Academic Council Meeting No. and Date : 4 / June 14, 2022

Agenda Number : 2 Resolution Number : 4.2 & 4.10

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

Syllabus for

Programme : Bachelor of Science

Specific Programme : Biochemistry

[S.Y.B.Sc. Biochemistry]

Revised under Autonomy

From academic year 2022 - 2023

This page is intentionally left blank

Preamble

Biochemistry is the branch of science that bridges chemical sciences with biological sciences. A biochemist not only study of living beings but also the non-living things inside them. It lies at the core of life sciences. 'Life sciences' is a broad term that involves study of various branches. Hence it is of utmost importance to have a sound knowledge of all these subjects to a Biochemist.

With a little brush-up to the knowledge obtained in earlier levels of graduation, the student enrolling in this program would find himself learning exciting concepts of Genetics, Enzymology, Biochemical Physiology, Cell & Tissue culture, Industrial biochemistry, Animal and Plant Physiology, Trends in Biotechnology etc.

Inclusion of a brand-new unit of Bionanotechnology and its applications will help students relate with the current happenings in the field and stay updated. Concepts of Clinical Biochemistry would make student job ready. The chapter of bioremediation comes with introduction to recent molecular methodologies being used in the field. The syllabus gives a perfect bird's eye view of various fields to student where the biochemistry graduates can enter. This will help them plan their career well in advance. Hands-on techniques taught during the practical sessions would help in thorough understanding of the concepts through self-experience.

The learner would follow student-centric 'Credit System', which will allow holistic evaluation of the candidate through internal and external modes. With this thoughtfully designed syllabus, it is expected that the learner would have a very strong conceptual base built up to enroll for the last year of graduation in the subject of Biochemistry.

Eligibility:

Cleared F. Y. B. Sc. with Biochemistry as one of the subjects.

Duration: 3 years

Mode of Conduct: Laboratory practicals / Offline lectures / Online lectures

Program Specific Outcome

- Learner would know the various avenues that are open to biochemistry graduates to work in.
- Learner would have the updated knowledge of Bio-nanotechnology, Industrial Biochemistry,Analytical Biochemistry,Biotechnology, Enzymology, Genetics etc.
- Learner will be able to apply the knowledge gained for sustainable development.

VPM's B.N.Bandodkar College of Science (Autonomous), Thane

S.Y.B.Sc. (Biochemistry)

Structure of Programme

Semester III

Course Code	Unit	Topics	Credits	Lectures
Bioorganic Chemistry & Biophysical MethodsBiophysical Chemistry I				
BNBUSBC3T1	**I**	Acid, Bases, Buffers & Ionic EquilibriapH and Buffers	**2**	15
	II	Physicochemical Principles		15
	III	Microscopy		15
Fundamentals of Genetics and Physiology I				
BNBUSBC3T2	**I**	Genetics I	**2**	15
	II	Blood and Body Fluids		15
	III	Biological Transport Mechanisms Plant Physiology		15
Applied Biochemistry I				
BNBUSBC3T3	**I**	Microbiology in Human Health and Diseases	**2**	15
	II	Cell & Tissue Culture		15
	III	Industrial Biochemistry		15
BNBUSBCP03	Practicals based on courses in theory - BNBUSBC301, BNBUSBC302,BNBUSBC303		**3**	9/week

Semester IV

Course Code	Unit	Topics	Credits	Lectures
Bioorganic Chemistry & Biophysical Methods		**Biophysical Chemistry II**		
BNBUSBC4T1	**I**	Enzymology	**2**	15
	II	Endocrinology Membrane Transport		15
	III	Approaches to Biochemical Investigation Analytical Biochemistry		15
Fundamentals of Genetics and Physiology II				
BNBUSBC4T2	**I**	Genetics II	**2**	15
	II	Movement & Locomotion Endocrinology		15
	III	Animal Physiology		15
Applied Biochemistry II				
BNBUSBC4T3	**I**	Trends in Biotechnology	**2**	15
	II	Introduction to Pharmacology Bionanotechnology & its Applications		15
	III	Resource Management Waste management & Bioenergy Production		15
BNBUSBCP04	Practicals based on courses in theory – BNBUSBC401, BNBUSBC402, BNBUSBC403		**3**	9/week

Semester III

Course Code BNBUSBC3T1	Course Title **Biophysical Chemistry I**	Credits 2	No. of lectures

Learning outcomes: After successful completion of this course Learner will be able to

- Recall the basic definitions of pH, Buffers and Microscopy learnt in Previous classes.
- Explain the concepts of formol titration and physiological buffers.
- Apply the concepts of diffusion and osmosis in various examples and will develop deeper understanding of types of advanced microscopy.
- Analyze relation between pI, pKa1 and pKa2, compare various types of microscopy techniques.
- Evaluate and apply the concepts of buffer action, viscosity, surface tension in problem solving.

