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

**Agenda Number : 4** **Resolution Number : 4.8 and 4.24**

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

# Syllabus for

# Programme : Bachelor of Science

# Specific Programme : Biochemistry

# [ F.Y.B.Sc. (Biochemistry)]

| Initiated in Academic year 2001-2002 | Revised under Autonomy academic year 2021 - 2022 |
|---|---|

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# Preamble

Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. Biochemistry is central to all areas of the "biological" and "life" science.

The overall aims of Bachelor's degree in Biochemistry are to:

- Provide learners with learning experiences that help instill deep interests in learning biochemistry; develop broad and balanced knowledge and understanding of biomolecules, key biochemical concepts, principles and theories related to biochemistry.
- Equip students with appropriate tools of analysis and with theoretical, technical and analytical skills to solve issues and problems in the field of biochemistry.
- Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in biochemistry.
- Provide students with the knowledge and skill base that would enable them to undertake further studies in biochemistry and related areas or in multidisciplinary areas that involve biochemistry.
- Help develop a range of generic skills that are relevant for research and higher academic achievements in the field of biochemistry and allied subjects.

Therefore, the FYBSc Biochemistry syllabus is structured to touch upon broad base at the beginning. Biomolecules are the basic and important constituents of a living system. Hence, it is mandatory to study structure, occurrence and functions of large biomolecules like carbohydrates, lipids and proteins along with nucleic acids. Unique physical and chemical characteristics of water enable it to function in ways essential to human and other life processes due to its structure and composition. Life on Earth began more than 3 billion years ago, evolving from the most basic of microbes into a dazzling array of complexity over time, which makes it necessary to study the origin of life and evolution of a modern species over span of years. Life evolved from a small microbe, it is our aim to study living microscopic size organisms.

The course seeks to be diverse and yet will present the essence of biochemistry in a focused manner. This will prepare students for achieving better understanding of the major thrust areas in the disciplines like Chemistry of Biomolecules, Cell biology, Microbiology and Physiology.

Eligibility :

Passed 12th standard (HSC) of Maharashtra State Board / CBSE / ICSE board or equivalent.

Duration : 3 years

Mode of Conduct :

Laboratory practicals / Offline lectures / Online lectures

## Program Specific Outcome

1. Develop an adequate background to enable the first year students to study more advanced biochemistry topics in UG and PG.
2. Acquaint the learners with the unique properties of the universal solvent - water, essential for life processes.
3. Understand the life constituting bio molecules: proteins, carbohydrates, lipids, nucleic acids.
4. Familiarize the learners about the origin of life and take them through the process of evolution.
5. Focus on Cell as the basic unit of life which is the center for all biochemical processes.
6. Familiarize the learners to the world of microorganisms which exist as independent cellular units.
7. Develop an interest in the learner in nutrition for sustaining life, and physiology and functioning of life systems.
8. Appreciate the importance of the broad spectrum of biochemistry.

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

# F. Y. B. Sc. (Biochemistry)

# Structure of Programme

| Semester I | | | |
|---|---|---|---|
| **Course Code** | **Course Title** | **No. of lectures** | **Credits** |
| **BNBUSBC1T1** | Biochemistry - Paper I | **45** | **2** |
| **BNBUSBC1T2** | Biochemistry - Paper II | **45** | **2** |
| **BNBUSBC1P1** | Biochemistry Practical | **30** | **2** |
| **Total** | | **120** | **6** |

| Semester II | | | |
|---|---|---|---|
| **Course Code** | **Course Title** | **No. of lectures** | **Credits** |
| **BNBUSBC2T1** | Biochemistry - Paper I | **45** | **2** |
| **BNBUSBC2T2** | Biochemistry - Paper II | **45** | **2** |
| **BNBUSBC2P1** | Biochemistry Practical | **30** | **2** |
| **Total** | | **120** | **6** |

# Semester I

| Course Code | Course Title | Credits | No. of lectures |
|---|---|---|---|
| **BNBUSBC1T1** | **Biochemistry Paper - I** | **2** | |

**Course Outcomes:** After successful completion of this course learner will be able to

- Understanding of Biochemistry as a discipline and milestone discoveries in life sciences that led to establishment of Biochemistry as separate discipline.
- Acquainted with chemical and molecular foundations of life and appreciate the role of water in biological systems.
- Introduced to the structure, properties and roles of carbohydrates- Monosaccharides, disaccharides and polysaccharides.

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|---|---|---|
| **Unit I :** | **History of Science: General history of science**<br>**Overview of Biochemistry**: Definition, Scope and significance of Biochemistry, Important discoveries in Biochemistry.<br>**Contributions of Scientists** in the Field of Biochemistry- Har Gobind Khurana, G N Ramachandran , Homi Jehangir Bhabha, Kamla Sohonie, R Rajalaxmi, Venki Ramakrishnan. | **15** |
| **Unit II :** | **Biochemistry of Water:** Its effect on Biomolecules, hydrogen bonding and structure, properties (surface tension, latent heat, specific heat, viscosity, dielectric constant, colligative properties) of water and their biological significance, water as a universal solvent, Entropy and dissolution of solute,<br>Effect of non-polar compounds on the structure of water,<br>Weak interactions of biomolecules in aqueous solutions<br>**Concentration units:** Avogadro's number, mole, mole fraction, molarity, equivalent weight, normality, molality, percentage (Problems to be worked out).<br>**pH and Buffers** - Definition, action, physiological buffers - phosphate and carbonate. | **15** |
| **Unit III :** | **Carbohydrates:** Definition, Classification and functions of carbohydrates (mono, oligo polysaccharides)<br>**Monosaccharides:** Classification in terms of aldoses and ketoses Occurrence, structures and significance of glucose, fructose, galactose,mannose, and ribose<br>**Properties:**<br>a) Physical - isomerism D & L, optical; epimers: anomers<br>Chemical reactions - Oxidation to produce aldonic. aldaric and uronic acids (with respect toglucose);<br>b) reducing action in boiling alkali, enediol formation (with respect to glucose and fructose)<br>c) Osazone formation (with respect to glucose and fructose).<br>d) Orcinol (with respect to ribose)<br>**Disaccharides:** Occurrence and structure of maltose, lactose and sucrose Formation of glycosidic bonds<br>**Polysaccharides:** Classification based on function, storage and structure<br>Composition: homo & hetero. with examples<br>Storage : starch and glycogen - action of amylase on starch Structural: cellulose, chitin. | **15** |

| Course Code | Course Title | Credits | No. of lectures |
|---|---|---|---|
| **BNBUSBC1T2** | **Biochemistry Paper – II** | **2** | |

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

- Gain knowledge about cell theory and basic cell structure, structure and function of various cell organelles in a eukaryotic cell.
- Get acquainted with the composition of cytoskeleton and extracellular matrix.
- Acquire insight into cell division and cell death mechanisms.
- Understand about the origin of life and take them through the process of evolution.

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| **Unit I :** | **Origin of Life & Formation of cells:** Big bang theory, Theories on the origin of life: Abiogenesis, Heterotroph hypothesis, RNA world, protein world, Miller's experiment, Formation of the first cell, endosymbiont theory<br>**Evolution** - Darwinian theory, Modern synthetic theory of evolution and its factors: Gene mutations( recombination), heredity, natural selection and isolationBiological evidences: Fossil record, chemical and anatomical similarities of related life forms, geographic distribution of related species, genetic changes in living organisms over generations and Mechanism of evolution, Gene flow and genetic drift, Hardy-Weinberg principle | **15** |
| **Unit II :** | **The cell and cell organelles:**<br>**Structural organization of cells:**<br>Cell Theory, Prokaryotic, Eukaryotic (plant & animal) - a comparative overview<br>Cell wall structure (plant), cell membrane (fluid mosaic model)<br>**Cell organelles:**<br>**Nucleus:** Structure & function of the nucleus, nuclear envelope, nuclear pore, nuclear matrix and Nucleolus<br>**Mitochondrion:** Organization & function of the mitochondria, mitochondrial genome<br>**Chloroplast:** Structure and function of the chloroplast. the chloroplast genome, other plastids<br>**Ribosome:** Structure & Function of Ribosome<br>**ER:** SER and RER structure and function. **Golgi apparatus**: Structural Overview<br>**Peroxisome & Lysosome:** Peroxisome function & assembly (in brief) andLysosome structure and function | **15** |
| **Unit III :** | **Cytoskeleton, ECM and Cell Cycle:**<br>Cytoskeleton Structure, assembly and function of Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies)<br>**Extracellular Matrix and Cell Junctions**<br>**ECM components –** proteins, polysaccharides and adhesion proteins; basic concept of anchoring junctions, tight junctions and communication junctions (gap junctions and plasmodesmata)<br>**Cell Cycle**: Cell Cycle Checkpoints, Cell Division (mitosis and meiosis)<br>Cell Death- Brief overview of apoptosis and necrosis | **15** |

| Course Code<br>BNBUSBC1P1 | Course Title | Credits<br>2 | No. of lectures |
|---|---|---|---|

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

- Understanding Good laboratory practices in a biochemistry laboratory.
- Learn safety and precautionary measures for working in a laboratory.
- Develop skill and proficiency in preparation of laboratory reagents.
- Able to identify and quantitate various biomolecules in the laboratory.
- Gain expertise in the identification of various cell organelles and staining of cellular biomolecules.

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| **Practical I** | | |
| **Practical 1** | Safety Measures in Laboratory & Use of Basic instruments: Analytical balance & Microscope | |
| **Practical 2** | Calibration of volumetric glassware (Burette, pipette and measuring cylinder) | |
| **Practical 3** | Preparation of laboratory reagents- Concept of Molar, Normal and Percent solutions. | |
| **Practical 4** | Standardization of Laboratory Reagents- Primary standards - 0.1Noxalic acid, Secondary standards - 0.1N NaOH, 0.1N HCl | |
| **Practical 5** | Qualitative tests for Functional groups. | |
| **Practical 6** | Qualitative tests for Carbohydrates – Monosaccharides (glucose and fructose),Disaccharides (lactose ,maltose and sucrose) Polysaccharides (starch and dextrin) | |
| **Practical 7** | Detection of unknown carbohydrate. | |
| **Practical 8** | Assignment/ Case Study based on Unit 1. | **30** |
| | | |
| **Practical II** | | |
| **Practical 1** | Effect of isotonic, hypertonic and hypotonic solutions on cells – onion peel. | |
| **Practical 2** | Adsorption of oxalic acid on activated charcoal. | |
| **Practical 3** | Oxidation Reduction test- MBRT | |
| **Practical 4** | To study of cell organelles by using electron micrographs. | |
| **Practical 5** | Study of stages of mitosis using onion root tips. | |
| **Practical 6** | Permanent slides of mitosis and meiosis. | |
| **Practical 7** | Preparation of buffers. | |
| **Practical 8** | Assignment based on Unit 1. | |

# Semester II

| Course Code | Course Title | Credits | No. of lectures |
|---|---|---|---|
| **BNBUSBC2T1** | **Biochemistry Paper - I** | **2** | |

**Learning Outcomes:** After successful completion of this course learner will be able to –

- Able to comprehend the structure, function and properties of amino acids.
- Able to understand the structure, function and classification of Lipids.
- Introduced to the structure, properties and roles of nucleic acids.

| | | |
|---|---|---|
| **Unit I :** | **Lipids:** Definition, classification (Bloor's) and functions of Lipids, Fatty' acids and Triacylglycerol<br>**Classification &Chemistry:** Saturated fatty acids - classification of C2 to C20: even carbon: Common and IUPAC names. Unsaturated fatty acids MUFA, PUFA (2.3.4 double bonds), Omega - 3.6.9 fatty acids. Triacyl glycerol - simple and mixed - names and structure<br>**Chemical Reactions of fats:** Saponification, Iodination, Ozonolysis, Auto- oxidation, Action of heat on glycerol andcholine,<br>Rancidity Definition & significance - Acid number, Saponification number, Iodine number, Reichert - Meissel number<br>**Compound Lipids :** Functions of glycerophospholipids (PE.PC.PL) Phosphosphingolipids (ceramide, sphingomyelin), Glycolipids / Cerebrosides (gluco & galactocerebrosides ), Steroids Cholesterol structure and biochemical significance. | **15** |
| **Unit II :** | **Nucleic Acids:** Structure - Purine & Pyrimidine bases, ribose, deoxyribose, nucleosides and nucleotides (ATP, CTP, GTP, TTP, UTP) Formation of polynucleotide strand with its shorthand Representation<br>**DNA:** Physical evidence of DNA helical structure. Chargaff's rules (chemical evidence), Watson-Crickmodel of DNA & its features Physical properties of DNA - Effect of heat on physical properties of DNA (Viscosity, buoyant density, UV absorption), Hypochromism, hyperchromism, denaturation of DNA.<br>**RNA:** various types in prokaryotes and eukaryotes- mRNA & rRNA - general account, tRNA - clover leaf model, Ribozymes<br>**Reactions of nucleic acids** (with DPA and Orcinol) | **15** |
| **Unit III :** | **Amino acids and proteins:**<br>**Amino acids:**Amino acid structure - D & L forms of all 20 amino acids. Detailed classification based on polarity, essential and non-essential amino acid<br>**Physical properties:** Zwitter ions, pI of amino acids amino acids as ampholytes, melting point, optical rotation, UV absorption.<br>**Chemical properties:** Chemical reactions of amino acids with Ninhydrin,Sanger's reagent, Edman's reagent and Dansyl chloride, Non Standard amino acids, Functions of amino acids.<br>**Peptides and Proteins:** ASBC - APS classification on the basis of shape and function Primary structure - Formation and characterization of the peptide bond<br>Secondary structure - Alpha helix and beta sheet Tertiary(myoglobin) and Quaternary (hemoglobin) structures - An introduction Protein denaturation | **15** |

| Course Code | Course Title | Credits | No. of lectures |
|---|---|---|---|
| **BNBUSBC2P2** | **Biochemistry Paper - II** | **2** | |

**Learning Outcomes:** After successful completion of this course learner will be able to –

- Broadly study digestion for absorption of nutrients through the digestive system.
- Appreciate and understand the biochemical, molecular and cellular events that coordinate working of the organ systems that regulate life processes.
- Understand the disorders and diseases related to organ systems.
- Understanding of world of Microbes and conditions required for growth of microbes.

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| **Unit I :** | **Physiology of digestion, absorption and Excretion:**<br>Parts and Functions of Organs associated with GIT, Glands associated with GIT<br>Secretions and Juices of GIT (Saliva, Gastric juice, Intestinal juice,pancreatic and Bile juice)<br>Digestion and Absorption of carbohydrates, Lipids, Proteins.<br>Disorders - Peptic ulcer, Lactose Intolerance<br>**Excretion:** Structure of the nephron: Bowman's capsule & glomerulus - Structure & function, (ultrafiltration, pressures involved, GFR, regulation of GFR); Renal tubule - structure & function (proximal and distal convoluted tubulesand Henle's loop) Urine formation: Reabsorption / Secretion of glucose, Na+, K+. HCO3 $Cl^-$ and $H^+$ : renal threshold, Excretory disorder: Nephritis | **15** |
| **Unit II :** | **Physiology of Respiration and Circulation.**<br>Respiratory system, Breathing - inspiration and expiration, Composition of air and partial pressure of gases<br>Physical exchange of gases: Transport of oxygen, Transport of carbon dioxide<br>Respiratory disorders – cyanosis, respiratory acidosis and alkalosis<br>**Cardiovascular system:** Anatomy and physiology of Blood Vessels and Cardiac Muscle. Cardiac Cycle. Regulation of heart rate, Blood Pressure. ECG and measurement of blood pressure. Circulatory Disorders- congestive heart disease, myocardial infarction, cardiacarrhythmias | **15** |
| **Unit III :** | **Microbiology:** Historical background (contributions of Leeuwenhoek. Pasteur)<br>General characteristics (size, shape and structure) of Bacteria, classification of bacteria based on morphology (shape and flagella)<br>**Bacterial cell wall:** Structure and function, components of peptidoglycan frame work (structures of NAG and NAMA not necessary)<br>An introduction to Extremophiles**:** thermophiles, psychrophiles, halophiles, magnetotactic, radiation resistant - examples with their application,<br>**Staining methods** - principles of staining & types or stains,<br>**Microbial Growth** - Growth Curve, Mathematical expression, Synchronous growth, Generation time, **Culture media** (N, C, Special requirements), Natural and Synthetic media. **Sterilization and Disinfection techniques-** Physical Agent of sterilization - Hot Air Oven, Autoclave, Radiations (UV, Gamma). Chemical agents of sterilization - Alcohol,Halogens, Formaldehyde. | **15** |

| Course Code<br>BNBUSBC2P1 | Course Title | Credits<br>2 | No. of lectures |
|---|---|---|---|

**Learning Outcomes:** After successful completion of this course learner will be able to –

- Able to identify microorganisms by using various staining techniques.
- Perform and analyze various physiological tests that examine the function of various systems of the human body.
- Determine presence of biomolecules like Nucleic acids, proteins, lipids in known and unknown samples.
- Determine the extent of adulteration in samples containing biomolecules.

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|---|---|---|
| **Practical I** | | **30** |
| **Practical 1** | Qualitative tests for lipids | |
| **Practical 2** | Determination of SAP value of given oil sample | |
| **Practical 3** | Determination of Acid value of give oil sample | |
| **Practical 4** | Qualitative tests for Nucleic Acids. | |
| **Practical 5** | Qualitative test for amino acids. | |
| **Practical 6** | Qualitative analysis for Proteins. | |
| **Practical 7** | Qualitative test to detect unknown protein. | |
| **Practical 8** | Ammonium sulphate precipitation of Proteins. | |
| **Practical 9** | Concept of Dialysis in Protein purification | |
| **Practical II** | | |
| **Practical 1** | Analysis of the action of salivary α - amylase action on starch. | |
| **Practical 2** | Urine analysis- Normal and Abnormal constituents. | |
| **Practical 3** | Estimation of titrable acidity of Urine. | |
| **Practical 4** | Identification of organs / parts of digestive system. | |
| **Practical 5** | Identification of organs / parts of excretory system. | |
| **Practical 6** | Identification of organs / parts of respiratory system. | |
| **Practical 7** | Identification of organs / parts of Circulatory system. | |
| **Practical 8** | Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides. | |
| **Practical 9** | To Perform Gram Staining<br>Demonstration of Staining techniques- Capsule, Endospore, Negative staining. | |

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## Evaluation Scheme

**Internals**

| Group discussion/ Seminar/ Poster presentation/ Assignments | Class Test | Attendance and Leadership qualities | Total |
|---|---|---|---|
| 15 | 20 | 05 | 40 |
| OR Certification of Swayam / NPTEL in concern course | | | |

**Theory Examination : Suggested Format of Question paper**

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

- **All questions are compulsory**

| | | | |
|---|---|---|---|
| **Q. 1** | Answer **any two** of the following | | **16** |
| | a | Based on Unit I | |
| | b | Based on Unit I | |
| | c | Based on Unit I | |
| | d | Based on Unit I | |
| | | | |
| **Q. 2** | Answer **any two** of the following | | **16** |
| | a | Based on Unit II | |
| | b | Based on Unit II | |
| | c | Based on Unit II | |
| | d | Based on Unit II | |
| | | | |
| **Q. 3** | Answer **any two** of the following | | **16** |
| | a | Based on Unit III | |
| | b | Based on Unit III | |
| | c | Based on Unit III | |
| | d | Based on Unit III | |
| | | | |
| **Q. 4** | | | **12** |
| | a | Define the following. | |
| | b | True and False with reasons. | |

** ( 4 questions of 8 marks each / 8 questions of 4 marks can be asked with 50% options)

## Marks Distribution and Passing Criterion for Each Semester

| Semester I | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | **Practical** | | |
| Course Code | Internal | Min marks for passing | Theory Examination | Min marks for passing | Course Code | Practical Examination | Min marks for passing |
| BNBUSBC1T1 | **40** | **16** | **60** | 24 | BNBUSBC1P1 | **100** | **40** |
| BNBUSBC1T2 | **40** | **16** | **60** | 24 | | | |

| Semester II | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | **Practical** | | |
| Course Code | Internal | Min marks for passing | Theory Examination | Min marks for passing | Course Code | Practical Examination | Min marks for passing |
| BNBUSBC2T1 | **40** | **16** | **60** | 24 | BNBUSBC2P1 | **100** | **40** |
| BNBUSBC2T2 | **40** | **16** | **60** | 24 | | | |

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