Academic Council Meeting No. and Date : July 06, 2023

Agenda Number : 2 Resolution Number : 23,24 / 4.2 & 4.7

Vidya Prasarak Mandal's

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

Syllabus for

Programme : Bachelor of Science

Specific Programme : Biotechnology

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

Revised under Autonomy

PREAMBLE

Biotechnology is one of the most promising applied branches of modern biology. Developing with a fast pace, the field is drawing attention in youth interested in interdisciplinary studies. Continuing the Choice Based Credit System (CBCS) implemented by the esteemed University from the academic year 2016-2017; with the objective of exposing preliminary learners to concepts in and applications of basic Biotechnology, the syllabi of F.Y.B.Sc. and S.Y.B.Sc. Biotechnology have been restructured under the autonomous status of VPM's B. N. Bandodkar College of Science, according to the CBCS pattern, and are being implemented since 2021-22. The approach towards restructuring of syllabus has been to maintain the pace in concept building for better hierarchical learning and also for updating the learner with advances in the field of biotechnology.

The T.Y.B.Sc. syllabus is aimed at equipping the students with knowledge in various fields of Biotechnology; such as Cell Biology, Virology, Recombinant DNA Technology, Transgenic Plants & Animals, Analytical Techniques, Bioinformatics and Biostatistics, Biochemistry, Bioprocess Technology Pharmacology and Neurochemistry. Topics like drug development, advanced enzymology and applications of Biotechnology have been newly introduced to keep pace with trends in industry.

The entire graduate program syllabus aims to cater to the needs of diverse groups of students, those interested in going for research career, Biotechnology-management studies, taking up jobs as well as aspiring entrepreneurs.

Eligibility:

Student should have passed semester I, II or Student should have passed semester III, IV, that is, should pass either FY.B.Sc or S.Y.B.Sc all subjects/ courses. such student stands eligible to seek admission at T.Y.B.Sc semester V.

Duration: 1 year

Mode of Conduct: Laboratory Practical / 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

T.Y.B.Sc. (Biotechnology)

Structure of Programme

Course Code	Course Title	No. of lectures	Credits
BNBUSBT5T1	Cell biology	**60**	**2.5**
BNBUSBT5T2	Virology, Advanced Enzymology and Analytical Techniques	**60**	**2.5**
BNBUSBT5T3	Recombinant DNA Technology, Transgenic Plants & Animals	**60**	**2.5**
BNBUSBT5T4	Marine Biotechnology	**60**	**2.5**
BNBUSBT5T5	Bioinformatics and Biostatistics	**48**	**2**
BNBUSBT5P1	Practical Based on BNBUSBT5T1 & BNBUSBT5T2	**72**	**3**
BNBUSBT5P2	Practical Based on BNBUSBT5T3 & BNBUSBT5T4	**72**	**3**
BNBUSBT5P3	Practical Based on BNBUSBT5T5	**48**	**2**
Total		**480**	**20**

Course Code	Course Title	No. of lectures	Credits
BNBUSBT6T1	Biochemistry	**60**	**2.5**
BNBUSBT6T2	Bioprocess Technology	**60**	**2.5**
BNBUSBT6T3	Pharmacology and Neurochemistry	**60**	**2.5**
BNBUSBT6T4	Applications of Biotechnology, Gene sequencing & editing and Environmental Biotechnology	**60**	**2.5**
BNBUSBT6T5	Agribiotechnology	**48**	**2**
BNBUSBT6P1	Practical Based on BNBUSBT6T1 & BNBUSBT6T2	**72**	**3**
BNBUSBT6P2	Practical Based on BNBUSBT6T3 & BNBUSBT6T4 + project work/ internship/ entrepreneurial work	**72**	**3**
BNBUSBT6P3	Practical Based on BNBUSBT6T5	**48**	**2**
Total		**480**	**20**

Teaching pattern:

One (01) Credit would be of thirty- forty (30-40) learning hours; of this more than fifty percent of the time will be spent on class room instructions including practical as prescribed by the University. Rest of the time spent invested for assignments, projects, journal writing, case studies, library work, industrial visits, attending seminars / workshops, preparations for examinations etc. would be considered as notional hours. The present syllabus considers (60L as class room teaching and 15 lectures as Notional hours/ paper). Each lecture duration would be 48 min. The names of the reference books provided in the syllabus are for guidance purpose only. Students and faculty are encouraged to explore additional reference books, online lectures, videos, science journals for latest/ additional information.

Semester V

Course Code BNBUSBT5T1	Course Title Cell biology	Credits 2.5	No. of lectures

Learning Outcomes: Learners will be able to:

1. Comprehend regulators of cell cycle progression.
2. Acquire knowledge on cell signaling pathway.
3. Get acquainted to the various model organisms used to study the process of development.
4. Get acquainted with basics of cancer biology.

Unit I: **Cell cycle**	**1. The eukaryotic cell cycle** Phases of cell cycle Regulation of the cell cycle by cell growth and extracellular signals Cell cycle checkpoints Restricting DNA replication to once per cell cycle **2. Regulators of cell cycle progression** Protein kinases and cell cycle progression (Discovery of MPF) Families of cyclins and cyclin dependent kinases (Identification of cyclins) Growth factors and the regulation of G1 Cdks DNA damage checkpoints **3. The events of M phase** Stages of Mitosis Cdk1/ Cyclin B and progression to metaphase The spindle assembly checkpoint and progression to anaphase Cytokinesis **4. Meiosis and fertilization** The process of meiosis Regulation of oocyte meiosis Fertilization **5. Apoptosis (Programmed Cell Death)** Programmed cell death versus accidental cell death: Apoptosis versus Necrosis The Extrinsic Pathway of Apoptosis The Intrinsic Pathway of Apoptosis Linking apoptosis to the cell cycle by p53	**15**
Unit II: **Cell Signaling**	1. The basic elements of cell signaling systems 2. A survey of extracellular messengers and their receptors 3. G protein-coupled receptors and their second messengers (signal transduction by G protein-coupled receptors, second messengers) 4. Protein-tyrosine phosphorylation as a mechanism for signal transduction 5. JAK STAT and TGF beta/SMAD pathways 6. Signaling networks: (feedback and crosstalk, networks of cellular signal transduction)	**15**