Unit I **Acid, Bases, Buffers & Ionic EquilibriapH and Buffers**	**1.1 Definition** – pH, pK, pKw, isoelectric pH, buffer, buffering capacity, Electrolytic Dissociation & Electrolytes **1.2 Derivations:** Ionic product of water, Henderson– Hasselbalch equation **1.3 Relation** between pI, pKa1 and pKa2 for a neutral, acidic and basic amino acid **1.4 Ionization and titration curves** of weak acid, glycine, lysine and aspartic acid; pKa and pI values of these amino acids **1.5** Sorensen's reaction and formol titration of amino acids Arrhenius Theory, Lewis Acids and Bases, Bronsted - Lowry Theory, Amphoteric substances **1.6 Physiological buffers:** Hb-HHb, carbonate bicarbonate, phosphate and protein **1.7 Numericals** on above concepts.	**15**
Unit IIPhysicochemical Principles	**2.1 Diffusion &Osmosis:** Ways of expressing solute concentration - mole, molal, normal, percent, activity & ionic strength Diffusion & diffusion coefficient and factors affecting diffusion of solute in solution Osmosis - Vant Hoff's law of osmotic pressure law & mathematical expression (no derivation),mechanism of osmosis, role of osmosis in physiology.Renal dialysis: Principles and process **2.2 Colloids:**True solution, colloidal solution, coarse suspension, distinctionbetween lyophilic and lyophobic sols.Tyndall effect. Fundamental study ofDonnan equilibrium, Its relation with osmotic pressureApplications of colloids in biological system, Electrical properties of colloids,Types of colloids: precipitation and flocculation. **2.3 Viscosity** - definition, Factors affecting viscosity, Measurement of Viscosity, Applications of Viscosity in Biological Systems **2.4 Surface tension**: Measurement, factors, affecting surface tension E.g., Role of bile in digestion **2.5 Adsorption:** Concept, Characteristics & Importance	**15**
Unit III Microscopy	**3.1 Revision of Basic concepts of Microscopy learnt in First Year:** History, Principles of microscopy, Parts of Microscope, Refractive index & Magnification, Resolution & Numerical Aperture, Foldscope, Bright Field, Dark Field **3.2 Microscopes & Microscopy:** Principle, working and applications of each of the following microscopy types: Fluorescent, Phase Contrast, DIC, confocal **3.3 Electron Microscopy in detail:** SEM & TEM Cryoelectron& AFM (in brief) Limitations of EM, Comparative overview of all microscopy types	**15**

Course Code BNBUSBC3T2	Course Title **Fundamentals of Genetics and Physiology I**	Credits 2	No. of lectures

Learning Outcomes: After successful completion of this course Learner will be able to

- Define ECF and ICF.
- Remember the concepts of genetics, Blood Composition and Photosynthesis.
- Analyze genetic information and solve problems based on Mendelian Genetics.
- Compare various plant growth regulators.
- Evaluate the data and solve complex problems based on concepts like Epistasis, multiple alleles etc.

Unit I **Genetics I**	History: Contributions of Mendel, Bateson, Hardy- Weinberg, Garrod, Morgan, Griffith, Beadle and Tatum, Avery, Mac Leod, Mc Carthy, Lederberg, Tatum, Barbara Mclintock, Hershey & Chase, Watson &Crick. **1.1 Mendelian genetics:** Mendel's Experiments-Monohybrid, Dihybrid crosses, Laws of inheritance Ecophenes, Ecotypes **1.2** Dominance, recessivity, co-dominance, incomplete (semi) dominance, lethal genes **1.3 Gene interaction**:Epistasis, types of epistasis, multiple alleles, maternal effects, Extranuclear Inheritance **1.4 Numerical** on above concepts **1.5 Chromosomal abnormalities** (Down's Syndrome, Edward, Patau, Klinefelter's Syndrome, Turner's Syndrome, Cri-du-chat syndrome, Philadelphia Chromosome)Case studies of social challenges faced by these patients and their management (Assignment)	**15**
Unit II **Blood and Body Fluids**	**2.1 Fluid compartments of the body**–ICF and ECF **2.2 Haematopoiesis Blood:** Composition, characteristics and function; role of plasma proteins, Starling's hypothesis blood clotting and factors involved **2.3 Transport in blood:** Transport of gases CO_2 and O_2, Role of haemoglobin, O2 dissociation curves **2.4** Bohr effect, Chloride shift in Body Physiology & its diagnostic importance **2.5 Bile:** Composition, characteristics and function;storage, Lymph: Composition,Formation and CirculationImportance of testing body fluids: Bile & urineformation of urine **2.6**Brief account of the function andcomposition of interstitial fluid, cerebrospinal fluid, synovial fluid, seminal fluid, tears, sweat and faeces.	**15**
Unit III **Biological Transport Mechanisms Plant Physiology**	Transport in plants: Role of xylem and phloem Transport in blood: Transport of gases CO2 and O2, Role of hemoglobin, O2 dissociation curves, Bohr effect Chloride shift Transport of Metabolites: transport of lipids – lipoproteins and their types, role of plasma protein, albumin in transport of metabolites and drugs Transport of Ions: Fe -Ferritin and transferrin and calcium Transport across cell membranes Channel proteins and Carrier proteins Passive transport (simple and facilitated diffusion) with suitable examples; concept of symport, antiport, uniport, Endocytosis and Exocytosis – with one example each Active transport: primary– Na+&K+ pump, secondary Glucose-amino acid transport, types of glucose transporters (GLUT 1 to GLUT 4), aquaporins, ion channel inhibitors like gramicidin and valinomycin **3.1 Photosynthesis** - Light and dark reactions, Z scheme and electron carriers, photophosphorylation [linear and cyclic]; Photorespiration, Photoperiodism Calvin cycle – schematic with enzymes, C4 and CAM pathway. **3.2 Plant growth regulators**- Structure, Chemistry and function of- auxins, gibberellins, cytokinins, ethylene and abscisic acid. Brief Introduction about	**15**

