

Deccan Education Society's  
**FERGUSSON COLLEGE, PUNE**  
**(AUTONOMOUS)**

**SECOND YEAR B. Sc. Microbiology syllabus**

**SEMESTER – I**

**Academic Year 2017-2018**

**PAPER CODE: MIC2301**  
**PAPER –I: TITLE: Microbial Genetics**  
**[Credits-3: No. of Lectures = 48]**

	Title and Contents	No. of Lectures
<b>Unit –I</b>	<p><b>1. Understanding Molecules of Heredity</b></p> <p>a. RNA world and shift to DNA world with time</p> <p>b. Evidence for nucleic acid as genetic material in bacteria -</p> <p>i. Discovery of transforming material (hereditary material): Griffith's experiment.</p> <p>ii. Avery and MacLeod experiment</p> <p>c. Evidence for nucleic acid as genetic material in viruses -</p> <p>i. Gierer and Schramm / Fraenkel-Conrat &amp; Singer experiment (TMV virus)</p> <p>ii. Hershey &amp; Chase experiment (T2)</p> <p><b>2. Prokaryotic genome organization</b></p> <p>i. Bacterial Nucleoid structure, Concept of Gene</p> <p>ii. Basic structure of B form of DNA, Properties of nucleotides related with DNA stability</p> <p>iii. Comparative account of different forms of DNA</p> <p><b>3. DNA REPLICATION</b></p> <p>i. Isolation of DNA from bacterial cell</p> <p>ii. J. Cairn's experiment.</p> <p>iii. Messelson and Stahl's experiment (semiconservative)</p> <p>iv. DNA replication: Theta model (semi-discontinuous)</p>	<b>16</b>
<b>Unit -II</b>	<p><b>Gene expression and Bacterial Systematics</b></p> <p><b>1. Gene expression</b></p> <p>a. Properties of genetic code</p> <p>b. Mechanism of transcription</p> <p>c. Mechanism of translation</p> <p><b>2. Plasmids</b></p> <p>a. Structure and Properties of plasmids, plasmid encoded properties</p> <p>b. Types of plasmids – F, R, Col, degradative plasmids of <i>Pseudomonas</i></p> <p>c. Plasmid replication -rolling circle model (plasmid DNA, <math>\lambda</math> phage DNA)</p> <p><b>3. Bacterial Systematics</b></p> <p>a. Introduction of concept of species and taxonomic levels.</p> <p>b. Criteria used for bacterial classification with reference to developments of laboratory manuals - Ultrastructure, Serology and Immunology, Chemotaxonomy.</p> <p>c. Genetic basis of taxonomy</p> <p>i. G + C content</p> <p>ii. DNA hybridization</p> <p>iii. Base sequence similarity (Use of 16s rRNA databanks)</p> <p>d. Numerical taxonomy</p>	<b>16</b>

<b>Unit –III</b>	<b>Mutation and Reversions</b> <b>1. Spontaneous mutations</b> i. Occurrence and Mechanisms ii. Fluctuation test <b>2. Mechanisms of induced mutations</b> Base pair substitution (Transitions, Transversions), Base analogues (2amino purine, 5bromo uracil), HNO <sub>2</sub> , Alkylating agents (ethyl methyl sulphonate) Frame shift mutations (Insertions and deletions), Intercalating agents (EtBr, acridine orange), Cross linking agents (Psorolin, mitomycin), UV rays, X rays, Biological mutagens (bacteriophage $\mu$ , transposomes) <b>3. Types of mutations</b> Nonsense, Missense, Silent, Null, Conditional lethal temperature sensitive, amber, leaky & non leaky <b>4. Isolation of Mutants:</b> Replica plate technique <b>5. Reversion</b> i. True reversion ii. Suppression (intragenic and intergenic)	<b>16</b>
<b>References:</b> 1. Benjamin Lewin (1994) Genes I. Oxford University Press 2. Freifelder D. (1995) Molecular Biology, 2nd Edn. Narosa Publishing House. 3. Gardner E.J., Simmons M.J and Snustad D.P. (1991) Principles of Genetics. 8th Ed. John Wiley & Sons Inc. 4. Russel Peter. Essential Genetics. 2nd Edn, Blackwell Science Pub. 5. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY 6. Stent S.G. & Calender R. (1986) Molecular Genetics: An Introductory Narrative, 2nd Edition, CBS Publishers and Distributors, India. 7. Strickberger M.W. (1985) Genetics. 3rd Edition Macmillan Pub. Co. NY. 8. Watson J.D. (1987) Molecular Biology of the Gene, 4th Ed. The Benjamin Cummings Publishing Company Inc. 9. Bergey D. H. & Holt J. G. (1994) Bergey's Manual of Determinative Bacteriology. 9th Edition. Lippincott Williams & Wilkins. (Unit I) 10. Garrity G. M. (2005) Bergey's Manual of Systematic Bacteriology. 2nd Edition. (Vols. 1 – 4). Williams & Wilkins. (Unit I) 11. Madigan M. T., Martinko J. M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc. (Unit I, II & III) 12. Prescott L. M., Harley J. P. and Klein D. A. (2005) Microbiology, 6th Edition. MacGraw Hill Companies Inc. (Unit II) 13. Priest F. G. & Brian Austin. (1993) Modern Bacterial Taxonomy. Edn 2, Springer. (Unit I)		

