **Organization of original research article:** Writing Abstract, Introduction, Materials & Methods, Results, Discussion and Conclusion 3L 1.3 **Importance of tables, figures and schematics in a research article** 1L **1.4 Review of Literature** 2L **1.5 Bibliography and different citation formats** 1L **1.6 Importance of statistics in research** 1L	**15**

Unit II: Interpretation, Report writing and use of IT in research	2.1 **Interpretation:** Meaning of Interpretation, Why Interpretation? Technique of Interpretation, Precautions in interpretation. 2.2 **Report writing:** Different steps in writing report, Layout of research report, Types of reports, Plagiarism, Poster & Oral Presentation. 2.3 **Use of ICT in research:** List of software available for Pre-data, data and post data analysis 2.4 **Demonstration of Use of websites and software useful in Research:** Google scholar, Shodhganga, Mendeley, NDLI, JSTOR, working with Microsoft excel, introduction to SPSS, use of software for plagiarism check	**15**

Course Code 23BUIK2T02	Course Title Ayurveda for Healthy Lifestyle	Credits 2	No. of lectures

Course Outcomes		
On completion of this course, students will be able to:		
CO1	Explain the importance of ayurvedic diets	L2
CO2	Choose the correct ingredient to make a balanced diet	L3
CO3	Recall the importance of ayurvedic herbs and the methods of their preparations	L1
CO4	Select appropriate ayurvedic herb for treating common ailments	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	0	1	1	0	1
CO2	1	0	1	2	0	2
CO3	1	0	1	2	0	1
CO4	1	0	1	1	0	1

Units	Description	No of lectures
Unit I:	a. Ayurvedic detox programs b. Yogic & Ayurvedic Diets c. A balanced diet, the six tastes &Vipaka	**15**
Unit II: Ayurveda & Ancient Indian Drugs	a. **Ayurvedic Herbs:** Amla, Ginger, Ritha, Maka, Behada, Bell, Tondali, Brahmi, Anar, Coriander seeds, Durva, Erand, Papita, Gulvel, Haldi, Hirada, Hing, Jamun, Hibiscus, nutmeg, Cumin seeds, Banana,Karanja, Karela, Karpur, Khajur, Khaskhas, Kulith, Aloevera, Kesar, Lajalu, Lasun, Laung, Pepper, Methi, Saunf, Mula, Pan, coconut, Kadunimb, Onion, Fig, Sadafuli, Rai, Shatavari, Kadipatta, Shivga, Eliachi, Chandan, Chakraful, teel, Tulasi, Dalchini, Tamalpatra, Almond, Yashtimadhu, Ajwain, Ghee, Honey b. **The Five Main Methods of Herbal Preparation**	**15**

Course Code 23BUBT2P01	Course Title Practicals Based on 23BUBT2T01 & 23BUBT2T02	Credits 2	No. of Lectures in hrs-60

Course Outcomes

On completion of this course, students will be able to:

CO1	Estimate the concentration of macromolecules	L5
CO2	Analyse eukaryotic chromosomal structures	L4
CO3	Plan an experiment to carry out base catalyzed aldol condensation	L3
CO4	Recall the reaction involved in estimation of metals	L1

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	2	0
CO2	3	0	0	0	0	0
CO3	2	0	0	0	0	0
CO4	2	0	0	0	0	0

Practical 1	Spot test for Carbohydrates, Fats, Proteins, Amino Acids and Nucleic Acids	**3**
Practical 2	Estimation of Reducing sugar by DNSA method	**4**
Practical 3	Estimation of Protein by Biuret method and Lowry method	**4**
Practical 4	Study of Saponification of Fats & Determination of Saponification Value of Oil or Fat	**3**
Practical 5	Determination of Iodine value of Oil	**3**
Practical 6	Study of polytene chromosomes in *Drosophila*	**3**
Practical 7	Study of karyotype of normal male and normal female	**2**
Practical 8	Study of Trisomy-21, Trisomy-18, Trisomy-13, Turner syndrome, Klinefelter syndrome and Cri-du-chat	**2**
Practical 9	Study of Barr body	**3**
Practical 10	Use of PDB/ colchicine for induction of polyploidy	**3**