	Brassinosteroids and Jasmonic Acid **3.3 Plant Movements**- Tropic Movements, Nastic Movements **3.4 Special features of secondary plant metabolites**: terpenes (classification), lignin, tannins, pigments, phytochrome, waxes, alkaloids, Nicotine, functions of alkaloids Toxins of plant origin – mycotoxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins.	

Course Code BNBUSBC3T3	Course Title **Applied Biochemistry I**	Credits 2	No. of lectures

Learning Outcomes: After successful completion of this course Learner will be able to

- Understand the mechanism of pathogenesis of various organisms that cause human infections
- Remember the basics of plant and animal tissue culture
- Analyze the various applications of Plant tissue culture and Animal tissue culture
- Apply basics of fermentation for various industrial fermentations
- Deduce ways to applyenzyme immobilization and enzyme engineering for better industrial productions

Unit I Microbiology in Human Health and Diseases	Beneficial Microorganism: Lactobacillus, Normal flora of human gut, Probiotics, Yeast, Nitrogen fixing bacteria, (Rhizobimu and Azotobacter) **1.1 Microorganisms: Friends or Foe?** A quick brush up to the comparative analysis of useful and harmful organisms, Concept of normal flora, Normal flora of human body **1.2 Harmful microorganisms:** Characteristics, Pathogenesis, Treatment **Air borne organisms**- *Mycobacterium tuberculosis* (Tuberculosis), *Corynebacterium diphtheriae* (Diphtheria), *Candida sp.Haemophilus influenzae* (Influenza), morbillivirus (measles) **1.3 Water borne organisms** - *Shigella sp.* (Dysentery), *Vibrio cholerae* (Cholera), *Salmonella sp.* (Enteric fever), Hepatitis virus **1.4 Food borne organisms** - *Staphylococcus aureus, Clostridium botulinum (Botulism)* **1.5 Soil borneorganisms** - *Clostridium tetani* **1.6 Viruses:** General structure of a typical virus, classification of viruses based on genome (DNA, RNA); symmetry (helical, icosahedral, complex), host (Insect), symmetry (helical, icosahedral, complex) Examples of Plant (TMV) and Animal viruses (Influenza, Corona), Bacteriophages (T even), Concept of Lytic and Lysogenic cycle	**15**
Unit II Cell & Tissue Culture	**2.1 Plant Tissue Culture:** Introduction, History, Important definitions (Explant, Callus, Dedifferentiation, Redifferentiation, Totipotency) Requirements for In-Vitro cultures **2.2** Culture techniques Basic steps, Types of culture (Explant, Callus, Organ, root, shoot, cell suspension, protoplast culture, cell culture) **2.3 Applications:** secondary metabolites in plant culture, Micropropagation **2.4 Animal Cell Culture:** History, Introduction to Primary cell culture, Cell lines (Finite and continuous), Equipments & materials for Animal cell culture technology, Concept of cell viability, Culture techniques used for primary cultureStem cell culture, Animal Organ Culture, Whole embryo culture **2.5 Applications of Animal cell culture:** Hybridoma (monoclonal antibody), production of Vaccines, Valuable products	**15**
Unit III Industrial Biochemistry	**3.1 Basics of fermentation:** Typical Fermenter, Types of Fermenters (CSTF, Bubble cap, Airlift, Fluidized Bed reactor) **3.2 Industrial production** of wine, penicillin, Gluconic acid, Vitamin B12, Amylase, Cheese, SCP **3.3 Immobilized Enzyme:** Introduction, Methods of immobilization (entrapment, adsorption, covalent binding, microencapsulation, cross linking)Applications - Biosensors: Features of Biosensors, classification based on transducers, applications **3.4 Enzyme Stabilization strategies:** Stabilization of soluble enzyme (solvent and substrate stabilization, enzyme stabilization by polymer. Salts and chemical modification)	**15**

