MIDNAPORE COLLEGE

(AUTONOMOUS)

Accredited by NAAC: Grade-A CGPA - 3.58 (in 4 point scale)
P.O. – Midnapore, Paschim Medinipore - 721101

Syllabus

For

B.Sc. (Hons.) Microbiology

THREE YEAR (6 SEMESTER) FULL TIME PROGRAMME

Department of Microbiology

(Effective from 2016)
# SEMESTER-WISE DISTRIBUTION OF SUBJECTS

<table>
<thead>
<tr>
<th>Semester</th>
<th>Paper</th>
<th>Subject content</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester - 1</td>
<td>MCBH 101</td>
<td>Basic microbiology</td>
<td>50 (40 + 10)</td>
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<tr>
<td></td>
<td>MCBH 102</td>
<td>Practical</td>
<td>50 (25 + 25)</td>
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<tr>
<td>Semester - 2</td>
<td>MCBH 201</td>
<td>Microbial physiology</td>
<td>50 (40 + 10)</td>
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<tr>
<td></td>
<td>MCBH 202</td>
<td>Biochemistry</td>
<td>50 (40 + 10)</td>
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<tr>
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<td>MCBH 203</td>
<td>Practical</td>
<td>50 (25 + 25)</td>
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<tr>
<td>Semester - 3</td>
<td>MCBH 301</td>
<td>Microbial Metabolism and Biophysics</td>
<td>50 (40 + 10)</td>
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<td></td>
<td>MCBH 302</td>
<td>Food, Industrial and Applied microbiology</td>
<td>50 (40 + 10)</td>
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<td>MCBH 303</td>
<td>Practical</td>
<td>50 (25 + 25)</td>
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<tr>
<td>Semester - 4</td>
<td>MCBH 401</td>
<td>Agricultural and Environmental microbiology</td>
<td>50 (40 + 10)</td>
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<tr>
<td></td>
<td>MCBH 402</td>
<td>Basics of Computers, Bioinformatics, Biostatistics and Bioinstrumentation</td>
<td>50 (40 + 10)</td>
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<tr>
<td></td>
<td>MCBH 403</td>
<td>Practical</td>
<td>50 (25 + 25)</td>
</tr>
<tr>
<td>Semester - 5</td>
<td>MCBH 501</td>
<td>Immunology &amp; Medical microbiology</td>
<td>50 (40 + 10)</td>
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<td></td>
<td>MCBH 502</td>
<td>Microbial genetics &amp; Molecular biology</td>
<td>50 (40 + 10)</td>
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<tr>
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<td>MCBH 503</td>
<td>Practical</td>
<td>50 (25 + 25)</td>
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<tr>
<td>Semester - 6</td>
<td>MCBH 601</td>
<td>Biotechnology</td>
<td>50 (40 + 10)</td>
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<tr>
<td></td>
<td>MCBH 602</td>
<td>Practical including Project work</td>
<td>50 (25 + 25)</td>
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</tbody>
</table>

The total number of Honours papers = Theory -10
Practical – 06
Honours theory 500 marks and Practical 300 marks.

For Theory, 20% (50% for written test and 50% for attendance) of each paper will be for internal assessment.

For Practical, 50% marks will be from Continuous Internal Assessment (CIA), (Attendance 10% and Performance in Lab 40 %)
Unit I: History of Development of Microbiology

- Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, development of various microbiological techniques, concept of fermentation, establishment of fields of medical microbiology, immunology and environmental microbiology with special reference to the work of following scientists: Anton von Leeuwenhoek; Joseph Lister; Paul Ehrlich; Edward Jenner; Louis Pasteur; Robert Koch; Martinus W. Beijerinck; Sergei N. Winogradsky; Alexander Fleming; Selman A. Waksman; Elie Metchnikoff; Norman Pace; Carl Woese; Ananda M. Chakraborty; Griffith; Avery, Macleod and McCarty; Watson & Crick; Smith, Arber and Nathans.

Unit II: Microscopy and Staining Techniques

- General principles of optics, different components of light wave (i.e. UV, Visible, IR), compound microscopy, dark field, phase contrast microscopy, fluorescent microscopy, electron microscopy (principles and applications).
- Stains and staining techniques: Stains and Dyes; classification and types.
- Types of staining: Simple (Monochrome, Negative), Differential (Gram, acid fast and endospore staining) fungal and algal staining.