**PAPER CODE: MIC2302**  
**PAPER –II: Microbial Metabolism**  
**[Credits -3: No. of Lectures = 48]**

	<b>Title and Contents</b>	<b>No. of Lectures</b>
<b>Unit -I</b>	<p><b>Biomolecules as nutrients:</b></p> <ol style="list-style-type: none"> <li>1. Carbohydrates – Structure and types; biological role: storage polysaccharides – starch and glycogen; structural polysaccharides – cellulose, peptidoglycan and chitin</li> <li>2. Proteins – amino acids – general formula and concept of zwitterions, primary structures of proteins, secondary structure of proteins- peptide unit and its salient features, alpha helix and beta pleated sheets and their occurrence in proteins, tertiary and quaternary structure of proteins</li> <li>3. Lipids – Difference between oils and fats; Definitions and major classes of storage and structural lipids; structure and biological role of fatty acids; essential fatty acids; structure, function and properties of triacylglycerols; special lipids- sphingolipids, gangliosides</li> <li>4. Glycoproteins</li> <li>5. Glycolipids</li> <li>6. Lipoproteins</li> <li>7. Hierarchy of utilization of macromolecules</li> </ol>	<b>16</b>
<b>Unit -II</b>	<p><b>Utilization of nutrients:</b></p> <ol style="list-style-type: none"> <li>1. Radioisotopes in the study of metabolic pathways</li> <li>2. Autoradiography</li> <li>3. Pulse chase (tracer studies)</li> <li>4. Metabolic pathways               <ol style="list-style-type: none"> <li>i. Definitions: Metabolism, catabolism, anabolism, respiration, fermentation</li> <li>ii. Glycolysis</li> <li>iii. Hexose monophosphate pathway</li> <li>iv. Entner- Duodoroff pathway</li> <li>v. Glyoxylate bypass</li> <li>vi. Krebs Cycle (with emphasis on Amphibolism)</li> <li>vii. Homofermentative pathway</li> <li>viii. Heterofermentative pathway</li> </ol> </li> <li>5. High energy compounds, electron transport chain, oxidative phosphorylation and substrate level</li> </ol>	<b>16</b>

