# VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

*PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF*

## BACHELOR OF SCIENCE (HONOURS)

## MAJOR IN MICROBIOLOGY

## 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 MICROBIOLOGY
# (under CCFUP, 2023)

| Level | YR. | SEM | Course Type | Course Code | Course Title | Credit | L-T-P | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CA | ESE | TOTAL |
| B.Sc. (Hons.) | 2nd | III | SEMESTER-III | | | | | | | |
| | | | Major-3 | MCBHMJ03 | T: Biochemistry; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | Major-4 | MCBHMJ04 | T: Concepts on Microbial physiology and metabolism; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | SEC | MCBSEC03 | P: Experiments on Applied Microbiology-I (Practical) | 3 | 0-0-3 | 10 | 40 | 50 |
| | | | AEC | AEC03 | Communicative English -2 (***common for all programmes***) | 2 | 2-0-0 | 10 | 40 | 50 |
| | | | MDC | MDC03 | Multidisciplinary Course -3 (***to be chosen from the list*** ) | 3 | 3-0-0 | 10 | 40 | 50 |
| | | | Minor-3 (Disc.-I) | MCBMIN03 | T: Introduction to Biomolecules and microbial metabolism; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | | | **Semester-III Total** | 20 | | | | 375 |
| | | IV | SEMESTER-IV | | | | | | | |
| | | | Major-5 | MCBHMJ05 | T: Cell Biology; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | Major-6 | MCBHMJ06 | T: Microbial Genetics; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | Major-7 | MCBHMJ07 | T: Introduction to Molecular Biology; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | AEC | AEC04 | MIL-2 (***common for all programmes***) | 2 | 2-0-0 | 10 | 40 | 50 |
| | | | Minor-4 (Disc.-II) | MCBMIN04 | T: Fundamental concepts on Cell Biology and Microbial Genetics; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | Summer Intern. | INT | Internship/ Apprenticeship - activities to be decided by the Colleges following the guidelines to be given later | 4 | 0-0-4 | - | - | 50 |
| | | | | | **Semester-IV Total** | 22 | | | | 400 |
| | | | | | **TOTAL of YEAR-2** | 42 | | | | 775 |

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

## *MAJOR (MJ)*

**MJ-3: Biochemistry** **Credits 04 (Full Marks: 75)**

**MJ-3T: Biochemistry** **Credits 03**

**Course contents:**

**Unit 1: Bioenergetics**
Thermodynamics: First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

**Unit 2: Carbohydrates**
Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, (cellulose, peptidoglycan and chitin). Structure of sugar derivatives: glucosamine, galactosamine, muramic acid, N-acetyl neuraminic acid.

**Unit 3: Lipids**
Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

**Unit 4: Proteins**
Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysing, cystine and hydroxyproline, Nonprotein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins. Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins.

**Unit 5: Enzymes**
Enzyme: Definition, Structural component of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.

**Unit 5: Vitamins**
Classification and characteristics with suitable examples, sources and importance.

**MJ-3P: Biochemistry** **Credits 03**

**General Experiments:**

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
1. 3.Standard Free Energy Change of coupled reactions
3. Qualitative / Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars
4. Qualitative /Quantitative tests for lipids and proteins
5. Study of protein secondary and tertiary structures with the help of models
6. Study of enzyme kinetics – calculation of Vmax , Km, Kcat values
7. Study effect of temperature, pH and Heavy metals on enzyme activity
8. Estimation of any one vitamin

## Suggested Readings:


1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W. H. Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

## MJ-4: Concepts on Microbial physiology and metabolism Credits 04 (Full Marks: 75)

### MJ-4T: Concepts on Microbial physiology and metabolism Credits 03

**Course contents:**

**Unit 1: Microbial Growth and Effect of Environment on Microbial Growth**

Definitions of growth, techniques in measurement of microbial growth, Batch culture, Continuous culture, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.

**Unit 2 Nutrient uptake and Transport**

Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, ion uptake.