Unit III: Morphology of Bacteria

- Size, shape and arrangement of bacterial cells.
- Structures external to cell wall: Flagella, Pili, Capsule, Sheath and Prosthecae.
- Structures internal to cell wall: Cell membrane, nuclear material, cell wall (Protoplast and Sphaerooplast), spores, Cytoplasmic inclusions, Magnetosome and plasmids.
- Bacterial endospore: ultra structure, chemistry, sporulation and germination.
Unit IV: Microbial Diversity

- Bacteria with unusual properties: Rickettsia, Chlamydia, Mycoplasma, Archaeabacteria, Cyanobacteria, Actinomycetes.
- Viruses: Viroids and Prions. A general introduction with special reference to the structure of the following: TMV, poliovirus, T4 and λ phage, lytic and lysogenic cycles, one step multiplication curve
- Protozoa: General characteristics with special reference to Amoeba, Paramecium and Giardia. Clinical significance of these pathogens.
- Fungi: General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Detailed life cycle of Aspergillus and Rhizopus.
- Algae: Thallus structure, classification (Smith, 1955) and class character. Economic importance. Detailed life cycle of Laminaria and Oedogonium.
1. Safety measures in Laboratory.

2. Study of student microscope and research microscope: Construction, working, principle, care to be taken while using the microscope. Use of oil immersion objective.


4. Cleaning and sterilization of glassware.

5. Study of aseptic techniques: preparation of cotton plugs for test tubes and pipettes, wrapping of petri-plates and pipettes, transfer of media and inoculums.


7. Study (permanent slides) of fungi and algae: Volvox, Spirogyra, Oedogonium, Aspergillus, Penicillium, Rhizopus and Fusarium.
RECOMMENDED BOOKS

1. Microbiology, Authors- Pelczar, Chan and Kreig.
2. Microbiology- an Introduction- (8th Edn), Authors- Tortora, G.J., Funke, B.R., Case, C.L.
3. General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter.
4. General Microbiology, Authors- Stainer RY. Ingharam JL. Wheelis ML. Painter PR
5. Biology of Microorganisms, Authors- Brock and Madigan.
7. Microbial Physiology, Authors- Moat and Foster.
8. Textbook of Microbiology, Authors- Dubey and Maheshwari.
9. Microbiology, Author- S.S. Purohit.
10. Immunology, Microbiology and Biotechnology, Author- K.C. Soni.
12. Microbiology A Practical Approach Authors- Patel and Phanse
Unit I: Cultivation and Pure Culture Techniques
- Nutrition and nutritional types of bacteria.
- Bacteriological media (types and uses), cultivation of aerobic and anaerobic microbes.
- Isolation of microorganisms, pure culture and cultural characteristics.
- Maintenance and preservation of cultures.

Unit II: Microbial Growth
- Mathematical expression of bacterial growth, generation time and growth rate.
- Growth curve and phases of growth cycle.
- Batch, continuous and synchronous cultures; diauxic growth.
- Factors affecting microbial growth.
- Quantitative measurement of bacterial growth by cell mass, cell number and cell activity.

Unit III: Control of Microorganisms
- Microbial death curve under adverse condition.
- Concept of sterilization, disinfection, asepsis and sanitation.
- Physical methods of control- Temperature, radiation, desiccation, osmotic pressure, filtration.
- Chemical methods of control- Phenol, alcohol, halogens, heavy metals, dyes, detergents, quaternary ammonium compounds, aldehydes and gaseous chemosterilizers.
- Evaluation of antimicrobial potency of disinfectants and antiseptics- Tube dilution, Agar diffusion, Phenol coefficient.

Unit IV: Antibiotics and other chemotherapeutic agents
- Definition and classification of antibiotics.
- Characteristics of antibiotics that qualify them as chemotherapeutic agents.
- Antimicrobial spectrum of antibiotics and mode of action of the following antibiotics; Antibacterial - Penicillins, Cephalosporins, Bacitracin, Polymyxins, Streptomycin, chloramphenicoles, tetracyclines and Vancomycin; Antifungal - Nystatin, Gresiofulvin and Cyclohexamide; Antiviral – Zedovudine; Synthetic Chemotherapeutic agents
- Development of Resistance to antibiotics- a brief account.
Unit I: Carbohydrates

- Definition, classification, structural concept of triose, tetrose, pentose and hexose, monosaccharides, disaccharides (sucrose, maltose and lactose), homo and heteropolysaccharidts (starch, glycogen, cellulose), ammo sugars.
- Composition of peptidoglycan, Properties: asymmetric carbon atom, mutarotation, optical isomerism, Stereo chemistry.

Unit II: Amino acids and Proteins

- Amino acids- Classification and properties. Structure, Zwitterions nature.
- Proteins- Classification, Structure and function. Primary, secondary, tertiary and quaternary structure.

Unit III: Enzymes

- General characteristics. Factors affecting enzyme activity.
- Regulation of enzyme activity.
- Enzyme kinetics, Km, activation and inhibition
- Coenzymes and cofactors. Non-protein enzymes
- Applications of enzymes.

Unit IV: Lipids, Vitamins and Hormones

- Saturated and unsaturated fatty acids.
- Structure, classification, properties and function of lipids.
- Distribution and functions of lipids in microorganisms.
- Classification and function (deficiency and excess) of vitamins, Steroid hormones and its function.

Unit V: Nucleic acid:

- Definition, occurrence and classification of nucleic acids, concept of purine and pyrimidine bases, nucleosides and nucleotides,
- Chemical properties - effect of acid and alkali, viscosity, Tm value, types of DNA [A-DNA, B-DNA and Z-DNA (structure and difference)] and RNA (structure and types).
1. Preparation of Culture Media.

2. Isolation of bacteria and Fungi from soil.
   a) Preparation of serial dilutions.
   b) Spread plate and pour plate techniques.
   c) Streaking techniques for isolation and purification of bacteria.
   d) Study of colony characteristics of bacteria

3. Motility of bacteria by hanging drop technique.


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1. Microbiology, Authors- Pelczar, Chan and Kreig.
2. Microbiology- an Introduction- (8th Edn), Authors- Tortora, G.J., Funke, B.R., Case, C.L.
3. General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter.
4. Biology of Microorganisms, Authors- Brock and Madigan.
6. Introduction to Microbiology, Authors- Ingraham and Ingraham.
7. Microbial Physiology, Authors- Moat and Foster.
8. Textbook of Microbiology, Authors- Dubey and Maheshwari.
9. Microbiology, A Practical Approach. Authors- Patel and Phanse
11. Biochemistry, Author- Voet and Voet.
13. Biochemistry, Author- Stryer.
14. Microbiology A Practical Approach Authors- Patel and Phanse, .
SEMESTER - 3
Unit I: Carbohydrate metabolism:

Unit II: Protein metabolism:

Unit III: Lipid metabolism:

Unit IV: Nucleic acid metabolism:
- Biosynthesis of Purine and pyrimidine. Catabolism of nucleic acid.

Unit V: Bioenergetics:
- First and second law of Thermodynamics, closed and open system, entropy, enthalpy, Gib’s concept of free energy.

Unit VI: Fundamentals of isotopes:
- Radioactive and non-radioactive (heavy) isotopes, laws of radioactivity, half life and average life, types of radiations (alpha, beta and gamma radiations).
- Applications of radioactive and heavy isotopes in biology. Hazards or radioactivity in living systems.

Unit VII: Basic idea and significance or important physical phenomena:
- Basic idea and significance or important physical phenomena like Bonding, Solvent system, Order of reaction, surface tension, surfactant; viscosity, diffusion, osmosis, adsorption, absorption, colloid, Gib - Donnan membrane equilibrium, pH, buffer.
Unit I: Fundamentals of Industrial Microbiology

- General concepts of industrial microbiology, Primary and secondary screening, Strain development strategies, Sterilization of fermentor, media and air, Types of fermentations processes, Design of typical batch Fermentor, Factors affecting fermentor design, Control of agitation, aeration, pH, temperature and dissolved oxygen, Types of fermentors, Inoculum development, Scale up of fermentation process, Raw material for media preparation, Harvesting and product recovery.

Unit II: Industrial production

- Production of antibiotics- Penicillin and semi-synthetic penicillins, Production of enzymes- Amylase, Immobilization of enzymes and applications of immobilized enzymes, Production of solvent- Ethanol, Production of Vitamins- Cyanocobalamin, Production of Organic Acids- Acetic Acid, Production of Amino Acids- Glutamic Acid.

Unit III: Food Microbiology

- Food and Microorganisms: Food as a substrate for microorganisms. Sources of contamination of food.
- Food spoilage and food poisoning: Spoilage of canned food, cereals, fruits, vegetables, meat and fish. Food sanitation and control. Food poisoning-Endotoxin, staphylococcal poisoning, botulism and salmonella is Mycotoxins produced by fungi-Aflatoxin in stored food and grains.
- Food preservation: Principles of food preservation Methods of food preservation-high temperature, canning, freezing, dehydration, chemical preservatives and radiation.
- Microorganisms as food: Single cell proteins; Yeast and Spirulina.

Unit IV: Dairy Microbiology

- Microorganisms of Milk
- Methods of preservation of milk and milk products
- Fermentation in milk
- Fermented Milk Products: Yogurt-Types & production; Cheese-types and production; Cultured Butter milk.
Unit V: Microorganisms in Agriculture
- Bacteria and fungi as biopesticides.
- Genetically modified crops containing insecticidal genes.
- Biofertilizers- Nitrogen fixers, Phosphate Solubilizing Bacteria and Mycorrhiza.
- Fuel from microorganisms- Biogas technology, Microbial hydrogen production, Concept of gasohol.

Unit VI: Advanced Microbiology
- Biosensors and Biopolymers; Biochips, Biofilms and Bioplastics; Microorganisms as bioindicators
1. Preparation of buffers-citrate and phosphate buffers.
2. Estimation of DNA by Diphenylamine method.
3. Estimation of RNA by Orcinol method.
5. Estimation of sugar by DNS method.
6. Acid number of fat (coconut oil).
7. Estimation of Cholesterol by FeCl₃ method.
8. Qualitative estimation of Carbohydrate (Glucose, Fructose, Starch, Dextrin, Sucrose, Maltose and Lactose), Protein (Peptone, Albumin and Gelatin) and lipid (Glycerol and Cholesterol)
9. Determination of MIC of antimicrobial agents (Cefixime, Ampicilline and Streptomycin)
10. Isolation of amylase producer from soil sample.
11. Microbial examination of some fruits and vegetables.
12. Microbial examination of Milk.
14. Separation of amino acids by TLC.
15. Visit to a Laboratory / Institute of microbiological interest.
RECOMMENDED BOOKS

1. Principles of Biochemistry, Author- A.L. Lehniger
2. Fundamentals of Biochemistry, Author- J. L. Jain
3. Biochemistry, Author- Voet and Voet.
5. Biochemistry, Author- Stryer.
7. Microbiology A Practical Approach Authors- Patel and Phanse, .
9. Industrial Microbiology, Author- L. E. Cassida
10. Industrial Microbiology, Author- G. Reed.
11. Industrial Microbiology, Author- Agarwal And Parihar.
13. Principles of Fermentation Technology, Authors- Standbary, Whitaker and Hall.
Unit I: Agricultural Microbiology

- Soil-definition, types, physical and chemical characters, soil profile, Soil microflora.
- Interactions between plants and microorganisms-types of interactions.
- Microorganisms of rhizosphere, rhizoplane and phylloplane, mycorrhiza.
- Microorganisms in agriculture-Biochemistry, genetics and physiology of Nitrogen fixation, Symbiotic- Rhizobium, Non-symbiotic-Azotobacter, BGA and associative-Azospirillum associations.
- Biofertilizers-Definition, Types (bacterial, fungal, phosphate solubilizers, BGA, Plants-Azolla); kind of association, mode of application and merits.
- Biopesticides-Introduction types (bacterial-Bacillus thruiingiensis, Viral –NPV, fungal-Trichoderma), Mode of action, factors influencing, genes involved and target pests.
- Study of microbes as plant pathogens-Puccini, Plasmopara, Cercospora, Pyricularia; Xanthomonas oryzae; Mycoplasma-Sandal spike, grassy shoot.

Unit II: Environmental Microbiology

- Microbiology of air

- Microbiology of water

- Unit II: Microbiology of Soil
Unit I: Basics of computers
Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, Idea of I/O devices, System Tools
Data Representation, Boolean operation, Basic idea on internet.

Unit II: Bioinformatics
Databases: Nucleic acid.
Tools: Sequence alignments- Pair-wise (T-coffee) and multiple sequence alignment (Clustal w). Sequence similarity search and homology algorithms (BLAST) for protein and nucleic acids.

Unit III: Biostatistics
Measure of central tendency: Mean, Median, Mode, Skewness and Kurtosis.
Measure of dispersion: Standard deviation and Standard error.
Diagrammatic and graphic representation of frequency distribution.
Basic idea of probability.

Unit III: Bioinstrumentation
1. Isolation and enumeration of bacteria and fungi from rhizosphere and rhizoplane.
2. Study of Rhizobium (using Yeast Extract Mannitol Agar) and Azotobacter (using Ashby's Mannitol Agar) from soil.
3. Isolation of actinomycetes from soil microorganisms using Glucose Aspergine agar by plate methods.
4. Study of airborne microorganisms (bacteria and fungi) in different environments by exposure plate method.
5. Determination of DO, BOD, COD.
6. Microbial examination of water (Coli form bacteria) through MPN methods for potability.
7. Familiarizing with the Operating System, Control Panel.
8. Working with MS Excel: Spreadsheet Handing, working with worksheets, creating a spreadsheet, entering and formatting. Data analysis, chart & graph preparation.
9. Sequence alignment (BLAST).
RECOMMENDED BOOKS

1. Environmental Microbiology, Author- P.D. Sharma.
2. Environmental Microbiology, Author- K.G. Vijaya.
3. The nature and properties of soil. Authors- Harry buckman and Nyle C. brady.
11. The Internet and the New Biology: Tools for Genomic and Molecular Research, Author- Peruski and Peruski.
12. Principles of Biostatistics, Authors- Pagano et al.
13. Introduction to Biostatistics, Authors- Forthoter and Lec.
Unit I: Immunology

Immune System: Organs of Immune system- Spleen, thymus and lymph nodes, Cells of Immune system- T cells- its types and receptors. B cells and its receptors.

Immune Response: Innate and acquired Immunity, Host defense mechanism- First, second and third line of host defense, Primary and secondary responses.


Immunological techniques used in disease detection: Agglutination and precipitation reactions. Hemagglutination, Immunofluorescence, ELISA, RIA, Coombs test (Direct and Indirect).

Complement: Components and biological activities.

Vaccine: Inactivated, Attenuated, Toxoid.

Unit II: Medical microbiology

Epidemiology of Infectious Diseases: Epidemiological study. Transmission of diseases.

Types of diseases - Epidemic, pandemic, endemic and sporadic. Nosocomial infections.


Transmission of drug resistance. Antiviral and antifungal drugs.

Hypersensitivity: Hypersensitivity- Immediate and delayed type. Skin tests.

Autoimmune diseases.

Microbial Diseases: Gram Positive Cocci - Staphylococcus aureus, Gram Negative Bacilli - Vibrio cholari, Acid fast bacteria - Mycobacterium tuberculosis, Anaerobic & Gram positive bacilli - Clostridium tetani, Fungal skin infections - Dermatophytosis, Viral disease – HIV and Hepatitis B.
PAPER – MCBH 502
MICROBIAL GENETICS & MOLECULAR BIOLOGY (40 LECTURES)

Unit I: Genome type:

Unit II: Flow of hereditary characters:
Concept of central dogma, Replication of prokaryotic chromosome, Transcription of RNA, Translation of protein, Concept of operon. induction and repression, lac & typ operon system in bacteria.

Unit III: Mutation and Repair:
Spontaneous and induced mutation, types of mutation; base pair changes (transition, transversion) frameshifts, deletion, inversions, tandem duplication, insertions. Major physical and chemical mutagens and their mode of action. Isolation of microbial mutant (auxotrophic, conditional lethal, resistant). Type of repair systems like mismatch, base-excision, nucleotide excision, direct repair, photoreactivation, SOS repair.

Unit IV: Gene transfer and Recombination:

Unit V: Molecular Biology
Signal transduction and control of transcriptional regulator, Conserved mechanism of regulation, Signal integration, combinatorial control, Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA. Tumor cells and the onset of cancer, Development and Causes of Cancer, the genetic basis of cancer, Oncogenic mutations in growth promoting proteins.
Signaling at the cell surface, Signaling molecules and their receptor; receptor proteins, ligand binding and effector specificity, functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks, conserved intracellular protein functions in signal transduction, appropriate cellular responses.

DNA library. DNA fingerprinting, hybridization technique.
1. Estimation of hemoglobin by Sahli’s method.
2. Total count of W.B.C. & R.B.C.
4. Flocculation reaction - VDRL
5. Agglutination reaction - Widal test, Blood Grouping.
6. Immuno-diffusion techniques - ODD and RID.
7. Estimation of skin microflora (Bacterial and Fungal).
8. Isolation of bacterial Genomic DNA and Plasmid DNA.
9. Electrophoretic analysis of DNA.
10. Restriction analysis of bacterial genome / plasmid.
<table>
<thead>
<tr>
<th>No.</th>
<th>Book Title</th>
<th>Author(s)</th>
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<tbody>
<tr>
<td>1.</td>
<td>Text of Microbiology</td>
<td>Ananthanarayanan and Panikar.</td>
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<tr>
<td>2.</td>
<td>Epidemiology and Infections</td>
<td>Smith</td>
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<tr>
<td>3.</td>
<td>Diagnostic Microbiology</td>
<td>Baron, Peterson and Finegold.</td>
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<tr>
<td>4.</td>
<td>Immunology</td>
<td>J. Kuby</td>
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<td>5.</td>
<td>Fundamental Immunology</td>
<td>W.E. Paul</td>
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<td>6.</td>
<td>Fundamentals of Immunology</td>
<td>Coleman, Lombard and Sicard.</td>
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<td>7.</td>
<td>Essentials of Immunology</td>
<td>Roitt, I.M.</td>
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<td>8.</td>
<td>Medical Microbiology, Vol. 1</td>
<td>Mackie and McCartney</td>
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<tr>
<td>10.</td>
<td>Bailey and Scott’s, Diagnostic Microbiology</td>
<td>Baron EJ, Peterson LR and Finegold SM. Mosby, 1990</td>
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<td>11.</td>
<td>Genes XI</td>
<td>B. Lewin</td>
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<td>13.</td>
<td>Concepts of Genetics</td>
<td>Klug and Cummings</td>
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<td>14.</td>
<td>Microbial Genetics</td>
<td>Freifelder.</td>
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<td>15.</td>
<td>Genetics</td>
<td>Arora and Sandhu</td>
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Unit I: Tools used in Genetic Engineering
Tools and techniques in genetic engineering; Restriction endonucleases- Types and uses; Isolation of Genomic and Plasmid DNA.

Unit II: Vectors
Classification and properties of vector, structural significance of plasmid and phage vector, cosmid, phagemid.

Unit III: Cloning

Unit IV: Application

Unit V: Pharmaceutical Biotechnology
Genetically engineered microorganisms, GM crop: Bt cotton, Bt brinjal, delayed ripened tomato and herbicide resistant plants.
Production of heterologous proteins: Insulin, Growth hormones, Interleukins and plasminogen activator.
Recombinant vaccines: Subunit, Conjugate, DNA vaccines, vector vaccines.
Unit I: Statistical Analysis

Computation of frequency distribution, drawing of histogram and frequency polygon, mean, median, mode, standard deviation and standard error from the data obtained from any microbial experiment.

Unit II: Group Project

Any microbiological problem should be chosen as project topic. Each group consists of maximum 6 students and minimum of 4 students.

Unit III: Excursion

Visit to an Industry microbiological interest.
RECOMMENDED BOOKS


