

**SYLLABUS FOR**  
**M.Sc. CHOICE BASED CREDIT**  
**SYSTEM (CBCS) SEMESTER PATTERN**  
**IN**  
**MICROBIOLOGY**  
**RASHTRASANT TUKADOJI MAHARAJ**  
**NAGPUR UNIVERSITY, NAGPUR (M.S.),**  
**INDIA**  
**2018-2019 Onwards**

Candidates opting for this course are advised to go through the direction relating to the course “DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE, SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM) AND DEGREE OF MASTER OF SCIENCE AND TECHNOLOGY (APPLIED GEOLOGY). SEMESTER PATTERN, (CHOICE BASED CREDIT SYSTEM) (FACULTY OF SCIENCE & TECHNOLOGY)” which is available on R. T. M. Nagpur University website.

The direction will provide details on admission criteria, rules for ATKT, scheme of examination, absorption scheme for CBS students into CBCS pattern, elective papers, foundation course papers, subject centric papers, coding pattern, pattern of question papers, practicals, distribution of marks, seminars, project work, internal assessment, calculation of SGPA and CGPA, etc.

**SYLLABUS for M. Sc. MICROBIOLOGY**  
**Choice Based Credit System (CBCS) (Semester Pattern)**  
**Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur**

**Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Microbiology.**

| <b>M. Sc. Microbiology Semester I</b> |  |                                |           |           |                  |         |                    |              |             |                       |           |  |
|---------------------------------------|--|--------------------------------|-----------|-----------|------------------|---------|--------------------|--------------|-------------|-----------------------|-----------|--|
| Code                                  | Theory / Practical   | Teaching scheme (Hours / Week) |           |           |                  | Credits | Examination Scheme |              |             |                       |           |  |
|                                       |  | Th                             | Pract     | Total     | Duration in hrs. |         | Max. Marks         |              | Total Marks | Minimum Passing Marks |           |  |
|                                       |  |                                |           |           |                  |         | External Marks     | Internal Ass |             | Th                    | Pract     |  |
| 1T1                                   | <b>PAPER-I</b><br>MICROBIAL METABOLISM (MM)                          | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40                    |           |  |
| 1T2                                   | <b>PAPER-II</b><br>ENZYMOLGY AND TECHNIQUES (ET)                     | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40                    |           |  |
| 1T3                                   | <b>PAPER-III</b><br>ADVANCE TECHNIQUES IN MICROBIOLOGY (ATM)         | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40                    |           |  |
| 1T4                                   | <b>PAPER-IV</b><br>MEMBRANE STRUCTURE AND SIGNAL TRANSDUCTION (MSST) | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40                    |           |  |
| 1P1                                   | PRACTICAL-I  | -                              | 8         | 8         | 4                | 3-8     | 100                | -            | 100         |                       | 40        |  |
| 1P2                                   | PRACTICAL-II   | -                              | 8         | 8         | 4                | 3-8     | 100                | -            | 100         |                       | 40        |  |
| 1S1                                   | SEMINAR  | 2                              | -         | 2         | 1                |         |                    | 25           | 25          | 10                    |           |  |
|                                       | <b>TOTAL</b>   | <b>18</b>                      | <b>16</b> | <b>34</b> | <b>25</b>        |         | <b>520</b>         | <b>105</b>   | <b>625</b>  | <b>170</b>            | <b>80</b> |  |

**M. Sc. Microbiology Semester II**

| Code | Theory / Practical   | Teaching scheme<br>(Hours / Week) |           |           | Credits   | Examination Scheme |                |              |             |                       |           |
|------|--|-----------------------------------|-----------|-----------|-----------|--------------------|----------------|--------------|-------------|-----------------------|-----------|
|      |  | Th                                | Pract     | Total     |           | Duration in hrs.   | Max. Marks     |              | Total Marks | Minimum Passing Marks |           |
|      |  |                                   |           |           |           |                    | External Marks | Internal Ass |             | Th                    | Pract     |
| 2T1  | <b>PAPER-I</b><br>MICROBIAL METHODS<br>FOR ENVIRONMENT<br>MANAGEMENT (MEM) | 4                                 | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 2T2  | <b>PAPER-II</b><br>MICROBIAL<br>METABOLITES (MMT)                          | 4                                 | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 2T3  | <b>PAPER-III</b><br>MEDICAL<br>MICROBIOLOGY AND<br>PARASITOLOGY (MMP)      | 4                                 | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 2T4  | <b>PAPER-IV</b><br>IMMUNOLOGY AND<br>IMMUNODIAGNOSTICS<br>(IID)            | 4                                 | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 2P1  | PRACTICAL-III  | -                                 | 8         | 8         | 4         | 3-8                | 100            | -            | 100         |                       | 40        |
| 2P2  | PRACTICAL-IV   | -                                 | 8         | 8         | 4         | 3-8                | 100            | -            | 100         |                       | 40        |
| 2S1  | SEMINAR  | 2                                 | -         | 2         | 1         |                    |                | 25           | 25          | 10                    |           |
|      | <b>TOTAL</b>   | <b>18</b>                         | <b>16</b> | <b>34</b> | <b>25</b> |                    | <b>520</b>     | <b>105</b>   | <b>625</b>  | <b>170</b>            | <b>80</b> |