**Unit 3. Chemoheterotrophic and Phototrophic Metabolism**

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: components of respiratory chain, Anaerobic respiration with special reference to dissimilatory nitrate reduction, Fermentation - Alcohol fermentation; Lactate fermentation (homofermentative and heterofermentative pathways, Photosynthesis with reference to photosynthesis in cyanobacteria.

**Unit 4. Nitrogen Metabolism**

Biological nitrogen fixation with special reference to Rhizobium, nif-gene expression and nitrogenase activity, Ammonification, Nitrification, Assimilatory nitrate reduction, denitrification

## Suggested Readings:


1. Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc. Madigan MT, and Martinko JM (2014).
2. Microbial Physiology. 4th edition. John Wiley & Sons. Moat AG and Foster JW. (2002).
3. Bacterial Metabolism. 2nd edition. Springer Verlag. Gottschalk G. (1986).
4. General Microbiology. 5th edition, McMillan Press. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987).
5. Prescott's Microbiology. 9th edition. McGraw Hill Higher Education Willey JM, Sherwood LM, and Woolverton CJ. (2013).


### MJ-4P: Concepts on Microbial physiology and metabolism - Practical Credits 01

**General Experiments:**

1. Study and plot the growth curve of *E. coli* by standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*

5. Effect of salt on growth of *E. coli*
6. Demonstration of the thermal death point of *E. coli.*
7. Effect of different chemicals on bacterial growth.

## Suggested Readings:


1. Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino. J and Sherman N. (2010).
2. Practical Microbiology, 1st edition, S. Chand. R. C. Dubey and D. K. Maheswari (2010).


## MJ-5: Cell Biology — Credits 04 (Full Marks: 75)

**MJ-5T: Cell Biology — Credits 03**

**Course contents:**

**Unit -1 Structure and organization of Cell**

Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic (Bacterial): Structure and function Plasma membrane, Cell Wall, Mitochondria, chloroplasts and peroxisomes, Cytoskeleton; Nuclear organization (Eukaryotic and prokaryotic): Nuclear envelope, nuclear pore complex and nuclear lamina, Chromatin organization, Nucleolus.

**Unit-2 Protein sorting and Transport**

Ribosome, Endoplasmic Reticulum: Structure, targeting and insertion of proteins in the ER, protein folding, processing in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes

**Unit– 3 Cell signalling**

Signalling molecules and their receptors; Function of cell surface receptors; Pathways of intracellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.

**Unit– 4 Cell Cycle, Cell Death and Cell Renewal**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis (Molecular basis); Development of cancer, causes and types; Programmed cell death; Stem cells: Embryonic stem cell, induced pleuripotent stem cells

## Suggested Readings:


1. Becker's World of the Cell. 8th edition. Pearson, Hardin J, Bertoni G and Kleinsmith L. J. (2010).
2. Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc. Karp G. (2010)
3. Cell and Molecular Biology. 8th edition. Lipincott, Williams and Wilkins, Philadelphia. De Robertis, EDP and De Robertis EMF. (2006).
4. The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA Cooper, G.M. and Hausman, R.E. (2009).

**MJ-5P: Cell Biology (Practical)** **Credits 01**

## General Experiments:

1. Demonstration of the technique of microscopy.
2. Study of the electron micrographs of bacterial cell.
3. Study of the different fungal cells.
4. Study of different stages of mitosis using plant root tips.
5. Study of different stages of meiosis using plant parts.
6. Study of the structure of cell organelles through electron micrographs.
7. Study of polyploidy in Onion root tip by colchicines treatment.
8. Identification and study of cancer cells by photomicrographs

## Suggested Readings:


1. Cell and Molecular Biology: A Lab Manual, PHI. K. V. Chaitanya (2013).
2. Plant Cell Biology (A Practical Approach), Oxford University press. N. Harris and K.J. Oparka (Editor) (1994)
3. Cell Biology, Genetics, Molecular Biology, Evolution & EcologyPaperback, S.Chand. Verma P.S. and Agarwal V.K. (2004).


