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

Agenda Number : 2 **Resolution Number : 4.3 & 4.11**

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

Syllabus for

Programme : Bachelor of Science

Specific Programme : Biotechnology

[S.Y.B.Sc. Biotechnology]

Revised under Autonomy

From academic year 2022 - 2023

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PREAMBLE

Biotechnology is one of the most promising applied branches of modern biology. Developing with a fast pace, this field is drawing interest in many young scientists engaged in interdisciplinary research.

With the objective of exposing preliminary learners to many related field and applications of basic Biotechnology, the attempt has been made to build the syllabus of S.Y. B.Sc. Biotechnology. In addition to Imparting knowledge of basic skill set, deliberate efforts are being made to help learners apply the scientific knowledge in his/her day-to-day life, by engaging the learners ininteresting laboratory experimentation with real time experience.

Continuing the Choice Based Credit System (CBCS) implemented by the esteemed University from the academic year 2017-2018, the existing syllabus of S.Y.B.Sc. Biotechnology is restructured according to the CBCS pattern for its implementation from 2022-23 under the autonomous status of VPM's B. N. Bandodkar College of Science. While earlier revision of the syllabus took care of balancing both, the basic techniques and some of the advance techniques in Biotechnology, the present revision under autonomy is related to restructuring of syllabus for better progressive understanding by learners and updating it with a few recent advances.

With the basic knowledge of chemistry concept and techniques learnt in FYBSC, for upskilling students they are exposed to different concepts like green chemistry, bioinorganic chemistry, natural product chemistry. Biophysics components included would add up knowledge about optics and Electromagnetic radiations, heat, sound, magnetism, fluid dynamics etc. The important concepts of cellular processes, interactions, contribution of lymphoid cells in immune responses also can be learnt by the learners. An attempt has been made to introduce students to research methodology, and biostatistics as well.

Learning fundamentals of bioprocess technology, application of biochemistry, enzyme technology in industries would be made interesting for learners with industrial visits. Interesting Practical related to these topics would add up to the learner's knowledge through experiential learning.

Eligibility: Cleared F. Y. B.Sc. in Biotechnology.

Duration: 3 years

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

Program Specific Outcome: Students would be able to study basis of biological world by knowing biochemistry, genetics, immunology, cell structure and functions, along with various biophysical techniques. Students would be able to apply knowledge to make positive use of biological systems for betterment of community and for sustainable development.

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

S.Y.B.Sc. (Biotechnology)

Structure of Programme

Course Code	Course Title	No. of lectures	Credits
BNBUSBT3T1	Biophysics	**45**	**2**
BNBUSBT3T2	Applied Chemistry-I	**45**	**2**
BNBUSBT3T3	Immunology	**45**	**2**
BNBUSBT3T4	Cell Biology and Cytogenetics	**45**	**2**
BNBUSBT3T5	Molecular Biology	**45**	**2**
BNBUSBT3T6	Bioprocess Technology	**45**	**2**
BNBUSBT3T7	Research Methodology	**45**	**2**
BNBUSBT3P1	Practical Based on BNBUSBT3T1 & BNBUSBT3T2	**45**	**2**
BNBUSBT3P2	Practical Based on BNBUSBT3T3 & BNBUSBT3T4	**45**	**2**
BNBUSBT3P3	Practical Based on BNBUSBT3T5 & BNBUSBT3T6	**45**	**2**
Total		**450**	**20**

Course Code	Course Title	No. of lectures	Credits
BNBUSBT4T1	Biochemistry	**45**	**2**
BNBUSBT4T2	Applied Chemistry-II	**45**	**2**
BNBUSBT4T3	Medical Microbiology	**45**	**2**
BNBUSBT4T4	Basic Instrumentation and Enzymology	**45**	**2**
BNBUSBT4T5	Biosafety	**45**	**2**
BNBUSBT4T6	Basic Molecular Techniques and tissue culture	**45**	**2**
BNBUSBT4T7	Entrepreneurship Development	**45**	**2**
BNBUSBT4P1	Practical Based on BNBUSBT4T1 & BNBUSBT4T2	**45**	**2**
BNBUSBT4P2	Practical Based on BNBUSBT4T3 & BNBUSBT4T4	**45**	**2**
BNBUSBT4P3	Practical Based on BNBUSBT4T5 & BNBUSBT4T6	**45**	**2**
Total		**450**	**20**

Semester III

Course Code BNBUSBT3T1	Course Title Biophysics	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: • Revise and expand the knowledge of basics of biophysics. • Understand application-based concepts of optics, laser, temperature, sound, magnetism and fluid dynamics. • Comprehend instrumentation of Spectroscopy and Microscopy.			
Unit I: Optics and electromagnetic radiations	**1.1 Introduction to Optics and Laser**: a. Nature and Properties of Light: Day-to-day applications, Introduction to Light waves, Characteristics of light waves, Properties of light (Reflection, Refraction, Dispersion, Interference, Absorption, Diffraction, Scattering). b. LASER: Application of Laser in medicine, The Effects of Lasers on Biological Tissues, Applications to Biological Tissues (Only Optical tweezers), Interaction of light with matter (Absorption, Spontaneous emission, Stimulated emission), Laser beam characteristics. **1.2 Introduction to Electromagnetic Radiations:** Spectroscopy: Properties of electromagnetic radiation, Interaction with matter, UV-visible light spectroscopy (chromophores, principle, instrumentation, Applications). **1.3 Microscopy:** Electron microscopy (TEM, SEM), Fluorescence Microscopy, Confocal Microscopy, Scanning Probe Microscopy.		**15**
Unit II: Heat, Sound, Magnetism and Fluid dynamics	**2.1 Heat:** Measuring Temperature: Mercury in glass thermometer, electrical resistance thermometer, Thermocouple (Principle, Construction, Working). **2.2 Sound:** Sonicator, Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves. **2.3 Magnetism:** Introduction, Magnetic properties of materials (Para-magnetism, Diamagnetism, Ferromagnetism); Bio-magnetic fields and the human body. **2.4 Fluid Dynamics:** a. Viscosity: Stokes' Law; Measurement of viscosity, Applications of viscometry, Significance of viscosity in biological systems b. Surface Tension: Surface energy, Surface energy and Surface tension, Angle of contact, Capillary rise, Detergent and surface tension, significance of wettability in contact lenses		**15**

