

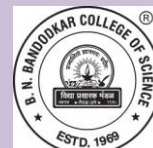
Academic Council Meeting No. and Date : 2 / April 30, 2021

Agenda Number : 4

Resolution Number : 4.9 and 4.25



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



Syllabus for

Programme : Bachelor of Science

Specific Programme : Biotechnology

[F.Y.B.Sc. (Biotechnology)]

Revised under Autonomy

From academic year 2021 - 2022

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Preamble

Biotechnology is applied branch of biology that includes the study that utilizes biological systems, to develop or create different products for betterment of society. Microbiology, biochemistry, immunology, Genetics, molecular biology, medicine (Drug development and personalized therapies), agriculture, marine, industrial biotechnology are among many other fields that forms beautiful collage of Biotechnology.

With the Goal of engaging the learners in biotechnological studies in the laboratory and *in silico*, harnessing experimental approaches that can be correlated better with the theoretical learning, the syllabus has been re-framed.

Continuing the Choice Based Credit System (CBCS) implemented by the esteemed University from the academic year 2016-2017, the existing syllabus of F.Y.B.Sc. Biotechnology is restructured according to the CBCS pattern for its implementation from 2021-22 under the autonomous status of VPM's B. N. Bandodkar College of Science. The present revision is related to restructuring of syllabus under autonomy to maintain the pace in concept building for better Hierarchical learning and also for updating it with a few more changes.

Inclusion of topic- Microbial diversity would help student realize the natural variation and exclusive features of members of microbial world. Foreseeing the workforce requirements of research settings topics like anaerobic cultures, culture collection centers have been introduced.

To keep up the pace with the development in field of Microscopy 'foldscope' has been newly introduced. To improve communication skills and scientific expression of learner, a module covering Basic English grammar has been introduced.

Eligibility:

Passed 12th standard (HSC) of Maharashtra State Board / CBSE / ICSE board with Mathematics as one of the subject.

Duration: 3 years

Mode of Conduct:

Laboratory practicals / 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
F.Y.B.Sc. (Biotechnology)
Structure of Programme

Course Code	Course Title	No. of lectures	Credits
BNBUSBT1T1	Basic Chemistry-I	45	2
BNBUSBT1T2	Basic Chemistry-II	45	2
BNBUSBT1T3	Basic Life Sciences-I: Biodiversity and Cell Biology	45	2
BNBUSBT1T4	Basic Life Sciences-II: Microbial Techniques	45	2
BNBUSBT1T5	Basic Biotechnology-I: Introduction to Biotechnology	45	2
BNBUSBT1T6	Basic Biotechnology-II: Environmental biology	45	2
BNBUSBT1T7	FCI: Societal Awareness	45	2
BNBUSBT1P1	Practicals Based on BNBUSBT1T1 & BNBUSBT1T2	45	2
BNBUSBT1P2	Practicals Based on BNBUSBT1T3 & BNBUSBT1T4	45	2
BNBUSBT1P3	Practicals Based on BNBUSBT1T5 & BNBUSBT1T6	45	2
Total		450	20

Course Code	Course Title	No. of lectures	Credits
BNBUSBT2T1	Chemistry-I: Bioorganic Chemistry	45	2
BNBUSBT2T2	Chemistry-II: Physical Chemistry	45	2
BNBUSBT2T3	Life Sciences-I: Physiology, Cell biology and Ecology	45	2
BNBUSBT2T4	Life Sciences-II: Genetics and evolution	45	2
BNBUSBT2T5	Biotechnology-I: Molecular biology, Scientific Writing and Communication Skills	45	2
BNBUSBT2T6	Biotechnology-I: Microbial growth, Immunology and Biostatistics	45	2
BNBUSBT2T7	FC II: Globalization, Ecology and Sustainable Development	45	2
BNBUSBT2P1	Practicals Based on BNBUSBT2T1 & BNBUSBT2T2	45	2
BNBUSBT2P2	Practicals Based on BNBUSBT2T3 & BNBUSBT2T4	45	2
BNBUSBT2P3	Practicals Based on BNBUSBT2T5 & BNBUSBT2T6	45	2
Total		450	20

Semester I

Course Code BNBUSBT1T1	Course Title Basic Chemistry - I	Credits 2	No. of lectures
Learning Outcomes:			
<ul style="list-style-type: none"> To acquaint the students with basic concepts of Chemistry like Classification and Nomenclature of Chemical compounds To impart hands-on skills in preparation of Buffers and Solutions 			
Unit I: Nomenclature Catalyst and Reagents	<p>1.1 Nomenclature and Classification of Inorganic Compounds:</p> <ol style="list-style-type: none"> Oxides Salts Acids Bases Ionic Molecular and Coordination Compounds <p>1.2 Nomenclature and Classification of Organic Compounds:</p> <ol style="list-style-type: none"> Cyclic Hydrocarbons Alcohols and Ethers Carbonyl compounds and their derivatives Amines Amides Heterocyclic Compounds (Quinolines and isoquinolines) <p>1.3 Catalyst for hydrogenation:</p> <ol style="list-style-type: none"> Raney nickel, Pt and PtO_2 ($\text{C}=\text{C}$, $\text{C}=\text{N}$, NO_2 aromatic compounds) Pd/C: $\text{COCl} \rightarrow \text{CHO}$ (Rosenmund) Lindlar catalyst: alkynes <p>1.4 Reagents:</p> <ol style="list-style-type: none"> LiAlH_4 (reduction of CO, COOR, CN, NO_2) NaBH_4 (reduction of CO) Reagents use in Oxidation of primary and secondary alcohol (Pyridinium dichromate $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$) d) Reaction involving Grignard reagents 	15	
Unit II: Chemical Bonds	<p>2.1 Ionic Bond:</p> <ol style="list-style-type: none"> Nature of Ionic Bond Structure of NaCl, KCl and CsCl, factors influencing the formation of Ionic Bond. <p>2.2 Covalent Bond:</p> <ol style="list-style-type: none"> Nature of Covalent Bond Structure of CH_4, NH_3, H_2O Shapes of BeCl_2, BF_3 <p>2.3 Coordinate Bond: Nature of Coordinate Bond</p> <p>2.4 Non Covalent Bonds: Van DerWaal's forces: dipole - dipole, dipole - induced dipole.</p> <p>2.5 Hydrogen Bond: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).</p>	15	

<p>Unit III: Basic concepts of physical chemistry</p>	<p>3.1 Solutions:</p> <ol style="list-style-type: none"> Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numericals expected). <p>3.2 Acids and Bases:</p> <ol style="list-style-type: none"> Lowry-Bronsted and Lewis Concepts. Strong and Weak Acids and Bases - Ionic Product of Water - pH, pK_a, pK_b. Hydrolysis of Salts. <p>3.3 Buffer solutions –</p> <ol style="list-style-type: none"> Concept of Buffers, Types of Buffers, Derivation of Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity (Numericals expected.) pH of Buffer Solution. <p>3.4 Principals of Oxidation & Reduction Reactions–</p> <ol style="list-style-type: none"> Oxidizing and Reducing Agents, Oxidation Number, Oxidation, Reduction, Addition and Substitution & Elimination Reactions. 	<p>15</p>
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Course Code BNBUSBT1T2	Course Title Basic Chemistry - II	Credits 2	No. of lectures
Learning Outcomes: <ul style="list-style-type: none"> To acquaint students with Concepts of Stereochemistry To impart knowledge of Titrimetric and Volumetric Estimations and handling of basic Analytical Techniques like Chromatography and Colorimetry 			
Unit I: Stereochemistry	<p>1.1 Isomerism –</p> <ol style="list-style-type: none"> Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism Chirality <p>1.2 Geometric Isomerism and Optical Isomerism:</p> <ol style="list-style-type: none"> Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis-Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring) <p>1.3 Conformation:</p> <ol style="list-style-type: none"> Conformations of Ethane. Difference between Configuration and Conformation. Configuration, Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality, Representation of Configuration by Flying Wedge Formula <p>1.4 Projection formulae –</p> <ol style="list-style-type: none"> Fischer, Newman and Sawhorse. The Interconversion of the Formulae. 	15	
Unit II: Quantitative methods of analysis: Gravimetry and Titrimetry	<p>2.1 Gravimetric Analysis:</p> <ol style="list-style-type: none"> Solubility and Precipitation Factors affecting Solubility Nucleation Particle Size Crystal Growth Colloidal State Ageing/Digestion of Precipitate Co-Precipitation and Post-Precipitation Washing, Drying and Ignition of Precipitate. (Numericals Expected). <p>2.2 Titrimetric Analysis:</p> <ol style="list-style-type: none"> Titration, Titrant Titrand End Point Equivalence Point Titration Error Indicator Primary and Secondary Standards Characteristics and examples 	15	