Practical 11	Determine the rate constant for hydrolysis of ester using HCl as a catalyst	**3**
Practical 12	Study the kinetics of reaction between Thiosulphate ion and HCl	**3**
Practical 13	Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction	**3**
Practical 14	Study the reaction between NaHSO3 and KMnO4 and balancing the reaction in acidic, alkaline and neutral medium	**3**
Practical 15	Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate	**3**
Practical 16	Investigation of the reaction between copper sulphate and sodium hydroxide (Standard EDTA Solution to be provided to the learner)	**4**
Practical 17	Estimate the amount of nickel present in the given nickel chloride/nickel sulphate solution (Estimation of Nickel (II) as Ni-dmg)	**4**
Practical 18	Organic Preparation: Base catalyzed aldol Condensation (synthesis of Dibenzalpropanone)	**4**
Practical 19	Microwave synthesis: Synthesis of coumarin by Knoevenagel reaction using Salicylaldehyde, and ethyl acetate	**3**

Course Code 23BUBT2P02	Course Title Practicals Based on 23BUBT2T03 & 23BUBT2T04	Credits 2	No. of Lectures-60

Course Outcomes

On completion of this course, students will be able to:

CO1	Evaluate microbial cell density	L5
CO2	Inspect the quality of milk using platform test	L4
CO3	Estimate penicillin and/or ethanol	L5
CO4	Judge the effect of various environmental parameters on microbial growth	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	1	0
CO2	3	1	0	1	1	0
CO3	3	1	0	0	1	0
CO4	3	1	0	1	1	0

Practical 1	Enumeration of microorganisms by a)Spread plate technique, b)Pour plate technique, c)Hemocytometer, Brown's opacity tubes	**13**
Practical 2	Study of bacterial Growth Curve	**4**
Practical 4	Study of growth pattern in liquid media	**2**
Practical 5	Effect of temperature, pH, Solute concentration on growth of micro-organisms	**4**
Practical 6	Analysis of milk keeping quality by MBRT	**3**
Practical 7	Analysis of milk keeping quality by RRT	**3**
Practical 8	Determination of TDP and TDT (Demonstration)	**6**
Practical 9	Determination of MIC of salt/ sugar (Demonstration)	**3**
Practical 10	Study of Lactic acid bacteria – Homofermentative and heterofermentative	**3**
Practical 11	Primary screening of antibiotic producers	**5**
Practical 12	Amylase production by surface and submerged fermentations	**3**
Practical 13	Ethanol production	**3**
Practical 14	Estimation of ethanol using Dichromate method	**4**
Practical 15	Chemical estimation of Penicillin	**4**

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23BUBT1T01

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1.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood &Woolverton	McGraw-Hill	7th	2008
2.	Microbiology	Michael J Pelczar Jr. E. C. S Chan Noel R. Krieg	Tata McGraw-Hill	5th	1993
3.	Cell Biology, genetic, Molecular Biology, Evolution and Ecology	Verma &Agarwal	S Chand	1st	2004
4.	Brock Biology of Microorganisms	Madigan, Martinko, Stahl & Clark	Benjamin Cummings	13th	2012
5.	Textbook of Plant Physiology	V. Verma	ANE Books	Ane's Student edition	-
6.	Textbook of Medical Physiology	Guyton and Hall	Elsevier Saunders	11th	2006

23BUBT1T02

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	F.Y.B.Sc Organic chemistry, F.Y.B.Sc Inorganic chemistry & S.Y.B.Sc Organic chemistry textbooks	Puniyani , Parulekar, Upadhyay , Mukherjee &Turakhai ,Dixit ,Arora	Himalaya	5th 5th	2018
2.	F.Y.B.Sc Physical chemistry & S.Y.B.Sc Analytical chemistry Textbooks	Dr.Yogesh V. Ghalsasi, Deepak Teckchandani, Padma Sathe	Himalaya	5th 19th	2018 & 2017

23BUBT1T03

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1.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood &Woolverton	McGraw-Hill	7th	2008
2.	Microbiology	Michael J Pelczar Jr. E. C. S Chan Noel R. Krieg	Tata McGraw-Hill	5th	1993
3.	Cell Biology, genetic, Molecular Biology, Evolution and Ecology	Verma&Agarwal	S Chand	1st	2004