Unit III: Developmental biology	1. Overview of how the modern era of developmental biology emerged. 2. Concept of potency, Embryonic stem cells, Cytoplasmic determinants, differential gene expression, terminal differentiation in cells, concept of fate maps. 3. Concept of Morphogens with examples, Conditional and autonomous specification, cell fate and commitment- 4. Stages of development: Cycle of Life, Zygote, blastula, gastrula, neurula 5. Model organisms in developmental biology 6. Pattern formation in Drosophila, Sea urchin fertilization and axis specification, Vulva development and mutation in C. elegans, Fertilization in frog	**15**
Unit IV: Cancer biology	1. Types of cancer 2. The development and causes of cancer 3. grade and stage of neoplasms 4. Tumor staging: clinical, imaging, surgical, pathologic staging 5. Properties of cancer cell, transformation of cells in culture, The Theory Of ‘‘Hits’’ (example of ‘five-hit scenario’ for colorectal cancer as illustrated by Ruddon) 6. Carcinogens, metabolic activation of carcinogens, Interaction of Chemical Carcinogens with Oncogenes and Tumor Suppressor Genes, endogenous carcinogens- role of spontaneous mutations, irradiation carcinogenesis, role of oxidative stress and aging (one example of each) 7. Carcinogen-Induced Epigenetic Changes 8. Retro-oncogenes, Proto-oncogenes and Oncogenes (ras, bcr-abl), Tumor suppressor genes (Rb and p53), gain-of function vs. loss of function mutation, role of oncogenes and tumor suppressor genes in tumor development 9. Cancer Treatment: Retinoic acid, Herceptin, Erbitux, Imatinib 10. Molecular approaches to cancer treatment: Prevention and early detection	**15**

Course Code BNBUSBT5T2	Course Title Virology, Advanced Enzymology and Analytical Techniques	Credits 2.5	No. of lectures
Learning Outcomes: Learners will be able to 1. Understand various mechanisms of viral replication, antiviral therapies and viruses as cause of cancer. 2. Have better understanding of practical aspect of enzymology. 3. Gain an understanding of the basic principle and instrumentation of analytical techniques. 4. Introduction to some applications of these analytical techniques in biotechnological research.			
Unit I: Virology	1. A quick brush up to basics of Viruses learnt in FY, Baltimore classification & Taxonomy (ICTV), Concept of satellite and helper viruses, largest virus Mimivirus 2. Viral Life cycle: Influenza, HIV, Bacteriophage T4 3. Diagnostic methods in Virology 4. Purification, Cultivation, Enumeration, Detection 5. Cytocidal infections and cell damage 6. Role of viruses in cancer: Viral oncogenes, Examples of viruses involved in cancer: EB, HPV, HBV, Kaposi's Sarcoma 7. Control of viral diseases by immunization (Brush up to SY Vaccines), Antiviral chemotherapy 8. Viroids and Prions		**15**
Unit II: Advanced Enzymology	1. Need for isolation of enzymes, Identification of enzyme sources. 2. Methods of Isolation of enzyme 3. Ammonium sulphate precipitation and dialysis 4. Methods of purification (Tabulation) 5. Some representative techniques employed initially for enzyme isolation 6. Choice of methods of purification, Terms related to enzyme purification 7. Enzyme immobilization 8. Non-canonical enzymes: abzymes, synzymes, ribozymes		**15**
Unit III: Analytical Techniques-I	Principle, instrumentation, working and applications of following spectroscopic techniques: 1. Revision of basics 2. Raman spectroscopy 3. Atomic Absorption spectroscopy 4. Flame atomic emission spectroscopy 5. Real time (SYBR/ Taqman), RT PCR, Nested PCR (Variations of PCR shifted from sem 4 to sem 5, nested PCR newly added) 6. Introduction to imaging techniques (PET, CT)		**15**

Unit IV: Analytical Techniques-II	1. Basics of chromatography 2. HPLC: Normal and reverse phase chromatography 3. Principle, Instrumentation and applications of the following types of chromatography: i. Size exclusion-gel filtration ii. Ion exchange chromatography, iii. Affinity chromatography, covalent chromatography, Chromatography for Nucleic acids and DNA binding proteins (DNA cellulose chromatography), use of oligo-dT columns for eukaryotic mRNA isolation iv. Hydrophobic interaction chromatography 4. Gas Liquid Chromatography (GLC)	**15**

Course Code BNBUSBT5T3	Course Title Recombinant DNA Technology, Transgenic Plants & Animals	Credits 2.5	No. of lectures

Learning Outcomes: Learners will be able to:

1. Learn enzymes and vectors used in recombinant DNA technology and their applications to raise transgenic plants and animals.
2. Understand genomic and cDNA libraries.
3. Apply knowledge of RDT to create transgenic plants and animals.
4. Learn important applications of transgenic plants and animals.

Unit I: Recombinant DNA Technology-I	1. Enzymes in RDT: TDT, polynucleotide kinase, alkaline phosphatase, T4 phage polymerase: properties and applications 2. Cutting and joining DNA: Restriction enzymes: Types, properties, nomenclature, blunt Vs. sticky end cutters, rare Vs frequent cutters, Calculation of probability of cutting a given piece of DNA, isoschizomers and neoschizomers, star activity, partial and complete digestion of DNA 3. DNA ligase: definition, mode of action, sources and properties, temperature for ligation, use of linkers 4. Cloning vectors-Plasmids (pUC series), lambda phage replacement vectors, cosmids, phagemids M13, shuttle vectors, YAC vectors, expression vectors (introduction) 5. Methods of gene transfer in prokaryotes: transformation, electroporation, in vitro packaging followed by transduction	**15**
Unit II: Recombinant DNA Technology -II	1. Genomic, chromosomal and cDNA libraries: definition and construction 2. Radioactive and non- radioactive probes, synthesis of probe (random primer, nick translation, end labelling), autoradiography 3. Southern hybridization (RE digestion, denaturation, neutralization, blotting, baking/ crosslinking, pre-hybridization, hybridization, post-hybridization washes, detection), 4. Northern and Western hybridization for library screening 5. Restriction mapping 6. FISH, *in situ* hybridization: pros and cons 7. Advantages and drawbacks of PCR Vs. hybridization 8. Complementation of mutants 9. Chromosome walking	**15**
Unit III: Transgenic plants	1. Plant transformation with the Ti plasmid of A.tumefaciens, Ti plasmid derived vector systems (cointegrate, binary, mini-binary) 2. Transfer of T-DNA 3. Physical methods of transferring genes to plants: electroporation, microprojectile bombardment, liposome mediated, protoplast fusion 4. Advantages and drawback of each method highlighting problem	**15**

	associated with protoplast regeneration 5. Marker vs. reporter genes 6. Plant viruses as vectors: CaMV, Geminivirus, Agroinfection, TMV- pros and cons 7. Transient vs stable expression 8. Application of TG plants: Improvement of seed quality protein 9. Chloroplast engineering	
Unit IV: Transgenic animals	1. Transgenic mice- methodology-retroviral method, DNA microinjection, ES method 2. genetic manipulation with cre-loxP 3. Definitions and significance: gene knock-out and gene knock-down 4. GFP 5. Applications of TG mice: model for Alzheimer disease 6. TG livestock: production of pharmaceuticals in milk-Pharming 7. Cloning by nuclear transfer: The Dolly sheep 8. Transgenic fish	**15**

Course Code BNBUSBT5T4	Course Title Marine Biotechnology	Credits 2.5	No. of lectures

Learning Outcomes: Learners will be able to:

1. Understand the concepts associated with marine biotechnology.
2. Comprehend the difference in handling and cultivation of marine resources and terrestrial resources.
3. Gain knowledge of current research in marine biotechnology and the use of resources currently in various fields.

Unit I: Introduction to Marine Biotechnology and bioprospecting	**1.** Introduction to Marine Biotechnology **2.** The marine ecosystem and its functioning: Intertidal (Rocky intertidal, Sandflats and Mudflats, Salt marshes and Mangroves, Estuarine, Neritic Environments, coastal sedimentary environments, coral reef), Open-ocean environments (Oceanic, deep sea, hydrothermal vents and seeps) **3.** Bioprospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms, Methods for microbial bioprospecting in Marine environments **4.** Biotechnological Potential of Marine Microbes- Bioactive compounds from Marine Organisms: fungi, Microalgae, Seaweeds, Actinomycetes, sponges	**15**
Unit II: Marine drugs and enzymes	**A. Drugs from Marine organisms:** 1. Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents 2. Approved Marine Drugs as Pharmaceuticals **B. Marine Microbial Enzymes:** Marine Extremozymes and Their Significance: Thermostability, Cold Adaptivity, Extreme pH Tolerance, Halotolerance, Barophilicity Current Use of Marine Microbial Enzymes	**15**
Unit III: Marine Nutraceuticals	1. Marine Functional Foods: 2. Marine Sources as Healthy Foods or Reservoirs of Functional Ingredients 3. Marine-Derived Ingredients with Biological 4. Properties 5. Functional Foods Incorporating Marine-Derived Ingredients 6. Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated Fatty Acids, Carotenoids, Soluble Calcium, Fish Collagen **7.** and Gelatin, Marine Probiotics	**15**

Unit IV: Cosmetology	**A. Marine Bioresources:** Marine Secondary Metabolites: Halogenated Terpenes, Steroids and Sterols, Polyphenols Marine Proteins, Marine Lipids **B. Cosmetics from Marine Sources:** Cosmetics: Definition and Regulations, Cosmeceuticals, Target Organs and Cosmetics Delivery Systems Components of Cosmetics: Excipients, Additives (Antioxidants, Antimicrobials, Perfumes and Colorants), Water Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals: Physicochemical and Technological Properties, Biological Activities Treatments Based on Marine Resources: Firming, Cellulite, Hair Growth Disorders Products Based on Marine Resources	**15**

Course Code BNBUSBT5T5	Course Title Bioinformatics and Biostatistics	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: 1. Know the various nucleic acid and protein databases 2. Gain an understanding of the basic concepts in Bioinformatics and Biostatistics 3. Understand and use the databases and tools for alignment used in bioinformatics 4. Know the standard statistical distributions 5. Solve the problems based on t-test, Z-test and Chi-square test			
Unit I: Biological databases	1. Definition, Aims, Scope, Applications and limitations of bioinformatics 2. Databases, types of databases, 3. Biological databases: Primary databases, secondary databases, specialized databases, interconnection between biological databases 4. Pitfalls of biological databases 5. Nucleic acid sequence databases: EMBL, DDBJ 6. Protein structure database: PDB 7. Protein sequence database: PIR, SWISS-PROT 8. Protein structural visualization: Rasmol, Swiss-PDB viewer **9.** Protein structure classification: CATH and SCOP		**12**
Unit II: BLAST and Sequence alignment	1. Various File Formats for Biomolecular Sequences: GenBank, FASTA 2. Basic concepts of sequence analysis: Sequence homology versus Sequence similarity, Sequence similarity versus sequence identity (Only concepts, no calculation) 3. Definition of sequence alignment 4. Pairwise Alignment: Global Alignment (brief), Local Pairwise Alignment, Dot matrix and dynamic programming, gap penalty 5. Scoring matrices: Nucleotide and Amino acid scoring matrix (PAM and BLOSUM) 6. Database similarity searching, Unique requirements of database searching, Heuristic database searching, Basic local alignment search tool (BLAST) and its variants, BLAST Output Format 7. Multiple Sequence Alignment: The need for MSA, Basic concepts of MSA, Progressive approach and CLUSTAL. Concept of Phylogeny, Phylogenetic tree		**12**

Unit III: Biostatistics I	1. Design of experiments 2. Introduction to Binomial distribution and Poisson distribution 3. Normal distribution: Overview, standard normal distribution, Application of normal distribution 4. Student t distribution 5. Basics of hypothesis testing 6. Testing a claim about a mean	**12**
Unit IV: Biostatistics II	1. Inferences about two means (independent and dependent samples) 2. Correlation, Regression 3. Chi-square test	**12**

Course Code BNBUSBT5P1	Course Title Practical Based on BNBUSBT5T1 & BNBUSBT5T2	Credits 3	No. of lectures
1.	Ammonium sulphate precipitation and dialysis		**72**
2.	Demonstration: Separation of components from a mixture by: i. Size exclusion chromatography ii. Ion exchange chromatography iii. Affinity chromatography		
3.	Monitoring protein purification: protein estimation by Bradford method		
4.	Monitoring protein purification: Separation of proteins by SDS-PAGE		
5.	Comparison of crude and purified enzyme activity		
6.	Detection of Vitamin B12 by paper chromatography: Bioautography		
7.	Immobilization of yeast cells for invertase production		
8.	Estimation of phosphatase enzyme activity		
9.	Demonstration: Chick embryo candling and inoculation methods		
10.	Bacteriophage assay		
11.	Assignment: identify a carcinogen, its metabolic activation, if any, and the cancer it leads to		

Course Code BNBUSBT5P2	Course Title Practical Based on BNBUSBT5T3 & BNBUSBT5T4	Credits 3	No. of lectures
1.	Study of any 5 marine bacteria and algae (Macro and micro)		**72**
2.	Identification of Shrimp/ sponges		
3.	DPPH assay for antioxidant extracted from marine algae		
4.	Extraction of carotenoids from marine algae/Bacteria/Fungi		
5.	Extraction and estimation of Gelatin.		
6.	Extraction and estimation of Collagen.		
7.	Extraction of alkaloids from marine organisms and their separation by TLC.		
8.	Genomic DNA Extraction from Animal cells and agarose gel electrophoresis.		
9.	Restriction enzyme digestion		
10.	Ligation		
11.	Preparation of competent cells and Transformation in *E. coli.*		
12.	Blue -white selection		
13.	Sothern Hybridization demonstration (up to blotting step)		

Course Code BNBUSBT5P3	Course Title Practical Based on BNBUSBT5T5	Credits 2	No. of lectures
1.	Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases.		**48**
2.	Use of NCBI BLAST Tool		
3.	Pairwise alignment		
4.	Multiple Sequence Alignment and Phylogeny		
5.	Classification of proteins using CATH/ SCOP		
6.	Visualization of PDB molecules using Rasmol		
7.	Study of normal distribution of data using MS Excel/ R-software		
8.	Hypothesis testing using MS Excel/ R-software. a. T-test b. Z-test c. Chi-square test		
9.	Study of correlation of data using MS Excel/ R-software.		
10.	Study of regression of data using MS Excel/ R-software.		

Semester VI

Course Code BNBUSBT6T1	Course Title Biochemistry	Credits 2.5	No. of lectures
Learning Outcomes: Learners will be able to: 1. Relate to the pathways of carbohydrate metabolism in different living beings and analyze their regulatory mechanisms. 2. Comprehend structural hierarchy of proteins. 3. Students will able to explain metabolic pathways of lipids. 4. Understand the biological processes and systems applicable to human nutrition.			
Unit I: Protein Biochemistry	1. Primary structure: The function of protein depends on its amino acid sequence 2. Protein sequences can elucidate the history of life on earth 3. Secondary structure: 4. Peptide bonds restrict possible secondary conformations 5. Alpha helix 6. Beta sheets 7. Loops and bends 8. Tertiary and Quaternary structure 9. Fibrous proteins: Collagen, Alpha keratin 10. Globular proteins: Myoglobin and hemoglobin 11. Defects in Protein Folding Provide the Molecular Basis for a Wide Range of Human Genetic Disorders 12. Protein denaturation		**15**
Unit II: Carbohydrate Biochemistry	1. Quick brush up to metabolism learnt in SY, Reciprocal regulation of metabolic pathways (Glycolysis & Gluconeogenesis) 2. Interconnections of metabolic pathways 3. Biosynthesis & regulation of Peptidoglycan in Bacteria 4. Synthesis of Starch, Sucrose & Cellulose in Plants 5. Metabolism & regulation of Glycogen in Animals 6. Common metabolic disorder: Lactose Intolerance		**15**
Unit III: Lipid metabolism	1. Lipids- classification, membrane lipids, triacylglycerols, 2. Digestion, Mobilization and transport 3. Catabolism: Oxidation of fatty acids: Beta, alpha and omega oxidation, Oxidation of unsaturated fatty acids, Oxidation of odd chain fatty acids 4. Anabolism: Synthesis of saturated (fatty acyl synthase complex, synthesis of palmitic acid from acetyl CoA). unsaturated fatty acids synthesis 5. Ketone Bodies 6. Cholesterol synthesis 7. Disorders related to cholesterol		**15**

Unit IV: Nutrition	1. Basics of energy metabolism, nutrition & dietetics – Unit of measuring energy, calorific value of food, BMR & factors affecting it, 2. A Balanced diet, Nutrition in health & diseases (protein energy malnutrition) and Over nutrition (obesity) 3. Vitamins- Dietary sources, bioactive form, functions and disorders associated with fat soluble (A D E K) and water-soluble vitamins. 4. Minerals - Overview of important trace elements and minerals, Physiological and biochemical functions of principal and trace elements (Na, K and Ca - in detail).	**15**

Course Code BNBUSBT6T2	**Course Title Bioprocess Technology**	**Credits 2.5**	**No. of lectures**
Learning Outcomes: Learners will be able to: 1. Understand milk processing technology, safety considerations in product manufacturing. 2. Be aware of the conventional and modern methods of drug discovery. 3. Know the intricacies of representative fermentation processes. 4. Document GMP practices and learn quality assurance & quality control.			
Unit I: Dairy Technology	1. Normal flora of milk, Changes in raw milk, Microbiological Quality of Milk & Milk Products: SPC, coliform count, LPC, thermophilic, psychrophilic counts and DMC. 2. Raw and fluid milk products Pasteurization & Ultra-pasteurization, Preservation methods (drying, evaporation, condensation). 3. Microbiology of butter, Yogurt, cultured buttermilk, dry milk and whey (flowsheet). 4. Cheese: Cheddar, Cottage, Processed Cheese, Cheese Defects. Enlist other cheese and associated microorganisms. 5. Rapid detection of milk borne pathogens- Nucleic acid based methods, immunological assays, biosensors.		**15**
Unit II: Basics of drug discovery process	6. Introduction 7. Conventional Processes of Drug Discovery 8. Cell-based assays 9. Receptor binding assays 10. Enzyme assays 11. Newer Methods of Drug Discovery		**15**

	12. Computer aided drug design 13. Combinatorial chemistry 14. Genomic methods in the search for new drugs, including antibiotics 15. Search for drugs among unculturable microorganisms 16. Approval of New Antibiotic and other Drugs by the Regulating Agency 17. Pre-submission work by the pharmaceutical firm 18. Submission of the new drug to the FDA 19. Approval 20. Post approval research 21. DSP: Covered in SY syllabus	
Unit III: Fermentation processes and microbiological assays	Fermentation process for 1. Penicillin 2. Vitamin B12 3. Glutamic acid 4. ethanol 5. Mushroom Analytical microbiology for assaying the products 1. Introduction 2. Methods 3. Advantages and limitations 4. Assay for antibiotics, vitamin, amino acid, trace elements, bioassay by blotting and hybridization, automation	**15**
Unit IV: QA/QC	1. Definitions: Manufacture, Quality, Quality control, concept of QC. 2. Concept of GMP and requirements of GMP implementation. Documentation and regulatory certification of GMP. 3. Variables of batch process. 4. QA and QC - Concept and requirements 5. QA and QC w.r.t- Raw materials, methods of manufacturing, in process items, finished products, labels and labeling and packaging materials. 6. Control of microbes during the manufacturing process. 7. Documentation and Regulation of QA and QC with example- FSSAI (regulatory agency). 8. Concept of HACCP with principles.	**15**

Course Code BNBUSBT6T3	Course Title Pharmacology and Neurochemistry	Credits 2.5	No. of lectures
Learning Outcomes: Learners will be able to: 1. Elucidate the concepts of pharmacology. 2. Obtain clarity about mechanism of absorption of drugs from different tissues. 3. Ability to examine the mechanism of different poisons and toxins. 4. Have familiarity with current literature related to functions and diseases associated with neurotransmitters.			
Unit I: General principles of Pharmacology	1. Clinical testing of drugs 2. Phases of clinical investigation, Special population, Adverse reaction surveillances 3. Receptors, Drug receptors and biological responses 4. Second-messenger systems 5. The chemistry of drug–receptor binding 6. Dynamics of drug receptor binding 7. Dose–response relationship 8. Therapeutic index, ED, LD 9. Equations derived from drug receptor interactions 10. Potency and Intrinsic Activity 11. Drug antagonism		**15**
Unit II: Drug Absorption and Distribution	1. Absorption of drugs from the alimentary tract 2. Factors affecting rate of gastrointestinal absorption – 3. Absorption of drugs from lungs, skin 4. Absorption of drugs after parenteral administration factors influencing drug distribution 5. Binding of drugs to plasma proteins 6. Physiological barriers to drug distribution		**15**
Unit III: Basic and regulatory Toxicology	1. Background Definitions - Causation: degrees of certainty Classification 2. Allergy in response to drugs Effects of prolonged administration: chronic organ toxicity 3. Adverse effects on reproduction 4. Poisons: Deliberate and accidental self-poisoning Principles of treatment Poison-specific measures General measures 5. Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, herbicides and pesticides, biological substances (overdose of medicinal drugs is dealt with under individual agents) 6. Incapacitating agents: drugs used for torture - Nonmedical use of drugs		**15**

Unit IV: Neurochemistry	1. Types of nervous systems (an overview) 2. Types of neurons and their structure 3. Chemical impulses and electrical impulses 4. Chemical- acetylcholine receptors, action potential 5. Electrical - gap junctions and synapses 6. Neuronal excitation and inhibition 7. Action of Neurotoxins and neurotransmitters 8. Tetrahydrocannabinol- As an example of drugs affecting the action of neurotransmitters	**15**

Course Code BNBUSBT6T4	Course Title Applications of Biotechnology, Gene sequencing & editing and Environmental Biotechnology	Credits 2.5	No. of lectures
Learning Outcomes: Learners will be able to: 1. Apply knowledge gained about recombinant DNA technology. 2. Understand DNA sequencing and editing tools. 3. Learn about different methods used for potable water sanitation and bacteriological analysis of potable water. 4. Know the nature of sewage and treatment of wastewater before it is released in environment.			
Unit I: Applications of Biotechnology	1. Heterologous protein production: available systems, their pros and cons 2. Production of human insulin in E. coli 3. Vaccines: advantages of modern vaccines over traditional ones 4. Production of vaccine using RDT: a. Subunit vaccines (HSV) b. Peptide vaccine (FMDV) c. Attenuated vaccine (cholera) d. Edible vaccines 5. Diagnostics: DNA molecular testing: SCA 6. Therapeutics: Gene therapy 7. DNA typing: principle, methodology and applications 8. Introduction to microarrays- only basic 9. Biosensors: general features, types, microbial biosensor for pollution detection		**15**
Unit II: Gene sequencing and editing	A. DNA sequencing Methods: 1. Sanger's dideoxy method 2. Automated DNA sequencing 3. Pyrosequencing B. Human genome project C. Gene Editing Tools 1. RNAi (siRNA, miRNA,) 2. ZNF (Zinc finger nucleases) 3. TALENS (Transcription Activator Like Effector Nucleases) 4. CRISPER/ Cas system (Clustered Regularly Interspersed Repeats)		**15**
Unit III: Environmental Biotechnology-I	**A. Potable water treatment, and analysis** 1. Potable water: Definition, water quality standards and pathogens transmitted through water 2. Drinking water purification treatment processes: Preventive treatment, Sedimentation, Flocculation and		**15**

	filtration, Reverse osmosis, Disinfection: Chlorine and Ozone treatment and UV disinfection 3. Routine bacteriological analysis of water: Indicator organisms and their detection in water- Presumptive, Confirmed, Completed tests, Total Coliforms, Fecal Coliforms, Fecal Streptococci, *Clostridium perfringens* **B. Domestic sewage treatment** 1. Ecology of wastewater 2. Nature of wastewater 3. Modern Waste Water treatment: Primary, Secondary and Tertiary Treatment 4. Oxidation Ponds and Septic tanks 5. Sludge Processing; Disposal of treated waste water and Biosolids	
Unit IV: Environmental Biotechnology-II	1. Biological processes for industrial effluent treatment: Aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (Nitrogen and Phosphorous removal), Solid waste treatment 2. Biological filters, RBC, FBR Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB 3. Pollution indicators & biosensors 4. Biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation 5. Use of immobilized enzymes or microbial cells for treatment; 6. Packaged organisms and genetically engineered organisms in waste treatment	**15**

Course Code BNBUSBT6T5	Course Title Agribiotechnology	Credits 2	No. of lectures
Learning Outcomes: Learners will be able to: 1. Explain different criteria to be considered for greenhouse design and construction 2. Describe different interactions of plants with pathogens 3. Understand applications of molecular markers in plants 4. Explain role of microorganisms in plant growth promotion			
Unit I: Agriculture and Agriculture systems	1. Introduction to Agriculture and Agriculture systems 2. Greenhouse Technology- Agroclimate, Types of greenhouses, importance, functions and features of green house, Design criteria 3. Construction material, covering material and its characteristics, growing media, green house irrigation system, nutrient management. 4. Greenhouse heating, cooling and shedding and ventilation system, 5. Greenhouse environmental control (computerized control-overview) 6. Phytotrons, fertigation and roof system.		**12**
Unit II: Plant stress biology	1. Stress physiology Introduction 2. Types of stress- Abiotic, Biotic 3. Abiotic Stress- Types of Abiotic stress and physiological responses 4. Molecular responses of plants to different stress conditions- (water stress, salinity stress, temperature stress - heat and cold, Photooxidative stress): stress perception and stress signaling pathways 5. Biotic stress - plant interaction with bacterial, viral and fungal pathogens, 6. Systemic and induced resistance: pathogen derived resistance, signaling 7. Plant responses to pathogen - biochemical and molecular basis of host - plant resistance, toxins of fungi and bacteria		**12**
Unit III: Molecular Markers in Plant Breeding	1. Genetic markers in plant breeding- Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP). 2. Application of Molecular Markers to Plant Breeding [quantitative trait locus (QTL) mapping] 3. Plant DNA Barcoding- Barcoding 4. Markers (matK, rbcl, ITS, tmH-psbA), steps, recent advances, Benefits, Limitations		**12**

Unit IV: Biofertilizers and Biopesticides	1. Biofertilizer: Nitrogen - fixing Rhizobacteria - Symbiotic Nitrogen Fixers. 2. Nonsymbiotic Nitrogen Fixers 3. Plant Growth Promoting Microorganisms- Phosphate Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance 4. Plant Growth Promotion by Fungi- Mycorrhizae Arbuscular Mycorrhizae Ectomycorrhizae 5. Microbial Inoculants - Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations 6. Biopesticides – types, *Bacillus thuringiensis*, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application)	**12**

Course Code BNBUSBT6P1	Course Title Practical Based on BNBUSBT6T1 & BNBUSBT6T2	Credits 3	No. of lectures
1.	Determination of Vit C by DCPIP method from food samples		**72**
2.	Estimation of milk protein- Pyne's method		
3.	DMC of milk sample		
4.	Isolation of Normal flora from Milk and curd		
5.	Phosphatase test		
6.	Plate counts (SPC, LPC, Thermophilic and psychrophilic and coliform counts for provided milk sample)		
7.	Validation/ Calibration of instruments. a. Measuring cylinder b. Weighing balance c. Micropipette d. Colorimeter		
8.	Bioassay of antibiotic		
9.	Determination of serum cholesterol (total, HDL and LDL ratio)		

Course Code BNBUSBT6P2	Course Title Practical Based on BNBUSBT6T3 & BNBUSBT6T2	Credits 3	No. of lectures
1.	To detect the levels of antibiotics in body fluids using agar cup method.		**72**
2.	LD 50, ED 50 evaluation using suitable models e.g., Daphnia		
3.	Study of the effect of heavy metals on bacterial growth.		
4.	Routine analysis of water: a. Standard Plate Count b. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test, Eijkman test		
5.	Rapid Detection of *E.coli* by MUG Technique (Demonstration)		
6.	Study of microbial flora in raw and treated sewage		
7.	Determination of Total Solids from an effluent sample.		
8.	Study of physico-chemical parameters of any one industrial effluent sample: a. pH, color b. Turbidity c. BOD d. COD		
9.	Estimation of chromium from Effluents		
10.	Visit to ETP/ CETP		

Course Code BNBUSBT6P3	Course Title Practical Based on BNBUSBT6T5	Credits 2	No. of lectures
1.	RAPD analysis (demonstration experiment)		**48**
2.	Isolation of *Azospirillum*		
3.	Isolation of Phosphate solubilizing bacteria		
4.	Study of effect of abiotic stress on plants		
5.	Rapid screening tests for abiotic stress tolerance		
6.	Estimation of antioxidant – Ascorbate		
7.	Estimation of antioxidant enzyme activity a. Catalase b. Peroxidase		
8.	Visit to green house facility and submission of field visit report.		

References:

SEMESTER-V

BNBUSBT5T1 Cell biology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	The Cell: A Molecular Approach	Geoffrey N. Cooper	Sinauer Associates Inc	4th	2007
2.	Cell Biology	Thomas Pollard	Elsevier	3rd	2017
3.	Cell and Molecular Biology	Karp	John Wiley & Sons, Inc	6th	2010
4.	Cancer biology	Ruddon, R. W.	Oxford University Press	4th	2007
5.	Developmental Biology	Scott Gilbert	Sinauer Associates Inc.	9th and 12th	2010, 2012

BNBUSBT5T2 Microbiology and Instrumentation:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Cann Principles of Molecular Virology	Alan Cann	Elsevier Academic Press	4th	2005

2.	Fundamentals of Molecular Virology	Nicholas Acheson	John Wiley & Sons, Inc.	2nd	2011
3.	Understanding Viruses	Teri Shors	Jones & Bartlett Learning	2nd	-
4.	Prescott,Harley, and Klein's Microbiology	Willey, Sherwood, Woolverton	McGraw-Hill	7th	2008
5.	Principles of Virology	Flint, Racaniello, Rall, Skalka, Enquist	ASM Press	4th	2015
6.	Introduction to Modern Virology	Dimmock, Easton & Leppard	Wiley Blackwell	7th	2016
7.	Virology: Principles & applications	Carter & Saunders	John Wiley & Sons	-	2007
8.	General Enzymology	Dr. N .S.Kulkarni	Himalaya publishing house	1st	2007
9.	Understanding Enzymes: An Introductory Text	Dr. Aditya Arya	Drawing Pin Publishing, New Delhi, India	1st	2019
10.	Physical biochemistry - Applications to Biochemistry and	David Freifelder	W. H. freeman & Co, New York	2nd	

	Moleculkar Biology				
11.	Biophysical Chemistry Principles and Techniques	Upadhyay, Upadhyay and Nath	Himalaya Publications		
12.	Principles and Techniques of Biochemistry and Molecular Biology	Keith wilson and john walker	Cambridge University Press	7th	
13.	iGenetics: A Molecular Approach	Peter J. Russell	Pearson Education, Inc., publishing	3rd	
14.	Principles of gene manipulation and genomics	Sandy B. Primrose, Richard Twyman, Bob Old	John Wiley and Sons Ltd	7th	
15	A review of imaging techniques for systems biology Radiology book chapter on Fundamentals of PET and PET/CT Imaging , Ronald B. Workman	Kherlopian AR			
16	Biomedical Imaging Techniques	SS Ilangovan, 2017			
17	Intro to instrumentation in	Bisen Prakash			

	life science	Singh			

BNBUSBT5T3 Genomes and Molecular biology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	iGenetics	Peter Russell	Pearson Education Inc.	3rd	2010
2.	Principles of gene manipulation and genomics	Primrose, S. B., & Twyman, R.	John Wiley & Sons.	7th	2006
3.	Biotechnology: Fundamentals And Applications	S. S. Purohit	Agrobios (India)	4th	2005
4.	Molecular biotechnology: principles and applications of recombinant DNA.	Glick, B. R., Pasternak, J. J. & Patten	ASM press, Washington DC	4th	2010
5.	Biotechnology Expanding Horizons	B. D. Singh	Kalyani publication	1st	2014

BNBUSBT5T4 Marine Biotechnology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Springer handbook of marine	Se-Kwon Kim (Ed.)	Springer	-	-

	Biotechnology				
2.	Encyclopedia of life sciences	Paul Snelgrove	-	-	2003

BNBUSACBT5T1 Bioinformatics and Biostatistics:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Biostatistics for the Biological and Health sciences with Statdisk	Marc M. Triola and Mario F. Triola	Pearson Education Limited	1st	2012
2.	Biostatistics	P.N. Arora	Himalaya Publishing House	-	2012
3.	Basic Bioinformatics	S. Ignacimuthu	Alpha Science International Ltd.	2nd	2013
4.	Essential Bioinformatics	Jin Xiong	Cambridge University Press	-	2006
5.	Bioinformatics: A practical guide to the analysis of genes and proteins, (2001), New York.	Baxevanis, A. D. and Ouellette, B. F. F.;			
6.	Bioinformatics Sequence and Genome Analysis	Mount David	Cold Spring Harbor Laboratory Press, New		

	(2004),		York.		

SEMESTER-VI

BNBUSBT6T1 Biochemistry:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Harper's Illustrated Biochemistry	Robert K. Murray	McGraw Hill	26th	2003
2.	Principles of Biochemistry	Lehninger	W.H. Freeman & Company	6th	2013
3.	Biochemistry	U. Satyanarayana and Chakrapani	Elsevier	4th	2013
4.	Principles of Biochemistry	ry - Nelson and Cox,	W. H. Freeman & Co. Ltd.	4th	2004
5.	Biochemistry	Berg, Tymoczko, Stryer	W. H. Freeman and Company	6th	2007
6.	General Microbiology	Stanier, Ingraham, Wheelis, Painter	Prentice-Hall	5th	1987
7.	Zubays Principles of	Veer Bala Rastogi, K R	Medtech	5th	2017

	Biochemistry	Aneja			
8.	Nutrition science	B. Srilakshmi	Srilakshmi Publications	6th	2017
9.	Biochemistry	Satyanarayana and Chakrapani	Books and Alliance Pvt. Ltd.	4th	2017

BNBUSBT6T2 Industrial Microbiology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Applied Dairy Microbiology	Elmer.H. Marth, James. L. Steele	Mercel Dekker Inc.	2nd	
2.	Dairy Technology	Yadav and Grower			
3.	Fundamentals of Microbiology	Frobisher	W.B Saunders Company	9th	
4.	Industrial Microbiology	A. H. Patel	Laxmi Publications	2nd	2011
5.	Modern industrial Microbiology and biotechnology	Nduka Okafor	Science publisher	1st	2007
6.	Fermentation Technology	H.A. Modi	Pointer Publishers	-	2011
7.	Pharmaceutical Microbiology	Hugo, W.B. Russel	Oxford black scientific	6th	

			publishers		
8.	FSSAI Manual ob GLP.				
9.	Food Microbiology	W.C Frazier	McGraw Hill	5th	2014

BNBUSBT6T3 Pharmacology and Neurochemistry:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Modern Pharmacology with clinical applications	Charles R. Craig and Robert E. Stitzel	Lippincott Williams and Wilkins	5th	2003
2.	Clinical Pharmacology	Bennet P.N, Brown M.J, Sharma.P	Elsevier	11th	
3.	Toxicology- The basic science of poisons	Casarett and Doull's by Kurtis Klaassen	McGraw Hill	9th	-
4.	Biochemistry	Metzler D.E	Elsevier	-	-
5.	Textbook of Medical Physiology, Guyton	A.C and Hall	J.E. Saunders	11th	-
6.	The Cell : A Molecular Approach	Geoffrey.M Cooper, Rober Hausman	Sinauer Associates Inc.	6th	2013

BNBUSBT6T4 Applications of Biotechnology:

Sr. No.	Title	Author/s	Publisher	Edition	Year

1.	https://www.nature.com/scitable/topicpage/dna-sequencing-technologies-key-to-the-human-828/				
2.	https://journals.sagepub.com/doi/full/10.1080/01926230701197107				
3.	http://www.genetherapynet.com/gene-editing-tools/zinc-finger-nuclease.html				
4.	https://www.sciencedirect.com/topics/neuroscience/zinc-finger-nuclease				
5.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3547402/ http://www.genetherapynet.com/gene-editing-tools/talen.html				
6.	https://www.neb.com/tools-and-resources/feature-articles/crispr-cas9-and-targeted-genome-editing-a-new-era-in-molecular-biology https://www.takarabio.com/learning-centers/gene-function/gene-editing/gene-editing-technology-overviews/introduction-to-the-crispr/cas9-system https://www.annualreviews.org/doi/full/10.1146/annurev-biophys-062215-010822?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub%3Dpubmed				
7.	iGenetics	Peter Russell	Pearson Education Inc.	3rd	2010
8.	Gene cloning and DNA analysis	T.A.Brown	Wiley Blackwell	6th	2010
9.	Molecular Biology	David Friefelder	Narosa	2nd	2004
10.	Environmental Microbiology	Raina M. Maier, Ian L. Pepper, Charles P.Gerba,	,Academic Press	2nd	2010
11.	Fundamental Principles of	A.J. Salle	Tata Mc Graw Hill	7th	

	Bacteriology		Publishing Company		
12.	Fundamentals Of Microbiology	Martin Frobisher			
13.	Basic Principles of wastewater treatment	Marcos von Sperling			
14.	Environmental biotechnology (Industrial pollution management)	S. N. Jogdand			
15.	Environmental Biotechnology	Jordening-and-winter			
16.	Environmental biotechnology	Alan Scragg		2nd	2005
17.	Environmental biotechnology basic concepts and applications by	Indushekhar Thakur			
18.	Recombinant DNA Genes and Genomes A Short Course	Watson, J. D., Watson, C., Gilman, M., Witkowski, J. A., Zoller, M., & Witkowski, J.	Macmillan.	3rd	1992
19	Biotechnology Expanding Horizons	B. D. Singh	Kalyani publication	1st	2014
20	A Textbook of Biotechnology	R C Dubey	S. Chand Publishing	4th	1993

21	Molecular biotechnology: principles and applications of recombinant DNA.	Glick, B. R., Pasternak, J. J. & Patten	ASM press, Washington DC	4th	2010

BNBUSACBT6T1 Agribiotechnology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Agricultural systems (Agroecology and rural innovation)	Seiglinde Snapp and Barry Pound	Elsevier	2nd	2017
2.	Sustainable Crop Protection under Protected Cultivation	P. Parvatha Reddy	Springer		2016
3.	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1612				
4.	https://ncert.nic.in/vocational/pdf/kepc104.pdf				
5.	Introduction to Plant Physiology	William G. Hopkins and Norman P. A. H ¨uner	Wiley	4th	2008

6.	Biotic interactions in plant - pathogen association	M. J. Jeger			2001
7.	Comprehensive and Molecular Phytopathology	Yuri Dyakov, Vitaly Dzhavakhiya, Timo Korpela	Elsevier	1st	2007
8.	Plant Physiology	Taiz &; Zeiger	Springer		
9.	Plant Breeding from Laboratories to Fields Edited	Sven Bode Andersen			
10.	(Article) QTL mapping and its applications in crop plants	B M Prasanna			
11.	Plant DNA Barcoding and Phylogenetics	Ali, Gyulai, Al-Hemaid			2015
12.	Advances in Applied Microbiology 82	Sima Sariaslani and Geoffrey M. Gadd	Elsevier	1st	2013
13.	Biotechnology for Sustainable Agriculture	Ram Lakhan Singh, Sukanta Mondal	Elsevier	1st	2017

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
20	10	10	40

Internal Examination: **Based on Unit 1 / Unit 2 / Unit 3/ Unit 4**

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

	2	Based on Unit I / II / III/ IV							
	A		b		C		d		
	3	Based on Unit I / II / III/ IV							
	A		b		C		d		
	4	Based on Unit I / II / III/ IV							
	A		b		C		d		
	5	Based on Unit I / II / III/ IV							
	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		**12**
	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		**12**
	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		**12**
	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 IV	
	B	Based on Unit IV	
	C	Based on Unit IV	
	D	Based on Unit IV	
Q. 5	Answer ***any six*** of the following		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit II	
	e	Based on Unit II	
	f	Based on Unit II	
	g	Based on Unit III	
	h	Based on Unit III	
	i	Based on Unit III	
	j	Based on Unit IV	
	k	Based on Unit IV	
	l	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
BNBUSBT5T1	**40**	**16**	**60**	**24**	BNBUSBT5P1	**100**	**40**
BNBUSBT5T2	**40**	**16**	**60**	**24**			
BNBUSBT5T3	**40**	**16**	**60**	**24**	BNBUSBT5P2	**100**	**40**
BNBUSBT5T4	**40**	**16**	**60**	**24**			
BNBUSBT5T5	**40**	**16**	**60**	**24**	BNBUSBT5P3	**100**	**40**

Theory					Practical		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSBT6T1	**40**	**16**	**60**	**24**	BNBUSBT6P1	**100**	**40**
BNBUSBT6T2	**40**	**16**	**60**	**24**			
BNBUSBT6T3	**40**	**16**	**60**	**24**	BNBUSBT6P2	**100**	**40**
BNBUSBT6T4	**40**	**16**	**60**	**24**			
BNBUSBT6T5	**40**	**16**	**60**	**24**	BNBUSBT6P3	**100**	**40**

Practical Examination:

• Would be conducted over a period of 3 days; 50M each paper.

• Each student would be involved in research project for duration of at least 1 month (full-time)

/ Internship for duration of at least 1 month (full-time)/ Entrepreneurial work **(50M)**

• Sem VI would have ONLY project/ Internship/ Entrepreneurial work presentation

• Practical Examination of 100 M for Applied component would be conducted over a period of 2 days

Research Project

Students would undertake a project for at least 1 month during the last semester and submit the project report signed by research guide

The project should include either of the following:

- One/ more major instrumentation OR
- One / more major technique/s required in the field of interest OR
- Bioinformatics OR
- Biostatistics

Internship:

- Students would undertake internship in pathology laboratory or biotechnology/ pharmaceutical industry
- They would submit the internship report signed by concerned authority as well as present the work done

Entrepreneurial work:

Students would work upon an entrepreneurial idea related to the field of Biotechnology and submit the report signed by guiding teacher. The report and presentation during the exam should include:

- Uniqueness of idea
- Planning & Execution
- Prototype
- Regulatory certifications required for selling the idea or product
- Cost analysis