	3.5 Enzyme engineering- principles of enzyme engineering, steps in enzyme engineering, Examples	

Course Code BNBUSBC3P3	Course Title Practicals based on courses in theory BNBUSBC301, BNBUSBC302, BNBUSBC303	Credits 3	No. of lectures
BNBUSBC301	1. Preparation of Buffers and measurement of pH using pH papers and pH meter. Preparation of Buffers used in Molecular Biology		9 per week
	2. Acid –Base titration of a Polyprotic acid		
	3. Extraction of beta Amylase/Urease/Invertase. Demonstration of the activity Qualitatively. Determination of the Achromic point of Salivary Amylase.		
	4. Extraction of citric acid from lemon juice		
	5. Determination of viscosity by Ostwald's viscometer Demonstration of Osmosis through a semi permeable membrane. Potato osmometer		
	6. A study of some methods of cell rupture: effect of hypo, hyper and isotonic solutions on cells of the onion peel /plant cell (Hydrilla/ Vallisneria/ Spirogyra) Effect of organic solvents on cell rupture Preparation of colloidal solution of starch in water and egg/albumin in milk.		
	7. Comparative analysis of images obtained by different advanced microscopes		
BNBUSBC302	8. Problems& case studies based on Mendel's laws		
	9. A study of Human Karyotypes Field visit /Assignment on vermiculture, organic farming, composting, biogas plantfollowed by a detailed report of at least one		
	10. Determination of RBC - WBC Count		
	11. Urine Analysis by Dip Stick method		
	12. Bile: i. Detection of Bilirubin [Iodine test / Gmelin's Nitric acid test / Fouchet's test] ii. Detection of Bile salt [Pettenkofer's test. Hays sulphur test]		
	13. Estimation of bilirubin by sulfanilic acid method		
	14. Photosynthetic Pigments: i. Separation of photosynthetic pigments by TLC (Demo) ii. Estimation of chlorophylls and carotenoids from grass/spinach leaves		
	15. Estimation of ascorbic acid/phenols/tannins in fruits and vegetables		
BNBUSBC303	Demonstration of the working of an autoclave and a hot air oven. Optimization of curd – a demonstration. Sterility testing of air by plate exposure technique. [in sterile zone, in lab] and of tap water. A study of various culture inoculation methods. Cell count in a culture medium using optical density		

	Determination of the zone of inhibition of microorganisms using the agar wellmethod and disc method. 16. Study of Potability of Water: MPN-BGLB- Endo-IMViC	
	17. Isolation of Food Spoilage causing organisms	
	18. Callus Culture and Root-Shoot Induction (Demo)	
	19. Determination of cell viability using trypan blue	
	20. Alcoholic fermentation of fruit juice	
	21. Immobilization of Enzymes using Sodium Alginate	

Semester III: References

Sr. No.	Title	Author
1	Fundamentals of Biochemistry	Jain & Jain
2	Biophysical Chemistry	Upadhyay, Upadhyay & Nath
3	Fundamentals of Microbiology	Frobisher
4	Microbiology: An Evolving Science	Slonczewski and Foster
5	iGenetics	Russell
6	Genetics	Benjamin Pierce
7	Textbook of Medical Physiology	Guyton & Hall
8	Principles of Anatomy & Physiology	Tortora
9	Textbook of Medical Biochemistry	M N Chatterjee
10	Biochemistry	Satyanarayana U
11	Plant Physiology	Taiz & Zeiger
12	Plant Physiology: Development and Metabolism	Satish C Bhatla, Manju A Lal
13	Microbiology	Pelczar, Chan, Kleig
14	Fundamentals of Microbiology	Talarao
15	Prescott's Principles of Microbiology	Willey, Sherwood, Woolverton
16	Textbook of Microbiology	Ananthanarayan & Paniker
17	Plant Tissue Culture	K K De
18	Biotechnology	R C Dubey
19	Biotechnology	B D Singh
20	Textbook of Biotechnology	H K Das
21	Animal Tissue Culture	Sudha Gangal
22	Industrial Microbiology	Casida
23	http://repositorium.uminho.pt/bitstream/1822/51874/1/document_46913_1.pdf	

Semester IV

Course Code BNBUSBC4T1	Course Title **Biophysical Chemistry II**	Credits 2	No. of lectures

Learning outcomes: After successful completion of this course Learner will be able to

- Define important terms in enzymology.
- Explain the composition of biological membrane and proteins associated with it.
- Classify enzymes, understand mechanisms of enzyme action, basics of centrifugation& colorimetry
- Understand intricacies of types of membrane transport mechanisms and spectroscopy
- Apply the knowledge of enzyme kinetics.