	phosphorylation, chemiosmotic hypothesis of ATP formation, concept of standard redox potential (Nernst Equation)	
<b>Unit –III</b>	<p><b>Biocatalysts used for utilization of nutrients</b></p> <ol style="list-style-type: none"> <li>1. Introduction to Enzymes</li> <li>2. Nature of active site, Ribozymes, Coenzymes, Apoenzymes, Prosthetic group, Cofactors and Isoenzymes</li> <li>3. Nomenclature and classification of enzymes as per IUB (upto class level)</li> <li>4. Structure of active site and common amino acids at the active site</li> <li>5. Models of catalysis <ol style="list-style-type: none"> <li>i. Lock and key model</li> <li>ii. Induced fit hypothesis</li> <li>iii. Transition state hypothesis</li> </ol> </li> <li>6. Specific catalytic groups involved in enzyme catalysed reactions <ol style="list-style-type: none"> <li>i. Acid-base catalysis</li> <li>ii. Metal ion catalysis</li> <li>iii. Covalent catalysis</li> </ol> </li> <li>7. Effect of pH, temperature, substrate concentration, enzyme concentration, activators, inhibitors of enzymes</li> </ol>	<b>16</b>
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Conn E., Stumpf P.K., Bruening G., Doi RH. (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi. (Unit I &amp; II)</li> <li>2. Moat A.G. &amp; Foster J.W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York. (Unit II &amp; III)</li> <li>3. Nelson D. L. &amp; Cox M. M. (2005) Lehninger's Principles of Biochemistry, 4th edition, W. H. Freeman &amp; Co. NY (Unit II &amp; III)</li> <li>4. Voet D. &amp; Voet J. G. (1995) Biochemistry, 2nd Ed.. John Wiley &amp; sons New York. (Unit II &amp; III)</li> <li>5. Bergey D. H. &amp; Holt J. G. (1994) Bergey's Manual of Determinative Bacteriology. 9th Edition. Lippincott Williams &amp; Wilkins. (Unit I)</li> <li>6. Garrity G. M. (2005) Bergey's Manual of Systematic Bacteriology. 2nd Edition. (Vols. 1 – 4). Williams &amp; Wilkins. (Unit I)</li> <li>7. Madigan M. T., Martinko J. M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc. (Unit I, II&amp; III)</li> <li>8. Prescott L. M., Harley J. P. and Klein D. A. (2005) Microbiology, 6th Edition. MacGraw Hill Companies Inc.(Unit II)</li> <li>9. Priest F. G. &amp; Brian Austin. (1993) Modern Bacterial Taxonomy. Edn 2, Springer. (Unit I)</li> </ol>		

	<b>PAPER CODE: MIC2303</b> <b>PAPER –III: Practicals based on ‘Microbial Genetics &amp; Biochemistry’</b> <b>[Credits -2: No. of Practicals = 10]</b> <b>1 Practical=4 hrs</b>
	<b>Title of Experiment/ Practical</b>
<b>UNIT I</b>	1. Biochemical characterization of bacteria: ( <i>E. coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Bacillus subtilis</i> , <i>Staphylococcus aureus</i> ) a. Sugar utilization test b. Sugar fermentation test c. Enzyme detection – Amylase, Gelatinase, Catalase, Oxidase d. Oxidative-fermentative test  2. Diagnostic biochemical test: IMViC test
<b>UNIT II</b>	1. Induced mutation and Isolation of Mutants a. Induction of mutations by using physical mutagen (e.g. UV rays) b. Isolation of mutants by any suitable method c. Demonstration of UV survival curve  2. Qualitative test for Carbohydrate and proteins
<b>References :</b>	
<ol style="list-style-type: none"> <li>1. Fundamental Principles Of Bacteriology by Salle,A.J. Publisher McGraw Hill Book Company Inc.</li> <li>2. Experiments in Microbiology, Plant Pathology and Biotechnology Aneja, K.R.</li> <li>3. Benson's Microbiological Applications, Laboratory Manual in General Microbiology, Short Version Alfred Brown; Heidi Smith</li> <li>4. Microbiology: A Laboratory Manual, 10th Edition James G. Cappuccino</li> <li>5. Handbook Media Stains Reagents Microbiology by A. M. Deshmukh</li> <li>6. Principles and techniques of practical biochemistry by Keith Wilson and John Walker</li> <li>7. Biochemical methods by S Sadasivam and A. Manikam</li> <li>8. An Introduction to practical biochemistry by David T. Plummer</li> </ol>	

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**SECOND YEAR B. Sc. Microbiology syllabus**