**M. Sc. Microbiology Semester III**

| Code | Theory / Practical  | Teaching scheme (Hours / Week) |           |           | Credits   | Examination Scheme |                |              |             |                       |           |
|------|---|--------------------------------|-----------|-----------|-----------|--------------------|----------------|--------------|-------------|-----------------------|-----------|
|      |   | Th                             | Pract     | Total     |           | Duration in hrs.   | Max. Marks     |              | Total Marks | Minimum Passing Marks |           |
|      |   |                                |           |           |           |                    | External Marks | Internal Ass |             | Th                    | Pract     |
| 3T1  | <b>PAPER-I</b><br>MOLECULAR BIOLOGY<br>AND GENETICS (MBG)   | 4                              | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 3T2  | <b>PAPER-II</b><br>RECOMBINANT DNA<br>TECHNOLOGY AND<br>NANOBIOTECHNOLOGY<br>(RDTN)                                     | 4                              | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 3T3  | <b>PAPER-III</b><br>MICROBIAL DIVERSITY,<br>EVOLUTION AND<br>ECOLOGY (MDEE) - 1<br><b>OR</b><br>BIOINFORMATICS (BIF) -1 | 4                              | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 3T4  | <b>PAPER-IV</b><br>DRUG AND DISEASE<br>MANAGEMENT (DDM)   | 4                              | -         | 4         | 4         | 3                  | 80             | 20           | 100         | 40                    |           |
| 3P1  | PRACTICAL-V   | -                              | 8         | 8         | 4         | 3-8                | 100            | -            | 100         |                       | 40        |
| 3P2  | PRACTICAL-VI  | -                              | 8         | 8         | 4         | 3-8                | 100            | -            | 100         |                       | 40        |
| 3S1  | SEMINAR   | 2                              | -         | 2         | 1         |                    |                | 25           | 25          | 10                    |           |
|      | <b>TOTAL</b>  | <b>18</b>                      | <b>16</b> | <b>34</b> | <b>25</b> |                    | <b>520</b>     | <b>105</b>   | <b>625</b>  | <b>170</b>            | <b>80</b> |

| <b>M. Sc. Microbiology Semester IV</b> |  |                                |           |           |                  |         |                    |              |             |               |       |           |
|--|--|--------------------------------|-----------|-----------|------------------|---------|--------------------|--------------|-------------|---------------|-------|-----------|
| Code                                   | Theory / Practical   | Teaching scheme (Hours / Week) |           |           |                  | Credits | Examination Scheme |              |             |               |       |           |
|  |  | Th                             | Pract     | Total     | Duration in hrs. |         | Max. Marks         |              | Total Marks | Minimum Marks |       | Passing   |
|  |  |                                |           |           |                  |         | External Marks     | Internal Ass |             | Th            | Pract |           |
| 4T1                                    | <b>PAPER-I</b><br>VIROLOGY (VIR)   | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40            |       |           |
| 4T2                                    | <b>PAPER-II</b><br>MICROBIAL<br>FERMENTATION<br>TECHNOLOGY (MFT)   | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40            |       |           |
| 4T3                                    | <b>PAPER-III</b><br>MICROBIAL DIVERSITY,<br>EVOLUTION AND<br>ECOLOGY (MDEE) – 2<br><b>OR</b><br>BIOINFORMATICS (BIF)-2 | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40            |       |           |
| 4T4                                    | <b>PAPER-IV</b><br>VACCINES AND<br>DELIVERY SYSTEM (VDS)   | 4                              | -         | 4         | 4                | 3       | 80                 | 20           | 100         | 40            |       |           |
| 4P1                                    | PRACTICAL-VII  | -                              | 8         | 8         | 4                | 3-8     | 100                | -            | 100         |               |       | 40        |
| 4PROJ<br>1                             | PROJECT WORK   | -                              | 8         | 8         | 4                | 3-8     | 100                | -            | 100         |               |       | 40        |
| 4S1                                    | SEMINAR  | 2                              | -         | 2         | 1                |         |                    | 25           | 25          | 10            |       |           |
|  | <b>TOTAL</b>   | <b>18</b>                      | <b>16</b> | <b>34</b> | <b>25</b>        |         | <b>520</b>         | <b>105</b>   | <b>625</b>  | <b>170</b>    |       | <b>80</b> |

**NOTE Semester III & IV:**

**Foundation Course:** Candidate can opt for any one foundation course paper in the semester III and IV. However, Student shall opt for this paper from any other subject other than his / her main subject for post graduation. If the candidate decides to opt for foundation course papers then he/she shall not be eligible to opt for Core (Subject Centric) papers in their respective subjects.

**Core (Subject Centric):** Candidate can opt for this paper as shown in the semester III and IV in their main subject of post graduation only. If the candidate decides to opt for Core (Subject Centric) papers in their main subject of post graduation then he/she shall not be eligible to opt for foundation course papers neither in their own subject nor in any other subjects.

**SYLLABUS  
FOR  
M. Sc CHOICE BASED CREDIT SYSTEM (CBCS) IN MICROBIOLOGY SUBJECT  
RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY,  
NAGPUR (M.S.) INDIA**

**SEMESTER – I**

| <b>CORE PAPER :-</b> |     |   | <b>MARKS</b>   |
|----------------------|-----|---|----------------|
| PAPER-I              | 1T1 | MICROBIAL METABOLISM (MM)                         | <b>80 + 20</b> |
| PAPER-II             | 1T2 | ENZYMOLGY AND TECHNIQUES (ET)                     | <b>80 + 20</b> |
| PAPER-III            | 1T3 | ADVANCE TECHNIQUES IN MICROBIOLOGY (ATM)          | <b>80 + 20</b> |
| PAPER-IV             | 1T4 | MEMBRANE STRUCTURE AND SIGNAL TRANSDUCTION (MSST) | <b>80 + 20</b> |

**PRACTICALS**

|              |     |  |            |
|--------------|-----|--|------------|
| PRACTICAL-I  | 1P1 |  | <b>100</b> |
| PRACTICAL-II | 1P2 |  | <b>100</b> |
| SEMINAR      | 1S1 |  | <b>25</b>  |

**SEMESTER – II**

| <b>CORE PAPER :-</b> |     |   | <b>MARKS</b>   |
|----------------------|-----|---|----------------|
| PAPER-I              | 2T1 | MICROBIAL METHODS FOR ENVIRONMENT MANAGEMENT (MMEM) | <b>80 + 20</b> |
| PAPER-II             | 2T2 | MICROBIAL METABOLITES (MMT)                         | <b>80 + 20</b> |
| PAPER-III            | 2T3 | MEDICAL MICROBIOLOGY AND PARASITOLOGY (MMP)         | <b>80 + 20</b> |
| PAPER-IV             | 2T4 | IMMUNOLOGY AND IMMUNODIAGNOSTICS (IID)              | <b>80 + 20</b> |

**PRACTICALS**

|               |     |  |            |
|---------------|-----|--|------------|
| PRACTICAL-III | 2P1 |  | <b>100</b> |
| PRACTICAL-IV  | 2P2 |  | <b>100</b> |
| SEMINAR       | 2S1 |  | <b>25</b>  |

**SEMESTER – III**

| <b>CORE PAPER :-</b>     |     |  | <b>MARKS</b>                     |
|--------------------------|-----|--|----------------------------------|
| PAPER-I                  | 3T1 | MOLECULAR BIOLOGY AND GENETICS (MBG)   | <b>80 + 20</b>                   |
| PAPER-II                 | 3T2 | RECOMBINANT DNA TECHNOLOGY AND NANOBIO TECHNOLOGY (RDTN)   | <b>80 + 20</b>                   |
| <b>ELECTIVE PAPER :-</b> |     |  |                                  |
| PAPER-III                | 3T3 | ANY ONE OF THE FOLLOWING: -<br>1) MICROBIAL DIVERSITY, EVOLUTION AND ECOLOGY (MDEE) – 1<br>2) BIOINFORMATICS (BIF) - 1 | <b>80 + 20</b><br><b>80 + 20</b> |

**CORE (SUBJECT CENTRIC) :**

|          |     |   |         |
|----------|-----|---|---------|
| PAPER-IV | 3T4 | DRUG AND DISEASE MANAGEMENT (DDM)<br>(To be opted by students of Microbiology only) | 80 + 20 |
|----------|-----|---|---------|

**PRACTICALS**

|              |     |  |     |
|--------------|-----|--|-----|
| PRACTICAL-V  | 3P1 |  | 100 |
| PRACTICAL-VI | 3P2 |  | 100 |
| SEMINAR      | 3S1 |  | 25  |

**SEMESTER – IV****CORE PAPER :-****MARKS**

|          |     |   |         |
|----------|-----|---|---------|
| PAPER-I  | 4T1 | VIROLOGY (VIR)                          | 80 + 20 |
| PAPER-II | 4T2 | MICROBIAL FERMENTATION TECHNOLOGY (MFT) | 80 + 20 |

**ELECTIVE PAPER:-**

|           |     |   |                    |
|-----------|-----|---|--------------------|
| PAPER-III | 4T3 | ANY ONE OF THE FOLLOWING: -<br>1) MICROBIAL DIVERSITY, EVOLUTION AND ECOLOGY (MDEE) – 2<br>2) BIOINFORMATICS (BIF) -2 | 80 + 20<br>80 + 20 |
|-----------|-----|---|--------------------|

**CORE (SUBJECT CENTRIC) :**

|          |     |  |         |
|----------|-----|--|---------|
| PAPER-IV | 4T4 | VACCINES AND DELIVERY SYSTEM (VDS)<br>(To be opted by students of Microbiology only) | 80 + 20 |
|----------|-----|--|---------|

**PRACTICALS**

|               |         |  |     |
|---------------|---------|--|-----|
| PRACTICAL-VII | 4P1     |  | 100 |
| PROJECT WORK  | 4PROJ 1 |  | 100 |
| SEMINAR       | 4S1     |  | 25  |

**SEMESTER - I**  
**Paper-I**  
**1T1**  
**Microbial Metabolism (MM)**

**UNIT-I: - Carbohydrate and Lipid**

**Carbohydrates as informational Molecules:-**Sugar code, Plant Lectins: - ConA, GS4, WGA.

Animal:- Galectin A, MBP-1. Viral:- HA, VPI. Bacterial:- LT,CT.

Reverse TCA cycle, Biosynthesis of cell wall polysaccharides and bacterial peptidoglycan.

**Lipid:-**Membrane lipids, biosynthesis of membrane phospholipids, ketone bodies.

**UNIT-II: - Proteins and Nucleic acids**

**Proteins:-**Determination and characteristics of alpha-helix and  $\beta$ -sheets. Concept of protein domain and motif, common motifs and their role in metabolism, protein folding and denaturation curves, role of Chaperones and chaperonins, Biosynthesis of all amino acids.

**Nucleic acids:-**Structural details of Duplex DNA, Unusual structures: palindrome, inverted repeats, mirror repeats, triplet DNA, G tetraplex, secondary structure of RNA purine and pyrimidine biosynthesis, degradation and regulation, salvage pathway, Inhibitors.

**UNIT-III: - Photosynthesis**

**Anoxygenic photosynthesis:-**Green sulphur bacterial, non-sulphur bacterial, purple phototrophic bacteria.

**Oxygenic photosynthesis:-**Cyanobacterial.

**Chemolithotrophy:-** Hydrogen oxidation and autotrophy in hydrogen bacteria. Oxidation of reduced sulphur compounds and Iron.

**Bioluminescence**

**UNIT-IV:-Nitrogen and Sulphur metabolism and methanogenesis.**

Nitrification and Anammox. Nitrate reduction and Denitrification.

Nitrogen fixation: Symbiotic, nonsymbiotic. Sulphate reduction.

Methanogenesis, Acetogenesis, Acetate use and autotrophy.



**SEMESTER - I**  
**Paper-II**  
**1T2**  
**Enzymology and Techniques (ET)**

**UNIT-I: - Enzymes kinetics**

Overview of Michaelis-Menten equation and its transformation, Evaluation of kinetic parameters, Kinetics of bisubstrate reaction, multistep reactions, kinetics of enzyme inhibition, Classification of enzymes

**UNIT-II: - Catalytic mechanisms**

Concept of active site, determination of active site, acid –base catalysis, covalent catalysis, metal ion cofactors, proximity and orientation effects, preferential binding.

Active site determination and mechanism of lysozyme, Active site determination and mechanism of serine protease.

**UNIT-III: - Regulation of Enzyme activity**

Allosterism, Kinetic analysis of allosteric enzymes

Covalent Modification, Feed -back inhibition

Membrane bound enzymes, isoenzymes and marker enzymes.