23BUBT1T04

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7th	2008
2.	Microbiology	Michael J Pelczar Jr., E. C. S Chan, Noel R. Krieg	Tata McGraw-Hill	5th	1993
3.	Fundamentals of Microbiology	Martin Frobisher Ronald Hinsdill Koby Crabtree Clyde GoodHeart	Thomson Learning	6th	1957
4.	Fundamental Principles of Bacteriology	A J Salle	McGraw-Hill	2nd	1943
5.	General Microbiology	Stanier, Ingraham, Wheelis& Painter	McMillan Press Ltd.	5th	1987
6.	Microbiology: An Evolving Science	Slonczewski and Foster	Norton & Company, Inc.	4th	2016

23BUBT1T05

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Strickberger's Evolution	Brian K. Hall &BenediktHallgrimsson	Jones & Bartlett	5th	2013
2.	Evolutionary biology handbook	Richard Arber	Callisto reference	-	2015
3.	The biology of biodiversity	M.Kato	Springer	-	2012
4.	iGenetics: A Molecular Approach	Peter Russel	Benjamin Cummings	3rd	2010
5.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3rd	2007

23BUBT1T06

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Introduction to Bio-Statistics: A Textbook of Biometry	Dr. Pranab Kumar Banerjee	S.Chand	3rd Rev. Edition	2007
2.	Principles and application of Statistics in Biosciences	Dr. D.V.Kamat	MananPrakashan	-	2012
3.	Biostatistics for the Biological and Health Sciences with Statdisk	Marc M. Triola and Mario F. Triola	Pearson	1st	2014

4.	Kuby Immunology	Kindt, Goldsby, Osborne	W.H. Freeman	6th	2006
5.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3rd	2007

23BU1VEC01

Sr. No.	Title	Author/s	Publisher	Edition	Year
1	Environmental Biotechnology	M H Fulekar	Science Publishers	1st	2010
2	Environmental Biotechnology	Indu Shekhar Thakur	Dreamtech Press	2nd	2019
3	Environmental Biotechnology	Alan Scragg	Oxford Press	2nd	2005

23BUIK1T02

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Yoga and Ayurveda: Self-Healing and Self-Realization	David Frawley	Motilal Banarsidass Publishing House	5th Reprint edition	2022
2.	Everyday Ayurveda – a practical guide to healthy living	Danny Cavanagh & Carol Willis	Ayurveda UK	1st	2004
3.	The Yoga of Herbs	Dr David Frawley & Dr Vasant Lad	Lotus Press	2nd	1993
4.	New Perspectives in Stress Management	H. R. Nagendra & Dr.R. Nagarathna	Swami Vivekananda Yoga Prakashana	3rd	1986

SEMESTER-II

23BUBT2T01

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Lehninger, principles of biochemistry	David Nelson and Michael Cox	*W.H. Freeman* and Company, New York.	4th	2005
2.	Fundamentals of Biochemistry	D. Voet and J. Voet	Wiley plus	5th	2011
3.	iGenetics: A Molecular Approach	Peter Russel	Benjamin Cummings	3rd	2010
4.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3rd	2007

23BUBT2T02

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	S.Y.B.Sc Organic chemistry T .Y B.Sc Organic chemistry Green Chemistry Textbooks	V.K.Ahluwalia	Ane Books	5th 2nd	2012
2.	F.Y.B.Sc Physical chemistry	D. Teckchandani K.B.Baliga	Himalaya	5th	2018

23BUBT2T03

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Industrial Microbiology	L.E Casida, Jr	New Age International Publishers	2nd Edition	2019
2.	Principles of Fermentation Technology	P.F. Stanbury, A. Whitaker, S.J. Hall	Butterworth Heinemann , oxford	2nd Edition	2000
3.	Industrial Microbiology	A.H Patel	Macmillan	1st Edition	1984

23BUBT2T04

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Food Microbiology- An introduction	Mointville and Matthews	ASM Press	4th	2019
2.	Microbiology: An Evolving Science	Slonczewski and Foster	Norton & Company, Inc.	4th	2016
3.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood &Woolverton	McGraw-Hill	7th	2008
4.	Microbiology	Michael J Pelczar Jr., E. C. S Chan &Noel R. Krieg	Tata McGraw-Hill	5th	1993
5.	Fundamentals of Microbiology	Martin Frobisher, Ronald Hinsdill, Koby Crabtree &Clyde GoodHeart	Thomson Learning	6th	1957