Unit III: Electrophoresis	**3.1 General principles** **3.2 Support media:** Agarose and polyacrylamide. **3.3 Electrophoresis of proteins** a. SDS-PAGE. b. Native Gels. c. Gradient gels. d. Isoelectric focusing gels. e. 2D PAGE. f. Cellulose acetate electrophoresis. g. Detection, estimation, recovery of proteins in gels. **3.4 Electrophoresis of nucleic acids:** a. AGE of DNA (Rate of migration of DNA through agarose gels, classes of agarose and their properties, electrophoresis buffers, gel loading buffers, detection of DNA in agarose gels). b. DNA sequencing gels. c. PFGE (Types of apparatuses, factors affecting resolution). d. Electrophoresis of RNA. **3.5 Capillary electrophoresis.** **3.6 Microchip electrophoresis.**	**15**

Course Code BNBUSBT3T2	Course Title Applied Chemistry-I	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to • Develop an understanding of Bioinorganic chemistry. • Understand Microwave and Ultra sound Synthesis of Organic Compounds. • Discuss the role of Green Chemistry and its applications in Industry.			
Unit I: Bioinorganic Chemistry	**1.1** Reactions, Essential and Non-essential Elements in Biological Systems. Role of Metal Ions in Biological Systems. **1.2** Metal Coordination in Biological Systems: a. Enzymes, b. Apoenzymes, c. Coenzymes. **1.3** Biological Role of Metalloenzymes a. Myoglobin, b. Haemoglobin, c. Carboxypeptidases, d. Catalases and Peroxidases. **1.4** Metal Complexes in Medicine **1.5** Zinc metalloenzymes: a. Carboxypeptidase-A, b. Carbonic Anhydrase, c. Superoxide Dismutase (SOD), d. Blue Copper Proteins.		**15**
Unit II: Microwave and Ultra sound Synthesis of Organic Compounds	**2.1** Criteria for Ideal Synthesis: Selectivity and Yield; Linear and Convergent Synthesis and Multi-component Reactions. **2.2** Microwave Assisted Organic Synthesis a. Hoffmann elimination, b. Hydrolysis, c. Oxidation. **2.3** Ultrasound in Synthesis, Application of ultra sound synthesis: a. Esterification, b. Saponification, c. Substitution Reaction,		**15**

	d. Addition reaction, e. Alkylation, f. Friedel Crafts Reaction, g. Diels –Alder Reaction. **2.4** Polymer supported Synthesis: a. Polymer supported peracid, b. Polymer supported chromic acid, c. Poly–N-Bromosuccinamide, d. Polymeric organotin, Dihydride reagent as a reducing reagent. **2.5** Introduction to Retro synthesis pathways: a. Synthesis of nitro aniline (o-and p-isomers), b. Retro synthesis of alcohol (using Grignard Reagent).	
Unit III: Green Approach to Chemical reactions	**3.1** Introduction to Green Chemistry a. Need and Relevance b. Principles of Green Chemistry **3.2** Use of the following in green synthesis with suitable examples: a. Green reagents: dimethylcarbonate, polymer supported reagents. b. Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts, c. Phase transfer catalysts [Aliquat 336, benzyltrimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride, crown ethers], biocatalysts. d. Green solvents: water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide. e. Solid state reactions: solid phase synthesis, solid supported synthesis. **3.3** Comparison of traditional processes versus green processes: a. Synthesis of ibuprofen b. Synthesis of Adipic acid,	**15**

Course Code BNBUSBT3T3	Course Title Immunology	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: • Understand the role of different types of Cells, Effector Molecules and Effector immune mechanisms. • Understand the principles underlying various Immuno-techniques and their diagnostic applications. • Know various types of vaccines.			
Unit I: Immunological soldiers, weapons and modus operandi	**1.1** Hematopoiesis; Cells of the Immune System: T, B, NK, DC, Granulocytes. **1.2** TCR CD3 Complex. **1.3** Cytokines and its receptors **1.4** B cell Receptor **1.5** MHC Classes - General Organization and Inheritance; Structures and Peptide Interactions; Class I and II Diversity and Polymorphism, **1.6** Antigen Presentation - Endocytic and Exocytic Pathways **1.7** MHC Restriction.		**15**
Unit II: Immuno Diagnostic	**2.1** Antigen-Antibody Reactions: properties and types-Precipitation Reactions: Immunoprecipitation, Immuno-electrophoresis, CIEP, Rocket Electrophoresis and 2-D Immuno-electrophoresis. **2.2** Agglutination Reactions: Hemagglutination, Bacterial agglutination, Passive agglutination, Agglutination Inhibition **2.3** Complement Fixation Tests, RIA, ELISA, ELISPOT, Western Blot, Immunofluorescence, Flow Cytometry.		
Unit III: Preventive Immunology	**3.1** Vaccines: Introduction, significance **3.2** Active and passive immunization **3.3** Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines **3.4** Use of adjuvants in vaccine. **3.5** New vaccine strategies, Ideal vaccine		**15**

	3.6 Vaccine strategies for immerging infections/ illness: HIV, COVID 19, cancer **3.7** Monoclonal Antibodies **3.8** Production (Hybridoma technology), clinical use	

Course Code BNBUSBT3T4	Course Title Cell Biology and Cytogenetics	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: • Understand the role of cytoskeleton. • Unfold how cells interact. • Obtain knowledge about mapping and cytogenetics.			
Unit I: Cytoskeleton	**1.1 Overview of Major Functions of Cytoskeleton.** **1.2 Microtubule** structure and composition, MAPs Function- Role in Mitosis, Structural support and Cytoskeleton Intracellular motility. Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic properties of Microtubule. Microtubules in Flagella and Cilia. **1.3 Microfilament:** Structure, Composition, Assembly and Disassembly Motor Protein: Myosin, Muscle contractility: Sliding Filament. Actin Binding Proteins: Examples of Non-Muscle Motility. **1.4 Intermediate Filament:** Structure and composition; Assembly and Disassembly; Types and Functions.		**15**
Unit II: Cell-cell interactions	**2.1 Extracellular space:** ECM (Collagen, proteoglycans, fibronectin, laminin, dynamic properties). **2.2 Interaction of cells with extracellular materials**: integrin, focal adhesions, hemidesmosomes. **2.3 Interaction of cells with other cells**: Selectins, IgSF, cadherins, Adherens junctions, desmosomes, role of cell associated receptors in transmembrane signaling. **2.4 Tight junctions, Gap junctions, Plasmodesmata.**		**15**
Unit III: Cytogenetics	**3.1 Genetic linkage, Crossing Over and Mapping:** a. Conjugation, transformation, transduction mapping. b. Two-point testcross, Three-point testcross. c. Tetrad analysis **3.2 Conventional karyotyping e.g., CML.** **3.3 Pedigree.** **3.4 Legal and ethical issues.**		**15**

Course Code BNBUSBT3T5	Course Title Molecular Biology	Credits 2	No. of lectures

Learning Outcomes: Learners will be able to:

- Understand the mechanisms associated with Gene Expression at the level of translation.
- Understand the difference between prokaryotic and eukaryotic gene expression.
- Learn the mechanisms associated with Regulation of Gene Expression in Prokaryotes and viruses.
- Know the concept of mutations and mutagens along with methods of DNA repair.