	<p>2.3 Types of Titration –</p> <ol style="list-style-type: none"> Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration.-Strong Acid Vs Strong Base -Theoretical aspects of Titration Curve and End Point Evaluation. Theory of Acid –Base Indicators, Choice and Suitability of Indicators. 	
<p>Unit III: Analytical Techniques</p>	<p>3.1 Methods of Separation</p> <ol style="list-style-type: none"> Precipitation, Filtration, Distillation and Solvent Extraction. <p>3.2 Analytical Techniques Chromatography:</p> <ol style="list-style-type: none"> Definition, Principles, Types Introduction to Paper Chromatography, Thin Layer Chromatography, Column Chromatography and its Applications. <p>3.3 Colorimetry:</p> <ol style="list-style-type: none"> Principle Beer-Lambert's Law Measurement of Extinction Derivation of $E = kcl$, Limitations of Beer-Lambert's Law, Filter Selection 	<p>15</p>

Course Code BNBUSBT1T3	Course Title Basic Life Sciences I: Biodiversity & Cell Biology	Credits 2	No. of lectures
<p>Learning Outcomes: Learners will be able to:</p> <ul style="list-style-type: none"> • Comprehend structure, characteristics and classification of different bacteria and viruses. • Obtain knowledge about the structural details of prokaryotic and eukaryotic cell and their functions. • Understand about the different aspects of chromosomes viz.its structural details, variation in number and structure. • Obtain knowledge about the different ways of sex determination and concept of Barr body. 			
<p>Unit I: Bacteria & Viruses</p>	<p>1.1 Viruses:</p> <ol style="list-style-type: none"> Historical highlights general properties of viruses Structure of viruses- Capsids, envelopes, genomes <p>1.2 Introduction to Microbial diversity:</p> <ol style="list-style-type: none"> Rickettsia, Coxiella, Chlamydia, Mycoplasma: general features, medical significance Actinomycetes: General features of <i>Nocardia</i> and <i>Streptomyces</i> Importance: ecological, commercial and medical Archaea: Introduction- major Archaeal physiological groups, Archaeal cell wall, lipids and membranes, Ecological importance Eumycota (Fungi): Characteristics: Structure, reproduction, Cultivation of fungi, Biological and economic importance Protozoa <ol style="list-style-type: none"> Ecology and Morphology of Protozoa Major categories of Protozoa based on motility, reproduction Medical importance of Protozoa Life cycle of <i>Entamoebahistolytica</i> 	<p>15</p>	
<p>Unit II: Ultra structure Of prokaryotic & eukaryotic cells</p>	<p>2.1 Ultra structure of Prokaryotes:</p> <ol style="list-style-type: none"> Concept of cell shape, size and arrangement Detailed structure of Slime Layer, Capsule, Flagella, Pili, Cell Wall (Gram Positive and Gram Negative), Cell Membrane, Cytoplasm and Genetic Material, Storage Bodies and Endospores <p>2.2 Ultra structure of Eukaryotic cells:</p> <ol style="list-style-type: none"> Plasma Membrane, Cytoplasmic Matrix, Microfilament, Intermediate Filaments and Microtubules Organelles of biosynthesis: Endoplasmic reticulum & Golgi apparatus Lysosomes, Endocytosis, Phagocytosis, Autophagy, Proteasomes Eukaryotic Ribosomes, Mitochondria and Chloroplasts Nucleus- Nuclear structure, Nucleolus External cell covering: Cilia and flagella Comparison of Prokaryotic and Eukaryotic cells 	<p>15</p>	

<p style="text-align: center;">Unit III: Cytogenetics</p>	<p>3.1 Eukaryotic chromosomes:</p> <ul style="list-style-type: none"> a. Structure of chromatin b. Euchromatin and Heterochromatin <p>3.2 Variations in chromosome structure:</p> <ul style="list-style-type: none"> a. Deletion (Details of Drosophila not required) b. Duplication c. Inversion d. Translocation <p>3.3 Variations in chromosome number:</p> <ul style="list-style-type: none"> a. Changes in one or a few chromosomes b. Changes in complete sets of chromosomes <p>3.4 Sex chromosomes and sex determination:</p> <ul style="list-style-type: none"> a. Genotypic sex determination (mammals, Drosophila and Caenorhabditis, other organisms) b. Genetic sex determination 	<p style="text-align: center;">15</p>
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Course Code BNBUSBT1T4	Course Title Basic Life Sciences-II: Microbial Techniques	Credits 2	No. of lectures
<p>Learning Outcomes:Learners will be able to:</p> <ul style="list-style-type: none"> • Implement the knowledge acquired to identify the microscopic techniques to be used • Know different methods for control of microbes The learner would be able to choose appropriate methods for sterilization or control of microbes • Understand the nutritional requirements of bacteria and their nutritional types • Understand the appropriate use of different nutrient media for cultivation of various types of microorganisms • Be accomplished in pure culture techniques & have basic understanding of preservation and collection of microbial cultures 			
<p>Unit I: Microscopy & Stains</p>	<p>1.1 Microscope- Simple and Compound: Principle. Parts, functions & applications. 1.2 Dark field and Phase contrast microscope, Foldscope 1.3 Stains and staining solutions-Definition of dye and chromogen Structure of dye and chromophore 1.4 Functions of mordant and fixative 1.5 Natural and synthetic dyes 1.6 Simple staining, Differential staining and acid-fast staining with specific examples</p>	<p>15</p>	
<p>Unit II: Sterilization Techniques</p>	<p>2.1 Definition of frequently used terms Rate of microbial death, Factors affecting the effectiveness of antimicrobial agents & Properties of an ideal disinfectant 2.2 Physical methods of microbial control a. Dry & moist heat – mechanisms, instruments used and their operations b. Electromagnetic radiations – Ionizing radiations, mechanisms –advantages & disadvantages c. Bacteria proof filters d. Low temperature e. Osmotic pressure f. Desiccation 2.3 Chemical methods of microbial control-mechanism & advantages & disadvantages (if any) applications a. Phenolics b. Alcohols c. Heavy metals and their compounds d. Halogens e. Quaternary ammonium compounds f. Halogens g. Dyes h. Surfaces active agents/Detergents i. Aldehydes j. Peroxygens k. Sterilizing gases 2.4 Evaluation of disinfectant –Tube dilution & Agar plate techniques, Phenol coefficient, Tissue toxicity index</p>	<p>15</p>	