Unit I **Enzymology**	**1.1 Definition** – Enzyme, coenzyme, cofactor, apoenzyme, holoenzyme, prosthetic group, active site, Ribozyme. Units of enzyme -Turnover number, Katal, IU **1.2 IUB / EC classification up to one digit, Enzyme specificity** **1.3 Concept of active site, Allosteric site** **1.4** Activation energy, mechanism of enzyme action, Fischer's lock & key and Koshland's induced fit theories **1.5 Factors affecting enzyme activity** – substrate concentration, pH, temperature **1.6 Enzyme kinetics** – Derivation of Michaelis - Menten equation and Lineweaver Burk plot for mono-substrate reactions and numerical problems based on them **1.7** Enzyme inhibition – Reversible and Irreversible; competitive and non-competitive (one example of each) **1.8** Applications of Enzymes in different fields (To be given as assignment)	**15**
Unit II **Endocrinology** **Membrane Transport**	Movements of Locomotion Spontaneous: Ciliary, Amoeboid, Cyclosis (Rotation, Circulation) Induced: Chemotaxis,Phototaxis, Thermotaxis Movements of Curvature: Mechanical: hygroscopic movements Vital:i)Spontaneous-movements of growth(nutation, circumutation, Hyponasty, epinasty); movements of variation ii)Induced–Tropic-hapto/geo/hydrotropism; Nastic–seismonasty, Nyctynasty Structural organization of a muscle fibre, myofibril Contraction and Relaxation of Muscles; -mechanisms, Other types of contractions–e.g. twitch, tetanus, Isotonic, Isometric regulation of Muscle contraction **2.1 Composition of biological membrane and membrane proteins:** Lipid rafts, caveolae, tight junctions specialized structures of plasma membranes **2.2 Channel proteins and Carrier proteins** **2.3 Passive transport** (simple and facilitated diffusion) with suitable examples; concept of symport, antiport, uniport, Endocytosis and Exocytosis – with one example each **2.4 Active transport:** 1° (Na+&K+ pump), 2° (Glucose-amino acid transport) **2.5 Families of transporters** - P type, V type, F type, ABC, aquaporins, ion channel - Voltage gated ion channels, Ligand gated ion channels **2.6 Types of glucose transporters** (GLUT 1 to GLUT 4, inhibitors like gramicidin and valinomycin	**15**
Unit III **Approaches to Biochemical**	Whole animal and plant studies - the advantages and disadvantages of any four model systems for biochemical investigation (e.g. *E. coli*, yeast, Dictyostelium, C. elegans, Drosophila, Arabidopsis) Organ & tissue studies: Isolated and cultured tissue and cell techniques: isolation, culture and counting of cells, Cell	**15**

Course Code BNBUSBC4T2	Course Title **Fundamentals of Genetics and Physiology II**	Credits 2	No. of lectures

Investigation Analytical Biochemistry	Fractionation Cell rupture – solid shear, liquid shear, high pressure, ultrasound, osmotic shock, chemical treatment (enzyme, organic solvent), temperature. Choice of suspension medium (isotonic & hypotonic solution, PBS) and separation methods. **3.1 Centrifugation:** Principle, concept of RPM & RCF **3.2 Types and applications of centrifuges** – Clinical, High speed, Ultra centrifuge - preparative and analytical. **3.3** Types of centrifuges and its applications – Differential, Rate zonal, Isopycnic (Centrifugation with and without density gradients) **3.4 Colorimetry:** Beer-Lambert law, derivation, limitations, application – estimation of sugar (DNSA) and protein (Biuret); concepts ofLambda max; determination of molar extinction coefficient, Construction and working of a simple colorimeter **3.5 Spectrophotometer:** Construction & Working UV/Vis Spectrophotometer & Its applications **3.6 Numerical Problems based on above concepts**	

Learning outcomes: After successful completion of this course Learner will be able to

- Acquire the basic knowledge about genome organization in various life forms and different concepts of recombination in prokaryotes.
- Remember components, functions of nervous system, mechanism of contraction & relaxation of muscle
- Compare chromosomal structure in prokaryotes and eukaryotes
- Analyze synaptic transmission, various neurotransmitters functioning and endocrine disorders.

Unit I GeneticsII	**1.1 Central dogma** of molecular biology and its modification **1.2 Genome organization** a. Prokaryotic Genome: Nucleoid structure b. Eukaryotic chromosomes: Packaging of DNA (up to Solenoid structure), DNA supercoiling, Topoisomerase, Chromatin structure - Euchromatin, Heterochromatin, structure of condensed chromatin, Centromere, kinetochore, telomere, Comparison of chromosomal structure in prokaryotes and Eukaryotes Recombination in prokaryotes **1.3 Banding Pattern** in Chromosome **1.4 Transformation:** Transformation in *S. pneumoniae* **1.5 Transduction:** General features with one example **1.6 Conjugation:** Mechanism F+, F- and Hfr strain **1.7 Lampbrush and Giant chromosome**	**15**
Unit II Movement & Locomotion Endocrinology	Movements of Locomotion Spontaneous: Ciliary, Amoeboid, Cyclosis (Rotation, Circulation) Induced: Chemotaxis, Phototaxis, Thermotaxis Movements of Curvature: Mechanical:hygroscopicmovementsVital: i) Spontaneous-movements of growth (nutation, circumutation, Hyponasty, epinasty); movements of variation ii)Induced–Tropic-hapto/geo/hydrotropism; Nastic–seismonasty, Nyctynasty Structural organization of a muscle fibre, myofibril Contraction and Relaxation of Muscles; -mechanisms, Other types of contractions–e.g. twitch, tetanus, Isotonic, Isometric regulation of Muscle contraction **2.1 Definition** of hormones, hormone receptor, endocrine & exocrine glands, Hormone receptors - extracellular and intracellular **2.2 Classification of hormones** on the basis of: Distance of target tissue - autocrine, paracrine, endocrine. and Chemistry of Hormones **2.3 Hierarchal organization** of the mammalian endocrine system **2.4 Functions of hormones** of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads (Reproductive Cycle) **2.5 Mode of action** of steroid hormones and epinephrine. (Amplification cascade Only till the level of protein kinase A) G protein not to be covered. Concept of messengers. E.g.: cAMP, DAG, IP3, G-protein. **2.6 Endocrine disorders** related to Pituitary, Thyroid, pancreatic (Hypo and Hyper) hormones	**15**

Unit III Animal Physiology	**3.1 Nervous System Classification:** CNS,PNS; Components: Neurons (3types)& Neuroglia(6types)–structure andfunction, Axonal transport **3.2 Nerve impulse transmission:**Resting Membrane Potential ion channels [voltage and ligand gated], Action Potential (depolarization, polarization and refraction period), propagation of action potential (salutatory & continuous conduction) **3.3 Synaptic transmission:**Physiological anatomy of a synapse;– Electrical & Chemical synapses, Excitatory & inhibitory postsynaptic potentials,Agonists & Antagonists, inactivation of Neurotransmitter **3.4 Neurotransmitters:**Structure and function of acetylcholine, catecholamines, GABA, glutamate, glycine **3.5** Agonists & Antagonists, inactivation of Neurotransmitter **3.6 Structural organization of a muscle fibre:** myofibril Contractile and regulatory proteins of muscle. Sliding filament model of skeletal muscle **3.7 Contraction and Relaxation of Muscles:**Mechanisms, Isotonic, Isometric regulation of Muscle contraction	**15**

Course Code BNBUSBC4T3	Course Title **Applied Biochemistry II**	Credits 2	No. of lectures

Learning outcomes: After successful completion of this course Learner will be able to

- Understand the basics of bioremediation and waste management
- Identify the types of bioremediation.
- Illustrate the various types of waste using examples
- Explain the types of Nanomaterials and their methods of their synthesis
- Analyze different means of Waste Management