Constitutive and inducible enzymes.

**UNIT-IV: - Techniques**

**Protein:** ligand binding studies: association and dissociation constants, co-operative ligand binding MWC or concerted model, sequential model.

**Enzyme biosensors:** General concept, glucose biosensor. Industrial applications of enzymes.

Protein engineering.

**SEMESTER - I**  
**Paper –III**  
**1T3**  
**Advance Techniques in Microbiology (ATM)**

**UNIT-I: - Biophysical Techniques-I**

Determination of size, shape and Molecular weight of Macromolecules:- by Viscosity, CD/ORD, Light scattering, diffusion sedimentation and Centrifugation techniques.

**UNIT-II: -Biophysical Techniques-II**

Electrophoresis: Agarose Gel, SDS-page, two-dimensional gel electrophoresis, capillary electrophoresis, immune-electrophoresis.

**UNIT-III: -Microscopical Techniques.**

Electron Microscopy: SEM, TEM, Staining procedures and microscopy. Fluorescent Microscopy: Staining procedures and Microscopy, FISH. Laser scanning, confocal microscopy. Scanning tunneling and atomic force microscopy. Immunoelectron microscopy, cryoelectron microscopy.

**UNIT-IV: -Other advance techniques**

**Blotting techniques:** Western, Southern, Northern, Radioimmunoassay. NMR and its biological importance. Site-directed mutagenesis, transcriptional start point mapping.

**SEMESTER - I**  
**Paper-IV**  
**1T4**  
**Membrane structure and Signal Transduction (MSST)**

**UNIT-I: - Structure and organization of membranes**

Mitochondria, endoplasmic reticulum, prokaryotic membrane, membrane junctions (Gap & tight junctions), techniques for membrane study: electron microscopic method, membrane vesicles, differential scanning calorimetry, fluorescence photobleaching recovery, flow cytometry.

**UNIT-II: - Membrane Transport**

Active and Passive transport, uniport, ATP powered pumps, non-gated ion channels, cotransport by symporters and antiporters, transepithelial transport.

**UNIT-III: - Signal Transduction**

General concept of cell signaling, G-protein coupled receptors and their effectors. RTK and MAP Kinases. Down regulations of pathways. Cytokine receptors and their mechanism (JAK-STAT pathway).

**UNIT-IV: - Bacterial signal transduction**

Basic two component system. Histidine kinase pathway. Sporulation as a model of bacterial signal transduction. Osmoregulatory pathways. Heat shock proteins. Mating types of yeast.

## PRACTICAL-I 1P1

- 1) Detection of enzyme activity of lipase, Urease, invertase, protease, Tween 80 hydrolysis.
- 2) Determination of kinetic constant of amylase:-Amylase activity,  $V_{max}$ ,  $K_m$ .
- 3) Effect of pH and temperature on amylase activity.
- 4) Effect of inhibitors on amylase activity.
- 5) Estimation of protein:
- 6) Production, isolation and purification of enzyme and determination of fold purification (any one enzyme)
- 7) Estimation of sucrose in presence of glucose.
- 8) UV absorption of proteins, DNA and RNA.
- 9) Estimation of L-leucine by colorimetric method.
- 10) Determination of  $pK_a$  of an amino acid.

**Minimum seven experiments must be performed in the semester.**

## PRACTICAL-II 1P2

- 1) Separation of DNA by agarose gel electrophoresis and estimation of DNA by Diphenylamine method.
- 2) Estimation of RNA by Orcinol method.
- 3) Separation of amino acids by paper chromatography.
- 4) Separation of serum proteins by paper electrophoresis.
- 5) Thin layer chromatography of mycotoxins
- 6) SDS-Page of proteins.
- 7) Performance of affinity chromatography.
- 8) Performance of Gel filtration chromatography.
- 9) Demonstration of blotting technique.[any one].
- 10) Ion exchange chromatography

**Minimum seven experiments must be performed in the semester.**

**SEMESTER - II**  
**Paper-I**  
**2T1**  
**Microbial Methods for Environment Management (MMEM)**

**UNIT-I: - Eutrophication, Biodeterioration and Biomagnification**

**Eutrophication:** Microbial changes induced by organic and inorganic pollutants, factors influencing eutrophication process and control of eutrophication.

**Biodeterioration:** Definition and concept of biodeterioration, biodeterioration of woods and pharmaceutical products.

**Biomagnification:** concept and consequences, Biomagnifications of chlorinated hydrocarbons and pesticides.

**UNIT-II: - Biotransformation and Bioleaching, Biodegradation**

**Biotransformations:** metals and metalloids, mercury transformations, biotransformation of pesticides such as hexachlorobenzene.

**Bioleaching:** Bioleaching of ores, leaching techniques and applications.

**Biodegradation:** Biodegradation of plastics.

**UNIT-III: - Pollution Management**

Waste water management using activated sludge, aerated lagoons, trickling filter, rotary biological contractors, fluidized bed reactors, stabilization ponds. Concept of phytoremediation and applications.

**UNIT-IV: - Global Environmental Problems**

Ozone depletion, UV-B, green house effect, acid rain, their impact and biotechnological approaches for management. Acid mine drainage and associated problems. Global warming and climate change.

**SEMESTER - II**  
**Paper –II**  
**2T2**  
**Microbial Metabolites (MMT)**

**UNIT-I:- Overview of metabolites**

**Metabolites:** General account of metabolites, secondary metabolites. Classification, structure and mode of action of secondary metabolites. Plants secondary metabolites: Digitoxine, Salicylic acid, Mycotoxins-Aflatoxin, Ochratoxin, Patulin.

**Biopolymers:** Polypeptides (collagen, casein and serum albumin), Polynucleotides and polysaccharides(amylose, amylopectin, alginate, cellulose) and other biopolymers like chitin, Xanthan, dextrin, Gellan, Pullulan, curdlan and hyaluronic acid.

**Polyamines:** Brief outline and functions of polyamines. Synthesis of linear polyamine-putrescine, cadoverine, spermidine and spermine.