**SEMESTER – II**

**Academic Year 2017-2018**

**PAPER CODE: MIC2401**  
**PAPER –I: TITLE: Environmental Microbiology**  
**[Credits-3: No. of Lectures = 48]**

	Title and Contents	No. of Lectures
<b>Unit -I</b>	<p><b>Air Microbiology</b></p> <ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>i. Air flora – Transient nature of air flora</li> <li>ii. Droplet, droplet nuclei, and aerosols</li> <li>iii. Transmission of air-borne pathogens</li> </ol> </li> <li>2. Air pollution: Chemical pollutants, their sources in air and effects on human health</li> <li>3. Principles of air sampling for microbial               <ol style="list-style-type: none"> <li>i. Impaction on solids</li> <li>ii. Impingement in liquid</li> <li>iii. Sedimentation</li> </ol> </li> <li>4. Air sanitation: Physical and chemical methods</li> </ol>	<b>8</b>
<b>Unit -II</b>	<p><b>Water Microbiology</b></p> <ol style="list-style-type: none"> <li>1. Types of water: natural and processed- surface, ground, stored, distilled, mineral and de-mineralized water</li> <li>2. Purification of raw water</li> <li>3. Bacteriological standards of potable water                Maharashtra pollution control board (MPCB), Central pollution control board (CPCB), Bureau of Indian standards (BIS) World health Organization (WHO)</li> <li>4. Indicators of faecal pollution;               <ol style="list-style-type: none"> <li>i. <i>Escherichia coli</i></li> <li>ii. <i>Bifidobacterium</i></li> <li>iii. <i>Streptococcus faecalis</i></li> <li>iv. <i>Clostridium perfringens</i></li> <li>v. <i>Campylobacter</i> and <i>Pseudomonas</i></li> <li>vi. Bacteriophages</li> </ol> </li> <li>5. Water borne Infections</li> <li>6. Bacteriological analysis of water for potability               <ol style="list-style-type: none"> <li>i. Multiple tube fermentation test</li> <li>ii. Confirmed test</li> <li>iii. Completed test</li> <li>iv. Eijkman test</li> <li>v. Membrane filter technique</li> </ol> </li> <li>7. Sewage and Waste Water Microbiology</li> </ol>	<b>24</b>

	<ul style="list-style-type: none"> <li>i. Analysis of waste water – Physico- chemical parameters: pH, temperature, total solids, suspended solids, Chemical Oxygen Demand (C.O.D.); Biological parameters: B.O.D., Toxicity (Fish bioassay); Industrial water pollutants, their ecological effects and health hazards (Biomagnification and eutrophication)</li> <li>ii. Methods of effluent treatment – Primary, secondary, tertiary treatment methods</li> <li>iii. Recycling and reuse of waste water</li> <li>iv. Treatment of sludge – sludge thickening and dewatering and its disposal; biochemical mechanisms of Biomethanation, Types of anaerobic digesters, Applications of biogas (Methane)</li> </ul>	
<b>Unit –III</b>	<b>Soil Microbiology</b> <ul style="list-style-type: none"> <li>1. Soil microorganisms, composition and types of soil.</li> <li>2. Rhizosphere microflora and its role in the rhizosphere</li> <li>3. Role of microorganisms in composting and humus formation</li> <li>4. Role of microorganisms in following elemental cycles in nature -Carbon, Nitrogen, Sulphur, Phosphorous</li> <li>5. Role of microorganisms in degradation of cellulose, hemicelluloses, lignin and pectin</li> <li>6. Brief account of microbial interactions -</li> <li>7. Symbiosis, Neutralism, Commensalism, Competition, Ammensalism, Synergism, Parasitism, and Predation</li> </ul>	<b>16</b>
<b>REFERENCES:</b> <ul style="list-style-type: none"> <li>1. Daniel Lim., Microbiology, 2nd Edition; McGraw-Hill Publication</li> <li>2. Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.</li> <li>3. Madigan M.T, Martinko J.M. (2006) Brock’s Biology of Microorganisms. 11th Edition. Pearson Education Inc.</li> <li>4. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Publishing Co.</li> <li>5. Tortora G.J., Funke B.R., Case C.L. (2006) Microbiology: An Introduction. 8th Edition.</li> <li>6. Stanier R. Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY</li> <li>7. Pelzar M. J., Chan E. C. S., Krieg N. R.(1986) Microbiology. 5th Edition, McGraw-Hill Publication</li> <li>8. Prescott, Lancing M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education</li> <li>9. Hans G. Schlegel (1993) General Microbiology, 8th Edition, Cambridge University Press</li> <li>10. Martin Frobisher (1937) Fundamentals of Microbiology, 8th Edition, Saunders, Michigan University press</li> <li>11. Standard Methods for the Examination of Water and Wastewater (2005) 21<sup>st</sup> edition, Publication of the American Public Health Association (APHA), the American Water</li> </ul>		

- Works Association (AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton, Mary Ann H. Franson.
12. Martin A. Introduction to Soil Microbiology (1961) John Wiley & Sons, New York and London publication
  13. Subba Rao N. S. (1977) Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd.
  14. Dubey R.C., and Maheswari, D.K. Textbook of Microbiology, S. Chand & Co.
  15. Martin A. (1977) An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
  16. Alexander M. (1977) Introduction to soil microbiology, John Wiley NY.
  17. Dube H.C. and Bilgrami. K.S.(1976) Text book of modern pathology. Vikas publishing house. New Delhi.
  18. Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi.
  19. Stanbury P. F. and Whittaker A. (1984) Principles of Fermentation technology. Pergamon press