Unit I **Trends in Biotechnology**	**1.1 Terminology**–Bioremediation,Bioaugmentation, Biotransformation, Xenobiotics, Recalcitrant xenobiotics, Biomagnification **1.2 Factors affecting bioremediation** **1.3 Types of Bioremediation** (In-situ, Ex-situ); Types of reactions (Aerobic, anaerobic, sequential) **1.4 Applications of Biodegradation** - hydrocarbons, (Oil spills) Pesticides and herbicides, Heavy metals (Uranium) contaminated soil and waste land, Ground Water; Genetically Engineered Microbes in bioremediation **1.5 Biopesticides:** Introduction; Types of Biological Control (Classical, inoculation, Inundation), Examples each of Bacterial, Viral, Fungal and Protozoal biopesticide **1.6 Bio-fungicide, Bioherbicides and Biofertilizers:** Concept, Examples and Applications	**15**
Unit II **Introduction to Pharmacology Bio-nanotechnology & its Applications**	Scope of pharmacology Sources, Classification, Chemical & physical properties of drug and Nomenclature of drugs Dosage forms and routes of drug administration Factors affecting dosage and drug delivery; Pharmacokinetics: LD 50, ED 50 Half Life, Loading dose, Maintenance dose (Explanation of terms only); Therapeutic index Novel Drug delivery system (NDDS): Transdermal and oral modesLiposomes **2.1 Introduction to Nanotechnology:** Concept of Biomimicry, what are nanomaterials? Introduction & formsNanoparticles, Nanofilms, Nanotubes **2.2 Synthesis & Characterization** of Nanomaterials: Top-down & bottom-up approach, Methods (Physical, Chemical and Biological) **2.3 Properties of Nanomaterials:** Microscopic, Magnetic, Spectroscopic **2.4 Applications of Nanomaterials:** in Medicine (Drug Delivery), Agriculture & food, Cleaner and Sustainable Environment, Boosting the business with Nanotech **2.5 Biosensors & Biochip:** Features of Biosensors, classification based on transducers, applications	**15**
Unit III **Resource Management Waste management & Bioenergy Production**	**3.1 Waste water**- sewage, Composition of sewage, types of sewage, detection of pathogenic organism of sewage **3.2 Treatment:** Primary treatment, secondary treatment; tertiary treatment, disinfectant, Oxidation Ponds and Septic tanks, Sludge treatment and disposal; waste water collection vs sewage treatment in developing countries**Solid Waste:** Municipal Solid Waste (Hazardous & Non-hazardous waste) Types of waste, treatment, recycling **3.3 Biomass and Bio energy production: Biofuel and Biomass:** Fossil fuel; Energy rich crops (sugar and starch; wood-rich, petroleum plants); Animal energy, Sources of biofuel, its cultivation and extraction process**Biogas:** Production, Composition, Applications. Gobar gas. [MSW and LFG, Renewable natural gas, NG vehicle] **3.4 Other types of wastes:** biomedical Waste, electronic waste, agricultural waste, mining waste, radioactive waste, **3.5 Zero waste Management& Eco-parks**	**15**

Course Code BNBUSBC4P4	Course Title Practicals based on courses in theory BNBUSBC401, BNBUSBC402, BNBUSBC403	Credits 3	No. of lectures
BNBUSBC401	Parts and maintenance of a microscope. A study of electron micrographs of cell organelles. Permanent slides of Muscle tissue Recrystallization of Benzoic acid and determination of its yield. Ammonium sulphate fractionation of protein and its estimation by a suitable method. Field visit/ assignment on any topic from the syllabus 1. Studying the effect of different temperatures/pH during enzyme activity measurements.		9 per week
	2. Determination Km & Vmax of Beta amylase		
	3. Checking the effect of inhibitor on amylase activity		
	4. Determination of activity & Specific activity of Amylases		
	5. Detection of Mitochondrial activity		
	6. Determination of λmax		
	7. Estimation of reducing sugar by DNSA method		
	8. Estimation of proteins by Biuret method		
	9. Working & mechanism of UV-Vis Spectrophotometer (Demo)		
BNBUSBC402	Blood experiments Urine Analysis Bile Analysis A demonstration of online muscle twitch Demonstration of plant movements 10. Extraction of DNA from a plant source.		
	11. Determination of absorption maxima of nucleic acids		
	12. Giant Chromosome (Demo)		
	13. Estimation of iodine content in table salt		
	14. Working and mechanism of Pregnancy Testing Kit (Demo)		
	15. Permanent slides of Muscle tissue		
BNBUSBC403	Isolation of DNA from Onions and confirmation by DPA test Determination of the MIC of any one disinfectant Determination of the potability of water by conducting a coliform count. (MPN)		

	Gram stain of sewage Preparation of immobilized yeast/ amylase and determination of enzyme activity 16. Study of Chromium tolerance shown by microorganisms	
	17. Preparation of Biofertilizers (Demo)	
	18. Preparation of nanoparticles by chemical methods (Demo) & checking its antimicrobial activity	
	19. Determination of the COD &BOD of an effluent sample	
	20. Visit to CETP Plant / Biomedical waste treatment plant	
	21. Visit to Nanotechnology laboratory	