**UNIT-II:- Antimicrobial drugs: Secondary metabolites**

**Antibiotics:** History and discovery of antibiotics, Antibiotic resistance, Mechanisms of antibiotic resistance.

**Structure and mode of action of antibiotics:**

Aminoglycosides (Amikacin), Carbapenems (Imipenim), Microlids (Azithromycin), Nitrofurantoin (Nitrofurantoin), Penicillin (Amoxicillin), Quinolones (Gatifloxacin/Ciprofloxacin), Sulphonamides (Sulfamethoxazole), Tetracyclines (Doxycyclines), Chloramphenicol, Fucanazole.

**UNIT-III:-Pigments as secondary metabolites**

General account of pigments, Chlorophylls, Carotenoids of eukaryotes, phycobilliproteins. Hemoglobin, Myoglobin, Melanin and bile pigments. Microbial pigments: Bacteriochlorophylls, Carotenoids of prokaryotes, rhodopsin and accessory pigments(Pulcherrimin, indigoidin, voalecin) Defensive role of pigments.

**UNIT-IV:-Microbial vitamins**

Characteristics of fats and water soluble vitamins.

**Structure, function and chemistry of:** Retinol (vitamin A), Riboflavin (vitamin B<sub>2</sub>), Cynocobalamine (Vitamin B<sub>12</sub>) and ascorbic acid (vitamin C).

**Deficiency diseases in humans:**

Xerophthalmia, Beri Beri, Pellegra, Scurvey, Keratomalacia, osteoporosis, Osteomalacia, Cheilosis, Glossitis, Pernicious anemia and Erythroid hypoplassia.

**SEMESTER - II**  
**Paper-III**  
**2T3**  
**Medical Microbiology and Parasitology (MMP)**

**UNIT-I: - Infection**

**Infection:** Definition, Types, stages of infection, process of infection.

**Establishment of pathogenic microorganisms:** Entry, spread and tissue damage. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Aggressins and toxins.

**UNIT-II: - Bacteriology**

**Pathogenic Bacteria:** Morphological characteristics, Pathogenesis and Laboratory diagnosis including rapid methods of following pathogenic bacteria;

*Klebsiella pneumoniae; Proteus vulgaris; Proteus mirabilis; Shigella dysenteriae;*

*Pseudomonas aeruginosa; Vibrio cholerae; Streptococcus pneumoniae.*

**New emerging infections:-** *Streptococcus suis; community associated Methicilin resistant Staphylococcus aureus (MRSA), Bordetella pertusis, Clostridium difficile, Multi drug resistant tuberculosis.*

**UNIT-III: - Mycology**

**Pathogenic Fungi:** Morphological characteristics, pathogenesis and laboratory diagnosis of following pathogenic fungi:-

*Microsporum; Trichophyton; Histoplasma capsulatum; Blastomyces dermatitidis; Candida albicans; Cryptococcus neoformans; Pneumocystis carinii.*

**UNIT-IV: - Parasitology**

**Parasites:** *Entamoeba histolytica; Giardia lamblia; Plasmodium vivax; Leishmania donovani.*

**Helminths:** *Taenia saginata; Taenia solium; Hymenolepis nana; Schistosoma haematobium.*

**SEMESTER - II**  
**Paper –IV**  
**2T4**  
**Immunology and Immunodiagnostics (IID)**

**UNIT-I: - Overview of the Immune system and CMI**

**Cells involved in Immune system:** Hematopoiesis, Lymphocytes, mononuclear phagocytes, Antigen presenting cells, Granulocytes.

**Lymphoid organ:** Lymphatic system, Primary and Secondary lymphoid organs.

**Complement System:** Pathways of complement activation, regulation of complement system, Biological functions of complement system.

**Inflammation:** Intracellular cell adhesion molecules, Mechanism of cell migration, Inflammation. Pathways of antigen processing and presentation.

**Cell Mediated Immunity:** General properties of effector T cells, Cytotoxic T Cells, Natural Killer cells, Antibody-Dependent cell mediated cytotoxicity. T-Cell dependent and T-cell independent defense mechanisms.

**UNIT-II: - Specific Immune Response**

**Cancer and the Immune system:** Origin and Terminology, Malignant Transformation of cells, oncogenes and cancer induction, Tumor Antigens, Immune surveillance theory, Tumor evasion of the Immune system, Cancer Immunotherapy.

**Transplantation Immunology:** Immunological basis of Graft Rejection, Mechanism of Graft rejection. Immunosuppressive therapy: General and specific. Clinical Transplant.

**Tolerance:** Central and peripheral tolerance to self antigens, Mechanism of induction of natural tolerance.

**UNIT-III: - Immune Dysfunction**

**Immunodeficiency disorders:-** Phagocytic cell defect (Chediak-Higashi syndrome); B-cell deficiency (Bruton's X-linked hypogammaglobulinemia); T-cell deficiency disorder (DiGeorge Syndrome); Combined B-cell & T-cell deficiency disorder (SCID-Severe combined immunodeficiency diseases, Wiskott-Aldrich syndrome); Complement deficiencies and secondary immunodeficiency conditions carried by drugs, nutritional factors & AIDS.

**Autoimmunity and autoimmune diseases:-**General consideration, Etiology, Clinical categories, Diagnosis and treatment. RA(Rheumatoid arthritis); SLE (Systemic Lupus Erythematosus); Guillain-Barre Syndrome; Multiple sclerosis; Myasthenia gravis; Grave's disease; Goodpasture syndrome, Autoimmune haemolytic disease; Pernicious anaemia.

**Hypersensitivity :-** Type I, Type II, Type III & Type IV

**UNIT-IV: - Immunodiagnostics**

**Precipitation reactions:** Immunodiffusion, immunoelectrophoresis,

**Agglutination reactions:** Bacterial Agglutination, Hemagglutination, Passive agglutination, Reverse passive agglutination and agglutination inhibition.