<p style="text-align: center;">Unit III: Nutrition & Cultivation of Microorganisms</p>	<p>3.1 Nutritional Requirements: Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth Factors (definition only)</p> <p>3.2 Classification of Different Nutritional Types of Organisms</p> <p>3.3 Design and Types of Culture Media</p> <p>3.4 Simple Medium, Differential, Selective and Enriched Media (with examples)</p> <p>3.5 Concept of Isolation and Methods of Isolation and Pure Culture Techniques</p> <p>3.6 Study of colony characteristics</p> <p>3.7 Culture of anaerobic microorganisms</p> <p>3.8 Preservation of microorganisms</p> <p>3.9 Culture Collection Centers</p>	<p style="text-align: center;">15</p>
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Course Code BNBUSBT1T5	Course Title Basic Biotechnology I: Introduction to Biotechnology	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: <ul style="list-style-type: none"> • Get acquainted with the different branches of Biotechnology • Gain information about Biotechnology research, institutions in India • Know various products generated by using Biotechnology • Implement their knowledge to identify model organisms to be used for research. • Know about food safety and its scope in quality control of foods. 			
Unit I: Introduction to Biotechnology	1.1 History of Microbiology & Biotechnology 1.2 What is Biotechnology? a. Definition of Biotechnology b. Traditional and Modern Biotechnology 1.3 Introduction to different branches of Biotechnology- Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology. 1.4 Biotechnology Research in India: Funding agencies. 1.5 Biotechnology Institutions in India (Public and Private Sector) 1.6 Biotech Success Stories 1.7 Biotech Policy Initiatives 1.8 Biotechnology in context of Developing World 1.9 Public Perception of Biotechnology 1.10 Applications of Biotechnology: GM Papaya, Bt cotton, Golden rice	15	
Unit II: General Classification and Model Organisms	2.1 General classification: 7 Levels of classification 2.2 Kingdoms: 6 kingdom classification (Plant, Animal, Protists, Fungi, Archaeobacteria, Eubacteria). 2.3 Classification and characteristics study of model organisms: a. <i>Drosophila</i> b. Algae, microalgae and cyanobacteria c. Earthworm d. Zebrafish e. <i>Arabidopsis thaliana</i>	15	
Unit III: Food and Fermentation Biotechnology	3.1 Microbial growth in foods: intrinsic factors and extrinsic factors 3.2 Microbial growth and food spoilage: a. Controlling food spoilage: Homeostasis and hurdle technology b. Antimicrobial chemicals: organic acids, nitrites, parabenoic acid, sodium chloride, phosphates, sulfites c. Naturally occurring antimicrobials: lysozyme, lactoferrin and other Fe binding proteins, avidin, spices and essential oils, onions and garlic, isothiocyanates, phenolic compounds 3.3 Biopreservation: controlled acidification, bacteriocins, probiotics, prebiotics and symbiotic 3.4 Physical methods of food preservation:	15	

	<p>a. Drying, freeze-drying, cold storage (Overview)</p> <p>b. Heat treatment: concept of TDP and TDT</p> <p>c. Preservation by irradiation: UV and ionizing radiations (Overview)</p> <p>3.5 Microbiology of fermented foods:</p> <p>a. Overview of fermented foods: importance and major chemical conversions</p> <p>b. Chocolate: The sweet side of fermentation!</p> <p>c. Fermented Milks: Lactic Acid Bacilli; mesophilic and thermophilic milk fermentations</p> <p>d. Yeast lactic fermentation: Kefir</p> <p>e. Meat and fish fermentation</p> <p>f. Production of bread</p> <p>g. Other fermented foods</p> <p>h. Alkaline fermentation: alkali-fermented vegetables</p>	
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Course Code	Course Title	Credits	No. of lectures
BNBUSBT1T6	Basic Biotechnology II: Environmental Biotechnology	2	
<p>Learning Outcomes: Learners will be able to:</p> <ul style="list-style-type: none"> • Know about bio-aerosols and their properties, control and biosafety • Get introduced to various organisms in soil, their role, their association with vascular plants that can be beneficial • Obtain knowledge about renewable energy sources • Have an idea about global environmental problems & know about the use of bioremediation strategy for removal of gaseous pollutants, oil spills • Comprehend the concept of phytoremediation and metal bioremediation 			
Unit I: Air & Soil Microbiology	<p>1.1 Air microbiology</p> <p>a. Important Airborne Pathogens,</p> <p>b. Important Toxins released by Airborne bacteria,</p> <p>c. Nature of Bioaerosols,</p> <p>d. Microbial survival in the air,</p> <p>e. Extramural and Intramural aeromicrobiology,</p> <p>f. Bioaerosol Control,</p> <p>g. Gravity sedimentation and air sampler (comparison of semi-quantitative and quantitative method for air sampling)</p> <p>h. Biosafety in the Laboratory</p> <p>1.2 Soil Microbiology</p> <p>a. Soil- definition, composition, textural triangle, Physicochemical characters of earth environment</p> <p>b. Types of soil organisms</p> <p>c. Microorganisms in soil</p> <p>d. Microorganism associations with vascular plants:</p> <p>e. Phyllosphere</p> <p>f. Rhizosphere & Rhizoplane</p> <p>g. Mycorrhizae</p> <p>h. Nitrogen Cycle; nitrogen fixation: Rhizobia, Actinorhizae, Stem</p>		15

	<p>Nodulating Rhizobia</p> <ol style="list-style-type: none"> i. Fungal & Bacterial endophytes j. <i>Agrobacterium</i> & other plant pathogens 	
<p>Unit II: Renewable energy sources and Pollution</p>	<p>2.1 Renewable Energy Sources Overview of Solar, wind, hydro / geo power</p> <p>2.2 Biofuel</p> <ol style="list-style-type: none"> a. Types: solid, liquid b. Bioethanol and Biodiesel c. Microbial hydrogen gas production and use as a fuel d. Use of algae as a source of energy (<i>Botryococcus braunii</i>) <p>2.3 Biogas technology: Biogas plant and types Biogas production, composition, Applications</p> <p>2.4 Pollution Air pollution: Types, sources and classification of air pollutants and Soil and solid waste pollution</p> <p>2.5 Global Environmental Problems: ENSO, Green House Effect, Acid rain, Ozone depletion, Global warming deforestation, biodiversity loss.</p>	15
<p>Unit III: Role of Biotechnology in Environmental Management</p>	<p>3.1 Bioremediation:</p> <ol style="list-style-type: none"> a. Concept b. Bioremediation Strategies <p>3.2 Types:</p> <ol style="list-style-type: none"> a. <i>in situ</i> (land farming, bioventing, biosparging, bioaugmentation) b. <i>ex-situ</i> (composting, biopile process, bioreactors) c. Gaseous bioremediation: Air pollution bioscrubbers and biofilters d. Bioremediation of contaminated ground water and oil spills e. Phytoremediation f. Metal bioremediation <p>3.3 EIA:</p> <ol style="list-style-type: none"> a. Definitions, b. Purpose c. basic steps of EIA, d. EIA in India 	15

Course Code BNBUSBT1T7	Course Title Foundation Course I: Societal Awareness	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: <ul style="list-style-type: none"> To impart knowledge of Society and make students aware about the Problems in Society 			
Unit I: Overview of Indian Society	1.1 Understand the multi-cultural diversity of Indian society through its demographic composition 1.2 Population distribution according to religion, caste, and gender 1.3 Appreciate the concept of linguistic diversity in relation to the Indian situation 1.4 Understand regional variations according to rural, urban and tribal characteristics 1.5 Understanding the concept of diversity as difference		15
Unit II: Concept of Disparity	2.1 Concept of Disparity- I <ol style="list-style-type: none"> Understand the concept of disparity as arising out of stratification and inequality Explore the disparities arising out of gender with special reference to violence against women, female foeticide (declining sex ratio), and portrayal of women in media Appreciate the inequalities faced by people with disabilities and understand the issues of people with physical and mental disabilities 2.2 Concept of Disparity-II <ol style="list-style-type: none"> Examine inequalities manifested due to the caste system and inter-group conflicts arising thereof Understand inter-group conflicts arising out of communalism Examine the causes and effects of conflicts arising out of regionalism and linguistic differences 		15
Unit III: The Indian Constitution and Significant Aspects of Political Processes	3.1 The Indian Constitution <ol style="list-style-type: none"> Philosophy of the Constitution as set out in the Preamble The structure of the Constitution-the Preamble Main Body and Schedules Fundamental Duties of the Indian Citizen Tolerance, peace and communal harmony as crucial values in strengthening the social fabric of Indian society Basic features of the Constitution 3.2 Significant Aspects of Political Processes <ol style="list-style-type: none"> The party system in Indian politics Local self-government in urban and rural areas The 73rd and 74th Amendments and their implications for inclusive politics Role and significance of women in politics 		15

Course Code BNBUSBT1P1	Course Title Practicals Based on BNBUSBT1T1 & BNBUSBT1T2	Credits 2	No. of lectures
1.	Safety Measures and Practices in Chemistry Laboratory, Working and use of a Digital Balance, Functioning and Standardization of <i>pH</i> Meter, Optical Activity of a Chemical Compounds by Polarimeter		3
2.	To prepare 0.1 N succinic acid and standardize the NaOH of two different concentrations.		3
3.	Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions		3
4.	Determination of strength of HCl in commercial sample.		3
5.	Qualitative Analysis of Inorganic Compounds - Two experiments		3
6.	Characterization of Organic Compounds containing only C, H, O elements (no element test) - Compounds belonging to the following classes: Carboxylic Acid, Phenol, Aldehyde/Ketone, Ester, Alcohol, Hydrocarbon and Characterization of Organic Compounds containing C, H, O, N, S, Halogen Elements (element tests to be done) Compounds belonging to the following classes: Amine, Amide, Nitro Compounds, Thiamide, Haloalkane, Haloarene		6
7.	To Standardize commercial sample of NaOH using KHP (Potassium hydrogen phthalate) and sample of HCl using borax.		3
8.	Dissociation Constant of Weak Acids by Incomplete Titration Method using <i>pH</i> Meter and determination of Acetic acid in Vinegar by Titrimetric Method		3
9.	Determination of the amount of Fe (II) present in the given solution Titrimetrically		3
10.	Determination of amount of NaHCO ₃ + Na ₂ CO ₃ in the given solid mixture Titrimetrically		3
11.	Determination of the amount of Mg (II) present in the given solution complexometrically		3
12.	Determination of percent composition of BaSO ₄ and NH ₄ Cl in the given mixture Gravimetrically		3
13.	Separation of Cu, Ni and Fe using Paper Chromatography and amino acids - paper chromatography		3
14.	To Verify Beer-Lamberts Law Using KMnO ₄ Solution by Colourimetric Method.		3

Course Code BNBUSBT1P2	Course Title Practicals Based on BNBUSBT1T3 & BNBUSBT1T4	Credits 2	No. of lectures
Practical 1	Practical Based on Unit I of BNBUSBT1T3		
a.	Fungal Staining		2
b.	Slide Culture technique (Actinomycetes)		2
c.	Cultivation of fungi on Sabouraud's agar		2
d.	Spot assay for bacteriophages (Demonstration)		1
e.	Permanent slides of Protozoa		1
Practical 2	Practical Based on Unit II of BNBUSBT1T3		
a.	Monochrome staining		2
b.	Gram's staining		2
c.	Cell wall staining		2
d.	Capsule staining		2
Practical 3	Practical Based on Unit III of BNBUSBT1T3		
a.	Study of karyotype of normal male and normal female		2
b.	Study of Trisomy-21, Trisomy-18, Trisomy-13, Turner syndrome, Klinefelter syndrome and Cri-du-chat		2
Practical 4	Practical Based on Unit I of BNBUSBT1T4		
a.	Construction and working of simple and compound microscope		2
b.	Foldscope (Demonstration)		2
Practical 5	Practical Based on Unit II of BNBUSBT1T4		
a.	Sterilization equipments: Principle, Construction and Working of Autoclave & Hot Air Oven		3
b.	Methods of preparation of glassware for Sterilization (Pipettes, Petri Plates, Flasks)		2
c.	Effect of UV light on micro-organisms (Qualitative)		2
d.	Study of antimicrobial effect of dyes, phenolics and heavy metals		2
Practical 6	Practical Based on Unit III of BNBUSBT1T4		
a.	Study of general purpose, selective and differential medium		3
b.	Preparation of culture media: liquid and solid		2
c.	Preparation of slant, butts and plates		3
d.	Isolation of organism and study of colony characteristics		4

Course Code BNBUSBT1P3	Course Title Practicals Based on BNBUSBT1T5 & BNBUSBT1T6	Credits 2	No. of lectures
Practical 1	Practical Based on Unit I of BNBUSBT1T5		
a.	Assignment: Brief overview of a Technique / Equipment / Concept in Biotechnology from Past to Present		2
Practical 2	Practical Based on Unit II of BNBUSBT1T5		
a.	Culturing of <i>Drosophila/ Zebrafish</i>		2
c.	Study of microalgae and cyanobacteria using permanent slides		1
Practical 3	Practical Based on Unit III of BNBUSBT1T5		
a.	Analysis of milk keeping quality by MBRT and RRT		3
b.	Determination of TDP and TDT (Demonstration)		3
c.	Determination of MIC of salt/ sugar (Demonstration)		3
d.	Isolation of organisms causing Food Spoilage		4
e.	Study of Lactic acid bacteria – Homofermentative and heterofermentative		4
f.	Preparation of Kefir and study of its microflora		3
Practical 4	Practical Based on Unit I of BNBUSBT1T6		
a.	Study of air microflora by Gravity Sedimentation Method		2
b.	Determination of soil pH and moisture content		2
c.	Visualizing soil micro-organism using contact slide method		2
d.	Study of following organisms from soil Nitrifying bacteria (enrichment) qualitative detection Cellulolytic bacteria (enrichment and isolation) qualitative detection		3
e.	Enrichment and Isolation of <i>Rhizobium</i>		2
f.	Enrichment and Isolation of <i>Azotobacter</i>		2
g.	Winogradsky's column to study soil ecosystem		3
Practical 5	Practical Based on Unit II of BNBUSBT1T6		
a.	Visit and report of biogas plant		2
Practical 6	Practical Based on Unit III of BNBUSBT1T6		
b.	Effect of heavy metals on growth of bacteria		2

Semester II

Course Code BNBUSBT2T1	Course Title Bio-organic Chemistry	Credits 2	No. of lectures
Learning Outcomes: <ul style="list-style-type: none"> To acquaint students with Bioorganic Molecules To impart the knowledge of Classification, Structure and Characterization of Biomolecules 			
Unit I: Biomolecules Carbohydrates, Lipids, sterols &Nucleic acid	1.1 Carbohydrates: <ol style="list-style-type: none"> Structure Function Classification Isomers of Monosaccharides Chemical/Physical Properties of Carbohydrate, 1.2 Lipids: <ol style="list-style-type: none"> Classification of Lipids Properties of Saturated Unsaturated Fatty Acids Rancidity, and Hydrogenation of Oils 1.3 Sterols: <ol style="list-style-type: none"> Cholesterol: Structure and Function, Lipoproteins: Structure andFunction, Storage Lipids, Structural Lipids, Action of Phospholipases,Steroids 1.4 Nucleic Acids: <ol style="list-style-type: none"> Structure of Purine and Pyrimidine Bases Hydrogen Bonding between Nitrogenous Bases in DNA Structure of Nucleosides, Nucleotides and Polynucleotides. 		15
Unit II: Biomolecules: Proteins & Amino Acids	2.1 Amino acid <ol style="list-style-type: none"> Classification, Preparation and Properties, Isoelectric Point, Peptide Synthesis 2.2 Proteins: <ol style="list-style-type: none"> Classification based on Structure and Functions, Primary Structure, N-terminal (Sanger and Edmans Method and C-terminal Analysis (Enzyme) 1.3Reactions of Amino Acids, Sorenson 's Titration, NinhydrinTest. Denaturation of protein Structure of Peptides. Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitter ion. Glycoproteins (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides). 		15
Unit III: Basic Organic reactions & Name reactions	3.1 Basic Organic reactions <ol style="list-style-type: none"> Nucleophilic substitution reaction: SN1 and SN2, Elimination reactions (E1 and E2 mechanism). 3.2 Name reactions <ol style="list-style-type: none"> Aldol condensation, Cross- Aldol Condensation Wolf kishner reduction, Clemmensen reduction, Reformatsky reaction, Perkin reaction Hydroboration, 		15

	<ul style="list-style-type: none">h. Friedal Craft's Reaction,i. Baeyer-Villiger Reaction,j. Knoevenagelreaction, Witting reaction,k. Benzoin condensation,l. Cannizzaroreaction, pH of Buffer Solution.	
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Course Code	Course Title	Credits	No. of lectures
BNBUSBT2T2	Physical Chemistry	2	
Learning Outcomes			
<ul style="list-style-type: none"> To acquaint students with concepts in Thermodynamics, Kinetics and Redox Reactions To impart skills in Kinetics and Chemical Reactions 			
Unit I: Thermodynamics	<p>1.1 System, Surrounding, Boundaries Sign Conventions, State Functions.</p> <p>1.2 Laws of thermodynamic: Internal Energy and Enthalpy: Significance, examples, (Numerical based on internal energy and enthalpy expected).</p> <p>1.3 Qualitative discussion: Carnot Cycle for ideal Gas and Mechanical Efficiency, Laws of Thermodynamics as applied to Biochemical Systems.</p> <p>1.4 Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes, Hess law</p>		15
Unit II: Chemical Kinetics	<p>2.1 Order & Molecularity of Reaction,</p> <p>2.2 Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numerical expected)</p> <p>2.3 Determination of Order of Reaction by a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numerical expected),</p> <p>2.4 Transition state theory: Collision theory, Transition state theory (Derivation not expected) Arrhenius equation and calculation of activation energy</p>		15
Unit III: Adsorption & Catalyst	<p>3.1 Adsorption:</p> <ol style="list-style-type: none"> Common adsorbents, Reversible and Irreversible Adsorption, Characteristic of Adsorption, Types of adsorption, Adsorption isotherm <p>3.2 Catalysis:</p> <ol style="list-style-type: none"> Types of catalysis, Nature of solid catalyst, Enzyme catalysis, Mechanism of enzyme catalysis, Characteristic of enzyme catalysis. 		15

Course Code BNBUSBT2T3	Course Title Basic Life Sciences-I: Physiology, Cell biology and Ecology	Credits 2	No. of lectures
<p>Learning Outcomes: Learner will be able to:</p> <ul style="list-style-type: none"> Describe the phenomena of photosynthesis and respiration in plants, composition structure and function of blood Understand the concept of selective permeability of cell membrane and its significance, differentiate between different modes of solute transport, artificial membrane structures like liposomes Know about the basic concepts with respect to ecosystem, nutrient cycles, interactions between organisms 			
<p>Unit I: Plant and animal physiology</p>	<p>1.1 Plant Physiology:</p> <ol style="list-style-type: none"> Photosynthesis Intracellular Organization of Photosynthetic Systems Fundamental Reactions of Photosynthesis Photosynthetic Pigments Role of light, Hill reaction and its Significance, Light Reactions Cyclic and Non-Cyclic Photo induced Electron Flow, Energetics of Photosynthesis Photorespiration Dark phase of Photosynthesis, Calvin Cycle, C-3, C-4 pathways <p>1.2 Animal Physiology: Blood composition, Structure, Function, Coagulation (Hemophilia), Anti-coagulants</p>	<p>15</p>	
<p>Unit II: Cell biology</p>	<p>2.1 Cell Membrane</p> <ol style="list-style-type: none"> Biomedical importance The Major Lipids in Mammalian Membranes Membrane Lipids Are Amphipathic Membrane Lipids Form Bilayers Membrane Proteins Cell membrane as selective barrier <p>2.2 Diffusion</p> <ol style="list-style-type: none"> Passive Diffusion Facilitated Diffusion <p>2.3 Types of Transport proteins: Carrier and channels</p> <p>2.4 Active transport:</p> <ol style="list-style-type: none"> Types- Primary and Secondary active ABC transporters as an example of primary active transport Types of secondary active transport (Co-transport) Lactose permease as an example of secondary active transport <p>2.5 Sodium Potassium Pump</p> <p>2.6 Ion channels, ionophores and aquaporins</p> <p>2.7 Siderophores: Significance and examples</p> <p>2.8 Utilization of Substrates that cannot pass the cell membrane</p> <p>2.9 Liposomes: Definition and significance</p>	<p>15</p>	

<p>Unit III: Ecosystem and interactions</p>	<p>3.1 Ecology and Biogeography: a. Ecosystems, Definition and Components b. Structure and Function of Ecosystems c. Aquatic and Terrestrial Ecosystems c. Biotic and Abiotic Factors d. Trophic Levels e. Food Chain and Food Web f. Ecological Pyramids (Energy, Biomass and Number)</p> <p>3.2 Nutrient Cycle and Biogeochemical Cycles: Water, Carbon, Oxygen and Sulphur.</p> <p>3.3 Interactions: Commensalism, Mutualism, Predation and Antibiosis, Parasitism.</p>	<p>15</p>
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Course Code BNBUSBT2T4	Course Title Basic Life Sciences-II: Genetics & Evolution	Credits 2	No. of lectures
<p>Learning Outcomes: Learners will be able to:</p> <ul style="list-style-type: none"> • Firm the pillar of genetic fundamental right from Mendelian genetics to its modification. • Get familiar with basic terminologies related to microbial genetics. • Be well versed with the concept of conjugation, transformation and transduction • Acquire knowledge on concepts of evolution, origin of life and conservation of biodiversity. 			
<p>Unit I: Genetics Fundamentals</p>	<p>1.1 Mendel: The Father of Genetics:</p> <ol style="list-style-type: none"> Mendel's success Genetic terminology <p>1.2 Monohybrid and Dihybrid crosses:</p> <ol style="list-style-type: none"> What does monohybrid crosses reveal? (Principle of segregation and concept of dominance) Punnett square Testcross Genetic symbols Dihybrid crosses Principle of independent assortment Applying probability and branch diagram to dihybrid cross Dihybrid testcross <p>1.3 Modifications of Dominance relationships:</p> <ol style="list-style-type: none"> Incomplete dominance Codominance Molecular explanations of incomplete dominance and codominance <p>1.4 Genes and the environment:</p> <ol style="list-style-type: none"> Penetrance and expressivity Effects of the environment (Age of onset, sex, temperature, chemicals) <p>1.5 Gene interactions and modified mendelian ratios:</p> <ol style="list-style-type: none"> Gene interactions that produce new phenotypes Epistasis (Recessive epistasis, dominant epistasis, epistasis involving duplicate genes) <p>1.6 Multiple alleles</p>	<p>15</p>	
<p>Unit II: Microbial Genetics</p>	<p>2.1 The search for genetic material:</p> <ol style="list-style-type: none"> Griffith's transformation experiment Avery's transformation experiment Hershey and Chase Bacteriophage experiment <p>2.2 Genetic analysis of Bacteria:</p> <ol style="list-style-type: none"> Minimal medium, complete medium, auxotroph, prototroph Conjugation: Discovery of conjugation in bacteria, The sex factor F, High frequency recombination strains of <i>E.coli</i>, F' factors, Natural gene transfer and antibiotic resistance, concept of horizontal and vertical gene transfer Transformation (Only process) Transduction: Bacteriophages, Generalized transduction (Only process), Specialized transduction Transposable elements in bacteria: Insertion sequences and transposons 	<p>15</p>	

<p style="text-align: center;">Unit III: Evolution</p>	<p>3.1 Evolution:</p> <ol style="list-style-type: none"> a. Concept, time line of evolution b. Origin of Life: Earliest life on Earth, RNA world Hypothesis, Endosymbiont theory, Unicellular to Multi cellular, Diversification of life. c. Concept of Species, Origin of Species (Speciation): Allopatric, Sympatric, Parapatric, Peripatric d. Concept of Molecular Evolution in brief e. Evolution and Biogeography of Islands – Dispersal, establishment and extinction, adaptive radiation <p>3.2 Conservation of Biodiversity:</p> <ol style="list-style-type: none"> a. Biodiversity Hot Spots b. Seed Banks & Artificial seeds in conservation c. Significance of gene banks and germplasm conservation 	<p style="text-align: center;">15</p>
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Course Code BNBUSBT2T 5	Course Title Biotechnology-I: Molecular biology, Scientific Writing and Communication Skills	Credits 2	No. of lectures
<p>Learning Outcome: Learners will be able to</p> <ul style="list-style-type: none"> • Study proposed models of replication and recombination in prokaryotes and eukaryotes. • Build the conceptual understanding of mechanism of first step of Gene Expression: Transcription • Distinguish the transcription in prokaryotes and eukaryotes. • Demonstrate good comprehension of text in the area of research. • Evaluate and integrate appropriate information from various sources to create cohesive and persuasive arguments. 			
<p>Unit I: Replication</p>	<p>1.1 Importance of DNA as genetic material 1.2 DNA replication in prokaryotes and eukaryotes-</p> <ol style="list-style-type: none"> Semi-conservative DNA replication: Meselson and Stahl Experiment, Role of different proteins and enzymes in DNA replication: Initiator proteins, Helicases, Primase, SSBPs, DNA Gyrase, DNA ligase Semi-discontinuous Replication: The Okazaki experiment Bidirectional Replication of circular DNA molecules, Denaturation mapping to locate 'ori' Molecular model of DNA Replication in <i>E.coli</i>: Initiation, elongation and termination of replication DNA polymerases and their role Rolling circle replication DNA replication in Eukaryotes: Replicons, Initiation of replication, replication enzymes Replicating the ends of chromosomes, telomerase: action and significance 	<p>15</p>	
<p>Unit II: Transcription</p>	<p>1.1 Central dogma of molecular biology 1.2 Gene Expression- an Overview:</p> <ol style="list-style-type: none"> Fundamental difference in replication and transcription, its significance Bacterial gene structure, concept of 'consensus sequence' Bacterial RNA polymerases Transcription Process in Prokaryotes: Initiation, elongation, termination (rho dependent and independent) Coupled transcription and translation, polycistronic RNA in bacteria Transcription in Eukaryotes: Types of RNA molecules; Eukaryotic RNA Polymerases Eukaryotic Promoter, PPE, enhancer; introduction to concept of 'in cis' and 'in trans' action Transcription of Protein Coding Genes by RNA Polymerase II Production of Mature mRNA in Eukaryotes: 5' and 3' end modifications Introns, splicing of group II introns, overlapping genes, Significance of splicing RNA editing and its significance 	<p>15</p>	

	l. Applications of studying replication and transcription: as drug targets	
Unit III: Scientific writing & communication skills	<p>3.1 Sentences</p> <ol style="list-style-type: none"> Subject predicate and kinds (assertive, declarative, interrogative, Imperative, exclamatory) Types of sentences (simple, compound, complex) Sentence- Fragment (link) Run-on sentence and Comma splices, semicolon (link) Punctuations. articles- a, an, the <p>3.2 Clause and phrase</p> <ol style="list-style-type: none"> Voice- Active & passive (identify and change) Tenses Clauses- Independent and dependent; coordination and subordination <p>3.3 Scientific writing:</p> <ol style="list-style-type: none"> Process of Scientific writing Introduction to scientific reports and writings Examples of Scientific and Unscientific writing Types: Research article, review article, scientific communications, case study, scientific report Data collection & Compilation Presenting the data (Improving written and spoken data presentation) Bibliography Plagiarism-Introduction to Plagiarism, Examples of Plagiarism. 	15

Course Code	Course Title Biotechnology-II:	Credits	No. of lectures
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BNBUSBT2T6	Microbial growth, Immunology & Biostatistics	2	
<p>Learning outcome: Learner would be able to</p> <ul style="list-style-type: none"> • Have basic understanding of microbial growth. • Enumeration of microorganisms using appropriate techniques. • Comprehend the effect of various environmental parameters on the growth of microorganisms • Know important role played by different lymphoid cells and organs the learner would gain the knowledge about basic properties and types of antigen and antibody. • Have basic understanding of biostatistics 			
<p>Unit I: Microbial Growth</p>	<p>1.1 Definition of growth, Mathematical Expression, Growth curve 1.2 Measurement of growth 1.3 Direct microscopic count – Breed’s count, Petroff –Hausser counting chamber- Haemocytometer 1.4 Viable count – Spread plate and Pour plate technique 1.5 Measurements of cell constituents 1.6 Turbidity measurements – Nephelometer and spectrophotometer techniques 1.7 Synchronous growth, Continuous growth (Chemostat and Turbidostat) 1.8 Influence of environmental factors on growth: Solutes and Water Activity, pH, Temperature, Oxygen Concentration, Pressure, Radiation 1.9 Biofilm formation and quorum sensing</p>	<p>15</p>	
<p>Unit II: Immunology</p>	<p>2.1 Overview of immune system 2.2 Cells (T, B and NK cells) 2.3 Organs - primary and secondary and their functional significance 2.4 Innate immunity, acquired immunity 2.5 Local and herd immunity 2.6 Humoral and cell mediated immunity, factors influencing and mechanisms of each 2.7 Antigens Types and general properties 2.8 Antibody: basic Structure, classes antibodies, Ig superfamily 2.9 Complement: Nomenclature, activation pathways (Classical, alternative, lectin), biological function and regulation overview</p>	<p>15</p>	
<p>Unit III: Biostatistics</p>	<p>3.1 Introduction to biostatistics: Statistics, Biostatistics, Applications and uses of Biostatistics 3.2 Data: Types of data (Qualitative/Quantitative, Primary/Secondary, Univariable/Bivariable/ Multivariable. Raw data/ Derived data) 3.3 Population and sample: Population, Sampling, Sample, Random sample, Characteristic (Measurable/ Non-measurable) 3.3 Frequency distribution a. Types of frequency distribution (Simple/ Grouped) b. Terms associated with grouped frequency distribution (Class interval, class limit, class boundaries, class mark, class width, class frequency, frequency density, cumulative frequency) 3.4 Graphical representation of data: a. Advantages and disadvantages of graphical representation b. Graphical representation of ungrouped data: line graph, bar diagram (simple/ multiple/ component), pie chart c. Graphical representation of grouped data: histogram (equal class intervals/ unequal class intervals), frequency polygon, cumulative frequency polygon</p>	<p>15</p>	

	<p>3.5 Central tendency:</p> <ul style="list-style-type: none">a. Characteristics of central tendencyb. Measures of central tendency: mean, median, mode (Ungrouped data, grouped data, merits, demerits) <p>3.6 Measures of variation:</p> <ul style="list-style-type: none">a. Absolute and relative measure of dispersionb. For grouped and ungrouped data: Range, standard deviation <p>3.7 Standard error of mean</p>	
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Course Code BNBUSBT2T7	Course Title FCII: Globalization, Ecology & Sustainable Development	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to know the concepts of globalization, ecology and problems in society			
Unit I: Globalization, Indian Society & Human Rights	1.1 Globalisation and Indian Society: <ol style="list-style-type: none"> a. Understanding the concepts of liberalization, privatization and globalization b. Growth of information technology and communication and its impact manifested in everyday life c. Impact of globalization on industry: changes in employment and increasing migration d. Changes in agrarian sector due to globalization e. Rise in corporate farming and increase in farmers' suicides. 1.2 Human Rights <ol style="list-style-type: none"> a. Concept of Human Rights b. Origin and evolution of the concept c. The Universal Declaration of Human Rights d. Human Rights constituents with special reference to Fundamental Rights stated in the Constitution 	15	
Unit II: Ecology & Sustainable Development	2.1 Importance of Environment Studies in the current developmental context 2.2 Understanding concepts of Environment, Ecology and their interconnectedness 2.3 Environment as natural capital and connection to quality of human life 2.4 Environmental Degradation causes and impact on human life 2.5 Sustainable development, concept and components 2.6 Poverty and environment	15	
Unit III: Understandin & Managing Stress and Conflict in Contemporary Society	3.1 Understanding Stress and Conflict <ol style="list-style-type: none"> a. Causes of stress and conflict in individuals and society b. Agents of socialization and the role played by them in developing the individual c. Significance of values, ethics and prejudices in developing the individual d. Stereotyping and prejudice as significant factors in causing conflicts in society e. Aggression and violence as the public expression of conflict 3.2 Managing Stress and Conflict in Society <ol style="list-style-type: none"> a. Types of conflicts and use of coping mechanisms for managing individual stress b. Maslow's theory of self-actualisation c. Different methods of responding to conflicts in society d. Conflict-resolution and efforts towards building peace and harmony in society 	15	

Course Code	Course Title	Credits	No. of lectures
BNBUSBT2P1	Practicals Based on BNBUSBT1T1 & BNBUSBT1T2	2	
1.	Spot test for Carbohydrates, Fats and Proteins and Amino Acids and Nucleic Acids		3
2.	Standardization of Colorimeter and Estimation of Reducing sugar by DNSA method		3
3.	Estimation of Protein by Biuret method and Lowry method		3
4.	Saponification of Fats, Saponification Value of Oil or Fat, Iodine value of Oil and determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method		3
5.	To determine enthalpy of dissolution of salt like KNO ₃		3
6.	Determine the rate constant for hydrolysis of ester using HCl as a catalyst		3
7.	Study the kinetics of reaction between Thiosulphate ion and HCl		3
8.	Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction		3
9.	Study the reaction between NaHSO ₃ and KMnO ₄ and balancing the reaction in acidic, alkaline and neutral medium		3
10.	Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate)		3
11.	Determination of the volume strength of hydrogen peroxide solution by titration with standardized potassium permanganate solution		3
12.	Determination of amount of K-oxalate and oxalic acid in the given solution Titrimetrically		4
13.	Investigation of the reaction between copper sulphate and sodium hydroxide (Standard EDTA Solution to be provided to the learner).		4
14.	Estimate the amount of nickel present in the given nickel chloride/nickel sulphate solution. (Estimation of Nickel (II) as Ni-dmg)		4

Course Code BNBUSBT2P2	Course Title Practical Based on BNBUSBT2T3 & BNBUSBT2T4	Credits 2	No. of lectures
Practical 1	Practical Based on Unit I of BNBUSBT2T3		
a.	Study of Hill reaction		3
b.	Colorimetric study of Absorption Spectrum of Photosynthetic Pigments		3
c.	Determination of RBC count using hemocytometer		4
d.	Differential staining of WBCs using Romanowsky Stains		3
e.	Study of human blood groups		3
Practical 2	Practical Based on Unit II of BNBUSBT2T3		
a.	The study effect of detergents and other membrane active reagents on erythrocyte membrane.		3
Practical 3	Practical Based on Unit III of BNBUSBT2T3		
a.	Report of Sample study of ecosystem		5
Practical 4	Practical Based on Unit I of BNBUSBT2T4		
a.	PTC: The genetics of bitter taste		3
b.	Mendelian problems		4
c.	Problems based on incomplete dominance, codominance, multiple alleles and epistasis		3
Practical 5	Practical Based on Unit II of BNBUSBT2T4		
a.	Study of auxotroph and prototroph by spot inoculation on minimal and complete medium		4
Practical 5	Practical Based on Unit II of BNBUSBT2T4		
	Practical Based on Unit II of BNBUSBT2T4		
a.	Calculating Diversity indices – Shannon-Weaver, Simpson's, Similarity and Dissimilarity		3
b.	Observing regeneration in Hydra		4

Course Code BNBUSBT2P3	Course Title Practicals Based on BNBUSBT2T5 & BNBUSBT2T6	Credits 2	No. of lectures
Practical 1 & Practical 2	Practicals Based on Unit I& Unit II of BNBUSBT2T5		
a.	Preparation of reagents for Molecular Biology Practicals: <ul style="list-style-type: none"> • Concept of molarity, molality and normality, • Preparation of acid of required normality - problem based learning • Concept and importance of stock solution: Preparation of 1M Tris-Cl, pH 8.0; 0.5M EDTA, Tris equilibrated phenol pH 8.0 (Demonstration), 10% SDS, PBS, saline Buffers: Properties of ideal buffers • Preparation of phosphate and acetate buffer 		15
b.	Culture Maintenance		3
Practical 3	Practical Based on Unit III of BNBUSBT2T5 (Activity)		
Practical 4	Practical Based on Unit I of BNBUSBT2T6		
a.	Enumeration of microorganisms by <ul style="list-style-type: none"> • Spread plate technique • Pour plate technique • Hemocytometer, • Brown's opacity tubes 		11
b.	Study of bacterial Growth Curve		3
c.	Study of growth pattern in liquid media		2
	Effect of temperature, pH, Solute concentration, UV radiation on growth of micro-organisms		3
Practical 5	Practical Based on Unit III of BNBUSBT2T6		
a.	Representing statistical data on graph paper and using MS-Excel: Line graph, Bar diagram, Pie chart, Histogram, Frequency polygon.		4
b.	Solving problems based on measures of central tendency using MS-Excel.		2
c.	Solving problems based on measures of dispersion using MS-Excel.		2

References: SEMESTER-I

BNBUSBT1T1: Basic Chemistry – I:

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	University General Chemistry	C.N. R. Rao	Macmillan Publishers India	1 st	2000
2.	Physical Chemistry University for biological sciences	Chang R	Science Books	1 st	2005
3.	Essentials of Physical Chemistry	B S Bahl, G D Tuli, ArunBahl, S. Chand	Limited, India	24 th	2000
4.	Concise Inorganic Chemistry	Author: J. D. Lee	John Wiley & Sons, USA	5 th	2008
5.	Organic Chemistry	Morrison Robert Thornton, Pearson Publication, Dorling Kindersley	India Pvt.Ltd	6 th	1992
6.	Organic reaction and mechanism	P.S.Kalsi	New Age international publication	5 th	2000
7.	Stereochemistry Conformation and Mechanism	P.S.Kalsi	New Age international publication	5 th	2000

BNBUSBT2: Basic Chemistry-II

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	University General Chemistry	C.N. R. Rao	Macmillan Publishers India	1 st	2000
2.	Physical Chemistry University for biological sciences	Chang R	Science Books	1 st	2005
3.	Essentials of Physical Chemistry	B S Bahl, G D Tuli, ArunBahl, S. Chand	Limited, India	24 th	2000
4.	Concise Inorganic Chemistry	Author: J. D. Lee	John Wiley & Sons, USA	5 th	2008
5.	Organic Chemistry	Morrison Robert Thornton, Pearson Publication, Dorling Kindersley	India Pvt.Ltd	6 th	1992
6.	Organic reaction and mechanism	P.S.Kalsi	New Age international publication	5 th	2000
7.	Stereochemistry Conformation and Mechanism	P.S.Kalsi	New Age international publication	5 th	2000

BNBUSBT1T3: Basic Life Sciences-I: Biodiversity and Cell Biology

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7 th	2008
2.	Microbiology	Michael J Pelczar Jr. E. C. S Chan Noel R. Krieg	Tata McGraw-Hill	5 th	1993
3.	Cell Biology, genetic, Molecular Biology, Evolution and Ecology	Verma & Agarwal	S Chand	1 st	2004
4.	Brock Biology of Microorganisms	Madigan, Martinko, Stahl & Clark	Benjamin Cummings	13 th	2012
5.	Advanced Biotechnology	R C Dubey	S Chand	1 st	2014
6.	iGenetics: A Molecular Approach	Peter Russel	Benjamin Cummings	3 rd	2010
7.	Cell & Molecular Biology: Concepts & Experiments	Gerald Karp	John Wiley & Sons	6 th	2010
8.	The Cell: A Molecular Approach	Geoffrey Cooper & Robert Hausman	Sinauer Associates Inc	4 th	2007
9.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3 rd	2007

BNBUSBT1T4: Basic Life Sciences-II: Microbial Techniques

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

BNBUSBT1T5: Basic Biotechnology-I: Introduction to Biotechnology

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3 rd	2007
2.	Food Microbiology- An introduction	Mointville and Matthews	ASM Press	4 th	2019
3.	Microbiology: An Evolving Science	Slonczewski and Foster	Norton & Company, Inc.	4 th	2016
4.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7 th	2008
5.	https://www.intechopen.com/books/algae-organisms-for-imminent-biotechnology/microalgae-and-cyanobacteria-as-green-molecular-factories-tools-and-perspectives				
6.	https://www.ufz.de/export/data/2/92807_Fruend_et_al_2010_Pedobiol.pdf				
7.	https://www.intechopen.com/books/current-trends-in-cancer-management/zebrafish-em-danio-rerio-em-as-a-model-organism				

BNBUSBT1T6: Basic Biotechnology-II: Environmental biology

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Environmental Microbiology	Maier, Pepper & Gerba	Academic Press by Elsevier	2 nd	2009
2.	Introduction to Environmental Microbiology	Kolwzan, Adamiak, Grabas, Pawelczyk	Oficina Wydawnicza Politechniki Wroclawskiej, Wroclaw	-	-
3.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7 th	2008
4.	Environmental Biotechnology	M H Fulekar	Science Publishers	1 st	2010
5.	Environmental Biotechnology	Indu Shekhar Thakur	Dreamtech Press	2 nd	2019
6.	Environmental Biotechnology	Alan Scragg	Oxford Press	2 nd	2005

SEMESTER-II

BNBUSBT2T1 Chemistry-I: Bioorganic Chemistry

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	University General Chemistry	C.N. R. Rao	Macmillan Publishers India	1 st	2000
2.	Physical Chemistry University for biological sciences	Chang R	Science Books	1 st	2005
3.	Essentials of Physical Chemistry	B S Bahl, G D Tuli, ArunBahl, S. Chand	Limited, India	24 th	2000
4.	Concise Inorganic Chemistry	Author: J. D. Lee	John Wiley & Sons, USA	5 th	2008
5.	Organic Chemistry	Morrison Robert Thornton, Pearson Publication, Dorling Kindersley	India Pvt.Ltd	6 th	1992
6.	Organic reaction and mechanism	P.S.Kalsi	New Age international publication	5 th	2000
7.	Stereochemistry Conformation and Mechanism	P.S.Kalsi	New Age international publication	5 th	2000

BNBUSBT2T2: Chemistry-II: Physical Chemistry

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	University General Chemistry	C.N. R. Rao	Macmillan Publishers India	1 st	2000
2.	Physical Chemistry University for biological sciences	Chang R	Science Books	1 st	2005
3.	Essentials of Physical Chemistry	B S Bahl, G D Tuli, ArunBahl, S. Chand	Limited, India	24 th	2000
4.	Concise Inorganic Chemistry	Author: J. D. Lee	John Wiley & Sons, USA	5 th	2008
5.	Organic Chemistry	Morrison Robert Thornton, Pearson Publication, Dorling Kindersley	India Pvt.Ltd	6 th	1992
6.	Organic reaction and mechanism	P.S.Kalsi	New Age international publication	5 th	2000
7.	Stereochemistry Conformation and Mechanism	P.S.Kalsi	New Age international publication	5 th	2000

BNBUSBT2T3: Life Sciences-I: Physiology, Cell biology and Ecology

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Textbook of Plant Physiology	V Verma	ANE Books	Ane's Student edition	-
2.	Textbook of Medical Physiology	Guyton and Hall	Elsevier Saunders	11 th	2006
3.	Harper's Illustrated Biochemistry	Murray, Graner, Mayes, Rodwell	McGraw Hill	26 th	2003
4.	Lehninger Principles of Biochemistry	Nelson and Cox	WHFreeman& Co	5 th	2008
5.	Molecular biology of the cell	Bruce Alberts	Garland Science	4 th	2002
6.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood and Woolverton	McGrawHill	7 th	2008
7.	General Microbiology	Roger Stanier, Ingraham, Wheelis, Painter	Palgrave Macmillan	5 th	1987

BNBUSBT2T4: Life Sciences-II: Genetics and evolution

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Genetics: A conceptual approach	Benjamin A. Pierce	W. H. Freeman	3 rd	2008
2.	iGenetics: A Molecular Approach	Peter Russell	Pearson Education India	3 rd	2009
3.	Microbiology	Michael J. Pelczar Jr. E.C.S.Chan& Noel R. Krieg	Tata McGraw Hill	5 th	1993
4.	Strickberger's Evolution	Brian K. Hall &BenediktHallgrimsson	Jones & Bartlett	5 th	2013
5.	Evolutionary biology handbook	Richard Arber	Callisto reference	-	2015
6.	The biology of biodiversity	M.Kato	Springer	-	2012

**BNBUSBT2T5: Biotechnology-I: Molecular biology,
Scientific Writing and Communication Skills**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Lehninger Principles of Biochemistry	Nelson and Cox	WHFreeman	4 th	2004
2.	iGenetics: A Molecular Approach	Peter Russell	Pearson Education	3 rd	2009
3.	http://www.butte.edu/departments/cas/tipsheets/grammar/fragments.html				2019
4.	http://www.butte.edu/departments/cas/tipsheets/grammar/run_ons.html				2019
5.	High School English Grammar & Composition	Wren & Martin Revised by N.D.V. Prasad Rao	S. Chand	Upgraded format	1999
6.	Writing Scientific Research Articles: Strategy & Steps	Margaret Cargill & Patrick O'Connor	John Wiley & Sons	1 st	2009
7.	Successful Scientific Writing	J Matthews & R Matthews	Cambridge University Press	3 rd	2008
8.	A complete guide to referencing and avoiding plagiarism	Colin Neville	McGraw Hill	1 st	2007

**BNBUSBT2T6: Biotechnology-I: Microbial growth, Immunology
And Biostatistics**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Prescott, Harley & Klein's Microbiology	Wiley, Sherwood and Woolverton	McGraw Hill	7 th	2008
2.	General Microbiology	Roger Stanier, Ingraham, Wheelis, Painter	Palgrave Macmillan	5 th	1987
3.	Microbiology: An Evolving Science	Slonczewski and Foster	Norton & Company, Inc.	4 th	2016
4.	Introduction to Bio-Statistics: A Textbook of Biometry	Dr. Pranab Kumar Banerjee	S.Chand	3 rd Rev. Edition	2007
5.	Principles and application of Statistics in Biosciences	Dr. D.V.Kamat	MananPrakashan	-	2012
6.	Kuby Immunology	Kindt, Goldsby, Osborne	W.H. Freeman	6 th	2006

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	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	
	d	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	
	d	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	
	d	Based on Unit III	
Q. 4	Answer any two of the following		12
	a	Based on Unit I	
	b	Based on Unit II	
	c	Based on Unit III	
	d	Based on Unit IV	

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
BNBUSBT1T1	40	16	60	24	BNBUSBT1P1	100	40
BNBUSBT1T2	40	16	60	24			
BNBUSBT1T3	40	16	60	24	BNBUSBT1P2	100	40
BNBUSBT1T4	40	16	60	24			
BNBUSBT1T5	40	16	60	24	BNBUSBT1P2	100	40
BNBUSBT1T6	40	16	60	24			
BNBUSBT1T7	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
BNBUSBT2T1	40	16	60	24	BNBUSBT2P1	100	40
BNBUSBT2T2	40	16	60	24			
BNBUSBT2T3	40	16	60	24	BNBUSBT2P2	100	40
BNBUSBT2T4	40	16	60	24			
BNBUSBT2T5	40	16	60	24	BNBUSBT2P2	100	40
BNBUSBT2T6	40	16	60	24			
BNBUSBT2T7	40	16	60	24	-	-	-

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