## MJ-6: Microbial Genetics **Credits 04 (Full Marks: 75)**

**MJ-6T: Microbial Genetics** **Credits 03**

**Course contents:**

**Unit-1: Genome Organization (12 periods)**
Genome organization: *E. coli*, Saccharomyces, Mutation and mutagenesis: Definition and types of mutations; Physical and chemical mutagens; Molecular basis of mutations; Uses of mutations: Reversion and suppression; True Revertants; Intra and Inter genic suppression; Ames Test; Mutator genes.

**Unit-2: Change and structure of genetic material (10 periods)**
Types Plasmids: F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast – 2µ plasmid, Plasmid replication, Plasmid incompatibility, Plasmid amplification, Regulation of copy number.

**Unit-3: Mechanisms of Genetic Exchange (12 periods)**
Transformation- Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Bacterial recombination (Homologous), Recombination in fungi.

**Unit-4 Transposable elements (10 periods)**
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition

## Suggested Readings:


1. Concepts of Genetics, 10th Ed. Benjamin Cummings Klug WS, Cummings MR, Spencer, C, Palladino, M (2011).
2. Genetics: A Conceptual Approach, 4th Ed. Macmillan Higher Education Learning Pierce BA (2011)
3. Principles of Genetics. 8th Ed. Wiley-India. Gardner EJ, Simmons MJ, Snustad DP (2008).
4. Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings. Russell PJ. (2009).
5. Microbial Genetics 2nd EDITION. Jones and Barlett Publishers Maloy SR, Cronan JE and Friefelder D (2004).
6. Genetics, Monroe W. Strickburger, PHI publication.


**MJ-6P: Microbial Genetics (Practical)** **Credits 01**

## General Practical

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of DNA from given sample.
5. Quantification of DNA.
6. Study the conformations of plasmid DNA through Agaraose gel electrophoresis.
7. Demonstration of AMES test

## Suggested Readings:


1. Molecular biology and biotechnology: basic experimental protocols – M. P. Bansal
2. Practical Methods in Molecular Biology – Robert F. Schleif, Pieter C. Wensink.


**MJ-7: Molecular Biology** **Credits 04 (Full Marks: 75)**

**MJ-7T: Molecular Biology** **Credits 03**

**Course contents:**

**Unit-1 Genetic Material (DNA and RNA)**

DNA structure and types, Double helical model, Evidences on DNA and RNA as genetic material, Organization of DNA in prokaryotes and Eukaryotes, Extra chromosomal DNA, Mechanism of DNA replication, various models of DNA replication: rolling circle, Θ (theta) mode of replication, Mismatch and excision repair, RNA structure and types.

**Unit-2 Transcriptional and Post-Transcriptional Processing**

Transcription: Definition, promoter, RNA Polymerase and the transcription unit, Transcription: RNA polymerases, general Transcription factors, concept of introns and exons, RNA splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, mi RNA and its significance.

**Unit-3 Translation (Prokaryotes and Eukaryotes)**

Mechanism of Translation: Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Inhibitors of protein synthesis in prokaryotes and eukaryote.

**Unit-4 Regulation of gene Expression in Prokaryotes and Eukaryotes**

Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Changes in Chromatin Structure-DNA methylation and Histone Acetylation mechanisms

## Suggested Readings:


1. Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008).
2. The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009).
3. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia. De Robertis EDP and De Robertis EMF (2006).
4. Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc. Karp G (2010).
5. Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning. Krebs J, Goldstein E, Kilpatrick S (2013).
6. Principles of Genetics. 8th Ed. Wiley-India . Gardner EJ, Simmons MJ, Snustad DP (2008).


**MJ-7P: Molecular Biology** **Credits 01**

## General Experiments—

1. Study of different types of DNA and RNA using micrographs/model.
2. Study of semi-conservative replication of DNA through micrographs /model.
3. Estimation of calf thymus DNA using spectrophotometer (diphenylamine Reagent)
4. Estimation of RNA using spectrophotometer (orcinol reagent)
5. Gel preparation. (Agarose gel and SDS-PAGE) 6. Resolution and visualization of DNA by Agarose Gel Electrophoresis. 7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDSPAGE)

## Suggested Readings:


1. Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc. Karp G (2010).
2. Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press. Sambrook J and Russell DW. (2001).
3. Princeples and techniques of biochemistry and molecular biology, Cambridge press. K. Wilson and J. Walker (edition 2009).
4. Gene Cloning a laboratory manual, Cold Spring Harbour laboratory Press. Green and Sambrook (2012)

## *MINOR (MI)*

**MI – 3: Introduction to Biomolecules and microbial metabolism Credits 04 (Full Marks: 75)**

**MI – 3T: Introduction to Biomolecules and microbial metabolism Credits 03**

**Course contents:**

### Unit 1: Basic concept of Bioenergetics

Thermodynamics: First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, Entropy, Brief introduction of Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

### Unit 2: Carbohydrates

Basic concept of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, Polysaccharides, storage polysaccharides, starch and glycogen. Basic concept of structural Polysaccharides, (cellulose, peptidoglycan and chitin). Basic concept of sugar derivatives

### Unit 3: Lipids

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

### Unit 4: Proteins

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysing, cystine and hydroxyproline, basic concept of Nonprotein amino acids, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins. Tertiary and quaternary structures of proteins. Forces holding the polypeptide together.

### Unit 5: Enzymes

Enzyme: Definition, Structural component of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Concept of Km and allosteric enzymes. Definitions of terms – enzyme unit, specific activity and turnover number, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.

**Unit 5: Vitamins**
Classification and characteristics with suitable examples, sources and importance.

**Unit 6: Microbial Growth and Effect of Environment on Microbial Growth**
Definitions of growth, techniques in measurement of microbial growth, Batch culture, Continuous culture, diauxic growth curve Microbial growth in response to environment (in brief) -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.

**Unit 7: Nutrient uptake and Transport**
Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, ion uptake.

**Unit 8. Chemoheterotrophic and Phototrophic Metabolism**
Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: components of respiratory chain, Anaerobic respiration with special reference to dissimilatory nitrate reduction, Fermentation - Alcohol fermentation; Lactate fermentation (homofermentative and heterofermentative pathways, Photosynthesis in cyanobacteria.

**Unit 9. Nitrogen Metabolism**
Biological nitrogen fixation with special reference to Rhizobium, nif-gene expression and nitrogenase activity, Ammonification, Nitrification, Assimilatory nitrate reduction, denitrification

**MI-3P: Introduction to Biomolecules and microbial metabolism (Practical) Credits 01**

**General Experiments**

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Qualitative / Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars
3. Qualitative /Quantitative tests for lipids and proteins
4. Study of protein secondary and tertiary structures with the help of models
5. Study effect of temperature, pH and Heavy metals on enzyme activity
6. Study and plot the growth curve of E. coli by standard plate count methods.
7. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
8. Effect of temperature on growth of E. coli
9. Effect of pH on growth of E. coli
10. Effect of different chemicals on bacterial growth.

## Suggested Readings:

**Biomolecules—**


1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W. H. Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,


**Metabolism—**


1) Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino. J and Sherman N. (2010).
2) Practical Microbiology, 1st edition, S. Chand. R. C. Dubey and D. K. Maheswari (2010).


## MI-4: Fundamental concepts on Cell Biology and Microbial Genetics Credits 04 (Full Marks: 75)

### MI-4T: Fundamental concepts on Cell Biology and Microbial Genetics Credits 03

**Course contents:**

**Unit -1 Structure and organization of Cell**

Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic (Bacterial): Structure and function Plasma membrane, Cell Wall, Mitochondria, chloroplasts and peroxisomes, Cytoskeleton; Nuclear organization (Eukaryotic and prokaryotic): Nuclear envelope, nuclear pore complex and nuclear lamina, Chromatin organization, Nucleolus.

**Unit-2 Protein sorting and Transport**

Ribosome, Endoplasmic Reticulum: Structure, targeting and insertion of proteins in the ER, protein folding, processing in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes

**Unit– 3 Cell signalling**

Signalling molecules and their receptors; Function of cell surface receptors; Pathways of intracellular receptors – Cyclic AMP pathway and MAP kinase pathway.

**Unit– 4 Cell Cycle, Cell Death and Cell Renewal**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis (Molecular basis); Development of cancer, causes and types; Programmed cell death; Stem cells: Embryonic stem cell, induced pleuripotent stem cells.

**Unit-5: Genome Organization**

Genome organization: E. coli, Mutation and mutagenesis: Definition and types of mutations; Physical and chemical mutagens; Molecular basis of mutations; Uses of mutations: Reversion and suppression; Ames Test; Mutator genes.

**Unit-6: Change and structure of genetic material**

Types Plasmids: F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast – 2µ plasmid, Plasmid replication, Plasmid incompatibility, Plasmid amplification.

**Unit-7: Mechanisms of Genetic Exchange**

Transformation- Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates

## Suggested Readings:


**Cell Biology—**

1. Becker's World of the Cell. 8th edition. Pearson, Hardin J, Bertoni G and Kleinsmith L. J. (2010).
2. Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc. Karp G. (2010)
3. Cell and Molecular Biology. 8th edition. Lipincott, Williams and Wilkins, Philadelphia. De Robertis, EDP and De Robertis EMF. (2006).
4. The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA Cooper, G.M. and Hausman, R.E. (2009).

**Microbial Genetics—**

1. Concepts of Genetics, 10th Ed. Benjamin Cummings Klug WS, Cummings MR, Spencer, C, Palladino, M (2011).
2. Genetics: A Conceptual Approach, 4th Ed. Macmillan Higher Education Learning Pierce BA (2011)
3. Principles of Genetics. 8th Ed. Wiley-India. Gardner EJ, Simmons MJ, Snustad DP (2008).
4. Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings. Russell PJ. (2009).
5. Microbial Genetics 2nd EDITION. Jones and Barlett Publishers Maloy SR, Cronan JE and Friefelder D(2004).
6. Genetics, Monroe W. Strickburger, PHI publication


## MI-4P: Fundamental concepts on Cell Biology and Microbial Genetics (Practical) Credits 01

**General Experiments:**

1. Demonstration of the technique of microscopy.
2. Study of the electron micrographs of bacterial cell.
3. Study of the different fungal cells.
4. Study of different stages of mitosis using plant root tips.
5. Study of the structure of cell organelles through electron micrographs.
6. Identification and study of cancer cells by photomicrographs.
7. Preparation of Master and Replica Plates
8. Isolation of DNA from given sample.
9. Quantification of DNA.
10. Study the conformations of plasmid DNA through Agaraose gel electrophoresis

## Suggested Readings:

**Cell Biology—**


1. Cell and Molecular Biology: A Lab Manual, PHI. K. V. Chaitanya (2013)
2. Plant Cell Biology (A Practical Approach), Oxford University press. N. Harris and K.J. Oparka (Editor) (1994)
3. Cell Biology, Genetics, Molecular Biology, Evolution & EcologyPaperback, S.Chand. Verma P.S. and Agarwal V.K.(2004).


**Microbial Genetics—**


1) Molecular biology and biotechnology: basic experimental protocols – M. P. Bansal
2) Practical Methods in Molecular Biology – Robert F. Schleif, Pieter C. Wensink.

## *SKILL ENHANCEMENT COURSE (SEC)*

**SEC 3: Experiments on Applied Microbiology-I** **Credits 03**

**SEC3P: Experiments on Applied Microbiology-I** **Full Marks: 50**

**Course Outline:**

1. Enrichment and isolation of N2 fixing and phosphate solubilizing bacteria from soil.
2. Production of biofertilizer using N2 fixing and phosphate solubilizing bacteria
3. Production of wine from fruits.
4. Production of curd (Dahi) from milk
5. Enrichment and isolation of Keratin-degrading bacteria from soil using chicken feature as substrate.
6. Application of keratinolytic bacteria as protease