**Immunodiagnostic techniques:** Radioimmuno assay, ELISA, Chemiluminiscence immunoassay, Western blotting technique, Complement fixation test, Immunofluorescence, Immunoelectron microscopy.



## PRACTICAL-III 2P1

### 1) Different staining:

- a) Acid fast staining,
- b) Giemsa staining,
- c) Leishmann staining,
- d) Flurochrome staining
- e) Special staining methods to demonstrate granules, capsule and spores.

### 2) Isolation of pathogens from clinical samples pus, blood and urine.

### 3) Conventional and rapid methods of isolation and identification of following pathogenic bacteria, fungi and parasites.

**Bacteria:** *Staphylococcus aureus*, *Escherichia coli*, *Klebseilla pneumoniae*, *Proteus vulgaris*, *Proteus mirabilis*, *Salmonella typhi*, *Salmonella paratyphi*, *Shigella dysenteriae*, *Shigella flexneri*, *Pseudomonas aeruginosa*, *Vibrio cholerae*. [Any five]

**Fungi:** *Candida albicans*, *Cryptococcus neoformans*, *Microsporium*, *trichophyton*, *Histoplasma capsulatum*. [Any one]

**Parasite:** *Entamoeba histolytica*, *Girdia lamblia*, *Plasmodium spp*, *Trichomonas vaginalis*; *Taenia solium*, *Taenia saginata* [Any one].

### 4) Antibiotic sensitivity testing by various methods:

- a) Kirby-Bauer's disc diffusion method.
- b) Well plate method.
- c) Broth dilution method.
- d) Agar dilution method.
- e) E-strip method for MIC testing.

## PRACTICAL-IV 2P2

### Diagnostic immunologic principles and methods of followings:-

- 1) Immunodiffusion
- 2) Immuno-electrophoresis
- 3) Blood grouping
- 4) Widal [slide and tube] tests.
- 5) TRUST [Toluidine Red Unheated Serum Test]
- 6) Syphcard test
- 7) Australian latex antigen test.
- 8) Antistreptolysin 'O' test [ASO]
- 9) Pregnancy test.
- 10) Rheumatoid arthritis test [RA]
- 11) RPR [rapid plasma reagin] test.
- 12) Treponema pallidum haemagglutination test (TPHA).
- 13) One step test for Qualitative detection of HBs.
- 14) ELISA [Enzyme Linked Immunosorbent Assay]-HIV and HBs.

**SEMESTER-III**  
**Paper-I**  
**3T1**  
**Molecular Biology and Genetics (MBG)**

**UNIT-I: - Replication Repair and Recombination**

**Replication:**-Initiation-Priming in *E.coli* and Eukaryotes.

**Elongation:**-Holoenzyme and processivity of replication.

**Termination:**-In prokaryotes and eukaryotes.

**DNA Repair:**-Direct reversal of DNA damage, Base excision repair by nucleotide excision.

**Homologous recombination:**-Rec BCD; gene conversion.

**UNIT-II: - Gene Expression**

**Transcription:**-Comparative study of prokaryotic and eukaryotic transcription process, Class I, II, III promoters, Enhancers and silencers, General and specific transcription factors.

**Post transcriptional events:**-mRNA, rRNA and tRNA processing through splicing mechanism, trans splicing, RNA editing, post transcriptional control of gene expression, gene silencing, RNA interference, Catalytic RNA and antisense RNA.

**Translation:**-Initiation, elongation and termination mechanism. Post translational modifications.

**UNIT-III: - Gene Regulation Expression**

Lac, Arabino and trp operons.

Chromatin remodeling and mRNA and protein degradation control.

**UNIT-IV:- Genetics of Bacteria and Bacteriophages**

Gene mapping in bacteria by conjugation, transformation and transduction.

Mapping bacteriophage gene by recombination analysis, deletion mapping and complementation.

Transposons: Bacterial, P elements and retroposons

**SEMESTER - III**  
**Paper –II**  
**3T2**  
**Recombinant DNA technology and Nano Biotechnology (RDTN)**

**UNIT-I: - Molecular Cloning Methods.**

**DNA cloning**, restriction enzymes, cloning vectors, genomic library, cDNA library and chromosome libraries.

Screening and identification of genes, Expression vectors, heterologous probes, oligonucleotide probes, microarrays.

**PCR:** Steps, advantages, limitations, application, RT-PCR,

**UNIT-II:- Other molecular tools for studying genes**

Restriction mapping: DNA sequencing dideoxy and pyrosequencing, DNA fingerprinting.

S1 Mapping, primer expressions, Dnase footprinting, DMS footprinting.

Nuclear run on transcription, reporter gene transcription.

**UNIT-III:- Tissue Culture and stem cell technology**

**Tissue culture:** Tissue culture media and supplements, serum-free media, cell lines and cryopreservation of cells. Primary culture, subculture, suspension culture techniques, transformation and immortalization. Quantitation and characterization of cells.

**Stem cell technology-**embryonal stem cell and multipotent stem cells, present perspective.

**UNIT-IV:- RDT Products.**

Tissue plasminogen activator [TPA]. Tissue growth factor B. Dnase; **PDGF.**

**GEMS/GMO.**

Transgenic plants and plant products, Comparative account, Concept of nano biotechnology and its application.

**SEMESTER - III**  
**Paper –III**  
**3T3**  
**Microbial Diversity, Evolution and Ecology (MDEE) - 1**

**UNIT-I: - Microbial Evolution and Systematic**

Evolution of Earth and early life forms.

**Primitive life forms:**-RNA world, molecular coding, energy and carbon metabolism, origin of Eukaryotes, endosymbiosis.

**Methods for determining evolutionary relationships:**-Evolutionary chronometers, Ribosomal RNA sequencing, signature sequences, phylogenetic probes, microbial community analysis.

**Derivation of Microbial Phylogeny:**- characteristics of domain of life, classical taxonomy, chemotaxonomy, bacterial speciation.

**UNIT-II: -Microbial Diversity: Archea**

General Metabolism and Autotrophy in archea

**Phylum Euryarchaeota:**- Halophilicarchaea, methanogens, thermoplasma.

**Phylum Crenarchaeota:**- Energy metabolism, Thermoproteales, sulfobolales, desulfobolales.

**Phylum Nanoarchaeota:**- Nanoarchaeum.

Heat stable biomolecules and extremophiles, Evolutionary significance of hyperthermophiles.

**UNIT-III :-Microbial Diversity: Bacteria**

**Phylum Proteobacteria:**-Free living N<sub>2</sub> fixing bacteria, purple phototrophic bacteria nitrifying bacteria, sulphur and iron oxidizing bacteria, sulphate and sulphur reducing bacteria.

**Phylum prochlorophytes** and cyanobacteria,

**Phylum: Planctomyces,**

**Phylum: Verrucomicrobia.**

**UNIT-IV :- Microbial Diversity.**

Phylum: Cytophaga, Phylum: Green Sulfur Bacteria. Phylum: Deinococci.

Phylum: Green non –sulfur bacteria.

Phylum: Branching Hyperthermophiles, Thermotoga and Aquifex.

Phylum: Nitrospira and Deferribacter.

**SEMESTER - III**  
**Paper –III**  
**3T3**  
**Bioinformatics (BIF) - 1**

**UNIT-I: -**

Basic Concept of Computer Organization, Internet, File Transfer Protocol, Browser, Home Page, Hyper text transfer protocol, Uniform Resource Locator, Hyperlink and Web Applications.

**UNIT-II: -**

Database types, levels of omics, genome projects.

C-value paradox, reassociation kinetics.

Data researches and pairwise alignments:-

Dot Plots, Simple alignments, Dynamic programming global and local alignments

BLAST, FASTA, Scoring matrices, and alignment scores. Multiple sequence alignments. Pattern of substitution within genes, substitution number estimations, molecular clocks.

**UNIT-III: - Phylogenetics**

Phylogenetic trees, Pair wise alignment, distance matrix method, maximum likelihood approach, multiple sequence analysis,

Parsimony, Inferred ancestral sequence, consensus tress, comparison of phylogenetic methods.

**UNIT-IV:- Genomics and Gene recognition**

Prokaryotes genomes, prokaryotic gene structure GC content prokaryotic gene density, eukaryotic genomes, eukaryotic gene structure, ORF,GC content expression, Tranposition, Repetitive elements, gene density.

**SEMESTER - III**  
**Core (Subject Centric)**  
**(To be opted by students of Microbiology only)**

**Paper –IV**  
**3T4**  
**Drugs and Disease Management (DDM)**

**UNIT-I: -**

**Drug latention and Prodrug:** History, carrier-linked prodrugs, bioprecursors prodrugs, carboxylic acids and alcohols, amines, carboxyl compounds.

**Drug-microbe:** Host relationship, mechanism of drug action and drug resistance including MDR.

**UNIT-II:-**

**Antiinfective agents:** Iodophores (providone-Iodine), Benzylkonium chloride, gentian violet, mercury compounds.

**Antifungal agents:** Clotrimazole, Ketoconazole, Tolnaftate, Amphotericin B, Nystatin, Griscofulvin.

**Antitubercular agents:** Isoniazid, Ethambutol, rifamycin, cycloserine.

**UNIT-III: -**

**Antiprotozoal agent:** Metranidazole, 8-hydroxyquinoline

**Antimalarials:** Quininesulphate, Chloroquine, Primaquine phosphate, Pyrimethamine.

**UNIT-IV:-**

**Histamines and Antihistaminicagents:** Cimetidine, Ramitidine, Omeprazole.

**Analgesic agents:** Morphine and their derivatives anti-inflammatory analgesics- Phenylbutazone and oxyphenbutazone, Prostaglandins.

**PRACTICAL-V**  
**3P1**

- 1) Isolation of genomic DNA of bacteria.
- 2) Isolation of plasmid DNA.
- 3) Amplification of DNA by PCR.
- 4) Restriction digestion and RFLP
- 5) Demonstration of bacterial transformation.
- 6) Demonstration of cloning
- 7) Demonstration of UV induced mutagenesis in *E.coli*.
- 8) Demonstration of ligation.

**PRACTICAL-VI**  
**3P2**

- 1) Preparation of plant tissue culture media.
- 2) Growth of Callus.
- 3) Isolation of single cell from intact plant organs.
- 4) Microscopic observation of cultured cells.
- 5) Determination of starch in plant tissue.
- 6) To study Phytochemical analysis (qualitative detection) of plant

**SEMESTER - IV**  
**Paper-I**  
**4T1**  
**Virology (VIR)**

**UNIT-I: - History, Classification and composition of viruses**

Brief outline on discovery of viruses (Origin and evolution), Terminology, Differentiation with other groups of microorganisms.

Nomenclature and classification of viruses (Regenmortel et.al.2005, 8<sup>th</sup> Report of ICTV).

Genetic classification

Morphology and structure of viruses (size and shape/symmetry).

Chemical composition of viruses (viral capsid, spikes, envelopes and types of viral nucleic acids).

Assay of Viruses.

**UNIT-II:-Bacterial viruses**

Bacteriophages- Structural organization; life cycle (Extracellular phase; attachment, penetration of nucleic acid, transcription, translation, replication, maturation and release of phage particles) of  $\Phi$ X174, T4, lambda, M13 and MuPhages. Bacteriophage typing, One step growth curve.

**UNIT-III:-Animal and Plant viruses**

Life cycle, pathogenesis and laboratory diagnosis of following viruses.

**Animal Viruses:-**

**RNA viruses:** Picorna, Orthomyxo, Rhabdovirus and HIV.

**DNA viruses:** Pox, Herpes, Adeno and Hepatitis viruses.

**Oncogenic viruses:** Papova viruses, EB virus, HTLV viruses.

**Plant virus:** TMV, Cauliflower mosaic virus, potato virus.

**UNIT-IV:-General methods of Diagnosis and antiviral drugs**

**Serological methods:** -Haemadsorption; Haemadsorption inhibition; haemagglutination;

Haemagglutination inhibition(HAI);Complement fixation immunofluorescence methods. ELISA and Radioimmunoassays (RIA).