23BUBT2T05

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Cell Biology	Gerald Karp	John Wiley	6th Edition	2010
2.	iGenetics: A Molecular Approach	Peter Russel	Benjamin Cummings	3rd	2010
3.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3rd	2007

23BUBT2T06

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Kuby Immunology	Kindt, Goldsby, Osborne	W.H. Freeman	6th	2006
2.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3rd	2007
3.	Immunology	Kuby	W.H. Freeman	6th Edition	2006
4.	Immunology: essential and Fundamental	Palan and Pathak	Science Publishers	2nd Edition	2005
5.	The Elements of Immunology	Fahim Khan	Pearson Education	-	2009
6.	Igenetics	Peter Russell	Pearson Education India	3rd Edition	2009

23BUIK2T02

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Yoga and Ayurveda: Self-Healing and Self-Realization	David Frawley	Motilal Banarsidass Publishing House	5th Reprint edition	2022
2.	Everyday Ayurveda – a practical guide to healthy living	Danny Cavanagh & Carol Willis	Ayurveda UK	1st	2004
3.	The Yoga of Herbs	Dr David Frawley & Dr Vasant Lad	Lotus Press	2nd	1993

VPM's B.N. Bandodkar College of Science (Autonomous), Thane
Curriculum Structure for the Undergraduate Degree Programme F.Y.B.Sc Biotechnology

	SEMESTER – I	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major course title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BUBT1T01	Fundamentals of Life Sciences I	-	-	-	-	-	-	-
23BUBT1T02	Fundamental Chemistry I	-	-	-	-	-	-	-
23BUBT1T03	Fundamentals of Microbiology I	-	-	-	-	-	-	-
23BUBT1T04	Fundamentals of Microbiology II	✓	-	-	-	-	-	-
23BUBT1T05	Fundamental Genetics and Evolution	-	-	-	-	-	✓	-
23BUBT1T06	Fundamental Biostatistics and Immunology	✓	-	✓	-	-	-	-
23BU1VEC01	Environmental Biotechnology I	-	-	-	-	-	-	✓
23BU1VEC01	Practicals based on Environmental Biotechnology I	✓	✓	✓	-	-	-	✓
23BUEN1T02	Communication skills I	✓	-	-	✓	-	-	-
23BUIK1T02	Principles of Yoga for Body and Mind Management	-	-	✓	-	✓	✓	-
23BUBT1P01	Practicals Based on 23BUBT1T01 & 23BUBT1T02	✓	-	✓	-	-	-	✓
23BUBT1P02	Practicals Based on 23BUBT1T03 & 23BUBT1T04	✓	-	✓	-	-	-	✓

	SEMESTER – II	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major course title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BUBT2T01	Fundamentals of Life Sciences-II	-	-	-	-	-	-	-
23BUBT2T02	Fundamental Chemistry- II	-	-	-	-	-	-	-
23BUBT2T03	Industrial Microbiology	✓	-	-	-	-	-	-
23BUBT2T04	Fundamental Microbiology III	✓	✓	✓	-	-	-	✓
23BUBT2T05	Microbial genetics and Cytoskeleton	-	-	-	-	-	✓	-
23BUBT2T06	Cytogenetics and Immunological Weapons	-	-	-	-	-	✓	-
23BUBT2P01	Practicals Based on 23BUBT2T01 & 23BUBT2T02	✓	✓	✓	-	-	-	-
23BUBT2P02	Practicals Based on 23BUBT2T03 & 23BUBT2T04	✓	✓	✓	-	-	-	✓
23BUEN2T02	Communication Skills II	✓	✓	✓	✓	✓	-	-
23BUIK2T02	Ayurveda for Healthy Lifestyle	-	-	-	-	✓	✓	✓
23BUBT2P03	Field Project in Biotechnology I	✓	✓	✓	✓	-	-	✓
23BU2CC606	Departmental activities I	✓	✓	✓	✓	-	-	-