Unit I: Translation	**1.1 Nature of Genetic Code:** a. Overlapping Vs non- overlapping code. b. Deciphering the genetic code; concept of 'reading frame'. c. Characteristics of the genetic code; evidence that the genetic code is a triplet code. **1.2 Transfer RNA, structure of tRNA, tRNA genes**. **1.3 Translation**: Process of Protein Synthesis (Initiation, Elongation, Translocation, Proofreading on the ribosome, Termination). **1.4 From an RNA World to a Protein World:** a. Ribozyme in protein synthesis. b. The Wobble Hypothesis. c. The significance of GTP in protein synthesis. **1.5 Protein synthesis in eukaryotes.** **1.6 Inhibitors and modifiers of protein synthesis in prokaryotes and eukaryotes.** **1.7 Protein sorting in the cell.**	**15**
Unit II: Regulation of Gene Expression	**2.1 Principles of gene regulation:** a. Differences between genetic organization of prokaryotes and eucaryotes. b. Differences between protein synthesis in prokaryotes and eucaryotes. **2.2 Regulation of Gene Expression: In Bacteria**: lac Operon of *E. coli*, trp Operon of *E. coli.* **2.3 Regulation of Gene Expression: In Viruses: Lytic** / Lysogenic Regulation.	**15**

Unit III: Mutations and DNA Repair	**3.1 Definition and Types of Mutations.** **3.2 Mutation rate and mutation frequency.** **3.3 Types of Point Mutations:** transition, transversion, missense, nonsense, neutral, silent, frameshift, leaky mutations. **3.4 Reverse Mutations and Suppressor Mutations:** Induced Variation in the Genetic Code: Nonsense Suppression. **3.5 Spontaneous Vs Induced mutations;** Mutagenesis and Mutagens (Examples of Physical, Chemical and Biological Mutagens); mutator genes and mutational hotspots, **3.6** loss- of- function and gain- of -function mutation. **3.7 Conditionally expressed mutants.** **3.8 DNA Repair:** Photo-reversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, Non-homologous end joining (NHEJ) (mechanism), SOS Repair and Recombination Repair.	**15**

Course Code BNBUSBT3T6	Course Title Bioprocess Technology	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: • Develop an understanding of the various aspects of Bioprocess Technology. • Develop skills associated with screening of Industrially Important Strains. • Understand methods used in Downstream processing.			
Unit I: An Introduction to Fermentation	**1.1 An introduction to fermentation processes:** a. The range of fermentation processes. b. The Components of a fermentation process. **1.2 Screening methods:** a. Primary and secondary screening. b. High throughput screening methods. **1.3 Strain improvement:** a. Selection of induced mutants synthesizing improved levels of primary metabolites. b. The isolation of induced mutants producing improved yields of secondary metabolites. c. The improvement of strains by modifying properties other than the yield of product. **1.4 Preservation of cultures and Quality control of preserved stock** **1.5 Types of fermentations:** Surface and Submerged; Batch and Continuous, Aerobic and anaerobic.		**15**
Unit II: Fermenter, fermentation media and sterilization	**2.1 Design of a fermenter:** Stirred Tank Fermenter- Basic Design; Parts of a Typical Industrial Fermenter. **2.2 Composition of Media for industrial fermentations** **2.3 Sterilization** **2.4 Study of Representative Fermentation Processes:** Penicillin production and Ethanol Production by Fermentation along with a flow-diagram (study with respect to Inoculum development, downstream processing extraction and purification).		**15**

Unit III: Down-stream Processing	**3.1** Introduction to DSP. **3.2** Foam separation. **3.3** Types of Precipitation. **3.4** Filtration, Centrifugation, Chromatography in DSP. **3.5** Cell disruption- physical and chemical methods; **3.6** Solvent recovery, Membrane processes, Drying. **3.7** Crystallization and Whole broth processing.	**15**

Course Code BNBUSBT3T7	Course Title Research methodology	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: • Understand the principles of research methodology and identify a research problem. • Design a Research study. • Write a research report.			
Unit I: Introduction to Research Methodology & Research Design	**1.1** Meaning of Research, Objectives & Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research methods Vs. Methodology. **1.2** Research Process, criteria of Good Research, Problems encountered by researchers in India, what is a research problem? Selecting the problem, necessity of defining the problem, technique involved in defining a problem. **1.3** Research Design: Meaning, Need, features of a good design, Important concepts relating to Research Design, Basic Principles of Experimental Designs, Developing a research plan.		**15**
Unit II: Data Collection, Ethics in research & Research Grants	**2.1** Importance of Literature Review in research, searching for existing literature, Writing a review article. **2.2** Collection of Primary Data; Observation Method, Interview Method, Collection of data through questionnaires / schedules, other methods of data collection, collection of secondary data, Selection of appropriate method for data collection, case study method. **2.3** Ethics and Scientific Conduct: Ethics Theories (Consequentialism, Deontological ethics and Virtue ethics), Scientific conduct and misconduct, Norms, Plagiarism, Authorship issues, Punishment of Scientific misconduct. **2.4** Research Grants: Guide to grant applications, what goes into successful research grant? international research collaborations.		**15**
Unit III: Interpretation, Report writing and use of IT in research	**3.1** Meaning of Interpretation, Why Interpretation? Technique of Interpretation, Precautions in interpretation. **3.2** Significance of Report writing, Different steps in writing report, Layout of research report, Types of reports, mechanics of Research report, Precautions of Research report, Oral Presentation. **3.3** Use of ICT in research: List of software available for Pre-data, data and post data analysis. **3.4** Demonstration of Use of websites and software useful in Research: Google scholar, Shodhganga, Mendeley, NDLI, JSTOR, working with Microsoft excel, introduction to SPSS.		**15**

Course Code BNBUSBT3P1	Course Title Practical Based on BNBUSBT3T1 & BNBUSBT3T2	Credits 2	No. of lectures
1.	Verification of Beer-Lambert's Law.		**45**
2.	Determination of Purity and Concentration of Plasmid DNA using UV Spectrophotometry.		
3.	Study of alkaline phosphatase enzyme kinetics using spectrophotometer.		
4.	Study of SEM, TEM, Fluorescence microscope – Demonstration/Visit.		
5.	Cell lysis using sonicator.		
6.	Viscosity studies of BSA and varying concentrations of urea.		
7.	Agarose Gel Electrophoresis.		
8.	Electrophoresis of Proteins by PAGE and SDS-PAGE.		
9.	Purification Organic Compounds by Recrystallization Selecting Suitable Solvent: a) benzoic acid b) m- nitroaniline		
10.	Organic Estimations: Acetone		
11.	Organic Preparations: a. Acetylation of Primary Amine (Preparation of Acetanilide). b. Base catalyzed aldol Condensation (synthesis of Dibenzalpropanone).		
12.	Microwave synthesis: 1. Synthesis of Schiff's base from aniline and p-anisaldehyde in the presence of lime juice. 2. Synthesis of coumarin by Knoevenagel reaction using Salicylaldehyde, and ethyl acetate.		

Course Code BNBUSBT3P2	Course Title Practical Based on BNBUSBT3T3 & BNBUSBT3T4	Credits 2	No. of lectures
1.	SRID.		**45**
2.	DID.		
3.	Coomb's Test.		
4.	Immunoelectrophoresis / Rocket Immunoelectrophoresis: demonstration		
5.	ELISA.		
6.	Preparation of TAB Vaccine.		
7.	Induction of Polyploidy by Colchicine Treatment using Suitable Plant Material.		
8.	Demonstration: Study of Polytene Chromosomes.		
9.	Study of Barr Body.		
10.	Mapping based on Tetrad Analysis and Three Point Cross.		
11.	Pedigree Analysis- Autosomal and Sex-Linked.		
12.	Problems based on Conjugation, Transformation and transduction.		
13.	Demonstration: Bacterial conjugation		

Course Code BNBUSBT3P3	Course Title Practical Based on BNBUSBT3T5 & BNBUSBT3T6	Credits 2	No. of lectures
1.	Study of *E. coli* Diauxic Growth Curve- (Lactose and Glucose).		**45**
2.	Expression of β-galactosidase and Measurement of Activity.		
3.	UV survival curve – determination of exposure time leading to 90% reduction.		
4.	Isolation of mutants using UV mutagenesis.		
5.	Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant.		
6.	Gradient plate technique for isolation of dye resistant mutants.		
7.	Primary screening of antibiotic producers.		
8.	Amylase production by surface and submerged fermentations.		
9.	Sugar tolerance.		
10.	Ethanol production.		
11.	Estimation of ethanol using Dichromate method.		
12.	Chemical estimation of Penicillin.		

Semester IV

Course Code BNBUSBT4T1	Course Title Biochemistry	Credits 2	No. of lectures

Learning Outcomes: Learners will be able to:

- Understand basic aspects of bioenergetics and metabolism.
- Refine the knowledge of metabolism of carbohydrates, proteins and their regulation.
- Perceive knowledge about the role and action of different hormones.

Unit I: Bioenergetics	**1.1 Introduction to metabolism:** Metabolic pathways: Metabolites, Catabolism, Anabolism, Principal characteristics of metabolic pathways. **1.2 Energy Rich Compounds:** ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc. **1.3 Biochemical mechanism of generating ATP:** Substrate-Level-Phosphorylation, Oxidative Phosphorylation & Photophosphorylation. **1.4 Electron transport chain:** a. Universal Electron acceptors that transfer electrons to E.T.C. Carriers in E.T.C. b. Hydrogen carriers – NADH, Flavoproteins, Quinones. c. Electron carriers – Iron Sulphur proteins, Cytochromes. **1.5 Mitochondrial ETC:** a. Biochemical anatomy of mitochondria. b. Complexes in Mitochondrial ETC. **1.6 Explanation of terms** – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential). **1.7 Chemiosmotic theory.** **1.8 Structure & function of Mitochondrial ATP synthase and Mechanism by Rotational catalysis**. **1.9 Inhibitors of ETC, ATPase and uncouplers.**	**15**
Unit II: Carbohydrate and Protein Metabolism	**2.1 Carbohydrate metabolism:** a. Glycolytic Pathway (with structures) and its Regulation, b. Citric Acid Cycle (with structures) and its Regulation; c. Gluconeogenesis; Pentose Phosphate Pathway (with structures); d. Cori cycle; e. Homolactic Fermentation; Alcoholic Fermentation;	**15**

	f. Total energy yield during respiration (Calculation). **2.2 Protein metabolism:** a. General reactions of amino acid metabolism (Oxidative deamination, Transamination, Decarboxylation). b. Glucogenic and ketogenic amino acids, Urea cycle (with structures).	
Unit III: Endocrinology	**3.1 Types of hormones based on: chemical nature, mechanism of action.** **3.2 Structure, storage, release, transport, biochemical functions and disorders of:** a. Hormones of hypothalamus- TRH, CRH, GnRH, GRH, GRIH, PRIH. b. Hormones of Anterior Pituitary Gland- GH, Stimulating hormones. c. Posterior Pituitary- Oxytocin and vasopressin. d. Thyroid gland- Thyroxine, Calcitonin. e. Parathyroid- PTH. f. Adrenal medulla- Epinephrine and Norepinephrine. g. Adrenal Cortex- Glucocorticoids, Mineralocorticoids. h. Pancreas- Insulin and glucagon. i. Female gonads (Estrogen and progesterone), Male gonads (testosterone), Placenta (hCG). **3.3 Introduction to hormone action and signal transduction of Group I and Group II hormones.** **3.4 Hormones can influence specific biologic effects by modulating transcription.**	**15**

Course Code BNBUSBT4T2	Course Title Applied Chemistry- II	Credits 2	No. of lectures

Learning Outcomes: Learners will be able to:

- Develop an understanding of the different aspects of Analytical Chemistry.
- Gain knowledge of Electrochemistry.
- Build understanding of basic concepts in Polymer Chemistry and applications of Nanomaterials in biotechnology.

Unit I: **Analytical approach to Sampling and separation** **&** **Electrochemistry**	**A) Analytical approach to Sampling** **1.1 Sampling:** Importance of Sampling and Sampling Techniques **1.2 Types of Sampling:** a. Random and Non-Random Sampling of Solids b. Liquids and Gases. **1.3 Solvent Extraction** a. Partition Coefficient and Distribution Ratio b. Extraction Efficiency c. Separation Factor d. Role of Complexing Agents e. Chelation f. Ion Pair Formation g. Solvation **1.4 Electrochemistry** a. Redox reactions basic concepts b. free energy changes in redox reactions c. EMF of a cell and its measurements d. Computation of cell EMF e. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K) f. standard electrode potential g. sign conventions h. electrochemical series	**15**
Unit II: **Natural Product Chemistry**	**2.1 Natural Product Chemistry: Primary and Secondary Metabolites.** **2.2 Classification of Natural Products** a. Based on Bio-Synthesis. b. Based on Structure- Alkaloids, Phenolics, Essential Oils and Steroids.	**15**

	2.3 Structure Determination of Natural Products **2.4 Commercial Synthesis of Natural Products** **2.5 Application of Natural Products** (Food coloring agents, naturally occurring pesticides) **2.6 Chromatographic Separation of Natural Products:** a. Gas Chromatography and its Applications. b. Liquid Chromatography c. HPLC and its Applications. d. HPTLC for Separation and Analysis of Natural Products. **2.7 Soxhlation:** a. Introduction to soxhlation. b. Technique of soxhlation c. Application of soxhlation	
Unit III: Polymers and Nanomaterials	**3.1 Polymers:** a. Polymerization reactions: Kinetics of stepwise polymerization, b. Calculation of degree of polymerization for stepwise reaction. c. Kinetics of free radical chain polymerization, d. Kinetic chain length and estimation of average no of monomer units in the polymer produced by chain polymerization **3.2 Concepts of Nano biotechnology & Nano biomaterials:** a. Introduction to Bionanoscience and Bionanomaterials b. Biomacromolecules c. Bionanomachines d. DNA Nanotechnology e. Peptide Nanotechnology Cellular Engineering f. Ethical issues g. Tools and techniques in nanobiotechnology	**15**

Course Code BNBUSBT4T3	Course Title Medical Microbiology	Credits 2	No. of lectures

Learning Outcomes: Learners will be able to:

- Know about normal flora colonizing various organs and systems in human body.
- Comprehend the patterns, classification and spread of infectious diseases.
- Understand host–parasite interactions by in-depth study of pathogenesis of various microbial parasites.
- Understand the mode of action of various antibiotics used for treatment of infectious agents and mechanisms of microbial resistance to drugs.

Unit I: Infectious Diseases	**1.1** a. Pathology, Infection, and Disease. b. Normal microbiota of human body (Refer only the table) Gnotobiotic Animals, Microbiome (Definition only). **1.2** a. Virulence (Definition only) and Toxigenicity. b. Opportunistic Microorganisms. **1.3** The Etiology of Infectious Diseases. **1.4** Classifying Infectious Diseases. **1.5** Overview of bacterial pathogenesis. **1.6** Patterns of Disease. **1.7** The Spread of Infection. **1.8** Pathogenicity Islands (definition only), Nosocomial infections. **1.9** Principles of Laboratory Diagnosis of Infectious Diseases.	**15**
Unit II: Causative Agents	**2.1 Respiratory Tract Infection:** *M. tuberculosis* (Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). **2.2 Skin Infections:** *S. aureus, S. pyogenes*. **2.3 GI Tract Infections:** *Salmonella typhi, E. coli.* **2.4 Urinary Tract Infections:** Uropathogenic *E. coli* and *Proteus.* **2.5 Vector Borne disease:** Dengue. **2.6 Yeast infection:** *Candida albicans.*	**15**
Unit III: Chemotherapy	**3.1** a**.** Discovery and Design of antimicrobial agents b**.** Classification of Antibacterial agents, Selective toxicity, MIC, MLC.	**15**

	3.2 Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin. **3.3 Polypeptide antibiotic**: Bacitracin. **3.4 Injury to Plasma membrane:** Polymyxin. **3.5 Inhibition of protein synthesis:** Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides-Erythromycin. **3.6 Inhibition of Nucleic acid synthesis:** Quinolones, Rifampicin. **3.7 Antimetabolites**: Sulphonamides, Trimethoprim. **3.8 Drug Resistance:** a. Mechanism, Origin and transmission of drug resistance. b. Use and misuse of antimicrobial agents. **3.9 Antifungal drugs, Antiviral drugs.**	

Course Code BNBUSBT4T4	Course Title Basic instrumentation and Enzymology	Credits 2	No. of lectures

Learning Outcomes: Learners will be able to:

- Get introduced to the principles and instrumentation of basic techniques in biology and their applications in life science research laboratory.
- Learn about the concept of radioactivity and its use in biological sciences.
- Comprehend the basic principles of enzymology.
- Understand the mechanisms underlying the enzyme-catalyzed reactions and appreciate the role of activators and inhibitors on the rate of enzyme-catalyzed reactions.

Unit I: Instrumentation I	**1.1 Centrifugation:** a. Basic principles of sedimentation: RCF and sedimentation concepts, Sedimentation rate or velocity, Sedimentation equilibrium, Svedberg unit. b. Types of centrifuges. c. Types of rotors. d. Care and maintenance of centrifuge. e. Preparative centrifugation: i. Differential centrifugation, ii. Density gradient centrifugation. f. Applications of preparatory centrifuge. g. Analytical centrifugation: Ultracentrifuge. h. Applications of analytical centrifugation in biological sciences.	**15**
Unit II: Instrumentation II	**2.1 Spectroscopy I: Principle, working and applications related to biological science of the following:** a. Fluorescence spectroscopy b. Luminometry c. IR spectroscopy d. Light scattering spectroscopy **2.2 Isotopes in Biology** a. Nature of radioactivity b. Detection Techniques using GM counter, Scintillation counter, c. Autoradiography d. Applications of Tracer techniques in Biology. e. Safety aspect	**15**
Unit III: Enzymology	**3.1** History, Definition, Classification and Nomenclature of enzymes **3.2** Chemical Nature, Properties of Enzymes,	**15**

	3.3 Mechanism of Enzyme Action, **3.4** Active Sites, Enzyme Specificity **3.5** Effect of pH, Temperature, Substrate Concentration on Enzyme Activity **3.6** Enzyme Kinetics: Michelis-Menten Equation **3.7** Types of Enzyme Inhibitions-Competitive, Uncompetitive, Non-Competitive **3.8** Allosteric Modulators Co-Factors, Zymogens and isozymes, **3.9** Kinetics of multi-substrate reactions	

