KRISHNA VISHWA VIDYAPEETH (DEEMED TO BE UNIVERSITY), KARAD

Accredited By NAAC With 'A+' Grade

Syllabus (CBCS) For

Bachelor of Science Microbiology/Biotechnology (Horizontal Mobility)

To be implemented from 2022-23

(In a Phase Manner)

B.Sc. Biotechnology/Microbiology

Part I, Semester I (Horizontal Mobility)

B.Sc. Part I, Semester I (Horizontal Mobility (w.e.f. 2022-2023)													
	Sr. No	Course Code	Course Title	Teaching Hours/ Week			Marks					Credits
							Internal		External		Total	
				T	P	Total	T	P	T	P		
	CGPA Theory Courses											
CGPA	1	UG BT – T101 **CC**	Fundamentals of Microbial and Biological World	2	-	2	10	-	40	-	50	1.5
	2	UG BT – T102 **CC**	Fundamentals of Physics and Biophysics for Biologists	2	-	2	10	-	40	-	50	1.5
	3	UG BT – T103 **CC**	Fundamentals of Chemistry for Biologists	2	-	2	10	-	40	-	50	1.5
	4	UG BT – T104 **CC**	Fundamentals of Biosciences – Botany and Zoology	2	-	2	10	-	40	-	50	1.5
	5	UG BT – T105 **CC**	Basics of Bacteriology, Virology and Rickettsialogy	2	-	2	10	-	40	-	50	1.5
	6	UG BT – T106 **CC**	Basics of Mycology, Phycology and Protozoalogy	2	-	2	10	-	40	-	50	1.5
	7	UG BT – T107 **CCS**	Introduction to the world of amazing microorganisms	2	-	2	10	-	40	-	50	1.5
	8	UG BT – T108 **DSC**	Basics techniques in Microbiology, Biotechnology and Environmental Sciences	2	-	2	10	-	40	-	50	1.5
	CGPA Practical Courses											
CGPA	9	UG BT – P101 **CC**	Practicals related to the theory paper - Fundamentals of Microbial and Biological World	-	2	2	-	10	-	40	50	1
	10	UG BT – P102 **CC**	Practicals related to the theory paper - Fundamentals of Physics and Biophysics for Biologists	-	2	2	-	10	-	40	50	1

	11	UG BT – P103 **CC**	Practicals related to the theory paper - Fundamentals of Chemistry for Biologists	-	2	2	-	10	-	40	50	1
	12	UG BT – P104 **CC**	Practicals related to the theory paper - Fundamentals of Biosciences – Botany and Zoology	-	2	2	-	10	-	40	50	1
	13	UG BT – P105 **CC**	Practicals related to the theory paper - Basics of Bacteriology, Virology and Rickettsialogy	-	2	2	-	10	-	40	50	1
	14	UG BT – P106 **CC**	Practicals related to the theory paper - Basics of Mycology, Phycology and Protozoalogy	-	2	2	-	10	-	40	50	1
	15	UG BT – P107 **CCS**	Practicals related to the theory paper - Introduction to the world of amazing microorganisms	-	2	2	-	10	-	40	50	1
	16	UG BT – P108 **DSC**	Practicals related to the theory paper - Basics techniques in Microbiology, Biotechnology and Environmental Sciences	-	2	2	-	10	-	40	50	1
CGPA	17	UG BT – P109 **PP**	Project I	-	1	1	-	5	-	-	5	0.5
			Total	16	17	**33**	80	85	320	320	**805**	**20.5**
	Mandatory Non CGPA Courses											
Non-CGPA	18	UG BT – T109 **SECC**	Yoga and Meditation	0.5	-	0.5	25	-	-	-	25	0.5
	19	UG BT – T110 **AECC**	Spoken English - I	0.5	-	0.5	25	-	-	-	25	0.5
			Total	1	-	**1**	50	-	-	-	**50**	**1**

Total Credits for Semester I : 21.5 (T = Theory: 12, P = Practical : 8, Project : 0.5, Non-CGPA : 1)

CC : Core Course, CCS : Core Course Specialization, DSC : Discipline Specific Course, DSE : Discipline Specific Elective, PP : Project

SECC = Skill Enhancement Compulsory Course : 0.5, AECC = Ability Enhancement Compulsory Course : 0.5,

Total Credits for Semester I CGPA Course = 20.5 credits

B.Sc. Biotechnology/Microbiology/Environmental Sciences

Part I, Semester II (Horizontal Mobility)

B.Sc. Part I, Semester II (w.e.f. 2022-2023)													
	Sr. No	Course Code	Course Title	Teaching Hours/ Week			Marks					Credits
							Internal		External		Total	
				T	P	Total	T	P	T	P		
	CGPA Theory Courses											
CGPA	1	UG BT – T201 **CC**	Basics of Cell Biology and Physiology	2	-	2	10	-	40	-	50	1.5
	2	UG BT – T202 **CC**	Basics of Biochemistry – Biomolecules - I	2	-	2	10	-	40	-	50	1.5
	3	UG BT – T203 **CC**	Basics of Biochemistry – Biomolecules - II	2	-	2	10	-	40	-	50	1.5
	4	UG BT – T204 **CC**	Microbial Nutrition and Growth	2	-	2	10	-	40	-	50	1.5
	5	UG BT – T205 **CC**	Advanced Chemistry and Physics for Biologists	2	-	2	10	-	40	-	50	1.5
	6	UG BT – T206 **CC**	Applied Plant and Animal Sciences	2	-	2	10	-	40	-	50	1.5
	7	UG BT – T207 **CCS**	Basics of Ecology, Ecosystem and Geosciences	2	-	2	10	-	40	-	50	1.5
	8	UG BT – T208 **DSC**	Applied Microbiology and Basics of Environmental Pollution	2	-	2	10	-	40	-	50	1.5
	CGPA Practical Courses											
	9	UG BT – P201 **CC**	Practicals related to the theory paper - Basics of Cell Biology and Physiology	-	2	2	-	10	-	40	50	1
	10	UG BT – P202 **CC**	Practicals related to the theory paper - Basics of Biochemistry – Biomolecules - I	-	2	2	-	10	-	40	50	1
	11	UG BT – P203 **CC**	Practicals related to the theory paper - Basics of Biochemistry – Biomolecules - II	-	2	2	-	10	-	40	50	1

CGPA	12	UG BT – P204 **CC**	Practicals related to the theory paper - Microbial Nutrition and Growth	-	2	2	-	10	-	40	50	1
	13	UG BT – P205 **CC**	Practicals related to the theory paper - Advanced Chemistry and Physics for Biologists	-	2	2	-	10	-	40	50	1
	14	UG BT – P206 **CC**	Practicals related to the theory paper - Applied Plant and Animal Sciences	-	2	2	-	10	-	40	50	1
	15	UG BT – P207 **CCS**	Practicals related to the theory paper - Basics of Ecology, Ecosystem and Geosciences	-	2	2	-	10	-	40	50	1
	16	UG BT – P208 **DSC**	Practicals related to the theory paper - Applied Microbiology and Basics of Environmental Pollution	-	2	2	-	10	-	40	50	1
CGPA	17	UG BT – P209 **PP**	Project II	-	1	1	-	5	-	-	5	0.5
	Total			16	17	**33**	80	85	320	320	**805**	**20.5**
	Mandatory Non CGPA Courses											
Non-CGPA	18	UG BT – T209 **SECC**	Soft Skill and Personality Development	0.5	-	0.5	25	-	-	-	25	0.5
	19	UG BT – T210 **AECC**	Spoken English – II (Communication Skills)	0.5	-	0.5	25	-	-	-	25	0.5
	Total			1	-	**1**	50	-	-	-	**50**	**1**

Total Credits for Semester II : 21.5 (T = Theory: 12, P = Practical : 8, Project : 0.5, Non-CGPA : 1)

CC : Core Course, CCS : Core Course Specialization, DSC : Discipline Specific Course, DSE : Discipline Specific Elective, PP : Project

SECC = Skill Enhancement Compulsory Course : 0.5, AECC = Ability Enhancement Compulsory Course : 0.5,

Total Credits for Semester II CGPA Course = 20.5 credits

B. Sc. Part I Semester – I

UG HM - T101: Fundamentals of Microbial and Biological World

2 Credits – 40 hours

Unit 1: History – Three centuries of Microbiology

a) Development of Microbiology as a discipline:- [4]

Discovery of microscope and microorganisms (Antony Van Leeuwenhoek and Robert Hooke), abiogenesis versus biogenesis (Aristotle's notion about spontaneous generation, Francesco Redi's experiment, Louis Pasteur and Tyndall's experiments)

b) Golden era of Microbiology – [3]

Contributions of Louis Pasteur (Fermentation, Rabies vaccine, pasteurization and cholera vaccine – Foul cholera experiment), Robert Koch (Koch's postulates, germ theory of diseases, Tuberculosis and Cholera – isolation and staining techniques of causative agent, pure culture techniques), Ferdinand Cohn (Endospore Discovery), discovery of viruses (TMV- Ivanowsky and bacteriophages-deHerrale), Rivar's postulates, Contributions of Joseph Lister (Antiseptic Surgery), Paul Ehrlich (chemotherapy), Elie Metchnikoff (Phagocytosis), Edward Jenner (Vaccination), Alexander Flemming (Penicillin) and Selman Waksman (Streptomycin) in the establishment of fields of medical microbiology and immunology.

Contributions of Martinus W. Beijeirinck (Enrichment culture technique, *Rhizobium*),

Sergei. N. Winogradsky (Nitrogen Fixation, *Azotobacter* and Chemolithotrophy) in the development of fields of soil microbiology. [3]

c) Modern era of Microbiology- [2]

Prokaryotic and Eukaryotic Classification – Three domain and five domain systems, Carl Woese classification based on 16S rRNA gene sequencing.

Significance and applications of human microbiome, nanobiotechnology, space microbiology, geomicrobiology and r-DNA technology

d) Nobel Laureates in Life Sciences of 21st Century [2]

Unit 2 – Types of Microorganisms and their differentiating features

a) Cellular forms – Prokaryotic and eukaryotic [6]
   - Bacteria (Eubacteria, archaebacteria, Rickettsia, Mycoplasma and Actinomycetes)
   - Protozoa
   - Fungi
   - Algae

b) Acellular Forms – Viruses, Viroids, Prions, Virusoide [1]

Unit 3 – Beneficial and harmful effects of microorganisms in various fields of Microbiology, Biotechnology and Environmental Sciences:

a) Medical Microbiology (Enlist diseases caused by various microorganisms, vaccines and antibiotics)
b) Immunology (Normal Flora, Immune Sera, Three lines of defenses)
c) Food and Dairy Microbiology (Food spoilage, food borne diseases, prebiotics, probiotics and fermented foods)
d) Industrial microbiology (Microorganisms producing antibiotics, enzymes, growth factors, solvents and SCP; contaminants in industry– bacteria, fungi and phages)
e) Agricultural Microbiology (Enlist plant diseases, biofertilizers, plant growth promoters and biocontrol agents)
f) Space microbiology (Space microbes as a tool to study origin of life on the earth)
g) Geomicrobiology (Metal leaching from ores)
h) Nanobiotechnology (Production of nanoparticles using microorganisms)

UG HM - P101: Practical course based on theory paper

Fundamentals of Microbial and Biological World

Credit 2

1. Introduction, operation, precautions and use of common laboratory instruments used in life sciences [1]
   [Incubator, Hot air oven, Autoclave, Colorimeter, Centrifuge, Laminar air flow, pH meter, Digital balance, Microscopes, Anaerobic jar, Colony counter, Seitz Filter, Distillation Unit, Membrane Filter]
2. Learning basic techniques in life science laboratory [1]
   [Washing, plugging and wrapping of glassware, biological waste disposal, aseptic transfer techniques – broth, plate, slant and butt transfers]
3. Observation of motility in bacteria by hanging drop/ swarming growth method [1]
4. Checking efficiency of chemical disinfectants - [1]
   Phenol coefficient by Rideal- Walker method
5. Special staining techniques- Cell wall (Chance's method), flagella (Bailey's method/Leifson's method), acid fast staining (permanent slide) [3]

UG HM - T102: Fundamentals of Physics and Biophysics for Biologists

Unit 1. Measurements (4)

- Physical quantities, fundamental and derived units, system of units, order of magnitude
- Length: radius of proton to astronomical distances
- Mass: atomic mass unit to mass of earth
- Time: fast elementary particle to age of earth
- Amount of substance, luminous intensity, interconversions of units

Unit 2. Introduction to biophysics (7)

- Scope and definition of biophysics, biophysics at macroscopic, microscopic and molecular level.
- Biophysical properties: Surface tension, adsorption, diffusion, osmosis, dialysis, wetting and colloids

Unit 3. Fluid Mechanics: (5)

- Fluids: definition, pressure, density, variation of pressure with depth in a fluid at rest,
- Measurement of pressure- Various units of pressure and their interconversion, streamline and turbulent flow
- Equation of Continuity, Poiseulle's equation, Reynold's number, flow of liquids through capillaries, viscosity, Newton's law of viscosity, coefficient of viscosity, Ostwald's viscometer, Relevance to life Science, Bernoulli's theorem and its applications, methods of measurement of viscosity

Unit 4. Surface Tension & Surface Energy (3)

- Cohesive and adhesive forces, Capillary action, angle of contact, wettability, measurement of surface tension by capillary rise, Jaeger's and Quincke's method, factor affecting surface tension, applications, relevance to life sciences

Unit 5. Waves & Oscillations (7)

- Difference between waves and oscillations, Types of waves (Transverse & Longitudinal), Reflection of waves, Principle of superposition of waves, standing & travelling waves, Sound waves as pressure waves, Audible ultrasonic & infrasonic waves, characteristics of sound waves, vibration systems and source of sound, beats, Doppler's effect, Applications in life sciences, measurement of sound, decibel scale (dB).

Unit 6. Geometrical Optics (4)

- Reflection, Refraction, Snell's Law, types of lenses, combinational lenses, radius of curvature, focal length, lens maker equation.

Unit 7. Radioactivity: (5)

- Nucleus: Properties – size, shape, charge distribution, spin and purity binding and empirical mass formula, nuclear stability and radioactive decay, nuclear forces, nuclear models (Liquid drop & Shell model), radioactive nucleus
- Nuclear Radiations & their properties, Alpha, Beta & Gamma, half life, Physical & biological handling of alpha & beta emitting isotopes, UV and X-rays – properties, X-ray spectrum, Braig's law and applications
- GM Counter – Principle, construction & working

UG HM - P102: Practicals related to theory paper Fundamentals of Physics and Biophysics for Biologists

1) Study of Vernier callipers & micrometer screw gauge (1)
2) To Study the components & working of travelling microscope (1)
3) Surface tension measurement using Jaeger's method/ Soap bubble method (1)
4) Viscosity measurement using Ostwal's viscometer for known and unknown viscosity (1)
5) To Study plane diffraction grating (1)
6) Study the process of osmosis (1)
7) Determination of diffusion pressure deficit using potato tuber. (1)
8) Precipitation & Dialysis (1)
9) Working of GM counter (1)
10) Sonometer (1)
11) Determine surface tension of liquids

UG HM - T103 Fundamentals of Chemistry for Biologists

Unit 1: Atomic Structure **[2]**

Historical background, electronic structure of atom, JJ Thomson and Rutherford model, Bohr's Model and its postulates, atomic and molecular orbitals, four quantum numbers, shapes of atomic orbitals, selection rules to find out electronic configuration of elements, Plank's quantum theory, Wave particle duality, Uncertainty principle, Pauly's exclusion principle, Ionisation Potential, electronegativity, electron affinity

Unit 2: Molecules **[6]**

Diatomic molecules, valance bond theory, VSEPR theory, hybridization involving s, p, d orbitals (sp, sp^2, sp^3, dsp^2,sp^2d, sp^3d^2), homo and heteronuclear diatomic molecules, bond order, magnetic properties

Unit 3: Chemical Bonding **[4]**

Types of bonds: covalent, coordinate, metallic, ionic, hydrogen bonding, inter and intramolecular hydrogen bonding, dipole-dipole, dipole induced dipole interaction, structure of water molecule, oxidation state, hydrophobic and hydrophilic interactions

Unit 4: Basics of Organic and Stereochemistry and mechanisms **[5]**

- IUPAC nomenclature,
- reactions of functional groups : alkane, alkene, alkyne, alcohol, amine, alkyl halide, ether,
- organic reactions : oxidation, reduction, elimination, addition, substitution (electrophilic/ nucleophilic), inductive, mesomeric and electrometric effects, reactive intermediates – carbonations, carbon ion, free radicals, carbines, Arynes and Nytrins
- Conformations, configurations, isomerism (structural and stereo isomers), enantiomers, diesteroisomers, chiral centers, geometric isomers, optical isomerism
- Newman's and Fisher projection formulae, epimers, anomers, furanose, and pyranose forms, free radical reactions

Unit 5: Ionic Equilibrium

- pH, buffer, equilibrium constant, common ion effect, Le Chatelier's principle, acids and bases, strength of acids and bases, dissociation constant, pH, pK values, solubility product, acid-base titrations, indicators used in titration, titration

curves, Bronstied-Lowery theory, Levis theory, Acid-base concept in non gaseous solvents, Soft hard acid bases (SHAB) concept

- Ionic product, condition for precipitation, colligative properties of solutions
- Handerson – Hasselbalch equation and related problems, osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure
- Properties of water, water as reactant, interactions of biomolecules with water

Unit 6: Chemical Kinetics **[4]**

- Rates of reactions, order - zero, first and second order reactions and molecularity
- Differential and integrated rate equation, methods of determining order of reactions, catalysis and elementary enzyme reactions
- Half- life periods, Arrhenius equation, collision theory of reaction rate, temperature dependent reaction rates

Unit 7: Thermodynamics **[8]**

Introduction, types of system, intensive and extensive properties, equilibrium and non-equilibrium states, reversible and irreversible processes, laws of thermodynamics, internal energy, enthalpy, entropy – basic concept, physical significance, principle of increase in natural processes, endothermic and exothermic reactions, free energy and work, Gibb's Helmholtz equations, Isothermal and adiabatic relation, work done during isothermal and adiabatic changes, Carnot's engine and Carnot's cycle and its efficiency, Practical cycle used in internal combustion in engine (diesel engine)

Unit 8: Basics of Mole Concept **[3]**

- Mole concept, determination of molecular weight by gram molecular volume relationship, problems based on mole concept, solutions, colligative properties
- Methods of expressing concentrations, strength, normality, molarity and molality, ppm
- Volumetric experiments – acidometry, alkalometry, permanganometry, dichrometry, iodometry

Paper III – Foundations of Chemistry for Biologists

Practical Course Syllabus

1. **Titrations** **[2]**
   a. To study acid – base titration by indicator and conductivity meter
   b. To determine alkali content on antacid tablet using HCl
2. **Chemical kinetics** **[1]**
   To study kinetics of ester's hydrolysis
3. **Thermochemistry** **[1]**
   To determine enthalpy and entropy change of a reaction

   e.g.(1) $2FeCl_3 + 3Mg = 2Fe + 3MgCl_2$

   (2) Activation energy for an acid catalyzed hydrolysis of methyl acetate
4. **Hardness of water** **[1]**
   To estimate hardness of water by using EDTA
5. **Qualitative analysis** **[1]**
   To perform qualitative test for hydrocarbons, alcohols, aldehydes, ketones, aniline and amide
6. **pH metry** **[2]**
   To determine pK value of given weak acid by pH meter titration with strong base
7. **Biochemical calculation** **[2]**
   Preparation of solutions and buffers (Normality, Morality, molality, parts per million - ppm, weight by volume - w/v, volume by volume - v/v, percent - %, atomic weight, molecular weight, equivalent weight)
   Preparation of dilute solution from given stock solution (concentrated saline citrate, dilute saline citrate, normal/standard saline citrate)
8. To study different conformation of biomolecules using models
9. Organic preparations – Pthalimide, Methyl Salicylate
10. Inorganic preparations – Hexamine Nickel (II) chloride

UG HM - T104 : Fundamentals of Biosciences - Botany and Zoology

2 Credits – 40 H

Unit 1: Introduction to plant world and classification (Plant Diversity) (10)

- General and unique features of plants
- Principles, aims, objectives and outline of plant classification with examples
- A general account of different groups and their characters with one example each of
    - Thallophytes (Algae, Fungi and Lichens)
    - Bryophytes
    - Pteridophytes
    - Gymnosperms
    - Angiosperms (Dicot and Monocot)

Unit 2: Structure and organization of plant body (6)

- Structure of plant cell, characteristic feature and cell wall
- Morphology & modifications of plant organs
    - Vegetative plant organs – Stem, Leaf and Root
    - Reproductive plant organs – Flower and Types of Inflorescence
- Plant tissues and tissue systems
    - Meristematic tissue and its type
    - Permanent tissue - Simple and Complex
- Primary structure of shoot, root & leaf
- Secondary growth, growth rings formation: cambium and its activities, periderm-cork cambium, secondary cortex and cork

Unit 3: Introduction to Kingdom Animalia (14)

- Outline classification of non-chordates with examples
    - General characters and classification up to classes of phylum Porifera, Cnidaria, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemicordata
- Outline classification of chordates with examples

- General characters and classification up to classes of phylum Protochordates, Agnatha, Pisces, Amphibia, Reptiles, Aves and Mammals

Unit 4: Animal Tissues (Histology) (5)

- Structure, location, classification and functions of animal tissues
  - epithelial tissue
  - connective tissue
  - muscular tissue
  - nervous tissue
- Bone and Cartilage - structure and types

Practical Paper 4: Practical in Biosciences – Botany and Zoology

1. Study of - Thallophytes (Algae, Fungi and Lichens), Bryophytes, Pteridophytes, Gymnosperms with one example each (2)
2. Study of morphological parameters of Angiosperms (Dicot and Monocot) (2)
3. Study on anatomy of root, stem, leaf of monocot and dicot plants (2)
4. Study of Paramecium – morphology, reproduction, binary fission, conjugation
5. Study of phylum – Porifera, Cnidaria, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Protochordates, Agnatha, Pisces, Amphibia, Reptiles, Aves and Mammals with one example each (specimen) (2)
6. Study of Drosophila: characters, sexual dimorphism – eye & wing mutations, life cycle, culturing of Drosophila (2)
7. Staining of Animal and Plant Cells

UG HM - T105: Basics of bacteriology, Virology & Rickettsiology

(2C, 40 H)

Unit I : **Bacteriology**

Types of bacteria as per their carbon and energy requirements (nutritional classification), advanced classification of bacteria with example using G + C content, DNA –RNA hybridisation, 16 S rRNA gene sequencing & fatty acid lipid profile

Unit II -**Virology**

Discovery, nature of viruses, types of viruses, outline classification with example, structure of viruses

- **Bacteriophages -**T4 cycle & cultivation (Coliphages)
- **Animal Viruses** – Types, cultivation, AIDS, Swine Flu, Dengue, Corona viruses – Life cycle & control
- **Plant viruses** – Outline classification with examples, life cycle, and control mechanisms.
- Applications of viral genomes in biotechnology, microbiology & Environmental sciences
- Viroids, prion and virusoides

Unit III: Rickettsiology

Unique features of Rickettsia, Outline Classification, cultivation, significance, control measures

Vaccines in Rickettsial infections

Coxiella burnetii, *Chlamydia & Mycoplasmas* – General characteristics & significance

UG HM - T105: Practicals

1. Isolation of pigment producing yeast / bacteria from nature
2. Isolation & cultivation of autotrophs and heterotrophs
3. Isolation & titration of bacteriophages (Coliphages) from sewage
4. Inoculation of Viruses - Egg inoculation technique & cultivation of viruses
5. Animal viruses - AIDS, Swine Flu, Dengue, Corona, Chikungunia (chart/ animation)
6. Plant Viruses - TMV / Leaf curl virus (chart/ animation)
7. Rickettsia- life cycle study (Photos / Demonstration/ Charts/ Digital/ Animation)

UG HM - T106 : Fundamentals of Mycology, Phycology & Protozoology

(2C, 40H)

Unit 1 – Mycology – Yeasts and molds

- Outline classification, characteristics, structure and reproduction
- Cultivation of yeasts and molds
- Life cycle of yeasts and molds
- Biological and economic importance
- Important features and significance of slime molds, myxomycetes, mycorrhiza and mushrooms

Unit 2 – Phycology – Algae

- Outline classification, morphological characteristics, cultivation, reproduction and significance
- Characteristics of algae, pigments, major groups – an overview
- Biological, medical and economic importance of algae
- Differences between algae and cyanobacteria
- Examples of toxic algal forms in drinking water

Unit 3 – Protozoology – Protozoa

- Outline classification, morphological characteristics, cultivation, reproduction and significance
- Major categories of protozoa based on motility and reproduction
- Medically important protozoa
- Life cycle of *Entamoeba histolytica*

UG HM - T106: Practicals

1) Isolation and cultivation of algae/ cyanobacteria [Spirulina/Chlorella/Scytonemia]

2) SCP – Extraction from Spirulina/ Study of mushroom/ Study of lichens

3) Isolation of wine yeasts from spoiled pomegranate and preparation of wine

4) Isolation and cultivation of *Aspergillus niger* [from onion]/ *Penicillium*/ *Mucor*/ *Rhizopus*/ *Fusarium spp.* from soil

5) Detection, isolation [single cell isolation technique] and cultivation of protozoa from water bodies, [Zooplanktons/ Paramecium/Amoeba/Euglena/ Vorticella studies from water]

UG HM - T107: Introduction to the world of amazing microorganisms

(2C, 40 H)

Unit I- Autotrophic microorganisms- occurrence, characteristics, mechanism, energetics, significance & examples; Biocorrosion and Bioleaching (Thyobacillus)

Unit-II- Bioluminescent forms- Luminescence in nature, bioluminescence, bioluminescent bacteria & fungi- characteristics, occurrence, mechanism, energetics & significance in nature

Unit-III-Magnetotactic forms- Magnetotactic bacteria occurrence, mechanism, mechanism of magnotaxis, their role in detection of exotic (in space) life, significance in nature; Astrobiology (introduction to space environment and space microbiology)

Unit-IV- Extremophiles- Psychrophiles, acidophiles, xerophiles, barophiles, halophiles, radiophiles, thermophiles, basophiles, piezophiles, osmophiles - occurrence, characteristics, mechanism of survival, energetics, significance & examples

Unit-V- Bdellovibrio forms- examples, occurrence, characteristics, nature of parasitism, mechanism & significance

Unit-VI- Bacteria visible by naked eye (largest bacteria) - examples, occurrence & significance

Unit-VII- Obligate intracellular parasitic microorganisms - examples - *Rickettsia*, viruses- (animal viruses, plant viruses, bacterial viruses)

Unit-VIII- Actinomycetes & Myxobacteria

Unit-IX- Unculturable Microorganisms (metagenomic study) - *Mycobacterium leprae* - The organism not following Koch's postulates, their significance in nature

Unit X- Nitrogen fixing bacteria in nature, examples, mechanism and significance

Unit XI- Aromatic Compounds, plastic, Cyanide degrading microorganism – *Pseudomonas putida* (Anand Chakravorty)

UG HM - P107: Practical Course

1. Isolation, cultivation & characterization of bioluminescent bacteria
2. Isolation, cultivation & characterization of Magnetotactic bacteria (Optional)
3. Isolation & cultivation of Actinomycetes/Myxobacteria
4. Isolation, Cultivation and Characterization of Bdellovibrio forms

5. Isolation of bacteria degrading microplastic/ aromatic compounds/ cyanide
6. Isolation of *Azotobacter*/*Rhizobium* (Optional)
7. Isolation cultivation & characterization of Extremophiles – Psychrophiles/ Thermophiles/ Barophiles/ radiophiles/ basophiles/ acidophiles/ xerophiles/ piezophiles/ halophiles/ osmophiles
8. Slide of *Mycobacterium leprae*- acid fast stains, demonstration (Optional)

UG HM - T108: Basics Tools and Techniques in Microbiology, Biotechnology and Environmental Sciences

(2C, 40 H)

Unit 1 – Safety in Life Sciences laboratory

- Means of laboratory infections
- Potentially hazardous procedures
- Responsibility
- Risk assessment
- Restricted access
- Safety equipments and measures
- Immunization and medical records
- Training of personnel
- Laboratory procedures (SOPs)
- Levels of containments

Unit 2 – Microscopy

A. Bright field microscopy:
   a. Electromagnetic spectrum of light
   b. Simple and compound microscope - working of and ray diagram; concepts of magnification, numerical aperture and resolving power. Types functions of - eyepieces and objectives; aberrations in lenses - spherical, chromatic, comma and astigmatism
   c. Phase contrast microscopy – mechanism and applications
   d. Fluorescence Microscopy – mechanism and applications
   e. Electron Microscopy – Basic principle, mechanism, TEM, SEM, STM and their applications

B. Dark field microscopy: Mechanism and applications

Unit 3 – Chromatography – Paper and TLC, theory, instrument and applications

Unit 4 – Observation of cells:

A. Stains and staining techniques
   a. Definition of Stain; Types of stains (Basic, Acidic and Neutral), Properties and role of Fixatives, Mordants, Decolourisers and Accentuators

b. Staining procedures for bacteria – Monochrome (Simple) staining and Negative (Relief) staining
c. Differential staining - Gram staining and Acid-fast staining – mechanism and procedure
d. Special staining- mechanism and procedure - Capsule, Cell wall, Endospore, Flagella, Nuclear material, Lipid granules, metachromatic granules
e. staining of animal and plant cells
f. staining of algae, protozoa and fungi

B. Unstained preparations – wet mount and hanging drop techniques of bacteria, yeasts, molds, algae and protozoa

Unit 5: Control of Microorganisms

a. Definitions of frequently used terms – sterilization, disinfection, antiseptic, antisepsis, germicide, microbiostasis, sanitization, bacteriocide, Fungicide, viruside, sporicide, fundamentals of control, conditions influencing effectivity of antimicrobial agent, factors affecting death rate
b. Physical agents used to control microorganisms –
   - Heat - Dry and Moist; Radiations-Ionizing (X-ray, gamma and cathode) and Non-ionizing (UV rays); filtration- depth filters and membrane filters (cellulose acetate and polycarbonate filters, plastic – Teflon and Nylon), low and high temperature, osmotic pressure, desiccation, Sound waves – Ultrasonication
   - Checking the efficacy of sterilization – biological and chemical indicators
c. Chemical agents used to control microorganisms and their mode of action and applications–
   - Characteristics of an ideal disinfectant
   - Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and Phenolics, peroxigens
   - Heavy metals (Cu, Hg, Ag), alcohols, dyes, surface active agents, detergents, gaseous agents – ethylene oxide, beta propiolactone, formaldehyde, glutardaldehyde, clorhexidine and benzolkonium chloride
   - Checking efficiency of disinfectant – phenol coefficient (Rideal-Walker method)
   - Chemotherapeutic agents (enlist) and their site of action
   -

UG HM - P108: Practical course based on Paper VIII

1. a) Safety measures and good laboratory practices in laboratory [1]
   b) Preparation of SOP's for the instruments

c) Introduction and use of common laboratory glass wares
2. Construction, working and care of compound microscope [1]
3. Basic staining techniques- Monochrome, Negative and Gram's staining, Acid-fast staining (demo slide) [3]
4. Special staining techniques- Endospore, Capsule, Lipid granules, Nuclear material, Metachromatic granules, Flagella [5]

PG HM – T107SECC: Spoken English

Unit A: Traditional and Structural Grammar and Composition

1. Language :
   English as a foreign language
2. Writing English :
   Sentence structure, Essay composition, Summary writing, precise writing and comprehension
3. Reading English :
   Importance of reading, the process and mechanics of reading, Intensive and extensive reading: Rapid reading, making notes as you read, writing book review.
4. Use of Vocabulary :
   Meaning of words, precise usages, synonyms and antonyms, technical terms, context, superfluous words
5. Using a Dictionary :
   Definition of dictionary, types of dictionaries, information in dictionary, use of dictionary
6. Use of good English :
   Noun, pronoun, adjective, verb, adverb, conjunction, preposition, interjection, the article, tenses, spelling, use and misuse of words, abbreviations, active and passive voice, punctuation, remove 'too'.
7. Phonology :
   Pronunciation of vowels and consonants in English
8. Public speaking in English and oral presentation in English.

PG HM – T108 AECC: Yoga and Meditation

Unit 1: Introduction, Meaning, definition, Objectives; Introduction to Ashtangyoga; Performing Yogabhyasa

Unit 2: **Suryanamaskar:** Introduction, Postures, Benefits and practice

Unit 3: **Asanas :** Vajrasan, Padmasan, Vakrasan, UttanPadmasan, Pawanmuktasan, Shavasan, Bhujangasan, Shalabhasan, Makrasan, Tadasan, Verasan, Ardhachakrasan- Introduction, Postures, Benefits and practice.

Unit 4: **Pranayamanas**
AnulomVilom, Bhramari, Kapalbhati and Bhasrika; Omkar Sadhana, Prayer and Guruvandana

UG HM – T111VAC: Introduction to Research Methodology – I

Unit I	**Research terminology and fundamentals** 1) Definition on research, scientific thinking, significance and general characteristics of research, objectives, classification and type of research, types of research methods. 2) Research methods verses methodologies, research and scientific methods, criteria of good research. 3) Identification and formulation of research problem, topic
Unit- II	**Communication and scientific writing** **Communication skills**- 1) Importance of communication through English, the process of communication and factors that influence the communication – sender, receiver, channel, code, topic, message, context, feedback, noise, filters and barriers 2) Verbal and non- verbal communication: body language 3) Comparison of general communication and business communication, scientific communication. 4) Presentation skills- Structure of presentation, types of presentation – Oral, Power Point Presentation, Handling of Power Point, Slides organization, content, body language, gestures, voice modulation, online/ virtual presentation (Webinars) (MS team, ZOOM etc.) **Scientific Writing-** 1) Presentation of scientific research paper – Oral presentation, poster presentation, presentation in conferences & in symposia, thesis presentation (viva voce/ open defence) presentation & submission of proposal to funding agencies – selection of research topic, review of literature, writing research proposal & presentation (submission). 2) Use of computers in research methodology – Basics –Hardware/ software, application programme, binary programme, system programme, utility programme and programming, input unit, ALU unit (Arithmetic Logic Unit), control unit/RAM, ROM, PROM, EPROM, EEPROM, Magnetic core memory, Secondary storage devices; Computer programming language & operating system – Batch operating system, Personal Operating System (PCS), MS word, MS excel, MS power –point etc.,

Practical course Research methodology **60 hrs.**

1	Literature review on any current research topic of 10-20 typed pages using Google search or any search engines (it can be on research project topic)	02 hrs.
2	Assignment on analysis of data/results/conclusions	02 hrs.
3	Oral presentation (preparation)/webinar with different tools	03hrs.
4	Identification and formulation of research problem (may be for project work)	03hrs.
5	Using computer, preparation of research document – a case study (Use of MS word, MS power point, voice to text, MS Excel, Photoshop, Mobile application- use of mobile for research) creating WhatsApp group, mail ID, MAC ID)	03 hrs.

B.Sc. Part I Semester II

UG HM – T201 : Fundamentals of Cell Biology & Physiology

Unit I	▪ **Introduction to cell:** Discovery of cell, cell theory – Definition, three assumptions of cell theory, exceptions, organismal theory, protoplasm theory.
Unit II	▪ **Organization of Prokaryotic cells :** size (Micrometry), shape & arrangement of bacterial cells, Structure of typical bacterial cells, Structure & functions of cell wall & cell membrane (Fluid Mosaic Model), composition & functions of capsule, slime layer, flagella, Pili, fimbriae, Cytoplasmic matrics – inclusion bodies, magnetosomes, ribosomes, gas vacuoles, metachromatic granules, Carboxysomes, PHB granules, endospores, Nucleoid & plasmids
Unit III	▪ **Eukaryotic cell structure** – Micrometry (Plant & animal cell), Overview of eukaryotic cell structure, plasma membrane & membrane structure. Cytoplasmic matrix, microfilaments, intermediate filaments & microtubules ▪ **Organelles of biosynthesis** – Secretary & endocytic pathways – Endoplasmic Reticulum & Golgi apparatus, Definition of Lysosome, Endocytosis, phagocytosis, autophagy & proteosome ▪ Eukaryotic Ribosomes, Peroxisomes, Mitochondria, Chloroplast (plastids), Nucleus (Introduction, morphology, occurrence, shape, size, number, position, ultra structure of nucleus, nuclear membrane, nucleoplasma, nucleopore complex, nucleolus, chromosomes – euchromatin & hetero chromatin chromosome number, size, general structure & nomenclature, organization of nucleus, specialized chromosomes - polytene & lampbrush) ▪ External cell covering – Cilia & flagella ▪ Comparison of prokaryotic & eukaryotic cells
Unit IV	▪ **Cell membrane & membrane transport :** Types of membrane transport – Passive transports – simple diffusion, facilitated diffusion, osmosis, Active transport – Primary & secondary transport, Na –pump, Na+ - K+ ATPase pump, bulk transport, endocytosis & exocytosis.
Unit V	▪ **Cell cycle:** Introduction, phases & check prints – cell division in microorganism & plant, animals (Mitosis & Meiosis) – G_0, G_1, G_2 & M phases & significance

Unit VI	▪ **Cell Signalling**: Signalling molecules, Signalling receptors (cell surface receptors), autocrine, syncrine & paracrine signalling G-protein signalling & calcium signalling, membrane junctions
Unit VII	▪ **Cell death** – Aging, Theories of aging, apoptosis & necrosis, neoplasia, autophagy, ferroptosis & pyroptosis
Unit VIII	▪ Diseases associated with lysosomes (Tay Sachs disease), Peroxysomes (Zell Wager syndrome), Mitochondria (Leber Hereditary Optic Neuropathy -LHON & Mitochondrial encephalomyopathy, lactic acidosis and stroke-like episodes - MELAS)

UG HM – P201: Practical related to paper Fundamentals of Cell Biology & Physiology

(1C, 40H)

1	Study of prokaryotic cell structure and study of electron micrographs of all important cell organelles
2	Study of eukaryotic cell structure and study of electron micrographs of all important cell organelles
3	Micrometry- measurement of cell size taking different types of cell
4	Staining and observation of human cheek epithelial cells
5	Isolation and characterization of the following subcellular components using appropriate sample by differential centrifugation - nuclei (staining and counting), mitochondria (succinate dihydrogenase assay), Chloroplast (microscopic observation), lysosome (Acid phosphatase assay)
6	Methods of cell lysis and confirmation
7	Study of different stages of mitosis
8	Study of effects of colchicine on mitosis
9	Study of different stages of meiosis in *Tradescantia*
10	Study of polytene chromosomes (Drosophilla/Chironomous larvae)

B. Sc. Part I Semester II Biotechnology /Microbiology

UG HM T202: Fundamentals of Biochemistry and Biomolecules - I

Unit I	**Historical perspective-** Origin of life with respect to abiotic production of biomolecules, cellular and chemical foundation of life- an overview
Unit II	**Chemical foundation-(Overview)** a) Biomolecules as compounds of carbon with variety of functional groups b) Universal set of small molecules, macromolecules as the major constituents of cells: configuration and conformation with definitions and suitable example only, Types of stereoisomers and importance of stereoisomers in biology, types of bonds and their importance - electrovalent, covalent, ester, phosphodiester, thioester, peptide and glycosidic bonds
Unit III	**Water** - properties of water, hydrogen bonding, structure ionization, interactions of biological molecules in water, osmosis, concept of pH and buffers, Buffering system in living cells
Unit IV	**Carbohydrates-** Definition, classification, biological role, structure, sugars and non-sugars, Monosaccharides- families of monosaccharides- aldoses, ketoses, trioses, tetraoses, pentoses and hexoses Definition, classification and brief account of monosaccharides (based on aldehyde and ketone groups), D and L configuration, mutarotation, epimers, anomers, chemical and physical, properties, glycosidic bond-properties and reaction of glucose and fructose-isomerism, oxidation and reduction, esterification and glycoside formation, osazone- structure of ribose, deoxyribose, glucose, galactose and fructose Oligosaccharides and disaccharides- concept of reducing non-reducing sugars, glycosides bonds, structure of lactose, sucrose, maltose, cellobiose, inversion of sugars Polysaccharides- its classification based on function- storage polysaccharides, homopolymers - starch and glycogens, heteropolymere - inuline, Structural polysaccharides- cellulose and chitin, peptidoglycan – functions of carbohydrates
Unit V	**Lipids :** Blur's Classification, Storage and Structural lipids, Simple lipids (Triacylglycerol and waxes), Compound and complex lipids, phospholipids –phosphatydyl colin, ethanol amine, glycerolipids, sphingolipids, glycolipids, sterols, derived lipids, sphingomyline, cetebrosides, gangliosides, lipoproteins - LDL,VLDL,HDL; Lysosome Chylomicrones Fatty acids – nomenclature structure and properties (up to C18), Properties of lipids - Physical properties (state, colour, odour, melting point, solubility, specific gravity, geometric isomerism, emulsification and surface tension), Chemical properties (SAP value, Acid value, iodine number, rancidity), Functions of lipids

UG HM P202: Basics of Biochemistry-Biomolecules

1	Biochemical calculations - preparation of solutions and buffers (pKa values) – w/v, v/v, %, ppm, ppb, mg/L, normality, molarity, molality
2	Study of colorimetry and preparation of standard graph and calculation of λ_{max} for given samples (Tyrosine/ purines/ pyrimidines), Verification of be Beer-Lambert law by using Ammonium Copper compound, identification of purines from λ_{max}
3	Isolation and identification of Starch from plant source
4	Saponification number - To find out saponification number of given lipid
5	Qualitative analysis for sugars and lipids
6	To estimate concentration of reducing sugar by DNSA method
7	To estimate concentration of Cholesterol in given sample (Iron reagent)
8	To separate and identify sugars by paper chromatography/ TLC
9	Detection of unknown carbohydrate from mixture (glucose, fructose, maltose, xylose, starch and sucrose)
10	To estimate reducing sugar from apple juice by Benedicts methods/Molish Test
11	Validation of glass pipettes and balance
12	Standardization of solution (0.25 N $K_2Cr_2O_7$) using 0.1 N ferrous ammonium sulphate and ferroin indicator
13	Determination of pH of different food samples by using pH paper/ universal pH standards

B. Sc. Part I Semester II

UG HM – T203: Basics of Biochemistry-Biomolecules - II

Unit I	**Proteins:** i) Amino acids as building blocks of proteins, classifications of common amino acids (by R groups), uncommon amino acids and their functions, chemistry of amino acids, ionization of amino acid side chains, configuration, zwitterions, reactions of amino acids, titration of amino acids, isoelectric pH, reaction with Ninhydrin, Sanger reaction ii) Peptides and proteins:oligopeptides- structure and function of naturally occurring glutathione, insulin and synthetic aspartem Protein structure: importance of amino acid sequence; primary structures and concepts of N & C terminal, peptide bond formation, characteristics of peptide bonds; Secondary structures: Ramchandran Plot, alpha helix and beta sheets, secondary repeats; tertiary and quaternary structure of protein (Haemoglobin), forces holding the polypeptides together - hydrogen bonds, Vanderwaals forces, covalent, ionic bonds and salt linkages; Protein denaturation and renaturation; Classification of protein shape, structural, transport, chromosomal, phospho and glyco proteins and the biological role of proteins.
Unit II	**Nucleic acids:** Occurrence, purines, pyrimidines, Pentoses (Ribose and Deoxyribose) phosphates, AMP and cAMP, ADP and ATP, TDP and TTP, GDP and GTP, NDA, NADP, FMN and FAD; Polynucleotides, covalent structure of DNA (different forms of DNA) and RNA (mRNA, tRNA, rRNA and SnRNA); Forces stabilizing nucleic acid structures, N-β glyosidic bonds, Phosphodister bonds, Properties of nucleic acids, denaturation and renaturation, Watson and Crick's model of DNA structure, ribozyme, Biological role of nucleic acids
Unit III	**Vitamins:** Occurrence and sources, rich sources of different Vitamins, classification, structure & biochemical functions of water soluble vitamins; Role as coenzymes: Thiamine, Riboflavin, Niacin, Pyridoxine, Pantothenic acid, Coenzyme A, Lypoic acid, Folic acid and B12; functions and deficiency symptoms
Unit IV	**Minerals:** Role of Na, K, Mg,Fe, Zn, Co, Ca, P and I in physiology, general electronic configuration and their shape and significance in metalloenzymes
Unit V	**Enzymes :** Definition, structure and concept of Apoenzyme, Coezyme, Cofactor Prosthetic group, Active site, Types of enzyme, Extracellular and intracellular, Constitutive and inducible, general overviews of enzyme-substrate reaction, mechanism of enzyme action, factors affecting enzyme reactions
Unit VI	**Plant Pigments and Dyes:** Chlorophyll, Xanthophylls, Flavonides, Carotenes, etc.

