A brief description of the course: Department of Microbiology in Colleges affiliated to Goa University offer three year, full time B.Sc. Microbiology programme. This programme strengthens the basics of Microbiology and its application. It is job & research oriented facilitating placement of students in pollution control & sanitation, agriculture, clinical and & preventive medicine and industries viz. pharmaceuticals, food, beverage and genetic counseling.

- **Purpose:**
  i) Introduction of world of microbes to students by teaching the basics of microbiology along with its related subjects viz. physiology, biochemistry, molecular biology and genetic engineering through theoretical and practical course contents.
  ii) Introduction of Microbial techniques
  iii) Introduction to applications of microbiology in different fields like terrestrial and aquatic environment, medical immunology, agriculture and industries.

- **Prerequisites:** XIIth Science with physics, chemistry and biology as subjects.

- **Credits** (theory, tutorials, practicals): The course is without credits but possesses total 20 Units.

- **Number of semesters and course distribution:** Total Six semesters and course is distributed as shown in the following table:

<table>
<thead>
<tr>
<th>CLASS</th>
<th>SEMESTER</th>
<th>CODE OF PAPERS OFFERED</th>
<th>NUMBER OF UNITS**</th>
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<tr>
<td>First Year (FY)</td>
<td>I</td>
<td>101, 102</td>
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<td>103, 104</td>
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<td>Second Year (SY)</td>
<td>III</td>
<td>201, 202</td>
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<td>VI</td>
<td>307, 308, 309, 310, 311, 312</td>
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</tbody>
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*Project - done during Third Year ( semester V and VI).

** Students need to opt for two other subjects in FY & SY with 2 units each

- **Dissertation/ Project:** Project is of 100 marks.
- **Field work:** Visits to relevant academic institutions and industries.
B.Sc Microbiology

List of Courses

In the following tables, L refers to lectures, T to tutorials and P to practicals. Description of a course appears on the page number listed in the tables.

Compulsory Courses

<table>
<thead>
<tr>
<th>Course Number and Name</th>
<th>L-T-P (hours/week)</th>
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<td>302 Medical Microbiology</td>
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<td>305 Industrial Microbiology</td>
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<td>306 Practical (Molecular Biology + Industrial Microbiology)</td>
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<td>308 Medical Microbiology and Basic Immunology</td>
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<td>311 Food Microbiology</td>
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<tr>
<td>312 Practical (Genetic Engineering + Food Microbiology)</td>
<td>0-0-4</td>
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Project | 2/ batch of 5 |
Syllabus of B.Sc. Microbiology Programme

Compulsory Courses

COURSE CONTENT

**First Year (Semester I)**

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>101</td>
<td>Introduction to Microbiology and Biochemistry I</td>
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<td>Basic Techniques in Microbiology I</td>
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**First Year (Semester II)**

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<tr>
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<td>Introduction to Microbiology and Biochemistry II</td>
</tr>
<tr>
<td>104</td>
<td>Basic Techniques in Microbiology II</td>
</tr>
</tbody>
</table>
SEMESTER I

101: Introduction to Microbiology and Biochemistry

I. Introduction, Historical Aspects and Scope of Microbiology (15)

1. Introduction to Microbiology
   Types of Microorganisms; Distribution of microorganisms in nature, Brief description of classification schemes proposed by Linnaeus, Haeckel, Whittaker, Woese.

2. Historical Developments in Microbiology
   Development in microscopy; Discovery of the microbial world; theory of spontaneous generation vs. biogenesis; Germ theory of diseases, aseptic surgery, Development of pure culture. Widening horizons - golden age of microbiology, recent discoveries, Nobel Laureates, Landmarks in virology.

3. Scope of Microbiology
   Medical, aquatic, domestic and industrial Sewage, water, air, food, soil, agricultural, geochemical transformations, industrial applications.

II. Microbial associations (10)
   Types of associations: mutualism, commensalism, synergism, syntrophism, competition, antagonism, parasitism, predation; Ectosymbiosis and Endosymbiosis of plants, animal and other microorganisms. Examples of each type of interaction - mycorrhizal, root nodules, ruminant symbiosis, termites, bioluminescent bacteria.

III. Microbial cytology (20)
   Diversity in microbial cytology. Structure of eukaryotes and prokaryotes (Archaebacteria and Eubacteria) and differences (Tabular presentation).
   Organization and ultrastructure of prokaryotic cell- Bacterial cell. Cell wall: structure and composition in gram positive and gram negative bacteria, sphaeroplast, protoplast, L-forms; Flagella and pili; Cell membrane: architecture, structure & function; Slime and capsule: composition, function; Cytoplasmic organelles; Nuclear material: nature and function; Endospore: structure, sporulation and germination; Reserve materials: glycogen, lipid granules, polyhydroxyalkanoate, volutin, sulphur inclusion.

Practical (101)
   Safety in microbiology: good laboratory practices, disposal of infectious wastes.
   Working and handling of common laboratory equipments: autoclave, Hot air oven, Incubator, Colony counter, Bacteria proof filters, Laminar air flow.
   Use and care of compound microscope, wet mounts, Lactophenol cotton blue staining Monochrome staining; Negative staining; Gram staining; Hanging drop technique.
   Preparation of Laboratory Media: Peptone water, nutrient broth and agar, preparation of slants and butts, Saboraud’s broth and agar, MacConkey’s broth and agar.

List of Books
1. Microbiology by Prescott, Harley, Klein.
2. Essentials of Microbiology by Frobisher.
3. Microbiology by Pelczar.
4. General Microbiology by Stanier.

BACK
SEMESTER I
102 : Basic Techniques in Microbiology I

I) Microbial nutrition, cultivation, isolation, enumeration and preservation (22)

Nutrition
Nutritional Types: phototrophs, chemotrophs & their subgroups. Autotrophs and heterotrophs. Facultative types, fastidious groups (definition) eg Mycobacterium, Streptococcus. Basic nutritional requirements; Sources of C, N, S, P, O, H, micro nutrients, growth factors, organic/ inorganic electron donors

Physico-chemical conditions
pH: acidophiles, alkalophiles, neutrophiles, buffers & their use in culture media; Temperature: psychrophiles, thermophiles, mesophiles; Oxygen tension: aerobic, microaerophilic, anaerobic; use of pre-reduced media (Thioglycolate, Robertson's cooked meat), Anaerobic jar; Other conditions: osmotic pressure (osmophiles, halophiles), hydrostatic pressure (barophiles)

Cultivation
Types of culture media: synthetic, complex, enriched, enrichment, selective, differential, dehydrated solid and liquid.

Isolation
Concept & methods of pure culture technique; Methods: enrichment, streak plate, surface spread, pour plate, colony characters, pigmentation

Enumeration
Physical methods: Direct counting - microscopic counts (Breed's count, Haemocytometer count); Indirect counting - turbidometry (use of colorimeter), Dry-weight, wet-weight, PCV (packed Cell Volume)

Biological methods: Direct counting - SPC (serial dilution, viable counts, colony counts), membrane filter method; Indirect counting - MPN.

Preservation:
General principles of preservation. Methods - periodic transfer, overlaying with mineral oil, soil stock, preservation in liquid nitrogen, lyophilisation; Culture collection centers (culture banks) & their role.

II) Principles and methods of light microscopy (10)

Principles of optics, magnification, resolution, angular aperture, focal length, mechanical tube length.
Types of optical microscopes - simple, compound, binocular.
Lens systems: Objectives: low power, high power, oil immersion, function & importance, Eyepiece: Huygenian, Ramsden, Hyperplane, compensating ocular; Condensors: Abbe, Aplanatic, achromatic, differences & applications. Micrometry & its use
III) Stains and Principles of staining procedures (13)

1. Definition and classification of dyes, chromogen, Chromophore and auxochrome group, acidic/basic dyes, compound dyes, Leuco dyes, metachromatism, fluorochromes.
3. Types of staining: Simple- monochrome, vital staining; Differential- Gram staining & Acid –fast staining (physicochemical basis), significance in bacteriology; other stainings – DNA( Feulgen reaction), cell wall, capsule, flagella, lipids, endospores, metachromatic granules.

Practical (102)
Pure culture techniques: Aseptic pipetting and pouring Culture media in Petri dishes, streak plate (T, parallel line, quadrant, Zigzag method).
Preservation: stab culture, periodic transfer and mineral oil overlaying.
Cell wall staining: Capsule staining; Lipid staining, volutin granules; Endospore staining;
Cultivation of aerobic and anaerobic spore bearers Bacillus and Clostridium;
Enumeration of microorganisms – McFarland’s tubes, Breeds Smear, Hemocytometer
Viable counts by serial dilution ( pour plate, spread plate )
Micrometry

List of Books
1. Fundamental Principles of Bacteriology by A.J. Salle
2. Essentials of Microbiology by Frobisher
3. Microbiology by Pelczar
4. Microbiology by Modi
5. Microbiology by Prescott, Harley & Klein
6. Textbook of Microbiology by Ananthanarayan
7. Medical Microbiology Vol.I by Cruickshank
SEMESTER II

103 : Introduction to Microbiology and Biochemistry II

1. General characters, Morphology and salient Features of Groups of Microorganisms; economic importance: (23)
   - Rickettsias: Coxiella, Rickettsia
   - Actinomycetes: Nocardia, Streptomyces
   - Cyanobacteria: Oscillatoria
   - Algae: distinguishing characters of major algal groups, Reproduction
   - Yeasts: reproduction- sexual/sexual, budding, binary fission, pseudomycelium
   - Molds: nutrition, reproduction, sexual/sexual spores, distinguishing features of major groups with egs Lichens
   - Protozoa: nutrition, reproduction, distinguishing features of major groups with egs
   - Viruses: structure with egs; Criteria of viral classification: Morphology, nucleic acid, host; Viral replication (lytic and lysogeny), Cultivation.

II. Chemical Basis of Life (22)
   Introduction: Chemical composition of cell important elements, types of organic/inorganic molecules & polymers present in the cell structure, properties, biological functions.
   - Carbohydrates: Trioses, tetroses, pentoses, hexoses optical isomerism, pyranose and furanose forms, alpha/beta forms, reducing sugars, disaccharides, glycosidic bonds, lactose, maltose, sucrose, polysaccharides - storage: glycogen, starch; structural: cellulose.
     Principles of carbohydrate determination: Total carbohydrates by phenol sulphuric acid method, reducing sugars by DNSA method.
   - Amino acids: L & D forms, zwitterion, amphoteric nature, R groups, naturally occurring amino acids. Detection of amino acids by Ninhydrin method.
   - Proteins: peptide bond, peptides, primary, secondary, tertiary, quaternary structure.
     Protein determination: UV absorption, Colorimetrically by Biuret & Folin Lowry method.
   - Nucleic acid: purines & pyrimidines, nucleosides & nucleotides; principle of determination of DNA by diphenyl amine and RNA by Orcinol methods.

Practical (103)
   - Study of Actinomycetes- Nocardia and Streptomyces
   - Study of yeasts, budding
   - Study of fungi
   - Permanent slides of algae, protozoa, cyanobacteria
   - Chemical tests for starch, sugars, protein & fatty acids
List of books

1. Microbiology by Prescott, Harley & Klein
2. Essentials of Microbiology by Frobisher.
3. Microbiology by Pelczar
5. Outlines of Biochemistry by Cohn & Stumpf.
6. An Introduction to Practical Biochemistry by David T. Plummer.
7. Lab Manual in Biochemistry by Jayaraman
I. Microbial growth (12)
Definition of cell growth/population growth; generation time -definition & formulae,
Bacterial growth curve, characteristics of growth phases; diauxic growth
Synchronous growth Batch/Continuous cultures: principles, steady state,
chemostat/Turbidostat.

II. Effect of Physical and chemical agents on bacteria (10)
A. Physical agents: Low and high temperature - cardinal points of temperature; Osmotic pressure - plasmolysis, plasmoptysis, hypotonic, hypertonic, isotonic solutions; pressure; Dessication; pH; Surface tension; Ultrasonic waves; Radiations - UV, Ionising, α, β, γ, x-rays.

B. Chemical agents: Acids and alkalis, reducing/oxidizing agents (Phenols, cresols, alcohols, halogens, heavy metals, mercury compounds, aldehydes, quaternary ammonium compounds); Gases -- formaldehyde, ethylene oxide, β-propiolactone.

III Sterilization and disinfection (10)
Definition of important terms: sterilization, disinfection, antiseptic, sanitizer, germicide

A. Sterilization methods:
Physical methods:
Radiations: ionising and UV radiations; mechanisms of sterilization
Filtration: Bacteria-proof filters for sterilizing liquid (Asbestos, Sintered, glass, membrane) and air (glass wool and HEPA)
B) Disinfection - Properties of an Ideal Disinfectant, evaluation of disinfectants' - inhibition coefficient, phenol coefficient

IV. Principle, working & applications of pH meter, colorimeter (3)

V: Modification and advancement in microscopy (10)
Principles underlying the construction, working and ray diagram of
Dark field microscope
Fluorescence microscope
Phase contrast microscope
Electron microscope - SEM & TEM

Practical (104)
Working of the pH meter, preparation of buffer
Effects of environment on bacteria: temperature, pH, UV -light, Dessication, Osmotic pressure, Surface tension.
Oligodynamic action of heavy metals.
Efficacy of Sterilization.
Growth curve of E.coli.
Working of the colorimeter: Demonstration of Beer - Lambert's Law
List of books

1. Microbiology by Modi,
2. Essentials of Microbiology by Frobisher.
4. Microbiology by Pelczar.
5. An Introduction to Practical Biochemistry by David T. Plummer.
### B. Sc. MICROBIOLOGY
**COURSE CONTENT**

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th>COURSE</th>
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<tr>
<td><strong>III</strong></td>
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<tr>
<td>201</td>
<td>Microbial physiology – I</td>
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<tr>
<td>202</td>
<td>Microbial genetics - I</td>
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<tr>
<td><strong>IV</strong></td>
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<tr>
<td>203</td>
<td>Microbial physiology – II</td>
</tr>
<tr>
<td>204</td>
<td>Microbial genetics - II</td>
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</table>
I. **Thermodynamics:** (3)
Heat changes in chemical reactions, Entropy, Free energy, 1st and 2nd laws of thermodynamics, Equilibrium constant, Open and closed systems.

II. **Bioenergetics:** (12)
ATP as a high energy system, Structure of ATP, Hydrolysis of ATP & other high energy phosphate compounds, Utilization of ATP energy in chemical work, ATP cycle: The linkage of energy-yielding oxidation to energy-requiring biosynthetic reaction, ETC and Oxidative phosphorylation

III. **Enzymes:** (10)
Definition; protein nature, active site, specificity, Holoenzyme, Apoenzyme, Coenzyme, Cofactors, Prosthetic group, monomeric, oligomeric and allosteric enzymes.
Classification and nomenclature of enzymes with examples;

IV. **Metabolism:** (20)
Concept of Metabolism: Anabolism, Catabolism; Energetics
Carbohydrates: Major pathways in heterotrophs & regulation: EMP, HMP, ED pathway, TCA pathway (Amphibolic pathway, Anaplerotic reactions), Glyoxylate cycle, Alcohol fermentation, Mixed Acid Fermentations - Homo & Heterofermentative pathways
Lipids: Beta and omega-oxidation
Proteins: Digestion of proteins and peptides; Flow sheet of amino acid oxidation, Transamination, Deamination, Decarboxylation; Stickland reaction

**Practical (201)**

I. Detection of bacterial enzyme activity: amylase, caseinase, catalase, dehydrogenase, nitratase, urease, gelatinase, lipase, desulfurase, pectinase, cellulase
II. IMViC tests
III. Fermentation - sugars, HL test
IV. Estimation of lactic acid, alcohol (dichromate method)

**List of books**
1. Biochemistry by Lehninger
2. Outlines of Biochemistry by Conn and Stumpf.
6. General Microbiology Volume I by Pawar and Daginawala.
7. Microbial physiology - Moat, Foster et al.
10. An Introduction to Practical Biochemistry by David T. Plummer
11. Microbiology by Stanier.
I. Concept of gene; Chromosome, chromosome/DNA as carrier of gene (12)
   Structure of DNA: purines / pyrimidines, nucleosides / nucleotides, Watson -Crick model; Prokaryotic DNA (Circular DNA, Supercoiling Palindromic); Eukaryotic DNA ( Repetitive sequences, split genes, nucleosomes), mitochondrial and chloroplast DNA; RNA: mRNA, tRNA, rRNA;

II. Microbial tools to study genetics: (6)
   E.coli, yeast, Neurospora. Melting point of DNA (Tm) [(G+C)%), DNA/DNA homology & its significance in classification.

III. Central dogma in molecular biology; reverse transcriptase & its implication (2)

IV. Replication of DNA (17)
   (i) Modes of replication - Conservative, semi conservative (Meselson- Stahl experiment) and dispersive.
   Processes and enzymes involved in replication
   Models of replication in prokaryotes & eukaryotes - Rolling circle model, linear, sigma and theta.

V. Gene expression and regulation (8)
   Induction and repression; catabolite repression; Lac operon - structural and regulatory genes, positive and negative regulation, trp operon.

Practical (202)
II Estimations: DNA by Diphenylamine method
   RNA by Orcinol method
   Protein by Biuret method
   Reducing Sugar by DNSA method
   Sugar by Coles ferricyanide method

List of books
1. Microbiology by Frobisher.
2. Microbiology by Pelczar.
4. Microbiology by Stanier.
5. Biochemistry by Stryer.
9. Microbial Genetics by David Freifelder.
10. Microbial Genetics by Strickberger.
203 Microbial Physiology - II
SEMESTER IV (45 lectures)

I. Nutrient Transport:  
(a) Types of mechanisms of solute transport: passive diffusion, facilitated diffusion, active transport, group translocation
(b) Endocytosis: Phagocytosis, Pinocytosis

II. Enzymes:  
Specific activity of enzymes; factors affecting enzyme action (Substrate concentration, Enzyme concentration, Temperature, pH, Activators, Inhibitors (Competitive and non-competitive);
Enzyme Kinetics: Michaelis-Menten equation (derivation), Lineweaver- Burke plot (derivation);
Regulation of enzyme activity (Feedback inhibition, isofunctional enzymes, concerted, sequential);
Isolation and purification: Homogenization, salting-in & salting-out, Dialysis, Chromatography (Paper, TLC, Column- gel filtration), Ultracentrifugation & Electrophoresis.

III. Coenzymes:  
Definition, Coenzymes derived from vitamins: TPP (Thiamine), FMN, FAD (Riboflavin), Pyridoxal phosphate (Pyridoxine), cobamide coenzyme (Cyanocobalamin), NAD, NADP (Niacin), THFA (Folic acid), CoA (Pantothenic acid), Biotin; Functional role with examples in metabolism.

IV. Anabolism:  
(a) Biosynthesis of carbohydrates: Glycogen, Peptidoglycan
(b) Biosynthesis of Lipids: Poly beta-hydroxybutyric acid.
(c) Biosynthesis of saturated fatty acids: reactions of fatty acid synthetase system –palmitic acid.

IV Bacterial bioluminescence:  
Definition, mechanisms, significance & applications.

Practical (203)

I Production of invertase using Saccharomyces
II Purification of enzymes: ammonium sulphate precipitation, dialysis, specific activity
III Determination of optimum enzyme concentration, pH, temperature for invertase/amylase.
IV Determination of $K_m$; and $V_{max}$ of the enzyme; Michaelis-Menten and Lineweaver-Burke curve
V Isolation of bioluminescent bacteria
VI Chromatographic separation of sugars/aminoacids by paper.
VII Chromatographic separation of sugars/aminoacids by TLC.
List of books
1. Biochemistry by Lehninger
2. Outlines of Biochemistry by Conn and Stumpf,
6. General Microbiology Volume I by Pawar and Daginawala.
7. Microbial physiology - Moat, Foster and Spector
10. An Introduction to Practical Biochemistry by David T. Plummer.
11. Microbiology by Stanier.
Transcription in prokaryotes and eukaryotes; post transcriptional modification - RNA splicing, formation of mRNA, RNase H activity; Ribozyme

Translation:
Concept of genetic code, codon / anticodon, properties, Wobble hypothesis, start and stop codons, nonsense codons; Ribosomes as sites of protein biosynthesis; amino acid activation and specificity; Initiation, Elongation, Termination; post translational processing & modification, Inhibitors of protein synthesis; differences between prokaryotic and eukaryotic translation process

Gene transfer mechanisms with schematic illustrations and significance:
1) Transformation - Griffith's experiment; Avery, MacLeod and McCarty's experiment; competence factor
2) Transduction - Davis U-Tube experiment. Lytic and lysogenic cycle, Generalized, Specialized, Complete & abortive Transduction.
3) Conjugation, gene transfer by F+ strains, Hfr donor, F-prime state, gene mapping

Practicals (204)

Electrophoretic separation of nucleic acids
Isolation and enumeration of phages
Effect of protein synthesis inhibitor (antibiotic) on bacterial growth
Bacterial Conjugation.

List of books
1. Microbiology by Frobisher.
2. Microbiology by Pelczar.
4. Microbiology by Stanier.
5. Biochemistry by Stryer.
9. Microbial Genetics by David Freifelder.
10. Microbial Genetics by Strickberger.
T.Y. B.Sc.
Microbiology

Course content
Third Year

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<td>Medical microbiology *</td>
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<td>304</td>
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<td>Medical microbiology and Basic Immunology*</td>
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<td>309</td>
<td>Practical (307 + 308)*</td>
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<td>312</td>
<td>Practical (310 + 311)</td>
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*Papers will be offered for both Six and Three units
T.Y. B.Sc
301 Environmental Microbiology
Semester V (Lectures 45)

I Microbiology of Air
Numbers and types of microbes, Importance of state of suspension, aerosols, air samplers (Lemon, Andersen/ Hollander and Dalla Valle), Contamination hazards of lab techniques, significance of air flora in human health, hospitals, industries, and agriculture.

II Microbiology of water: Different types of aquatic environments, Normal and contaminant microflora, Indicators of fecal pollution. Bacteriological techniques for examination of water – water sampling and processing techniques, routine analysis, detection of coliforms, potability of water. Purification of water for potability – rapid and slow sand filters, coagulation, flocculation, sedimentation, diatomaceous earth filters, chlorination, reverse osmosis;

III Microbiology of sewage: Definitions and types of sewage, Objectives of sewage disposal, Chemical and microbiological composition of sewage, BOD (five days), COD Stages in sewage treatment: Physical: screening, settling tanks; Biological: Aerobic: Biofilms, activated sludge, oxidation pond; Anaerobic: sludge digestion, Imhoff tank and microorganisms involved; Chemical: Chlorination. Disposal of treated effluent: Dilution, Irrigation, Sludge as fertilizer, Waste recycling, Composting, Biogas

IV Microbial degradation of pollutants: oil, pesticides; concept of bioremediation

List of Books

1. Fundamentals of Bacteriology by A.V. Salle.
2. Microbiology by Pelczar, Chan and Kreig.
3. General Microbiology by Roger Stanier.
4. Essentials of Microbiology by Frobisher.
5. Microbiology by Prescott, Harley and Klein
I Normal microbiota of the human body: skin, eye, ear, oral cavity, respiratory-, digestive-, genito-urinary- tract, Significance of normal flora, Gnotobiotic maintenance and germ free animals

II Communicability of Diseases: General principles of communicability, sources, spread and its control, epidemiology (endemic, epidemic and pandemic), nosocomial infection; acute and chronic diseases, sources of infection, Route of infection, Koch’s Postulates and River’s postulates, Methods of prophylaxis

III Host Parasite interaction in relation to disease: Physiological basis of pathogenesis, chemoperception, Host defense mechanisms, Virulence and invasive factors, Opportunistic pathogens

IV Pathogenesis, epidemiology, lab diagnosis, chemotherapy, prophylaxis in relation to the study of diseases caused by:
   a) Parasites – malaria, amoebiasis, filariasis
   b) Bacteria – tuberculosis, syphilis, diphtheria, Proteus infections, cholera, typhoid, dysentery, staphylococcal infections, streptococcal infections, Helicobacter pylori infection. Coliform infections: E.coli, Klebsiella

List of Books

1. Textbook of microbiology by Ananthanarayan.
2. Medical Microbiology by Curikshank.
3. Medical Microbiology by Zinscr.
4. Medical Microbiology by Jawetz.
5. Practical Medical Microbiology by Mackie and McCartney.
7. Medical Microbiology by Greenwood, Slack and Peutherer.
1 Microbiology of air (qualitative studies)
2 Microbiology of water: MPN, SPC, Isolation of microflora of water, Routine analysis of potable water (Presumptive test, Confirmed test, Complete test), Na-azide test, Test for clostridia, Isolation and detection of agar digesters from marine water
3 Microbiology of sewage: SPC, Isolation of microflora of sewage, BOD test
4 Medical Microbiology: Isolation and study of *Staphylococcus aureus* (sputum), *Streptococcus* (sputum), and *Corynebacterium diphtheriae* (throat swab); acid fast staining of sputum (*Mycobacterium*), Isolation and study of enteric bacteria from stools (*E.coli, Aerobacter, Klebsiella, Salmonella, Shigella, Proteus*); Spirochaete staining from tooth tartar
5 Demonstration of malarial parasite
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**304 Molecular Biology**  
Semester V (Lectures 45)

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<td>II</td>
<td>Gene expression and regulation: Induction and Repression; catabolite repression. Lac operon – structural and regulatory genes positive and negative regulation; Trp operon</td>
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<td>III</td>
<td>Protein analysis: 1D/2D gel analysis, western blot and protein sequencing</td>
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<td>III</td>
<td>Mutations</td>
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<td>Spontaneous mutations: principle, methodology; and significance of replica plating and fluctuation test. Types of mutations: Transitions and transversions, Point mutations: base pair substitution, frame shift (tautomerism; slippage); Missense, nonsense, silent, suppressor, auxotrophs, mutations caused by transposable elements Induction of mutations – physical and chemical mutagens Teratogenicity testing – Ames test DNA damage and repair mechanisms</td>
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<td>IV</td>
<td>Genetic Recombination – General features, mechanism Models of recombination – reciprocal and non-reciprocal Rec genes – rec A and rec BCD complex</td>
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<td>V</td>
<td>Concept of bacterial evolution - rRNA studies and molecular taxonomy</td>
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**List of Books**

1. Microbiology by Pelczar, Chan and Kreig.
2. Essentials of Microbiology by Frobisher.
3. General Microbiology by Stanier.
4. Microbiology by Prescott, Harley and Klein
5. Genes by Lewer.
8. Microbial Genetics by David Friedferder.
Batch fermentation
Design and accessories of typical fermentor.
Maintenance of sterility: Principles of sterilization; Sterilization of equipment, production media, and air.

pH: Change of pH as a result of microbial activity, Control of pH by buffer action, in situ measurement and pH control
Dissolved oxygen (aeration and agitation): Definition/Concept of $K_{La}$, Factors affecting $K_{La}$ values in fermentation, determination of $K_{La}$ by Sulfite oxidation technique and using Clark’s oxygen electrode.


Continuous fermentation - Definition, advantages and disadvantages, Batch vs continuous fermentation

Fermentation media
Types of raw materials – Saccharine material, starchy materials, hydrocarbon and vegetable oils, nitrogenous materials.

Screening for Industrial strains
Introduction, Screening techniques: Primary screening – Crowded plate technique, Auxanography, Enrichment culture technique, Use of indicator dyes, Secondary screening

Preparation of inoculum or seed culture – Factors to be considered

Quality control (case study: pharmaceutical products)
Concept of Good Manufacturing Practice, Factors affecting GMP, assessment of microbial contamination and spoilage; LAL assay. Microbiological assays based on Diffusion, Turbidometry, Metabolic response, Enzyme.

Quality control (Example – vaccines):
- In-process control
- Final product control – general tests, Identity tests, Potency assays, Safety tests.

Industrial production: Upstream and downstream concepts, production, Harvest and purification of Penicillin, Vitamin B$_{12}$, Lysine, Beer, recombinant protein (Insulin)
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1  Batch fermentation for production of vinegar
2  Production and extraction of Penicillin; Bioassay of penicillin (agar well method); Chemical assay of Penicillin;
3  Bioassay of vitamin B₁₂ (agar well method);
4  UV survival curve (E.coli)
5  Mutagenesis using chemical mutagen
6  SDS-PAGE for separation of proteins
7  AMES test
T.Y. B.Sc
307 Ecology and Agricultural Microbiology
Semester VI (Lectures 45)

I Ecology and ecosystems: Ecosystems, Community structure, functioning of ecosystems, trophic levels
Soil as an ecosystem; Microorganisms in soil and their significance – bacteria, actinomycetes, fungi, algae, and protozoa; Rhizosphere biota; Winogradsky’s column – principle, set-up and significance; Biogeochemical cycles – nitrogen, carbon, sulphur and phosphorus, role of microorganisms
Mangrove ecosystem: Pneumatophores, formation of detritus, mangrove as nutrient sink, ecological importance of mangroves.

II Biopesticides: Definition, Bacteria eg. B.poppillae, B.thuringiensis, Other microbes: fungi, viruses and protozoa; Advantages and disadvantages.

III Biological Nitrogen Fixation: Symbiotic and non symbiotic modes of nitrogen fixation, Heterocyst, Mechanism of nodule formation and leghemoglobin, role of nif genes. Biofertilizers eg. Non-symbiotic: Azospirillum, Azotobacter, Nostoc; Symbiotic: Rhizobium, Azolla – Anabaena

IV Plant pathogenic microorganisms: introduction to bacterial, fungal and viral pathogens

List of Books
1. Soil Microbiology by Mark Coyne
2. Microbiology By Prescott, Harley and Klein
3. Fundamentals of Ecology by E. Odum
4. Soil Microbiology by Subba Rao
5. Soil Microbiology by M. Alexander.
I  Pathogenesis, epidemiology, lab diagnosis, chemotherapy, prophylaxis in relation to the study of diseases caused by:
   c) Fungi – ringworm, candidiasis,
   d) Viruses – hepatitis, poliomyelitis

II  Chemotherapy
   Antibiotics affecting cell-wall synthesis (Penicillin, Cephalosporins), membrane function (Polymyxin, Nystatin), DNA (Nalidixic acid, Novobiocin), ribosome function (Streptomycin, Tetracycline, Chloramphenicol); Metabolic inhibitors: sulphonamides; Development of resistance to antimicrobial drugs (Causes, mechanisms, prevention)

III  Immunology
   Immunity classification – innate and acquired immunity.
   Cells and organs of immune system
   Cell mediated and humoral immunity
   Antigens: definition, haptens, antigenic determinants, polysaccharides, lipids, nucleic acids
   Antibodies: immunoglobulins (structure, classes and properties); antibody dependent cell cytotoxicity (ADCC); Types and functions of T Cells; macrophage activation; phagocytosis; complement cascade and fixation; Hypersensitivity reaction and autoimmune disorders: definitions
   Antigen – antibody reactions: in vitro precipitation, flocculation, agglutination, haemagglutination, passive haemagglutination, immunofluorescence, immunodiffusion, immunoprecipitation, immuno-electrophoresis, ELISA, RIA.
   Immunohaematology: ABO blood group system, hemolytic disease of new born

List of Books
1.  Microbiology By Prescott
2.  Medical Microbiology by Jawetz
3.  Medical Microbiology By Sinzer
4.  Medical Microbiology by Crikshank
5.  Essential Immunology by Ivan Roitt
6.  Immunology by Eissen and David
7.  Immunology by James T. Barrett.
8.  Text Book of Microbiology by Ananthanarayan
9.  Immunology by Richard Goldshy, Thomas Kindt, Barbara Osbourne, Janis Kuby.
10. Immunology – A Short Course by Richard Coico, Geoffrey Sunshine and Eli Bengamini.
1 Microbiology of soil: Isolation of different groups of organisms from soil, set-up of Winogradsky’s column, Isolation of cellulose and pectin degraders, Nitrification, Symbiotic N\(_2\) fixation (microscopic examination of bacteriods from root nodules, Isolation of \(\text{Rhizobium}\)), non-symbiotic nitrogen fixers (\(\text{Azotobacter}\), Cyanobacteria), isolation of P-solubilisers, demonstration of biocontrol activity of soil microorganisms

2 Microbiology of mangrove sediment and water

3 Immunology: Hemagglutination (Blood grouping – ABO and Rh), Staining of blood (Leishman’s / Giemsa’s) and differential WBC counts, preparation of plasma and serum, VDRL test (qualitative), Widal test (Qualitative)

4 Antibiotic sensitivity tests (paper disc, agar cup and ditch plate)

5 Determination of MIC of Penicillin
T.Y. B.Sc  
310 Genetic Engineering  
Semester VI (Lectures 45)  

I Genetic Engineering – Introduction and tools  
Enzymes – restriction endonucleases, host controlled restriction and modification; ligases, lyases; terminal DNA transferase; alkaline phosphatase, DNA polymerase I, II, and III, S1 nuclease, RNase H, Reverse transcriptase.  
Vectors – Types of vectors with examples, plasmids (pBR322), cosmids (pJB8, pHCl9), bacteriophage vectors (lambda, M13); shuttle vectors (YePs); expression vectors (pUC); Ti plasmid based vectors (___, ___), YAC/BAC  
Characteristics of ideal host: *E. coli*  
Linkers, adapters and Nucleic acid probes – synthesis of probe and labeling - radioactive and non-radioactive  

II Techniques in genetic engineering – principles, methodology and application of agarose gel electrophoresis; autoradiography; southern and northern blotting.  


IV Polymerase chain reaction – principle, method, applications  

V DNA sequencing – chemical degradation and chain termination; Significance of rRNA homology and its role in taxonomic placement.  

VI Applications of genetic engineering – Medical, industrial, agricultural  

List of Books  
1. Foundation in Microbiology by Tauro and Talaro  
2. Basic and Practical Microbiology by Allas  
3. Microbiology by Daniel Lim.  
4. Biotechnology by Purohit and Mathur  
5. Principles and Applications of Recombinant DNA Technology by Bernard Glick; J. Pasternak.  
6. Microbiology by Pelizar, Chan and Kreig.  
8. Essentials of Microbiology by Frohisher.  
9. General Microbiology by Roger Stancer.  
13. Microbial Genetics by David Friedfelder  
1 MICROBIOLOGY OF MILK AND MILK PRODUCTS
Sources and types of microorganisms in milk - sources of contamination, different microorganisms implicated in spoilage and milk borne diseases of human and animal origin. Microbiological examination of milk – SPC, Breed’s Smear – advantages / disadvantages; Grading of milk by dye reduction test – MBRT and Resazurin – principle, techniques and applications.

2 MICROBIOLOGY OF FOOD
General principles of food spoilage, intrinsic and extrinsic factors responsible for food spoilage, microorganisms in spoilage; food borne pathogens, food poisoning and toxicity
Principles and methods of food preservation: dehydration, freezing, salting, pickling, wood smoking, canning, pasteurization and irradiations.
Microbiological examination: general and specific methods, identification of specific organisms by using selective and differential media.
Spoilage of canned foods, determination of TDP/TDT and its significance in canning industry.

3 MICROORGANISMS AS SOURCE OF FOOD AND ENZYMES
SCP – microorganisms, nutritive value and use; Mushroom cultivation
Enzymes-amylases and pectinases, their application in food industry

4 Fermented foods: yoghurt, Sauerkraut

List of Books
1. Fundamental Principles of Bacteriology by An. Salle
2. Microbiology By Peligar, Chan and Kreig.
3. Microbiology by Prescott, Harley and Klein
4. Food Microbiology by Frazier and Westhoff
5. Modern Food Microbiology by James A. Jay
6. Basic Food Microbiology by George Banwart
7. Milk Microbiology by Mahanta
8. Essentials of Microbiology by Frobisher.
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Semester VI

1 Milk Microbiology: Grading of milk – dye reduction tests (MBRT, resazurin); SPC, Breed’s smear, plating on selective media, Efficiency of pasteurization by phosphatase test
2 Microbiology of canned food, spoiled food and fresh food; TDP; TDT; MIC of food preservatives (Sugar, NaCl, Na-benzoate and K-metabisulfite)
3 Solid state fermentation (cultivation of mushrooms)
4 Preparation and analysis of fermented foods: Curd, Idli, Sauerkraut
5 Restriction mapping of plasmid and electrophoretic analysis
6 Ligation of restriction digested plasmid and electrophoretic analysis
7 Demonstration of PCR