**Antiviral agents:** Types of IFN, induction and Molecular basis of antiviral effect of interferon

Structure and Mechanism of action of:

Amantadine, Rimantidine, Vidarabine, Acyclovir, Ganciclovir, Ribavirin, Foscarnet, Stavudine, Lamivudine.

**NNRTIS(non-nucleoside RT inhibitors)-** Nevirapine; Delavirdine and Efavirenz.

**Protease inhibitors-** Saquinavir, Indinavir and Ritonavir.



**SEMESTER - IV**  
**Paper-II**  
**4T2**  
**Microbial Fermentation Technology (MFT)**

**UNIT-I:- General Principles of Fermentation**

**Bioreactors:** Bioreactor types, immobilized bioreactors, types of fermentation.

**Fermentation kinetics and Monods Model:-**Growth kinetics and Monod's Model, Substrate accelerated death, specific growth rate, stringent response, Ntr and Pho system, growth limiting substrate, maintenance energy, growth yield and product formation.

**Process optimization:** factors of optimization, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics. chemostat, turbidostat.

**UNIT-II:- Downstream Processing and scale up.**

**Downstream processes:** types of processing units and systems, Storage and packaging methods.

**Scale up;** scale down, criteria involved in scale up.

Productivity, power requirements Basic control theory.

**UNIT-III: - Industrial Fermentation Products**

**Biofuels:-**Ethanol, Hydrogen, Methane

**Antibiotics:-** $\beta$ -lactum antibiotics (Synthetic penicillin), Streptomycin, Cephalosporin.

**Biopreservative:** Lactobacillus sakei. Biopolymers:- Xanthan, Polyhydroxyalkanotes.

**Thermostable enzymes:-**Proteases. Biosurfactants: a comparative account.

**UNIT-IV:-Food and Healthcare products SCP,**

various types and processes. Carotenoides

**Aminoacids:-**Lysine, Glutamic acid.

**Vitamins:-**riboflavin, Vit.B12. Fatty acids (Palmetate, oleate).

**SEMESTER – IV**  
**Paper – III**  
**4T3**  
**Microbial Diversity, Evolution and Ecology (MDEE) - 2**

**UNIT-I: - Microbial Ecosystems**

Population, guilds, communities, homeostasis, Environment and microenvironment.  
Biofilms. Terrestrial environment, deep surface microbiology. Fresh water environment, lake and river microbiology. Marine Microbiology and Hydrothermal vents.

**UNIT-II: - Diversity, stability and succession**

Diversity indices, dominance indices, information statistics indices, Shannon index, Brillouin Index, Rank abundance diagrams, community similarity analysis, Jaccard Coefficient, Sorensen coefficient, cluster analysis. Community stability, stability hypothesis, Intermediate-disturbance hypothesis.  
**Meaning of succession:** Tolerance and inhibition patterns of succession, theories of succession.

**UNIT-III: - Ecology and Genetics**

**Genetic structure of population:-** Genotype frequency, allele frequencies.

**Hardy-Weinberg Law: -** Assumptions, predictions, derivation, extension and natural selection.  
Measuring genetic variation at protein level, measuring genetic variation at DNA level.

**Factors effecting gene frequencies:-** Mutation, Random genetic drift, migration, Hardy-Weinberg natural selection, Assortative mating, Inbreeding.

**UNIT-IV: -Interactions and Ecosystem Management**

**Microbial Interactions:** Competition and coexistence, Gause hypothesis, syntrophy, commensalism and Mutualism, predation, parasitism, and antagonism, Interaction with plants and animals.

**Concept of sustainable development:** microbial technology and sustainable development.

Management and improvement of waste land/barren land.

Oil spills, damage and management petroleum and oil shore management.

**SEMESTER – IV**  
**Paper – III**  
**4T3**  
**Bioinformatics (BIF) - 2**

**UNIT-I: -**

Data Mining- Definition, data mining problems, cluster analysis, data mining techniques and tools, data mining methods.

**UNIT-II: -**

Structure of proteins- primary, secondary, tertiary, quaternary. Protein motifs and folding, protein folding modeling, protein structure prediction.

**UNIT-III: -**

Structure of RNA, secondary structure of RNA, types of RNA, RNA structure prediction.

**UNIT-IV: -**

Insilico drug designing, insilico inhibitors designing, empirical methods of ligand screening, prediction techniques, post translational modification prediction.

**SEMESTER - IV**  
**Core (Subject Centric)**  
(To be opted by students of Microbiology only)

**Paper – IV**  
**4T4**  
**Vaccines and Delivery System (VDS)**

**UNIT-I: - Vaccines**

Definition and discovery of vaccines.  
Active and passive prophylactic measures.

**General account on :-**

- Exhalation & attenuation.
- Subunit vaccines
- DNA vaccines
- Vaccines additives and adjuvants

**UNIT-II: -**

**Conventional vaccines**

Contents and immunization schedule

- BCG
- Hepatitis vaccine
- Influenza vaccine
- Polio vaccine (Inactivated, live attenuated )
- DPT
- MMR

**UNIT-III: -**

**Advanced vaccines**

- Vaccines in development.
- Malaria vaccines
- Epstein Barr virus vaccines
- Cytomegalo virus vaccines
- HIV vaccines
- Herpes simplex viral vaccines

**UNIT-IV: - Designing & delivery system.**

- Drug designing
- Non-automated in vitro drug susceptibility testing.
- Rapid tests for susceptibility testing, and antibiotic assay in body fluid
- Drugs & vaccines delivery system.

**PRACTICAL-VII**  
**4P1**

- 1) Isolation of viruses from water sources.
- 2) Microbiological examination of foods.
- 3) Production of penicillin in lab and its estimation.
- 4) Determination of microbial reaction kinetics for an inhibitory substrate in a fed batch system.
- 5) Determination of the parameters of oxygen transfer.
- 6) Immobilization of cells/Enzymes.