Practicals:

1	Estimation of concentration of protein by Biuret method and Lowry method (Albumin)
2	Study of melting temperature of nucleic acid- to determine T_m of DNA and mole percent G+C content
3	To separate amino acid by TLC
4	To study amylase enzyme assay- and to study effects of pH, temperature, concentration of enzyme, activators and inhibitors
5	General tests for amino acids and detection of unknown amino acid from mixture (Arginine, cysteine, metheoinin. Tyrosine, histidine, proline and tryptophan)
6	Isolation and characterization casein from milk by Isoelectric pH method
7	Estimation of DNA by DPA and RNA by Orcinol methods
8	Preparation of titration curve of acidic, basic and neutral amino acids
9	Quantitative estimation of ascorbic acid
10	Bioassay of Vitamin B12
11	Separation of pigment and dyes by adsorption and ion exchange chromatography
12	Extraction of genomic DNA from onion/yeast/ rat liver/ bacteria and confirmation with DPA and agarose gel electrophoresis
13	Study of karyotype analysis (karyotyping)
14	Detection of significant industrial enzymes (amylase, protease, lipase, invertase, phosphatase and cellulase)
25	Enzymatic preparation of biomolecules - Dextrin- production of maltodextrin by using β amylase Glucose- Productive of glucose by bacterial α- amylase and amyloglucosidase Production of invert sugar by invertase Peptide preparation of proteolysis by using papain Softening of Chhole/Rajma/ Idli by using papain

F.Y. B. Sc. Semester II

UG HM T204: Microbial Nutrition, Growth and Bioenergetics

Unit I	**Chemical composition of microbial cell** • Nutritional requirements: Carbon, Oxygen and Hydrogen, Nitrogen, Sulphur and Phosphorous, Minerals, growth factors and energy source -auxotroph, prototroph and fastidious microorganisms • Classification/categories of microorganisms • Microbial Nutrition, Cultivation and Isolation and Preservation • Design and preparation of culture media, Types of culture media - liquid and solid media, synthetic/ chemically defined media, semisynthetic complex non synthetic media, anaerobic growth media, selective and deferential media, indicator media, transport media; enrichment, isolation and pure culture techniques for microorganisms • Methods of purification of microorganisms - streak plate, spread plate, pour plate techniques, single cell isolation technique • Preservation of microbial cultures – slants, slants + mineral oil overlay, butt method (stabs), cryopreservation, freeze drying method (ampoules)
Unit II	**Overviews of culture collection centres and their role:** Requirements and guidelines of National Biodiversity Authority (NBA) for culture collection centres
Unit III	**Microbial growth:** Inoculation techniques and study of growth - Inoculation of liquid medium (broth), Solid media (slants, butts and plates), Study of colony characteristics of pigment and pigment non producing bacteria, Study of motility- hanging drop preparation and sloppy agar method, Kinetics of bacterial growth (exponential growth model), phases of growth, Growth curve - generation time, continuous (exponential), Chemostat, diauxic and synchronous growth Measurement of microbial growth methods of enumeration a) Microscopic methods (Direct microscopic count, haemocytometry method), counting cells using improved Neubauer-Petroft-Hosser's chamber b) Plate count (serial dilution technique) - total viable count/SPC/Breed's smear count, membrane filtration technique

	c) Turbidometric method- Nephelometry/ Electronic counter method (Coulter counter) Tetrazolium chloride method d) Brown's opacity tube method/MBRT and Resazurine estimation of biomass (dry mass packed cell volume) e) Chemical methods- Cell carbon and nitrogen estimation Determination of optimum growth conditions – pH, temperature, solute concentration (salt, sugars), heavy methods and incubation period
Unit IV	**Microbial growth in natural environments:** (Soil, Water, Food, Animal and Plant body, Microbial Parasites) Methods for cultivation of photosynthetic, extremophilic and chemolithotropic (chemoorganotrops) bacteria, anaerobic bacteria, algae, fungi (yeast and molds), protozoa, actinomycetes and viruses
Unit V	Bioenergetics: Principle of bioenergetics, Role of ATP in metabolism, reducing power and its significance in metabolism, generation of ATP through substrate level phosphorylation, components of electrons transport chain (ETC)- Flavoproteins (FMN, FAD), Quinines (Ubiquinones, Menaquinons), Iron sulphur proteins, cytochromes - generation of ATP through ETC

Practicals

Sr. No.	Practical	Hours
1	Introduction & use of common laboratory glasswares / labwares – testtubes, culture tubes, suspension tube, screw capped tubes, Petriplate, Pipettes (Mohr & serological) Micropipettes,, Pasteur pipettes, Erleyer meyar flasks, Volumetric flasks, Glass spreaders, Durham's tubes, Cragie's tube & inoculating needle (wire loops, Stab needles)	
2	Learning basic techniques in Microbiology – Wrapping of glasswares, cotton plugging, cleaning & washing of glassware, biological waste disposal	
3	Preparation of simple laboratory media - nutrient agar, broth, Mac-Conkey's agar, Manitol salt agar, Peptone water, Sabouraud's agar & their sterilization, checking of sterilization efficacy of autoclave using biological indicator (*Bacillus stearothermophillus*)	
4	Study of motility by hanging drop method and study of swarming phenomenon on sloppy agar medium	
5	Preparation of Winogradsky's column & observation of different types of microorganisms using bright field microscope	
6	Pure culture techniques – Streak, spread, pour plate methods & study of colony characteristics	
7	Isolation, colony characteristics, gram staining, motility of following bacteria – *E. coli, Bacillus spp. Staphylococcus spp., Micrococcus spp.*, pigment & pigment non producing microorganisms	
8	Wet mount and slide preparation for algae, fungi & protozoa using sample sources for Amoeba spp., Paramecium spp., Nostoc, Chlorella, Aspergillus, Mucor & Penicillium, Fusarium, *Rhizopus spp*.	
9	Inoculation techniques & study of growth in liquid broth media, solid media, slants, butts & plates, coverslip & slide culture techniques for actinomycetes	
10	Effect of environmental factors on growth of bacteria (*E. coli*, *Staphylococcus aureus*) - pH, temperature, salt concentration, heavy metals (oligodynamic action)	
11	Study of normal flora of skin – observing & cultivating different morphoforms of microorganisms from skin & effect of washing of skin with soap & disinfectant on microflora	
12	Preservation of culture on slants, in soil & on grain surfaces, butts, vials/ampoules/lyophils & revival of these cultures & lyophils	
13	Enrichment, isolation & morphological studies of – Chemoautotrophs, Chemoorganotrops , Photoautotrophs, Photoorganotrops (one member each)	

14	Study of growth curve, continuous growth / diauxic / synchronous growth	
15	Measurement of bacteria by Direct Microscopic Count (DMC), Slide / Neubauer's chamber, direct plating (SPC) , Indirect – Nephalometery / Brown's opacity tube / MBRT	
16	Estimation of ATP generation	
17	Cultivation of anaerobic bacteria from natural sources	

B. Sc. Part I Semester II

UG HM -T205 Advanced Chemistry, Physics & Biophysics for Biologists

Unit	Topics	Hours
Unit I	• Chemistry of transition & non transition elements- ❖ Transition elements – General properties (d & f block elements), electronic configuration, oxidation state, magnetic movement & complexes of 3d & lanthanide elements ❖ Non – transition elements – General properties (s & p block elements); synthesis, properties & structure of halides & oxides of Carbon, silicon & Nobel gas compounds	
Unit II	• Colloidal state – Colloidal system, classification & size range of colloids, preparation & purification of colloidal solutions, general properties of colloidal system, some properties of hydrophobic colloidal system (electrical & electrokinetics), Surfactants, emulsions, Gels, importance & applications of colloids	
Unit III	• Electrochemistry – Introduction, electrochemical cell, cell constant, half cell & potential reaction, reduction potential, transport number, conductance, Kohlrausch law, electrochemical series, thermodynamics, potential function from cell, potential measurement & it's applications, Emf, Nernst's equation, Galvanic cells, Liquid – junction potential, Huckel theory, over voltage / over potential • Bioelectricity – Introduction, electricity observed in living system – examples, origin of bioelectricity, resting potential & action potential, conduction velocity, pace maker, ECG, EEG, EMG, EOG	
Unit IV	• Name reactions – Introduction, Mannich reaction, Hoffmann reaction, Diels – Alder reaction, Perken's reaction, Meerwein – Ponndorf – Verley (MPV) reduction	
Unit V	• Elasticity – Basic concept of stress & strain in solids, Hook's law, stress, strain curve, properties of fluids	
Unit VI	• Thermometry – Principles of thermometry, concept of temperature & it's measurement, Thermal energy, Platinum resistant thermometer, thermocouple, thermisters as thermometer	
Unit VII	• Conventional & non- conventional energy sources & devices – Introduction, various types of conventional & non-conventional	

	energy sources – Solar energy, direct use of solar energy – Silicon solar cells, principle of conversion of solar energy in to electricity & construction of solar cell (spectral distribution), efficacy, fill factor	
Unit VIII	• Ideal & real gases – Ideal gas – Kinetic model, gas equation, kinetic interpretation of temperature, degree of freedom, equipartition of energy, real gas – deviation of behaviour of real gases from the ideal gases, critical constants of a gas (Pc, Vc & Tc), Vanderwaal's equation, liquification of gases.	
Unit IX	• Current electricity – Introduction, active & passive components, A. C., L-R, R-C, L-C-R circuits, half wave rectifier, full wave rectifier, bridge rectifier & transformers	
Unit X	• Semiconductors – Introduction, definition & examples of conductor, semiconductor, insulator, intrinsic & extrinsic semiconductors, types of semiconductor diodes, Pn junction diode, Zener diode, Transistors – p-n-p & n-p-n transistors, common emitters & best circuits, light emitters diode (LED) and segment display, photodiode, optocoupler	
Unit XI	• Optics – Introduction, interference, in parallel test thin films, wedge – shaped thin films, Newton's rings, Polorization of light & concept of optical activity, diffraction - types, diffraction – grating, experimental, determination of wavelength by diffraction grating, Lasers – properties, Lasers action, (energy level diagram), Concept of population inversion, optical pumping & Einstein's equation, Nicol's prism properties, Rubby laser	
Unit XII	Introduction to digital electronics – • Number system & logic gates • Small signal voltage amplifiers, number systems – decimal, binary, BCD, Basic logic gate, bit groupings, CoR, NoR, AND, NAND, NoT, DeMorgon's theorem, Half adder & full adder	
Unit XIII	• Magnetism- Magnetic field, maghetism of earth, para, dia, ferro, nuclear & biomagnetism	
Unit XIV	Overview of green chemistry & synthesis – Microwave assisted synthesis of organic compounds, retrosynthesis	

UG HM -P205 Practicals

Sr. No.	Practical	Hours
1	Determination and adjustment of pH of solutions	
2	Preparation of different buffer solutions	
3	Determination of heat of solution of Benzoic acid / Salicylic acid by solubility measurements	
4	Estimation of acetone by idometric titration method	
5	Determination of conductivity of solutions	
6	Determination of Optical activity by polorimeter	

7	Study of depression in freezing point	
8	Determination of dissociation constant of weak acid Study of substituent on dissociation constant of weak acid	
9	Inorganic estimation of amount of magnesium from talcum powder by complexometric titration	
10	Study of principle, working & construction of pH meter & conductivity meter	
11	Demonstration of principle, working & construction of Refractometer, Laminar Air Flow	
12	Purification of any two organic compound by recrystallization selecting suitable solvent	

FY BSc Semester II

UG HM-T206 Advanced Plant and Animal Sciences

Part A: Plant Sciences

Plant water relationship and its importance

Definition, significance and mechanism:
i. Permeability; ii. Diffusion & imbibitions; iii. Osmosis & its types

Relation between osmotic pressure (OP), turgor pressure (TP) and wall pressure (WP), Diffusion Pressure Deficit - DPD (Suction pressure)

Absorption and Transport of water:

Introduction and mechanism of Ascent of sap - transpiration and guttation, Translocation of mineral elements (Capillarity, Imbibition, Atmospheric pressure and Cohesion-tension)

Plant Metabolism:

Photosynthesis: - Photosynthesis pigments, concept of two photo systems, photophosphorylation, Calvin cycle, CAM (Crassulacean Acid Metabolism) plants, photorespiration, compensation point.

Respiration: Mechanism - Glycolysis, Krebs's cycle and ETS

Nitrogen metabolism- inorganic & molecular nitrogen fixation

Growth and development of plants :

Essential nutrients for Plant growth and their role

Plant growth regulators

Introduction to physiology of flowering: a) Photoperiodism b) Vernalisation

Economic importance of plants: Cereals, Pulses, Oil seeds, Fiber plants, Medicinal Plants, Timber yielding, Beverages with examples

Part B: Animal Sciences:

Animal Physiology

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.

Functioning of Excitable Tissue (Nerve and Muscle) - Structure of neuron, Propagation of nerve impulse (myelinated and nonmyelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (sliding filament theory), Neuromuscular junction

Endocrine and Reproductive Physiology - Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis

Parasitology

Introduction to Host-parasite Relationship - Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism

Parasitic Protozoa: Life history and pathogenicity of *Plasmodium vivax*

Parasitic Helminthes: Life history and pathogenicity of *Fasciola hepatica*, *Taenia solium*.

Economic Zoology

Vermiculture; Aquaculture; Sericulture and Apiculture

Practicals in Plant and Animal Sciences

1. Study the process of Osmosis and Turgor pressure and determination of Diffusion Pressure Deficit
2. Determination of rate of respiration

3. Estimation of chlorophyll content in photosynthesizing and nonphotosynthesizing leaf
4. Effect of plant growth regulators on germination of seeds
5. Studies on economically important plants: Students should prepare herbarium specimens with their uses
6. Study and dissection of Honey Bee , Mounting of Mouth parts, pollen basket, Antenna Cleaner, Sting Apparatus , legs and wings
7. Study of Plasmodium spp.
8. Study of Fasciola sp.
9. Enumeration of red blood cells using haemocytometer.
10. Collection, Classification and preservation of Insects - Drosophila

B. Sc. Part I Semester II

UG HM T207: Ecology, Ecosystem & Geosciences

Unit	Topics	Hours
Unit I	Fundamentals of ecology • Environments: definition, components – a) Atmosphere - origin, composition, structure, variables b) Hydrosphere – Characteristics, hydrological cycle, El Nino, La Nina c) Lithosphere – Formation, zonal structure, soil studies – origin, profile, properties, classification d) Biosphere – Characteristics & inter-relationships • Ecological spectrum & hierarchy, levels of organization, autecology, synecology, population, community, biomes & ecosystem ecology.	
Unit II	Ecosystem structure & function – Concept of ecosystem, types of ecosystem structure – biotic & abiotic components, Macro & micro ecosystem Function – a) Food chain – Grazing, detritus b) Food web & ecosystem stability, Trophic levels c) Ecological energetics – Energy input / Energy flow (Single channel & Y shaped models) d) Productivity of ecosystem – Primary production (GPP & NPP), Secondary production, Standing crop (biomass) e) Ecological pyramids – Number, biomass & energy.	

Unit III	Biogeochemical cycles – • Nutrient cycling – a) Gaseous cycle - Hydrological, Carbon, nitrogen, Oxygen b) Sedimentary cycle – Phosphorus, sulphur, Calcium & Magnesium • Ecosystem nutrient cycling modes – Intra – system cycling & extra system transfer – Nutrient inputs, biotic accumulation of nutrients, nutrient outputs	
Unit IV	• Population ecology – Introduction, basic concept, population characteristics – size & density, dispersion (random, aggregate & uniform) nativity (potential & realized), fecundity, mortality (potential & realized), survival curve, age & sex structure, life table & viability analysis, concept of carrying capacity • Population growth – a) Growth curves exponential &logistic b) Population fluctuation c) Biotic potential & environmental resistance	
Unit V	• Community ecology – Characteristics of commonly – Spices diversity, growth forms & structure, Dominance, succession, trophic structure, ecological Niche, ecotone & edge effect • Characters in community structure – Analytic (Qualitative& Quantitative) & synthetic • Inter – specific & intra – specific relationships • Concept of succession, causes of succession, basic types – primary, secondary, autogenic, allogeneic etc. • Mechanism of succession – Nudation, invasion, competition, Co-action & reaction, stabilisation (climax), models & succession – Hydrosere & lithosere	
Unit VI	Threats to the environment & ecosystem	

Practical

Sr. No.	Practical	Hours
1	Study of ecosystem (Aquatic, forest, river etc.)	
2	Community sampling by quadrate methods for plants – Percentage of frequency, density, abundance, frequency class diagram & comparison with Raunkiaer's frequency chart, Simpson's index & dominance, Shannon diversity index	
3	Measurement of primary productivity of grassland by harvest method	
4	Determination of frequency, abundance (Line) & density (Belt) of spices across terrestrial – aquatic transitional zones	
5	Case studies on ecological succession	
6	Study of natural resources	

	Forest / Mineral / Food / Water / Land	
7	Study of ecological pyramids	
8	Study of different food chains	
9	Field visits	

B. Sc. Part I Semester II
Microbiology & Biotechnology
UG HM- T208 Basics of Environmental Pollution and Applied Microbiology & Biotechnology

Unit	Topics	Hours
Unit I	**Environmental Pollution & control**: Introduction, definitions, sources & types of pollution	
Unit II	**Water pollution & microbiology:** Sources & classification of water pollution, different types of aquatic environments, water pollution parameters & their biological significance: ▪ Physical – Colour, odour, temperature, turbidity & density ▪ Chemical – Solids (suspended, total & dissolved, volatile), Hardness, acidity, alkalinity, pH, DO, ions (Fe, Cu, Mn, Na, K, Ca, N, P, F, Cl) ▪ Pollutants – Chemicals, pesticides & detergents ▪ Biological coliforms (faecal, streptococci), Organic matter (BOD, COD) & their significance as pollution indicators ▪ Thermal pollutants – Waste heat & it's uses, cooling ponds & towers, effect of thermal pollution on light & atmosphere ▪ Normal flora of water, sources of microorganisms in water, faecal pollution, most prominent waterborne pathogens, indicators of faecal pollution ▪ Water quality assays – routine bacteriological examination of water (SPC) test for coliforms ▪ Qualitative (preventive, confirmed & completed tests), IMViC test, Eijkman test, Quantitative – MPN, Membrane filter technique ▪ Treatment & purification (primary-physical, secondary-biological & tertiary-chemical) of municipal drinking water supply ▪ Eutrophication ▪ Groundwater & marine pollution.	
Unit III	**Air pollution & aeromicrobiology** Compassion of air, types & classification of air pollutants, gaseous inorganic air pollutants – NO_x, SO_x, CO, CO_2, H_2S, NH_3 , O_3, CFC. ▪ Organic air pollutants – aliphatic & aromatic organic compounds, particulate matters, types & effects ▪ microbial pollutants – number & types of microorganisms in air, sources, infectious dust –droplets & droplets nuclei, microbiological examination of air – air samplers & samplings methods – solid impaction (sieve device) & liquid impingement – (bead bubbler device).	

	▪ Acid rain, photochemical SMOGs, London & LA SMOGs (mechanisms of formation) decrease of ozone layer (role of CFC's & control). ▪ Green house effects, instrumental analysis of SOx, NO_x, economic impact of air pollutant ▪ Effect of air pollution of human, plants, animals & atmospheric health	
Unit IV	Soil pollution & Microbiology: Definition, sources, role of pesticides in soil pollution. Soil types, types of microbes found in soil, role of microorganisms in soil fertility, soil pollution control measures.	
Unit V	Noise pollution – Sources & types of noise, sonic boom, measurements of noise effects & control measures	
Unit VI	Radiation pollution – Introduction, atomic radiations, effect of radiation, radioactive waste & disposal, radiation protection	
Unit VII	Environmental toxicology – Definition, classification & concept. Pesticide toxicity (organic & inorganic), mode of action of toxicants of metals – arsenic, mercury, cadmium, lead, Nickel, Asbestos, chromium, organo phosphate, carbamates, etc., mutagens & carcinogens, Cyanide, Peroxy Acetyl Nitrate (PAN), dioxins. Bioconcentration, bioaccumulation, Biomagnification, potentiation & Synergism Control of toxic effect, biotransformation & excretion	
Unit VIII	Energy – Renewable & Non-renewable energy sources, fossil fuels, CNG, Crude oil, Coal, fractional distillations of crude oil, bioethanol from sugary & starchy crops, petrocrops – rubber, Biodiesel (production, advantages & limitations)	

Practicals

Sr. No.	Practical	Hours
1	Determination of temporary & permanent hardness of water	
2	Estimation of COD & DO, BOD of polluted water samples	
3	Determination of solid content of polluted water samples (SS, TS, DS, VS)	
4	Routine bacteriological analysis of water – preventive, confirmed & completed test, MPN, Eijeckmen's Test	
5	Bacteriological analysis of water - IMViC test	
6	Study of degradation of pesticides using microorganisms	
7	Enumeration of microorganisms from air by solid impaction & liquid impingement techniques	
8	Study of effect of pesticides on azotobacter population by viable count method	
9	Study of effect of heavy metals on growth of microorganisms	
10	Estimation of noise by dB meter (L_{eq})	
11	Determination of nitrate & phosphate content in polluted water	
12	Determination of PM concentration using High Volume Air Sampler (HVS)	
13	Determination of organic matter and carbon from given soil sample	
14	Determination of chlorine demand for the potable water	

15	Detection of radioactive material in fruits & vegetables	

UG HM T209AECC: English – II (Communication Skills)

1. **Communication as part of science:**
   Language – a means of Communication; Communication – Meaning of Communication, Definitions; Principles of communications; Communication – Situation for and need of communication, Importance of communication Features, objectives and functions of communication, Communication cycle, Elements of Communication, Communication process, stages in Communication process.

2. **Types of Communications:**

   Formal – Informal, Verbal – Nonverbal, Vertical – Horizontal – Diagonal

3. **Principles of effective communication:**

   Definitions of effective communication; Communication barriers and ways to overcome them; Developing effective messages – Knowledge about the audience, purpose of communication, structure of message, selecting the proper channel, avoiding barriers in communication, facilitating feedback.

4. **Non -Verbal Communication**

   Non – verbal codes: Body Language, chronemics and Artifacts

5. **Illustrating with visuals**:

   Photographs, tables, graphs, flow charts, figures, maps, picture diagrams, pie diagrams, family tree.

6. **Formal written skills**

   i. Report writing: Seminar report, Conference report, Progress report, Investigative report, Accident report, Fall/rise in the Production, Joining report
   ii. Applications: Job Application with resume (C.V.), Sick leave application, Application for getting particular information (eg. prospectus / prescribed admission / scholarship form).
   iii. Business correspondence: Enquiry letter, Order letter, Complaint letter, Adjustment Letter
   iv. Office drafting: Circular, Notice, Memo, Defining and Describing object and Giving Instructions

UG HM T210 SECC: Soft Skill and Personality Development

Planning and Goal setting: 5 Hours
Five skills needed to achieve carrier goals: Human perceptions, Understanding people, types of soft skills, Types of soft skills, Need for achievement and Spiritual Intelligence, Developing potential and self actualization

Conflicts and stress: 5 Hours
Types of conflicts, conflict resolution skills, Types of stress, causes of stress, effects of stress and regulating the stress; Habits – Good and bad habits, Forming Habits of success, breaking bad habits.

Communication skills 5 Hour
Communication cycle advanced and essentials, Basic telephonic skills. Communication barriers- Interpersonal transactions, miscommunication Technology and Communication - E
mail- Principle, Netiquettes, E-mail etiquettes

Presentation skills: 5 Hour
Overcoming fear, Becoming a professional, the role of body language, effective reading and using visuals.

UG HM – T211VAC: Introduction to Research Methodology – II

Unit- I	**Scientific Writing-** 3) Language as means of communication – English language 4) Scientific writing verses unscientific writing- Scientific writing in English language 5) Good English and grammar in scientific writing - Basic grammar, Tenses, Voices, Prepositions and Conjunctions, conditional sentences, count and non count nouns, concord and punctuations, use and misuse of words, jargons and avoiding jargons, use of abbreviations, accepted abbreviations and symbols, common error in the style and in spellings. 6) Scientific methods – Concept, hypothesis, theory, law, design of experiment, inductive & deductive reasoning. 7) General structure of scientific reports (types of scientific documents) – Journal articles, books, posters, conference, papers, thesis, review papers, books reviews, project & conference reports. 8) Writing a scientific papers – IMRAD/IRDAM acronym/ system, literature search, title, listening of authors & addresses, abstract, key words, introduction, material –method, result & discussion, summary & conclusion, references, stating the acknowledgement, tables/graphs/diagrams & illustrations 9) Structure of project – Title, author & their institution, abstract/ summary, certificates (students undertaking, guide certificate, plagiarism checker certificate, ethical clearance), acknowledgements, list of content, abbreviations, introduction, literature survey, aim & objectives, material & methods, results & discussion, conclusion/ recommendation, bibliography, annexure (list of chemicals, glasswares, reagents, media used with composition, paper publication etc.).

UG HM – P211VAC: Practical course Research methodology
60 hrs.

1	Writing suitable title of research papers, search of instruction s to authors from website of scientific journal (its analysis and comparison)	02 hrs.
2	Writing abstract for research paper	02 hrs.
3	Writing summary and conclusion for given scientific paper	
4	Writing a bibliography for given research paper	02 hrs.
5	Preparation of research paper for publication (may be on their research project)	08hrs.
6	Prepare a plagiarized and non plagiarized document (use of plagiarism checker)	03 hrs.