# VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

*PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF*

## BACHELOR OF SCIENCE (HONOURS)

## MAJOR IN BIOTECHNOLOGY

## 4-YEAR UNDERGRADUATE PROGRAMME

*(w.e.f. Academic Year 2023-2024)*

***Based on***

**Curriculum & Credit Framework for Undergraduate Programmes**

**(CCFUP), 2023 & NEP, 2020**

# VIDYASAGAR UNIVERSITY
# BACHELOR OF SCIENCE (HONOURS) MAJOR IN BIOTECHNOLOGY
# (under CCFUP, 2023)

| Level | YR. | SEM | Course Type | Course Code | Course Title | Credit | L-T-P | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CA | ESE | TOTAL |
| B.Sc. (Hons.) | 1st | I | **SEMESTER-I** | | | | | | | |
| | | | Major-1 | BITHMJ101 | T: Biochemistry and Metabolism<br>P: Biochemistry and Metabolism (Practical) | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | SEC | BITSEC01 | P: Biosafety and instrumentation | 3 | 0-0-3 | 10 | 40 | 50 |
| | | | AEC | AEC01 | Communicative English -1 (***common for all programmes***) | 2 | 2-0-0 | 10 | 40 | 50 |
| | | | MDC | MDC01 | Multidisciplinary Course -1 (***to be chosen from the list*** ) | 3 | 3-0-0 | 10 | 40 | 50 |
| | | | VAC | VAC01 | ENVS (***common for all programmes***) | 4 | 2-0-2 | 50 | 50 | 100 |
| | | | Minor-1 (Disc.-I) | BITMI01 | T: Biotechnology and Human Welfare; P: Practical<br>***(To be taken from other Discipline)*** | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | | | **Semester-I Total** | 20 | | | | 400 |
| | | II | **SEMESTER-II** | | | | | | | |
| | | | Major-2 | BITHMJ102 | T: Cell Biology<br>P: Cell Biology (Practical) | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | SEC | BITSEC02 | P: Fundamentals in Enzymatic assay and Fermentation | 3 | 0-0-3 | 10 | 40 | 50 |
| | | | AEC | AEC02 | MIL-1 (***common for all programmes***) | 2 | 2-0-0 | 10 | 40 | 50 |
| | | | MDC | MDC02 | Multi Disciplinary Course-02 (***to be chosen from the list*** ) | 3 | 3-0-0 | 10 | 40 | 50 |
| | | | VAC | VAC02 | Value Added Course-02 (***to be chosen from the list***) | 4 | 4-0-0 | 10 | 40 | 50 |
| | | | Minor-2 (Disc.-II) | BITMI02 | T: Environmental Biotechnology; P: Practical<br>***(To be taken from other Discipline)*** | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | Summer Intern. | CS | Community Service | 4 | 0-0-4 | - | - | 50 |
| | | | | | **Semester-II Total** | 24 | | | | 400 |
| | | | | | **TOTAL of YEAR-1** | 44 | | | | 800 |

MJ = Major, MI = Minor Course, SEC = Skill Enhancement Course, AEC = Ability Enhancement Course, MDC = Multidisciplinary Course, VAC = Value Added Course; CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical, MIL = Modern Indian Language, ENVS = Environmental Studies

## *MAJOR (MJ)*

**MJ-1: Biochemistry and Metabolism** **Credits 04**
**(Full Marks: 75)**

**MJ-1T: Biochemistry and Metabolism** **Credits 03**

**Course contents:**

**UNIT I: Introduction to Biochemistry:**
**Amino acids & Proteins:** Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.
**Carbohydrates:** Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

**UNIT II**
**Lipids:** Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.
**Nucleic acids:** Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

**UNIT III**
**Enzymes:** Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: $NAD^+$, $NADP^+$, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

**UNIT IV**
**Carbohydrates Metabolism:** Reactions, energetics and regulation. **Glycolysis:** Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

**MJ-1P: Biochemistry and Metabolism (Practical)** **Credits 01**

**General Experiments:**
1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.

4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry**: (i)** Verification of Beer's law, estimation of protein. (**ii)** To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

## Suggested Readings:


1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.


## MJ-2: Cell Biology — Credits 04 (Full Marks: 75)

## MJ-2T: Cell Biology — Credits 03

**Course contents:**

**UNIT I**

**Cell: I**ntroduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

**Cell Membrane and Permeability:** Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

**UNIT II**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. **Endoplasmic reticulum:** Structure, function including role in protein segregation. **Golgi complex:** Structure, biogenesis and functions including role in protein secretion.

**UNIT III**

**Lysosomes:** Vacuoles and micro bodies: Structure and functions. **Ribosomes:** Structures and function including role in protein synthesis. **Mitochondria:** Structure and function, Genomes, biogenesis. **Chloroplasts:** Structure and function, genomes, biogenesis. **Nucleus:** Structure and function, chromosomes and their structure.

**UNIT IV**

**Extracellular Matrix:** Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal

transduction.
**Cancer:** Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

**MJ-1P: Cell Biology - Lab** **Credits 01**

**Experiments:**

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

## Suggested Readings:


1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

## *MINOR (MI)*

**MI – 1: Biotechnology and Human Welfare** **Credits 04 (Full Marks: 75)**

**MI – 1T: Biotechnology and Human Welfare** **Credits 03**

**Course contents:**

**UNIT I**
Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

**UNIT II**
Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

**UNIT III**
Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

**UNIT IV**
Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

**UNIT V**
Health: e.g. development of non- toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E. coli*, human genome project.

**MI-1P: Biotechnology and Human Welfare (Practical)** **Credits 01**

**Course Outline:**

*(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)*

1. Perform of ethanolic fermentation using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

**MI-2: Environmental Biotechnology** **Credits 04 (Full Marks: 75)**

**MI-2T: Environmental Biotechnology** **Credits 03**

**Course contents:**

**UNIT I**

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

**UNIT II**

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

**UNIT III**

Treatment of municipal waste and Industrial effluents. Bio-fertilizers. Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

**UNIT IV**

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

**MI-2P: Environmental Biotechnology (Practical)** **Credits 01**

**Course Outline:**

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

## Suggested Readings:


1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

## *SKILL ENHANCEMENT COURSE (SEC)*

**SEC 1: Biosafety and instrumentation** **Credits 03 (FM: 50)**

**SEC1P: Biosafety and instrumentation**

**Course Outline:**

**Unit-1: Biosafety**
Basic rules and regulations related to Biotechnological work, personal hygiene, sterility maintenance, Biotechnological Good Laboratory Practices and Biosafety. Level of Biosafety (BSL1-BSL4).

**Unit-2: Basic instrumentation in biotechnology**
Principle and applications of biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, water bath, shaker, light microscope, and pH meter used in the biotech laboratory.

**Unit-3: Qualitative and quantitative analysis of biomolecules**
Principle and applications of quantitative analysis through colorimeter and spectrophotometer. Principle and practical applications of different chromatographic approach (TLC, paper, column).

**Unit-4: Separation of biomolecules**
Agarose and polyacrylamide gel electrophoresis: principle, process and applications. Principle of centrifugation and its practical applications. Concept of RCF, rpm and sedimentation coefficient, density gradient centrifugation and ultracentrifugation.

### Suggested Readings:


1. Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino J and Sherman N. (2010).
2. Practical Microbiology, Dubey and Maheshwari ,S.Chand Publication, First edition 2002
3. Introductory Practical Biochemistry, S.K. Sawhney and Randhir Singh, Narosa publisher (2016)
4. An Introduction to Practical Biochemistry, D.T. Plummer (2001)


**SEC 2: Fundamentals in Enzymatic assay and Fermentation** **Credits 03 (FM: 50)**

**SEC 2P: Fundamentals in Enzymatic assay and Fermentation**

**Course Outline:**

**UNIT - I:**
Basic steps in enzymatic reaction, Quantitative estimation of enzyme unit. Methods of purification of enzyme, test of homogeneity of enzyme preparation. Methods for immobilization of enzymes.

**UNIT – II:**
Kinetics of enzyme activity, Michaelis- Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, Effect of substrate concentration, enzyme concentration, pH, temperature, inhibitors, salt on enzyme activity.

**UNIT- III**

Selection of substrate, inoculum, strain improvement for fermentation. Types of fermentation: submerged, solid state, batch, continuous. Major industrial products and their significance: chemicals, biochemicals and chemotherapeutic/pharmaceutical products, Biofuels, Enzymes, Microbial polysaccharides, Microbial insecticides, microbial flavours and fragrances, anticancer agents, amino acids..

**UNIT- IV**

Fermentation scale-up and factors affecting scale up, Upstream and downstream processing, Types of Bioreactors and their operation. Mathematical derivation of growth kinetics in batch and continuous culture operations.

**Suggested Readings:**


1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons,1995.