Semester IV: References

Sr. No.	Title	Author
1	Lehninger Principles of Biochemistry	David L. Nelson, Michal M. Cox
2	Outlines of Biochemistry	Conn & Stumpf
3	Harper's Biochemistry	Robert Murry, Darryl Granner, Peter Mayes & Victor Rodwell
4	Biochemistry	Satyanarayana U
5	General Principles of Biochemical Investigation	William & Wilson
6	iGenetics	Russell
7	Principles and Techniques of Biochemistry and Molecular Biology	Wilson and Walker
8	Biophysical Chemistry	Upadhyay, Upadhyay & Nath
9	Biochemistry	Mathews
10	Zubay's Principles of Biochemistry	Veer Bala Rastogi
11	Principles of Anatomy & Physiology	Tortora
12	Essentials of Biochemistry	Pankaja Naik
13	Industrial Microbiology	A H Patel
14	Industrial Microbiology	Casida
15	Environmental Biotechnology	B D Singh
16	Biotechnology	R C Dubey
17	Bioremediation technology: Recent Advances	M H Fulekar
18	Textbook of Medical Biochemistry	M N Chatterjee
19	Nanostructures & Nanomaterials: Synthesis, Properties & Applications	Guazhong Cao
20	Nanotechnology 101	John Mongillo
21	Environmental Biotechnology	Srinivas
22	Fundamental of Environmental and toxicological chemistry	Stanley Mahanan
23	Waste Management Practices	John Pichtel
24	A textbook of environmental	P. K. Mohapatra

	Biotechnology	
25	Environmental biotechnology: A biosystems approach	Daniel Vallero
26	Environment al biotechnology	Indu Shekhar Thakur
27	https://iopscience.iop.org/book/978-1-6270-5469-0/chapter/bk978-1-6270-5469-0ch1	
28	https://iopscience.iop.org/article/10.1088/1757-899X/263/3/032019/pdf	
29	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5784295/pdf/JLP-10-6.pdf	

Evaluation Scheme

Internals

Class Test	Assignment/ Study tour with report/Journal Movie club presentation/ Presentation of mini-research / project work/ Volunteering forDepartment fest/ poster making/ exhibition/case studypresentation	Total
20	20	40

Internal Examination: **Based on Unit 1 / Unit 2 / Unit 3**

Duration: 40 mins **Total Marks: 20**

No. of Questions: 15

Q. 1	**Answer the following choosing the correct alternative.**							**10**
	1	Based on Unit I / II / III						
	a		b		c		d	
	2	Based on Unit I / II / III						
	a		b		c		d	
	3	Based on Unit I / II / III						
	a		b		c		d	
	4	Based on Unit I / II / III						
	a		b		c		d	
	5	Based on Unit I / II / III						
	a		b		c		d	
	6	Based on Unit I / II / III						
	a		b		c		d	
	7	Based on Unit I / II / III						
	a		b		c		d	
	8	Based on Unit I / II / III						
	a		b		c		d	
	9	Based on Unit I / II / III						
	a		b		c		d	
	10	Based on Unit I / II / III						
	a		b		c		d	
Q.2	**Answer the following choosing the correct alternative.**							**10**
	1	Based on Unit I / II / III						
	a		b		c		d	
	2	Based on Unit I / II / III						
	a		b		c		d	
	3	Based on Unit I / II / III						

	a		b		c		d		
	4	Based on Unit I / II / III							
	a		b		c		d		
	5	Based on Unit I / II / III							
	a		b		c		d		

Theory Examination: Suggested Format of Question paper

Duration: 2 Hours **Total Marks: 60**

All questions are compulsory

Q. 1	Answer ***any two*** of the following		**16**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
Q. 2	Answer ***any two*** of the following		**16**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
Q. 3	Answer ***any two*** of the following		**16**
	a	Based on Unit III	
	b	Based on Unit III	
	c	Based on Unit III	
Q. 4	Answer ***any six*** of the following		**06**
	a	Based on Unit I / II / III	
	b	Based on Unit I / II / III	
	c	Based on Unit I / II / III	
	d	Based on Unit I / II / III	

	e	Based on Unit I / II / III	
	f	Based on Unit I / II / III	
	g	Based on Unit I / II / III	
	h	Based on Unit I / II / III	
	i	Based on Unit I / II / III	
	Answer ***any two*** of the following		**06**
	a	Based on Unit I / II / III	
	b	Based on Unit I / II / III	
	c	Based on Unit I / II / III	

Marks Distribution and Passing Criterion for Each Semester

Theory					Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Course Code**	**Practical Examination**	**Min marks for passing**
BNBUSBC3T1	**40**	**16**	**60**	**24**	BNBUSBC3P3	**150**	**60**
BNBUSIBC3T2	**40**	**16**	**60**	**24**			
BNBUSBC3T3	**40**	**16**	**60**	**24**			

Theory					Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Course Code**	**Practical Examination**	**Min marks for passing**
BNBUSBC4T1	**40**	**16**	**60**	**24**	BNBUSBC4P4	**150**	**60**
BNBUSIBC4T2	**40**	**16**	**60**	**24**			
BNBUSBC4T3	**40**	**16**	**60**	**24**			

~ * ~ * ~ * ~ * ~ * ~