**PAPER CODE: MIC2402**  
**PAPER –II: Industrial Microbiology**  
**[Credits -3: No. of Lectures = 48]**

	Title and Contents	No. of Lectures
<b>Unit -I</b>	<b>Introduction to industrial microbiology</b> 1. Strains of industrially important microorganisms: a. Desirable characteristics of industrial strain b. Different methods of strain improvement 2. Screening – Principles and methods of primary and secondary screening 3. Master, working and seed culture; development of inoculum 4. Types of fermentation – Batch, continuous and dual fermentation	<b>16</b>
<b>Unit -II</b>	<b>Fermentation equipment and media</b> 1. Design of a Fermenter (typical CSTR Continuous stirred tank Reactor); different parts and their operation. 2. Different types of fermenter 3. Media for industrial fermentations: a. Constituents of media (laboratory and production scale) b. Sources and nutritional aspects. (Carbon source, nitrogen source, amino acids and vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers)	<b>16</b>
<b>Unit –III</b>	<b>Contamination, process control and large scale production</b> 1. Contamination : Sources, precautions, and consequences 2.. Sterilization of media-batch and continuous sterilization 3. Sterilization by filtration (feed, air and heat labile supplements) 4. Process Control and Monitoring of different fermentation parameters (temperature, pH, aeration, agitation, foam) 5. Large scale production of biofertilizers: Bacterial, Cyanobacterial and fungal (Nitrogen fixation and Phosphate solubilization) 6. Large scale production of biocontrol agents: Bacterial ( <i>Bacillus thuringiensis</i> ), viral (NPV) and fungal ( <i>Trichoderma</i> ).	<b>16</b>

**References:**

1. Casida LE. (1984) Industrial Microbiology. Wiley Easterbs, New Delhi
2. Ingraham J. L. and Ingraham C.A. (2004) Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
3. Madigan M.T., Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
4. Modi H. A., (2008) Fermentation Technology – Volumes I and II, Pointer Publishers, Jaipur, India
5. Patel A.H. (1985) Industrial Microbiology, Macmillan India Ltd.

6. Pepler H.L. (1979) Microbial Technology, Vol I and II, Academic Press.
  7. Prescott S.C. and Dunn C.G. (1983) Industrial Microbiology. Reed G. AVI tech books.
  8. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Publishing Co.
- Stanbury P. F. and Whittaker A. (1984) Principles of Fermentation technology. Pergamon

	<b>PAPER CODE: MIC2403</b> <b>PAPER –III: Practicals based on ‘Environmental Microbiology &amp; Industrial Microbiology’</b> <b>[Credits -2: No. of Practicals = 10]</b> <b>1 Practical=4 hours</b>
	<b>Title of Experiment/ Practical</b>
<b>Unit I</b>	<b>1. Air Microbiology:</b> i. Demonstration of the working of an air sampler ii. Determination of the diversity of air flora and calculation of Simpson’s index <b>2. Soil microbiology:</b> i. Isolation and checking characters of bacteria producing antibacterial substance from soil ii. Isolation and checking characters of exopolysaccharide – producing bacteria from soil 3. Demonstration of presence of capsule and spores in bacteria.
<b>Unit II</b>	<b>Water Microbiology</b> 1. Bacteriological tests of potability of water i. MPN, Confirmed and Completed test. ii. Membrane filter technique (Demonstration) 2. Determination of B.O.D. of water sample 3. Determination of total solids and total suspended solids in sewage water
	<b>Compulsory visit to waste water treatment plant/ water purification plant</b>
	<b>References:</b> 1. Salle A.J. (1971). Fundamental Principles of Bacteriology. 7th Edition. Tata Mac Graw Publishing Co. 2. Standard Methods for the Examination of Water and Wastewater (2005) 21 <sup>st</sup> edition, Publication of the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton, Mary Ann H. Franson. 3. Martin A. (1961). Introduction to Soil Microbiology John Wiley & Sons, New York and London publication 4. Subba Rao N. S. (1977) Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd.