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

Agenda Number : 2 **Resolution Number : 30, 31/4.1 & 4.6**

Vidya Prasarak Mandal's

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

Syllabus for

Programme : Bachelor of Science

Specific Programme : Biochemistry

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

Revised under Autonomy

From academic year 2023 - 2024

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Preamble

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

With a little brush-up to the knowledge obtained in earlier levels of graduation, the student enrolling in this program would find himself learning exciting concepts of Genetics, Enzymology,Recombinant DNA technology, Immunology, Virology, Biostatistics, Bioinformatics, Clinical Biochemistry, Pharmacology, etc.

Inclusion of a brand-new unit of Developmental Biology and its applications will help students relate with the current happenings in the field and stay updated. Concepts of Clinical Biochemistry would make student job ready. The Units on Nutrition, Nutraceutical Science & Dietetics comes with introduction to the newly emerged field. The syllabus gives a perfect bird's eye view of various fields to student where the biochemistry graduates can enter. This will help them plan their career well in advance. Hands-on techniques taught during the practical sessions would help in thorough understanding of the concepts through self-experience.

The learner would follow student-centric 'Credit System', which will allow continuous assessment and holistic evaluation of the candidate through internal and external modes. With this thoughtfully designed syllabus, it is expected that the learner would have a very strong conceptual base to be used in whichever field he or she enters and would have a habit of self-learning deeper concepts in a particular field of his or her interest.

Eligibility:

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

Duration:1 year

Mode of Conduct: Laboratory practical& Offline lectures

Program Specific Outcome

- Learner would choose and enter into any one of the various avenues that are open to biochemistry graduates to work in.
- Learner would exhibitthe up-to-dateknowledge of Clinical Biochemistry,Biostatistics, Bioinformatics, Recombinant DNA technology, Industrial Biochemistry,Advanced Enzymology, Genetics etc.
- Learner would apply the knowledge gained for sustainable development.
- Learner would develop certain values and life skills important for Life Long Learning

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

T.Y.B.Sc. (Biochemistry)

Structure of Programme

Semester V

Course Code	Unit	Topics	Credits	Lectures
Metabolism & Analytical techniques – I				
BNBUSBC5T1	**I**	Carbohydrate Metabolism	**2.5**	15
	II	Bioenergetics & Oxidative Phosphorylation		15
	III	Spectroscopy& Radioactivity		15
	IV	Chromatography		15
Nutrition Science & Developmental Biology				
BNBUSBC5T2	**I**	Nutrition Science	**2.5**	15
	II	Nutraceutical Science		15
	III	Dietetics		15
	IV	Developmental Biology		15
Genetics &rDNA Technology – I				
\ **BNBUSBC5T3**	**I**	DNA Replication, Mutation& Repair	**2.5**	15
	II	Transcription & Translation		15
	III	Recombinant DNA Technology I		15
	IV	Recombinant DNA Technology II		15
Immunology & Pathophysiology I				
BNBUSBC5T4	**I**	Human Immune System	**2.5**	15
	II	Essentials of Immunology		15
	III	Antigen-Antibody Interactions		15
	IV	Cancer Biology		15
BNBUSBCP05 & BNBUSBCP06	Practicals based on courses in theory – BNBUSBC5T1, BNBUSBC5T2, BNBUSBC5T3, BNBUSBC5T4		**3**	**16/week**

VPM's B. N. Bandodkar College of Science (Autonomous), Thane
T. Y. B. Sc. (Biochemistry)
Structure of Programme

Semester VI

Course Code	Unit	Topics	Credits	Lectures
Metabolism & Analytical techniques - II				
BNBUSBC6T1	**I**	Lipid Metabolism	**2.5**	15
	II	Amino Acid & Protein Metabolism		15
	III	Advanced Enzymology		15
	IV	Electrophoresis		15
Clinical Biochemistry & Pharmacology				
BNBUSBC6T2	**I**	Aging & metabolic Disorders	**2.5**	15
	II	Clinical Biochemistry		15
	III	Pharmacology - I		15
	IV	Pharmacology - II		15
Biostatistics& Bioinformatics				
\ **BNBUSBC6T3**	**I**	Biostatistics and Descriptive Statistics	**2.5**	15
	II	Hypothesis Testing - I		15
	III	Hypothesis Testing- II		15
	IV	Bioinformatics		15
Immunology & Pathophysiology II				
BNBUSBC6T4	**I**	B & T cell Maturation	**2.5**	15
	II	Pathophysiology of Viral Diseases		15
	III	Vaccines		15
	IV	Disorders of Immune System & Transplantation Immunology		15
BNBUSBCP07 & BNBUSBCP08	Practicals based on courses in theory – BNBUSBC6T1, BNBUSBC6T2, BNBUSBC6T3, BNBUSBC6T4		**3**	**16/week**

Semester V

Course Code BNBUSBC5T1	Course Title Metabolism & Analytical techniques – I	Credits 2.5	No. of lectures

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

- Comprehend the catabolism and anabolism of carbohydrates and the disorders associatedwith these biomolecules
- Calculate the energy transactions involved in the metabolic pathways
- Apply principles of spectroscopy to solve real life problems
- Separate components of a mixture using chromatographic techniques

Unit I Carbohydrate Metabolism	1.1 Catabolism – Cellular location, sequence of reactions, labelling of carbon atoms, and energetics of: Glycolysis, (aerobic and anaerobic); Fate of Pyruvate, Rapoport-Leubering Cycle 1.2 Oxidation of pyruvate, PDH complex reactions, Krebs cycle; Glyoxylate pathway; Glycogenolysis – [schematic – no structures, but with enzymes and coenzymes] 1.3 Anabolism – HMP shunt & its Importance (Cellular location, sequence of reactions, multifunctional nature); Gluconeogenesis, Cori cycle, Glucose alanine cycle 1.4 Glycogenesis – [schematic – no structures, but with enzymes and coenzymes] Metabolism of different sugars - starch fructose and cellulose 1.5 Disorders of carbohydrate metabolism: Lactose Intolerance, Lactic Acidosis	**15**
Unit IIBioenergetics& Oxidative Phosphorylation	2.1 Bioenergetics: Concept of free energy; Respiratory electron transport chain – Carriers (basic chemistry, redox potentials, orientation on the membrane, sequence); Reaction of the Electron transport chain, Q cycle in Complex III; 2.2 Inhibitors of electron transport – Antimycin A, Amytal, Rotenone, CN, Azide, CO, 2.3 Malate-Aspartate shuttle, Glycerol phosphate shuttle, Creatine Phosphate shuttle 2.4 Oxidative phosphorylation – Chemiosmotic hypothesis, Proton motive force; Structure of ATP synthase, Uncoupler of ETC and Oxidative phosphorylation [DNP], Significance of uncoupling, Diseases associated with mitochondria 2.5 Bioluminescence. Phenomenon (in jelly fish and fireflies) and significance, applications of Bioluminescence	**15**

Unit III Spectroscopy& radioactivity	3.1 Principle, Instrumentation, working, applications, advantages and disadvantages of Fluorescence spectroscopy, Luminometry, Flame spectrophotometry, Atomic Absorption Spectroscopy 3.2 Basic Principle of Nephelometry and turbidometry 3.3 Isotopes in biology- Nature of Radioactivity, Radioactivity Decay,Decay constant; Half-life; Measurement of radioactivity (principle) Units of radioactivity 3.4 Measurement of radioactivity-Geiger- muller counter, Liquid scintillation counting	**15**
Unit IV Chromatography	4.1 Chromatography Principle, Technique and Applications of the following kinds of chromatography: a. Partition chromatography (Paper), b. Adsorption Chromatography (TLC and column); c. Ion exchange chromatography, d. Affinity chromatography e. Gel filtration 4.2 Basic principles and applications of GLC, HPLC, HPTLC 4.3 Numerical problems based on above concept	**15**

Course Code BNBUSBC5T2	Course Title **Nutrition Science & Developmental Biology**	Credits 2.5	No. of lectures
Learning outcomes: After successful completion of this course Learner will be able to • Explain importance of nutrition in human life • Design a balanced diet for a particular condition • Enlist the supplements rich in nutraceuticals • Cite examples of model organisms and enlist different stages of development and differentiation			
Unit I Nutrition Science	1.1 Introduction to Nutrition Science: Definitions, Nutrition Research in India. Food (Function and Composition of food, Classification of food) 1.2 Nutrition: Functions of nutrients, Nutrient Density and Health, Absorption and Utilization of Nutrients, Recommended dietary allowances (General principle of Deriving RDA and Use of RDA). Factors Affecting RDA 1.3 Vitamins- Dietary sources, bioactive form, functions anddisorders associated with fat soluble (A D E K) and water-solublevitamins 1.4 Concept of Balanced diet. Role of Macro and Micro molecules and their disorders (Ca, Mg, Na, Zn, Se, Mo, K, Fe & Zn) 1.5 Assessment of Nutritional status: Anthropometric, clinical, Biophysical, Dietary assessment. Calculation of BMR. Effects of lack of nutrition (Malnutrition) Protein deficiency: Protein quality indices: Chemical score of amino acids, Protein Deficiency corrected amino acid score and Net Protein utilization. Global problems of Nutrition		**15**
Unit IINutraceutical Science	2.1 Introduction to Nutraceuticals: History, Definition, Terminologies, Classification of Nutraceuticals based on Chemical nature (Isoprenoid Derivatives (Terpenoids), Food and Nonfood Sources of Nutraceutical 2.2 Functional food: Milk and dairy products as Functional foods, General idea about role of Probiotics and Prebiotics 2.3 Brief idea about some Nutraceutical rich supplements: e.g., Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina 2.4 Nutraceuticals from Seafood- Marine oils, omega -3, Chitin, Chitosan 2.5 Nutraceutical Foods derived from Fruits and vegetables:(Avocados, Banana, Bilberries, Orange, Cranberries, cabbage, beans) and Herbs(Alovera, tea) 2.6 Nutraceuticals in treatment: For cognitive decline, Nutraceutical remedies for common disorders (Any two can be taught by teacher and rest can be given as assignments: Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers, CVD, Arthritis, Inflammation, Cancer and Joint Disorders. etc.)		**15**

Unit III Dietetics	3.1 Meal Planning: Explanation of terms, planning of diet and food guide. Menu for healthful Tea- Time – Snacks 3.2 Nutrition and Food Requirements:During pregnancy, lactating, infancy, toddlerhood, preschool stage, school going children and adolescence, Adulthood and geriatric 3.3 Nutrition requirement during disease condition and development of a diet: Peptic Ulcer, Jaundice, Coeliacdisease and Obesity 3.4 Proximate principle of the diet 3.5 Introduction to Diet Therapy: Food, Nutrition and Drug interaction, Adjuncts to Diet therapy and Routine hospital diets, Summary of Therapeutic Diets	**15**
Unit IV Developmental Biology	4.1 Concept & characteristics of Model Organisms: *Drosophila melanogaster*, *E. coli*, Zebrafish, *Arabidopsis thaliana*, *C. elegans* 4.2 Stages of development- zygote, blastula, gastrula,neurula cell fate & commitment – potency 4.3 Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, Morphogenetic movements, mosaic and regulative development 4.4 Concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages ofthree germ layers, fate map 4.5 Pattern formation-- axis specification, positional identification (regional specification) 4.6 vulva formation in *C. elegans*	**15**

Course Code BNBUSBC5T3	Course Title Genetics & rDNA Technology	Credits 2.5	No. of lectures
Learning outcomes: After successful completion of this course Learner will be able to • Elaborate the mechanism of DNA replication • Explain the concepts of mutation and ways in which DNA gets repaired • Enlist the basic tools required and know the techniques of recombinant DNAtechnology • Compare and analyze different processes of gene transfer			
Unit I DNA Replication, Mutation& Repair	1.1 Replication of DNA in prokaryotes- Models of DNA replication: Semi-conservative, Dispersive & Conservative, Mechanism of semi-conservative replication 1.2 Modes of DNA replication: Theta & rolling circle, Enzymes, (pol I, II and III) and accessory proteins 1.3 Replication in Eukaryotes: Initiation, elongation and termination 1.4 Mutations: point and its types (Transition, transversion, missense, nonsense, neutral, silent, leaky mutation), Gross- structural (deletion, duplication, inversion, translocation, insertion): numerical (euploidy, aneuploidy), Spontaneous and induced mutations 1.5 DNA repair: Direct, Photoreactivation, O6 methyl guanine, DNA methyl transferase, Excision repair- Base, Nucleotide excision, Mismatch repair, Recombination repair, SOS-error prone repair		**15**
Unit II Transcription & Translation	2.1 Transcription - in prokaryotes, prokaryotic RNA polymeraseand promoter; mechanism of RNA transcription: Initiation,elongation and termination; processing of tRNA, rRNA, mRNA 2.2 Prokaryotes and eukaryotes- concept of split genes, reversetranscription. 2.3 Role of Inhibitor- Rifampicin, Actinomycin D 2.4 Translation (protein biosynthesis) in prokaryotes – Geneticcode, mechanism of translation: Activation of amino acids, chaininitiation, elongation & termination 2.5 Post translationalmodifications of proteins 2.6 Inhibitors and mode of action: Puromycin, Chloramphenicol,cycloheximide, tetracycline		**15**
Unit III rDNA Technology I	3.1 Introduction to RDT 3.2 Tools for RDT A. Enzymes- Restriction endonucleases, ligases, terminal transferases, reverse transcriptase: B. Cloning and Expression Vectors- Plasmid, pBR 322, PUC-19, Bacteriophage – Lambda phage; Cosmid; Artificial Chromosomes (BAC and YAC); Shuttle vectors; C. Probes- DNA probes 3.3 Applications of RDT- Agriculture (BT Cotton); Medicine (Insulin); GM		**15**

	food	
Unit IV **rDNA** **Technology II**	4.1 Isolation of gene: Gene library and cDNA library; Southern blot; Chimeric DNA 4.2 Gene Transfer: Transformation, Transfection, Electroporation, Microinjection, Liposome, Microprojectile (in brief) Selection and screening- Antibiotic and colony hybridization 4.3 DNA Amplification by PCR, RT-PCR, RAPD 4.4 DNA fingerprinting, DNA sequencing (Sanger, Pyrosequencing)	**15**

Course Code BNBUSBC5T4	Course Title **Immunology & Pathophysiology – I**	Credits 2.5	No. of lectures
Learning outcomes: After successful completion of this course Learner will be able to • Define basic terminologies of Immunology • Underline the importance of MHC, complement system, APCs for working of immune system • Analyze the role of antigen-antibody interactions as diagnostic techniques • Explain the role of oncogenes and tumour suppressor genes in cancer biology			
Unit I Human Immune System	1.1 Overview of immune system 1.2 Cells of the immune system: Lymphocytes – B cells and T cells, Natural killer cells – Mononuclear phagocytes, Granulocytes, APCs 1.3 Organs of the immune system: Primary lymphoid organs: Thymus, Bone marrow, Secondary lymphoid organs: Lymphatic system, Lymph nodes, Spleen, MALT 1.4 Humoral and cell mediated immunity, factors influencing and mechanisms of each 1.5 Antigens: Antigenicity, immunogenicity, epitope, factors determining immunogenicity, Haptens 1.6 Antibodies: Fine structure of immunoglobulin, Antibody mediated functions, Antibody classes, Ig superfamily		**15**
Unit II Essentials of Immunology	2.1 Complement: Nomenclature, activation pathways (Classical, alternative, lectin), biological function and regulation overview 2.2 Major histocompatibility complex: MHC polymorphism & organization of MHC genes- class I & class II; Cellular distribution & structure of class I & II molecules; Self MHC restriction of T cells 2.3 Transplantation Immunology 2.4 Cytokines: Concept, Types, Properties & Attributes of Cytokines, biological functions of IL-1, TNF, alpha, INF –alpha, INF -gamma, IL-2 2.5 Antigen presenting cells: Types, Endogenous (Cytosolic) Pathway & Exogenous (Endocytic) Pathway		**15**
Unit III Antigen Antibody Interactions	3.1 Antigen-Antibody Reactions: properties and types-Precipitation Reactions: Immunoprecipitation, Immuno-electrophoresis, CIEP, Rocket Electrophoresis and 2-D Immuno-electrophoresis. 3.2 Agglutination Reactions: Hemagglutination, Bacterial agglutination, Passive agglutination, Agglutination Inhibition 3.3 Complement Fixation Tests, RIA, ELISA, ELISPOT, Western Blot, Immunofluorescence, Flow Cytometry		**15**
Unit IV Cancer Biology	4.1 Biology of Cancer, Physiology of Cancer cells. 4.2 Causes of cancer Carcinogens: Types (Physical, Chemical andBiological, Environmental Factor); AMES test 4.3 Cancer and the cell cycle 4.4 Oncogenes and activation of oncogenes, Genetics of cancer with reference to p53, RB and Bcl2 4.5 Cancer therapy (Chemo – purine, pyrimidine and folate analogues)		**15**

Course Code BNBUSBC5T5	Course Title **Applied Environmental Science**	Credits 2.5	No. of lectures

Learning Outcomes: Learners will be able to:

- comprehend impact of the interrelationship between various components of the environment.
- create critical and creative thinking during designing, manufacturing, utilization of chemical products, which would reduce or eliminate the use or generation of hazardous substances.
- discover and design products, operations or processes, which conserve the energy resources.
- summarize the knowledge of various laws and regulations regarding the environment.

Unit I Introduction to Environment and pollution	1.1 Introduction to Environmental Science-Definition, Scope, Importance. Relationship with other branches of science: environmental biology, environmental chemistry, environmental engineering, environmental geology, environmental physics,environmental management. 1.2 Components of environment; biotic and abiotic. Composition of various segments of environment–atmosphere, hydrosphere, lithosphere, biosphere (with respect to composition and interrelationship). Types of pollution: 1.3 Water pollution: Pesticides and heavy metals. 1.4 Air pollution: Challenges posed by present day pollutants. 1.5 Others- Noise and nuclear pollution. Case Study of Thane Lakes, Case study of Thane Creek, GOI-UNDP Sea Turtle project.	**15**
Unit II Green Chemistry and Sustainability	2.1 The Twelve Principles of Green Chemistry. 2.2 Sustainable Development- Principlesand sustainable development indicators. 2.3 Goals of sustainable development. 2.4 Areas highlighted by Agenda 21. 2.5 Transition from Industrial economy to Green economy. Biography of Vandana Shiva - environmental activist, M.K. Prasad: A relentless green activist, Green Revolution M.S.Swaminathan.	**15**
Unit III Alternate Energy Resources	3.1 Renewable Energy-Definition and concept 3.2 Solar energy, wind energy, tidal energy, nuclear energy with examples. 3.3 Biomass & bio-fuels, petro crops, Algal biofuels 3.4 Use of wastes: Water-based biomass, energy from waste & solid waste Case study: Windmills & Wind Turbines in Maharashtra, Pawanchakki Aurangabad.	**15**
Unit IV Environmental Education and Legislation	4.1 Environmental education programmes in India. 4.2 Environmental organizations & agencies-CITES, EPA, IUCN & MAB. 4.3 Environmental laws in India: Wild life Protection Act, 1972, Water Prevention & Control of Pollution Act, 1974, Air Prevention & Control of Pollution Act, 1981, Environment Protection Act, 1986 & Biological Diversity Act, 2002. (Shifted from Sem VI) Case study: Water Conflicts: Sharing of Cauvery water between Karnataka and Tamil Nadu, Sharing of Godavari water Nashik, Ahmednagar & Marathwada.	**15**

Course Code BNBUSBCP05 BNBUSBCP06	Course Title Practicals based on courses in theory BNBUSBC5T1, BNBUSBC5T2, BNBUSBC5T3, BNBUSBC5T4	Credits 6	No. of lectures
BNBUSBC5T1	1. Estimation of sugar by Folin-Wu method		16 per week
	2. Estimation of glucose by Benedict's method		
	3. Estimation of phosphorus by Fiske and Subbarao method		
	4. Estimation of phospholipid by Bartlette's method (Lecithin/Cephalin)		
	5. Demonstration of Flame Photometry		
	6. Separation of sugars by circular paper chromatography		
BNBUSBC5T2	7. Estimation of total Nitrogen of foods by Kjeldahl and Micro Kjeldahl methods.		
	8. Estimation of reducing sugars by Cole's Method		
	9. Identification of Synthetic food colour by using chromatography		
	10. Extraction of gelatine from fish scales / any other source		
	11. DPPH assay of antioxidants		
	12. Estimation of proteins by Lowry's method		
	13. Estimation of crude fat contents of foods by Soxhlet's method (Butter, Margarine, edible oil)		
	14. Preparation of balanced meal for any of the conditions mentioned (Peptic ulcer, Obesity, Diabetes)		
	15. Estimation of Iron by colorimetric method		
	16. Estimation of carbohydrate by Anthrone method.		
	17. Determination of Chloride by the Mohr Method		
BNBUSBC5T3	18. Effect of UV on microbial cells		
	19. Isolation of dye resistant mutants by Gradient plate technique		
	20. Extraction of DNA from bacteria		
	21. Estimation of DNA by DPA method		
	22. Extraction of RNA		
	23. Estimation of RNA by Orcinol method		
BNBUSBC5T4	24. Field's staining of Blood film		
	25. Ouchterlony's method for understanding similarity between antigens		
	26. Identifying concentration of unknown antigen using Mancini's method		
	27. Blood typing for identification of Blood group		
	28. Confirmation of O & H antigen of Salmonella by WIDAL		

Semester V: Reference Books

Sr. No.	Title	Author
1	Fundamentals of Biochemistry	Jain & Jain
2	Biophysical Chemistry	Upadhyay, Upadhyay & Nath
3	iGenetics	Russell
4	Genetics	Benjamin Pierce
5	Textbook of Medical Physiology	Guyton & Hall
6	Principles of Anatomy & Physiology	Tortora
7	Textbook of Medical Biochemistry	M N Chatterjee
8	Biochemistry	Satyanarayana U
9	Zubay's principles of Biochemistry	Veer Bala Rastogi
10	Textbook of Biochemistry for Medical Students	D. M. Vasudevan
11	Lehninger Principles of Biochemistry	Nelson and Cox
12	Fundamentals of Food, Nutrition and Diet Therapy	Sumati Mudambi & M V Rajagopal
13	Nutrition Science	B Srilakshmi
14	A textbook of Food, Nutrition and Dietetics	M. Raheena Begum
15	Food Chemistry	Alex V Ramani
16	Food is Medicine: An Introduction to Nutraceuticals	Eng. Dr. Perkins Muredzi
17	Hand Book of Nutraceutical	Robert C E Wildman
18	Foods (facts and Principles)	N Shakuntala Manay
19	Day to Day Diet plan	Malti Karwarkar
20	Molecular biology	Weaver
21	General Principles of Biochemical Investigation	William & Wilson
24	Immunology	Goldsby and Kuby
25	Developmental Biology	Gilbert

Semester VI

Course Code BNBUSBC6T1	Course Title **Metabolism & Analytical techniques – II**	Credits 2.5	No. of lectures
Learning outcomes: After successful completion of this course Learner will be able to • Explain the metabolism of Lipids with the help of pathways involved • Elaborate on role of different amino acids in metabolic pathways of the body • Identify various sources of enzymes and develop assay to quantify them • Express the importance of electrophoretic methods & their applications			
Unit I Lipid Metabolism	1.1 Catabolism-Knoop's experiment; Fatty acid Oxidation: transport to mitochondria, activation of fatty acids, Beta oxidation of even carbon saturated fatty acids (C4 to C20) & its Energetics, ω oxidation and α-oxidation 1.2 Anabolism – Fatty acid biosynthesis (palmitic acid), FAS complex Enzymes 1.3 Ketone body formation, utilization, and the physiologicalsignificance of Ketone bodies in Diabetes mellitus, Starvation, Pregnancy and Alcoholism		**15**
Unit II Amino Acid & Protein Metabolism	2.1 Reactions of amino acids – Transamination [GOT/GPT and mechanism of transamination]; Decarboxylation [His, Trp, Glu, and mechanism of decarboxylation], Deamination [oxidative – NAD(P) linked dehydrogenases and D & L - Amino acid oxidases, non-oxidative – Asp, Cys, Ser] 2.2 Significance of GABA, serotonin, melatonin, Glucogenic and ketogenic amino acids, 2.3 Meister cycle, Detoxification of ammonia, Urea cycle – Cellular location, sequence of reactions, Regulation 2.4 Disorders of amino acid metabolism- hyper-ammonia, hyper-ornithinemia		**15**
Unit III Advanced Enzymology	3.1 Intracellular and extracellular enzymes 3.2 Identification of sources of enzymes, Extraction of enzymes: (Physical & chemical methods) 3.3 Terms related to Purification of enzymes: Yield, Specific activity, fold purification, Choice of method purification 3.4 Methods for purification: based on size, charge, solubility, specific binding sites 3.5 Development of qualitative and quantitative assays, Stabilization and crystallization of enzymes, Criteria for purity of enzyme 3.6 Immobilization of enzyme: Concept, applications, advantages and disadvantages Methods of Immobilization: Adsorption, Ionic Binding, Covalent binding, Cross linking, Entrapment, encapsulation		**15**
Unit IV Electrophoresis	4.1 Principle, Factors affecting rate of migration of sample in an electric field 4.2 Supporting media used – paper, cellulose acetate, agar, agarose and polyacrylamide 4.3 Instrumentation, working and applications of a) Discontinuous electrophoresis b) Native PAGE c) SDS PAGE d) Immuno-electrophoresis e) 2-D f) Pulsed Field g) Isoelectric Focusing 4.4 Applications of electrophoresis - Separation of proteins and Nucleic acids with one staining method for each;blotting techniques-Southern, Northern, and Western		**15**

Course Code	Course Title	Credits	No. of lectures
BNBUSBC6T2	Clinical Biochemistry & Pharmacology	2.5	

Learning outcomes: After successful completion of this course Learner will be able to • Compare different metabolic disorders and the reasons underlying them • Use the concepts of clinical biochemistry practically for diagnosis • Describe the importance of pharmacology and its application in therapeutics		
Unit I **Aging & Metabolic Disorders**	1.1 Metabolic disorder: Inborn error (With respect to etiology and clinical manifestations) 1.1.1 Carbohydrate metabolism disorder: Glycogen storage disease type I 1.1.2 Protein metabolism disorder: Albinism 1.1.3 Lipid metabolism disorder: Tay Sach's disease 1.2 Endocrine diseases: Diabetes mellitus, Diabetes insipidus 1.3 Blood related diseases: Iron deficiency anemia, sickle cell anemia, Thalassemia, Pernicious anemia, Hemophilia A & B 1.4 Cardio Vascular System and related diseases:Hypertension, Arteriosclerosis and Atherosclerosis 1.5 Aging: Definition, molecular changes during aging, Theories of aging, Alzheimer's disease, Parkinson's disease	**15**
Unit II **Clinical Biochemistry**	2.1 Basic concepts of Clinical Biochemistry: Scope of clinical biochemistry 2.2 Diagnostic importance of enzymes: Biochemical diagnosis of diseases by enzyme assays – SGOT, SGPT, alkaline phosphatase, Creatine kinase, cholinesterase, LDH 2.3 Organ function tests: Kidney function tests -Urea, creatinine, urea clearance test, creatinine clearance test, Liver function test, Gastric function test 2.4 Thyroid Function test -T3, T4, TSH 2.5 Water and Electrolyte Balance (Renin-Angiotensin-Aldosterone system)	**15**
Unit III **Pharmacology I**	3.1 Definitions & Historical Development, Sources, Nature & Nomenclature of drugs, Dosage forms & Routes of Administration of drugs 3.2 Factors influencing Dosage & Drug action 3.3 Pharmacodynamics, Physicochemical properties of drugs 3.4 Drug absorption: through-GIT, pulmonary, renal, placental blood-brain barrier 3.5 Bioavailability & Bioequivalence Drug Distribution, Metabolism and Excretion	**15**
Unit IV **Pharmacology II**	4.1 Mechanism of action of drugs a. Specific interaction – receptor mediated b. Partially specific – drugs via enzymes c. Nonspecific interactions – antimetabolites and antiseptics d. Through Antibodies e. Placebo effects 4.2 Therapeutic drugs: Mechanism of action and adverse effects a) Anti-inflammatory – non-steroid anti-inflammatory NSAID [Ibuprofen], Salicylates – [Aspirins] b) Cardiovascular drugs- CVS [Ca channel blocker-Amlodipine, and Beta blocker – Propranolol c) Antibiotic – Penicillin and Sulphonamide d) Antacid- Proton pump blocker –Omeprazole 4.3 Bioassays: Preclinical and clinical evaluation, Therapeutic drug monitoring 4.4 Pharmacokinetics: LD50, ED50, Half Life, Loading dose, Maintenance dose, Therapeutic dose, Therapeutic Index, Drug plasma concentration, Volume of distribution, Clearance	**15**

Course Code BNBUSBC6T3	Course Title **Biostatistics & Bioinformatics**	Credits 2.5	No. of lectures
Learning outcomes: After successful completion of this course Learner will be able to • Apply methods of biostatistics for analysis of data • Solve real life problems using biostatistics • Explain the importance of Bioinformatics and use it for analysis of various databases			
Unit I Biostatistics and Descriptive Statistics	1.1 Introduction: scope and applications of biostatistics 1.2 Common statistical terms: Sources, nature and presentation ofdata; Measurement and scales of measurement 1.3 Descriptive statistics: Measures of central tendency- Mean,Median and mode, Merits & Demerits of each 1.4 Measures of dispersion- Range, percentiles,Quartile, Deciles, Variance, SD, Meandeviation 1.5 Probability: Concept of probability: definition, Probability distribution: normal distribution and normal Curve, Asymmetric distribution 1.6 Statistical problems based on the above concepts		**15**
Unit II Hypothesis Testing I	2.1 Introduction; Single population mean, difference betweenpopulation means 2.2 Type I and Type II errors, 2.3 One-tailed and two tailed tests 2.4 Z-test 2.5 Statistical problems based on the above concepts		**15**
Unit III Hypothesis Testing II	3.1 t-test: Paired and unpaired 3.2 Chi-square test 3.3 Statistical problems based on the above concepts		**15**
Unit IV Bioinformatics	4.1 Definition, Aims and History of Bioinformatics 4.2 Applications of Bioinformatics in – Sequence analysis, Molecularmodeling and drug designing, Phylogeny/evolution, Ecology &population studies, medical informatics and agriculture. 4.3 Introduction to Genomics and Proteomics 4.4 Databases- Definition & types – Public domain database, Sequence database, Structural database, Motif database, Genome database, Proteome database, Annotated sequence database 4.5 Full form & function in brief of - GenBank, EMBL, PIR, SWISS PROT, PDB, GDB 4.6 Sequence analysis Tools - Explain the following terms in brief -BLAST, FASTA, L-ALIGN, CLUSTAL- X & W, RASMOL, 4.7 Software for protein sequencing - PROSPECT, AMMP, COPIA (Explanation of the terms in brief) 4.8 Micro-array analysis-concept and applications		**15**

Course Code BNBUSBC6T4	Course Title **Immunology & Pathophysiology II**	Credits 2.5	No. of lectures
Learning outcomes: After successful completion of this course Learner will be able to • Explain the roles of T & B cells in immune system and the process of their maturation • Identify the role of viruses in cancer • Elaborate on the need and working of vaccines • Prepare a concept map of all immunodeficiency disorders			
Unit I **B & T Cell Maturation**	1.1 T Cell Receptor-structure, TCR-CD3 complex - structure and functions. Accessory molecules 1.2 General properties of effector T cells 1.3 Cytotoxic T cells and destruction of target cell by perforin/granzyme pathway and Fas pathway 1.4 Killing mechanism of NK cells, ADCC 1.5 B cell receptor and co-receptor-structure and function 1.6 Signal transduction pathway activated by BCR-overview 1.7 Antibody diversity*:* Multigene organization of immunoglobulingenes – Lambda, kappa & heavy chain a. Light chain DNA – VJ rearrangements b. Heavy chain DNA - VDJ rearrangements 1.8 Role TH cell in B cell response-Formation of T-B conjugates, CD40/CD40L interaction, TH cells cytokine signals		**15**
Unit II **Pathophysiology of Viral Diseases**	2.1 Basics of Viral structure, Satellite viruses, Virophage &Mimivirus 2.2 Diagnostic methods in Virology: Purification, Cultivation, Enumeration, Detection, Cytocidal infections and cell damage 2.3 Viroid and Prions 2.4 AIDS: Structure and genetics basis of AIDS virus, Replication of AIDS Virus, Symptoms and Causes of AIDS, AIDS Therapy 2.5 Role of viruses in cancer: Viral oncogenes, Examples of viruses involved in cancers: EB, HPV 2.6 Antiviral chemotherapy		**15**
Unit III **Vaccines**	3.1 Vaccines: Introduction, significance, use of adjuvants, active and passive immunization 3.2 Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines 3.3 New vaccine strategies, Ideal vaccine 3.4 Vaccine strategies for immerging infections/ illness: HIV, COVID 19		**15**

Unit IV Disorders of Immune System &Transplantation Immunology	4.1 Primary Immunodeficiency disorders 4.2 Secondary Immunodeficiency disorders 4.3 Concept of Autoimmunity:Myasthenia Gravis, Hashimoto's Thyroiditis, RA, SLE 4.4 Transplantation Immunology (Graft rejection & GVHD)	**15**

Course Code BNBUSBC6T5	Course Title **Environmental Management**	Credits 2.5	No. of lectures
Learning Outcomes: Learners will be able to: • 1. study and comprehend the treatment practices applied for domestic wastewater and industrial effluents. • develop aptitude to examine and assess the outcome of the framework of current biodiversity hotspots, biosphere reserves and ecotourism. • relate the impacts of climate change to the environment. plan &execute environmental auditing.			
UNIT I **Ecological Restoration**	1.1 Domestic wastewater treatment. 1.2 Effluent treatment of Industrial waste. 1.3 Bioremediation. 1.4 Alternatives to conventional resources: biodegradable plastic, biodiesel, bio ethanol biopesticides. 1.5 Developing effluent treatments. Case study: Maharashtra Nature Park Society, Sion		**15**
UNIT II **Biodiversity Conservation and Ecotourism**	2.1 Hotspots of biodiversity and biosphere reserve. 2.2 Strategies for biodiversity conservation (in-situ and ex-situ). 2.3 Commercial wildlife photography. 2.4 Ecotourism–definition, policies and practices. 2.5 Eco sensitive zones of Thane Creek Flamingo Case study Tungareshwar Wildlife Sanctuary (TWLS) and Tansa Wildlife Sanctuary (TWS), Sanjay Gandhi National Park Borivali, Aarey forest, Mumbai.		**15**
UNIT III **Climate Change**	3.1 Introduction to climate change, global warming and its effects. 3.2 Geospatial technology- Remote Sensing & GIS. 3.3 Role of IPCC in climate change monitoring;, Earth Summit & UN Convention on Climate Change 3.4 COP 26. 3.5 The National Action Plan on Climate Change (NAPCC), Paris Agreement 3.6 Role of Ministry of Environment, Forests & Climate Change.		
UNIT IV **Environmental Audit**	4.1 Concept & economics of pollution control. 4.2 Concept, Objective and Scope of environmental audit. 4.3 Types of environmental audit 4.4 Green Audit Methodology 4.5 Benefits of environmental auditing.		

Course Code BNBUSBCP07 BNBUSBCP08	Course Title Practicals based on courses in theory BNBUSBC6T1, BNBUSBC6T2, BNBUSBC6T3, BNBUSBC6T4	Credits 6	No. of lectures
BNBUSBC6T1	1. Extraction of lipid from oil seeds by the cold percolation method		16 per week
	2. Estimation of Cholesterol by Zak's method		
	3. Estimation of Lecithin and cholesterol from egg yolk		
	4. Separation of amino acids by ascending chromatography		
	5. Isolation of casein from milk.		
	6. Estimation of protein by the Barford's method		
	7. Extraction of enzyme from different sources and checking its activity		
	8. Immobilization of enzyme on sodium alginate beads		
	9. Separation of DNA by AGE		
	10. Separation of proteins by PAGE / Native gels		
BNBUSBC6T2	11. Glucose tolerance test		
	12. Serum enzyme assays: alkaline phosphatase, SGOT, SGPT		
	13. Clotting and bleeding time		
	14. Interpretation of Organ Function Test reports and Problems based on them		
	15. Determination of RBC / WBC count		
	16. Bioassay of an antibiotic		
	17. Determination of purity of a drug		
	18. Determination of LD 50 of a drug		
	19. Antibiotic Sensitivity Test		
	20. Determining MIC of a drug		
BNBUSBC6T3 And BNBUSBC6T4	21. Submission of report on • Research Project **OR** • Internship at any laboratory or industry for a minimum of 3 weeks.		
	22. Bioinformatics (Data retrieval from NCBI- PubMed, Medline, Nucleotide, UniGene, Protein, Data retrieval from EBI - SwissProt, PIR, ENA, Taxon, Sequence alignment: Clustal W) 23. Application of Biostatistics for a Survey based Self-study using MS-Excel: Mean, Median, Charts, Correlation 24. Industrial Visit		

Semester V: Reference Books

Sr. No.	Title	Author
1	Outline of Biochemistry	Conn & Stumpf
2	General enzymology	Kulkarni & Deshpande
3	Textbook of Biochemistry for Medical Students	D. M. Vasudevan
4	Textbook of Medical Biochemistry	M N Chatterjee
5	Essential of Pharmacology	F S K Barar
6	iGenetics	Russell
7	Molecular Biology	Glick
8	Immunology	Goldsby and Kuby
9	Fundamentals of Biochemistry	Jain & Jain
10	Biophysical Chemistry	Upadhyay, Upadhyay & Nath
11	Genetics	Benjamin Pierce
12	Zubay's principles of Biochemistry	Veer Bala Rastogi
13	Methods in Biostatistics	B K Mahajan
14	Biostatistics	Arora
15	Biochemistry	Metzler

References and Additional Reading USACEVS501 & USACEVS601

1) A Text Book in Environmental Science, V. Subramanian, Narosa Publishing House. 2002.

2) An Advanced Textbook on Biodiversity, K.V. Krishnamurthy, Oxford & IBH Publishing Co. Pvt. Ltd. 2009.

3) Atmosphere, Weather & Climate, R.G. Barry & R.I. Charley, ELBS 1982.

4) Bioresource Ecology, T. N. Anatha krishnan, Oxford & IBM Publishing Company, New Delhi 1982.

5) Concepts of Ecology, E. J. Kormandy, Prentice Hall of India (Pvt.) Ltd.

6) Ecological Methods of Field & Laboratory Investigations, P. Michael, Tata Mc Graw Hill.

7) Ecology & Quality of our Environment, Charles H. Southwid, D. Van Nostrand Co. N.Y. 1976.

8) Ecotourism, Ecorestoration& Development, Solomon Raju, New Central book agency, 2007.

9) Environment, e-book, Shankar A.G.

10) Wildlife photography- Advanced field techniques for amazing images, Classen, Joe.

11) Environmental Biology, P.D. Sharma, Rastogi Publications 1996.

12) Environmental, Chemical & Biological Analysis, H.V. Jadhav & S.N. Jogdand, Himalaya Publishing House.

13) Environmental Impact Assessment Methodologies, Anjaneyulu Y., B.S Publication, Hyderabad. 2002.

14) Environmental Management, Khitolia, Chand Publications.

15) Environmental Management. Environmental Engineering Series; Vijay Kulkarni &T. V. Ramchandra, Publ. Commonwealth of Learning, Indian Institute of Science(IISC), Bangalore. 2011.

16) Environmental Pollution & Health Hazards in India, R. Kumar, Abhish Publ. House, New Delhi 1987. 17) Environmental Pollution & Management, Pramod Singh, Chugh Publ. Allahabad 1985.

18) Environmental Science Ahluwalia V.K. & Malhotra Sunita:. Ane Books India 2006. 19) Environmental Science, J. Turk, A. Turk & K. Arms, Saunders College Publishing 1983.

20) Environmental Science, S.C. Santra, New Central Book Agency (P) Ltd. 2001.

21) Environmental Science – Earth as living Planet, Daniel Botkin & Edward Kellere, J. Wiley & Sons 1995.

22) Environmental Studies, Sharma Narendra, Prashant Publications.

23) Environmental Studies: From crisis to cure, Rajagopalan R., Oxford Higher Education.

24) Fundamentals of Ecology, E. P. Odum, W.B. Saunders Company.

25) Global Environmental Issues – A Climatological Approach, David D. Kemp, Roult Ledge & Company, London & N. Y. 1990.

26) Indicator of Environmental Quality, Williams A. Thomas, Plenum Press, N.Y. & London 1971.

27) Industrial Hygiene & Chemical Safety, Fulekar .M.H., I. K. International Pvt Ltd, 2006.

28) Introduction to Climatology for the Tropics, J.O. Ayoade, J. Wiley & Sons 1983.

29) Management of Municipal solid waste; Environmental Engineering Series, T. V. Ramchandra, Publ.Common wealth of Learning, Indian Institute of Science (IISCBangalore.2011.

30) Pollution Control in Process Industries, S.P. Mahajan, TMH 1988.

31) Practical Methods in Ecology & Environmental Science,Trivedi, Goel &Trisal, Environmental Publications,Karad1987.

32) Text book of Environmental Chemistry & Pollution Control. Revised edition,Dara S.S. & Mishra D.D.,S. Chand Publications.

33) Waste Water Treatment for Pollution Control, Soli J. Arcivala, TMH 1986.

34) Water & Water Pollution Handbook, L.L. Caccio, Marcel Dekker Inc. N.Y. 1971.

35) https://www.un.org/en/climatechange/cop26

36) https://dst.gov.in/sites/default/files/NMSKCC_mission%20document%201.pdf

Evaluation Scheme

Internals

Class Test	Assignment/ Study tour with report/Journal Movie club presentation/ Presentation of mini-research / project work/ Volunteering forDepartment fest/ poster making/ exhibition/case studypresentation	Total
10-20	20-30	40

Suggested Format for 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		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	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	

Q. 3	Answer ***any two*** of the following		**12**
	a	Based on Unit III	
	b	Based on Unit III	
	c	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	
Q. 5		Answer ***any six*** of the following	**12**
	a	Based on Unit I / II / III / IV	
	b	Based on Unit I / II / III / IV	
	c	Based on Unit I / II / III / IV	
	d	Based on Unit I / II / III / IV	
	e	Based on Unit I / II / III / IV	
	f	Based on Unit I / II / III / IV	
	g	Based on Unit I / II / III / IV	
	h	Based on Unit I / II / III / 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**
BNBUSBC5T1	**40**	**16**	**60**	**24**	BNBUSBC5P05	**100**	**40**
BNBUSIBC5T2	**40**	**16**	**60**	**24**			
BNBUSBC5T3	**40**	**16**	**60**	**24**	BNBUSBC5P06	**100**	**40**
BNBUSBC5T4	**40**	**16**	**60**	**24**			
BNBUSBC5AC	**40**	**16**	**60**	**24**	BNBUSAC5P1	**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**
BNBUSBC6T1	**40**	**16**	**60**	**24**	BNBUSBC5P07	**100**	**40**
BNBUSIBC6T2	**40**	**16**	**60**	**24**			
BNBUSBC6T3	**40**	**16**	**60**	**24**	BNBUSBC5P08	**100**	**40**
BNBUSBC6T4	**40**	**16**	**60**	**24**			
BNBUSBC6AC	**40**	**16**	**60**	**24**	BNBUSAC6P1	**100**	**40**

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