Course Code BNBUSBT4T5	Course Title Biosafety	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: • Understand the concept and significance of biosafety. • Get introduced to the international guidelines for biosafety in microbiological and biomedical laboratories. • Know the importance of biosafety and regulatory guidelines pertaining to biotechnological research.			
Unit I: Introduction to Biosafety and GLP	**1.1 Introduction and Biological risk assessment.** a. Good Laboratory Practice training. b. Introduction and Biological risk assessment. c. Hazardous characteristics of an agent. d. Genetically modified agent hazards. e. Cell cultures. f. Hazardous characteristics of laboratory procedures. g. Potential Hazards associated with work practices. h. Safety equipment and facility safeguards. i. Pathogenic risk and management. **1.2** a. What is GLP? b. Good Laboratory Practice Training		**15**
Unit II: Detection and testing of contaminants	**2.1** a. Microbial Contamination in food and pharma products. b. Some common microbial contaminants. c. Microbiological Assays for pharmaceutical products. d. Regulatory microbiological testing in pharmaceuticals.		**15**
Unit III: Biosafety in Biotechnology	**3.1** a. Concepts on biosafety in Biotechnology. b. Regulations in rDNA technology. c. Food safety regulations. d. Genetically engineered crops, livestock Bioethics. e. Contemporary issues in Bioethics.		**15**

Course Code BNBUSBT4T6	Course Title Basic Molecular techniques and tissue culture	Credits 2	No. of lectures

Learning Outcomes: Learners will be able to:

- Understand the principle and know-hows of basic techniques in molecular biology.
- Know the components required to setup tissue culture laboratory.
- Learn the basic techniques of plant tissue culture.
- Know the Equipment and basic procedures used in animal tissue culture laboratory.

Unit I: Molecular Techniques - I	**1.1 Extraction, Isolation and Detection of DNA (genomic and plasmid) & RNA.** **1.2 Polymerase Chain Reaction:** a. General Principle. b. Components of a Typical PCR Reaction; Experimental Design; c. Primer Designing; d. Control of PCR e. Contamination and Mis-priming; f. PCR Product Clean-up and Detection **1.3 Chemical Synthesis of DNA.**	**15**
Unit II: Plant Tissue Culture	**2.1 Introduction** **2.2 Tissue Culture Laboratory:** a. General Laboratory b. Laboratory for aseptic inoculation c. Culture room d. Glass goods and instruments **2.3 Plant tissue culture media** a. Culture medium and the preparation of stock solution b. Selection of new medium **2.4 Techniques in plant tissue culture:** a. Preparation of Culture Medium b. Sterilization procedure c. Preparation of aseptic plants d. Aseptic techniques e. Incubation of culture **2.5 Callus Culture:** a. Introduction b. Principle	**15**

	c. Protocol d. How is the callus tissue formed? e. Morphology, internal structure and other characteristics of callus culture f. Significance of callus culture **2.6 Synthetic seeds** a. Introduction b. Method for making artificial seeds c. Importance of artificial seeds	
Unit III: Animal Tissue Culture	**3.1** Introduction & types **3.2** Design of ATC laboratory **3.3** Glassware, plasticware and Equipment for ATC **3.4** Sterilization protocols **3.5** Tissue culture media **3.6** Culture of cell lines: a. Procurement b. Initiation, c. Evolution, d. Maintenance, e. Phases and growth curve, f. Subculturing g. Preservation **3.7** Application & Limitations of Cell Cultures **3.8** Cell culture-scale up and automation	**15**

Course Code BNBUSBT4T7	Course Title Entrepreneurship Development	Credits 2	No. of lectures

Learning Outcomes: Learners will be able to:

- Understand the need of Bioentrepreneurship.
- Think differently to come up with innovative ideas to cater to the needs in the biotechnology industry.
- Understand the legal aspects of Bioentrepreneurship.

Unit I: Entrepreneurship & Opportunities	**1.1** Concept of Entrepreneur; Entrepreneurship; Need and Importance; Factors Influencing Entrepreneurship; Traits of a Successful Entrepreneur, Do's & Don'ts of Entrepreneur. **1.2** Nature of biotechnology Industry, concept of biotechnology park & Bioincubators, Role of biotech incubators and parks in India. **1.3** Role of Government and Financial Institutions in Entrepreneurship Development, Government Grants. **1.4** Opportunity areas for Bioentrepreneurship.	**15**
Unit II: Business planning, Market assessment and Indian Scenario of Bioentrepreneurship	**2.1** Business Plan, Characteristics and Importance of Planning, Marketing Plan for an Entrepreneur; Advertising and Sales Promotion; **2.2** Market Assessment, Domestic vs. International Market Research, Cost and Methodology of Market Research, Desk and Field Research. **2.3** Entrepreneurship in Rural Areas: Indian scenario; Biotechnology based programs for society by DBT.	**15**
Unit III: Intellectual Property rights and Patents	3.1 Licensing, Collaborations, Alliance, Mergers, Acquisition & Biopartnering for growth. 3.2 Introduction to IPR, types of IP (patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs), treaties in IPR. 3.3 Patent laws, Legislations covering IPR's in India, IPR Protection, patent filing in biotechnology, provisional and complete specification, patentable and non-patentable items. 3.4 Successful Entrepreneurs from India (Any 6 success stories from varied fields like Wine making, Mushroom cultivation, Hydroponics, Spirulina cultivation, Biocomposting, Bioinstrumentation etc).	**15**

Course Code BNBUSBT4P1	Course Title Practical Based on BNBUSBT4T1 & BNBUSBT4T1	Credits 2	No. of lectures
1.	Isolation and detection of Mitochondria.		**45**
2.	Problems based on bioenergetics.		
3.	Study of breakdown of amino acids – Lysine decarboxylase and deamination.		
4.	Protein estimation by Lowry's method.		
5.	Glucose detection by GOD/POD.		
6.	Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum.		
7.	Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum).		
8.	Thin Layer Chromatography		
9.	Separation of Binary (Solid-Solid) Mixture: a. Acid+ base b. Acid+ neutral c. Base+ phenol d. Base+ neutral		
10.	Identification of Organic Compound of Known Chemical Type: a. Oxalic acid/ salicylic acid b. o-nitroaniline/ m-nitroaniline c. α naphthol/ β naphthol d. neutral thiourea		
11.	Chemical and Biological Synthesis of Silver Nanoparticles and its Characterization by UV- VIS Spectrophotometer.		
12.	Estimation of total alkalinity of latex		
13.	Determination of: acid value/ hydroxyl value of given polymer sample.		

Course Code BNBUSBT4P2	Course Title Practical Based on BNBUSBT4T3 & BNBUSBT4T2	Credits 2	No. of lectures
1.	Identification of Candida species using the germ tube test and growth on Candida differential agar.		**45**
2.	Acid fast staining of *M. tuberculosis*- Demonstration.		
3.	Medical Microbiology a. Identification of *S.aureus*-Isolation, Catalase, Coagulase Test. b. Identification of *E. coli*- Isolation, Sugar Fermentations, IMViC. c. Identification of *Pseudomonas spp*- Isolation, OF, oxidase, IMViC.		
4.	Selection and testing of antibiotics using the Kirby-Bauer method.		
5.	Determination of MIC and MBC of an antibiotic.		
6.	Study of synergistic effect of antibiotic.		
7.	Separation of mononuclear cells by Ficoll-Hypaque		
8.	Enzyme Kinetics: a. Study of the effect of Temperature on activity of Enzyme b. Study of the effect of pH on activity of Enzyme c. Study of Effect of Substrate Concentration on enzyme activity and determination of Vmax and Km		
9.	Radio-isotopes half-life calculations		

Course Code BNBUSBT4P3	Course Title Practical Based on BNBUSBT4T5 & BNBUSBT4T3	Credits 2	No. of lectures
1.	Testing for adulterants in food; ex. Starch in milk.		
2.	Sterility of injectable.		
3.	Extraction of genomic DNA from *E. coli.*		
4.	Extraction of plasmid DNA pUC 18.		
5.	Agarose gel electrophoresis of genomic and plasmid DNA.		
6.	Preparation of laboratory and reagents for RNA extraction.		
7.	RNA extraction from bacteria (demonstration).		**45**
8.	Agarose gel electrophoresis of RNA (denaturing gel) (demonstration).		
9.	DNA amplification by polymerase chain reaction.		
10.	Preparation of Stock Solutions and Preparation of Media for PTC.		
11.	Surface Sterilization and Inoculation for Callus Culture.		
12.	Synthetic seed production.		
13.	Viable staining using trypan blue		

References:

SEMESTER-III

BNBUSBT3T1 Biophysics:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Nature and Properties of Light	Linda J. Vandergriff	PDF	-	-
2.	The Laser Technology: New Trends in Biology and Medicine	Luc G. Legres, Christophe Chamot, Mariana Varna, Anne Janin	PDF	-	-
3.	A Textbook of Optics	Dr. N Subrahmanyam	S. Chand	25th Edition	2012
4.	Principles of Fermentation Technology	Peter F. Stanbury Allan Whitaker Stephen J. Hall	Elsevier	3rd Edition	2017
5.	Biophysical Chemistry Principles and Techniques	Upadhyay, Upadhyay and Nath	Himalaya	Revised Edition	2009
6.	Principles and techniques of Biochemistry and Molecular Biology	Wilson and Walkar	Cambridge University Press	7th Edition	2010
7.	https://www.elprocus.com/what-is-a-thermocouple-definition-working-principle-diagram-applications/	-	-	-	-
8.	https://www.toppr.com/guides/physics/waves/what-is-sonication/	-	-	-	-
9.	https://www.drpawluk.com/education/magnetic-science/biomagnetic-fields/	-	-	-	-
10.	Chapter 10: Mechanical properties of fluid Chapter 5: Magnetism and	NCERT	-	-	-

	Matter				
11.	Oscillations, Waves and Acoustics	P. K. Mittal	I. K. International Pvt Ltd	-	2010
12.	Principle and techniques of Biochemistry and Molecular Biology	Wilson and Walkar	Cambridge University Pass	7th Edition	2010
13.	Molecular cloning: A lab manual	Sambrook and Russell	Cold Spring Harbor Laboratory Pass	3rd Edition	2001

BNBUSBT3T2 Applied Chemistry-I:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Green Chemistry: An Introductory Text	Mike Lancater	Royal Society of Chemistry	2nd Edition	2008
2.	New trends in green chemistry	V. K. Ahulwalia and M. Kidwai	Anamaya Publishers	2nd Edition	2010
3.	Organic Chemistry	Paula Y. Bruice	Pearson Education	6th Edition	2008
4.	Co-Ordination Chemistry	Ajay Kumar	Aarush education	3rd Edition	2010
5.	Inorganic chemistry	J.D.Lee	Wiley edition	5th Edition	2008
6.	Principle of Bioinorganic Chemistry	SJ Lipard	Wiley edition	4th Edition	2008
7.	Organic Chemistry	L.G. Wade Jr and M.S. Singh	Person	6th Edition	2008
8.	Organic Chemistry	J.G. Smith,	Special Indian Edition	2nd Edition	2008

BNBUSBT3T3 Immunology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Immunology	Kuby	W.H. Freeman	6th Edition	2006
2.	Immunology: essential and Fundamental	Palan and Pathak	Science Publishers	2nd Edition	2005
3.	The Elements of Immunology	Fahim Khan	Pearson Education	-	2009

BNBUSBT3T4 Cell Biology and Cytogenetics:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Cell Biology	Gerald Karp	John Wiley	6th Edition	2010
2.	Igenetics	Peter Russell	Pearson Education India	3rd Edition	2009
3.	ABC of Clinical genetics	Helen S Kingston	BMJ Publishing Group	3rd Edition	2002

BNBUSBT3T5 Molecular Biology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	iGenetics	Peter Russell	Pearson Education India	3rd Edition	2009
2.	Principles of Biochemistry	Nelson and Cox	WHFreeman	4th Edition	2004
3.	Molecular Biology	Friefelder		2nd Edition	
4.	General Microbiology	Stanier, Ingraham, Wheelis & Painter	McMillan Press Ltd.	5th Edition	1987

BNBUSBT3T6 Bioprocess Technology

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

BNBUSBT3T7 Research Methodology

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Research Methodology	C R Kothari	New Age International Publishers	2nd Revised Edition	2004
2.	Research Methodology in the Medical and Biological Sciences	Laake, Benestad & Olsen	Academic Press, Elsevier	2nd Edition	2007
3.	Introduction to Research Methodology	Imre Boncz	University of Pece	1st Edition	2015
4.	Research Methodology: A step-by-step guide to beginners	Ranjit Kumar	Sage Publication	5th Edition	2019
5.	https://www.scholarify.in/application-of-ict-in-research/	-	-	-	-

References:

SEMESTER-IV

BNBUSBT4T1 Biochemistry:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Illustrated Biochemistry	Harper	Lange Medical Books/McGraw-Hill	26th	2003
2.	Lehninger, principles of biochemistry	David Nelson and Michael Cox	*W.H. Freeman* and Company, New York.	4th	2005
3.	Fundamentals of Biochemistry	D. Voet and J. Voet	Wiley plus	5th	2011
4.	Biochemistry	Satyanarayana and Chakrapani	Books & Allied (P) Ltd	4th	2017
5.	The Physiology and Biochemistry of Prokaryotes	White, D.,	Oxford University Press	3rd	1995

BNBUSBT4T2 Applied Chemistry

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	General principles of Analytical chemistry	Skoog.	Royal Society of Chemistry	8th edition	2008
2.	An Introduction to Electrochemistry	Samuel Glasstone BiblioBazaar	edition reprint	2nd edition	2011
3.	Natural product chemistry, A mechanistic, biosynthetic and ecological approach	Kurt B.G. Torssell	Swedish Pharmaceutical Press.	5th edition	2010
4.	Natural products chemistry and applications	Sujata V. Bhat, B.A. Nagasampagi	Narosa Publishing House	3rd edition	2011

		and S. Meenakshi			
5.	Organic Chemistry Natural Products Volume-II	O. P. Agarwal	Krishna Prakashan	2nd edition	2011
6.	Nanobiotechnology: Concepts, Applications and Perspectives	Wiley- VCH	Mirkin Chad, Wiley	2nd edition	2009
7.	Chemistry of natural products	V.K. Ahluwalia	Vishal Publishing Co	2nd edition	2008
8.	General principles of Analytical chemistry	Skoog.	Royal Society of Chemistry	8th edition	2008
9.	An Introduction to Electrochemistry	Samuel Glasstone BiblioBazaar	Edition reprint	2nd edition	2011
10.	Application of Analytical Chemistry to Foods and Food Technology	Daniele Naviglio and Monica Gallo	MDPI	-	2020
11.					

BNBUSBT4T3 Medical Biotechnology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Prescott, Harley and Klein's Microbiology	Willey, Sherwood, Woolverton	McGraw-Hill International edition	7th	2008
2.	Prescott, Harley and Klein's Microbiology	Willey, Sherwood, Woolverton	McGraw-Hill International edition	5th	2002
3.	Microbiology, An Introduction	Tortora, Funke & Case	Pearson education	10th	2010
4.	Foundations in Microbiology	Kathleen Park Talaro	McGraw-Hill International edition	8th	2012
5.	Jawetz, Melnick and Adelberg's Medical Microbiology	G.F. Brooks, Morse, Carroll, Mietzner, Butel	Lange publication	26th	2013
6.	Ananthanarayan and Paniker's Textbook of	Reba Kanungo	Universities	10th	-

	Microbiology		Press		
7.	Mim's Medical Microbiology	Goering, Mark Zuckerman, Dockrell, Chiodini	Elsevier Limited	6th	2019

BNBUSBT4T4 Biosafety:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Principles and techniques of biochemistry and molecular biology	Edited by Keith Wilson and John Walker	Cambridge University Press	7th	2010
2.	Introductory Practical Biochemistry	SK Sawhney, Randhir Singh	Narosa Publishing House	1st	2014

BNBUSBT4T5 Basic Instrumentation and Enzymology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Lehninger, principles of biochemistry	David Nelson and Michael Cox	WH Freeman & Co	5th Edition	2008
2.	Outlines of Biochemistry	Conn, E.E., P. K.Stumpf, G. Bruening and R. Y.	John Wiley &Sons. New York.	5th Edition	1987
3.	Biochemistry	Satyanarayana and Chakrapani	Books & Allied (P) Ltd	4th Edition	2017
4.	Principles and techniques of biochemistry and molecular biology	Wilson and Walker	Cambridge University Press	5th edition	2000
5.	Principles and techniques of biochemistry and molecular biology	Wilson and Walker	Cambridge University Press	7th edition	2010
6.	Biophysical chemistry	Avinash Upadhyay & Kakoli Upadhyay & Nirmalendu Nath	Himalaya Publication House	Revised Edition	2009

BNBUSBT4T6 Basic Molecular Techniques and Tissue culture:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Molecular Diagnostics: Fundamentals, Methods and Clinical Applications	Lela Buckingham and Maribeth L Flaws	F.A. Davis Company	-	2007
2.	Molecular Cloning	Sambrook and Russel	Cold Spring Harbor, Hew York	3rd Edition	2001
3.	Plant tissue Culture	Kalyan Kumar De	New Central Book Agency	-	2008
4.	Introduction to Plant tissue Culture	M.K. Razdan	Oxford and IBH Publishing	2nd Edition	2019
5.	Principle and Practice of Animal Tissue Culture	Sudha Gangal	Universities Press	2nd Edition	2010

BNBUSBT4T7 Entrepreneurship Development

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Entrepreneurship & Business of Biotechnology	S N Jogdand	Himalaya publishing house	1st Edition	2007
2.	Entrepreneurship	Kurup	-	-	-
3.	Handbook of Entrepreneurship development	Basotia and Sharma	Mangaldeep publication	1st Edition	-
4.	The Entrepreneur's guide to a Biotech Start-up	Peter Kolchinsky	www.evelexa.com	4th edition	-Ne
5.	Entrepreneurship Ideas in Action	Cynthia Greene	South Western Educational Publishing	2nd Edition	-

Evaluation Scheme

Internals:

Class test	Assignment/ Study tour with report/Journal Movie club presentation/ Presentation of mini-research project work/ volunteering for Department fest/ poster making/ exhibition/ Departmental contribution/ case study presentation/Review writing	Attendance, Active Participation and Leadership Qualities	Total
20M	**10**	**10**	**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	
Q.5	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
BNBUSMB3T1	**40**	**16**	**60**	**24**	BNBUSMB3P3	**100**	**40**
BNBUSBT1T2	**40**	**16**	**60**	**24**			
BNBUSBT1T3	**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
BNBUSMB4T1	**40**	**16**	**60**	**24**	BNBUSMB4P4	**100**	**40**
BNBUSMB4T2	**40**	**16**	**60**	**24**			
BNBUSMB4T3	**40**	**16**	**60**	**24**			