

Department of Botany & Microbiology
Gurukul Kangri University, Haridwar

B.Sc. (TDC) Industrial Microbiology Syllabus
(w.e.f. Session 2008-09)

B.Sc. I

Paper I	General Microbiology	33 Marks
Paper II	Microbial Physiology and Biochemistry	33 Marks
Paper III	Biostatistics, Tools and Techniques	34 Marks
Practical		50 Marks
Total Marks		150 Marks

B.Sc. II

Paper I	Microbial Ecology	33 Marks
Paper II	Applied and Environmental Microbiology	33 Marks
Paper III	Medical Microbiology and Immunology	34 Marks
Practical		50 Marks
Total Marks		150 Marks

B.Sc. III

Paper I	Molecular Biology and Microbial Genetics	33 Marks
Paper II	Microbial Technology	33 Marks
Paper III	Industrial Microbiology	34 Marks
Practical		30 Marks
Project work		20 Marks
Evaluation & <i>Viva voce</i>		
Total Marks		150 Marks

Grand Total = 450 Marks

Note: A total of 10 questions are to be set by the examiners, 02 questions from EACH UNIT. The students are required to attempt 05 Questions in all, selecting 01 Question from each Unit. All questions will carry equal marks.

B.Sc. Part I (Industrial Microbiology)

Paper I: General Microbiology

Unit-I: Emergence of Microbiology, History and developments of microbiology, golden age of microbiology, Contributions of A. Leeuwenhoek, L. Pasteur, R. Koch and E. Jenner, Applications of microbiology.

Unit-II: Microscopy: Invention of microscope, compound microscope, phase contrast microscope (Zernike microscope), dark-field, fluorescent and electron microscope (SEM and TEM)

Unit-III: Bacterial nomenclature, identification and differentiation of bacteria, classification of bacteria (Bergey's manual); Whittaker's five kingdom classification, three domain concept of Carl Woese; Size, shape and arrangement of bacterial cells, flagella, pili, capsules, sheath, prosthecae, stalks; Structure of cell wall, cytoplasmic membrane, cytoplasmic inclusions, bacterial chromosomes and plasmids; protoplast, spheroplast, spores and cysts.

Unit-IV: Microbial Diversity: Culturable and non-culturable microorganisms: Yeasts, Archaeobacteria, Cyanobacteria, mycoplasma, actinomycetes, fungi, moulds and protozoa.

Unit-V: Viruses: Diversity of viruses, historical background; Morphology, structure and multiplication of bacteriophages T4, Tobacco mosaic virus, mycoviruses, cyanophages and HIV.

Practical based on above course

1. Laboratory equipments: Oven, Inoculation hood, Laminar air flow, Incubator and Autoclave.
2. Preparation of Media: a. Nutrient Agar Medium (NAM); b. Potato Dextrose Agar Medium (PDA); c. Yeast Extract Mannitol Agar Medium (YEMA); Martin's Agar Medium.
3. Autoclaving and sterilization of media and glassware, cleaning of glassware.
4. Isolation and maintenance of following microbes of different groups. Bacteria, Cyanobacteria, Fungi, Bacteriophages.
5. Single spore culture
6. Camera lucida drawing
7. Haemocytometer
8. Micrometry
9. Isolation of pathogens

B.Sc. Part I (Industrial Microbiology)

Paper II: Microbial Physiology and Biochemistry

Unit-I: Bacterial growth curve, synchronous growth, Microbial growth kinetics in batch culture; growth measurement by cell mass, cell count and cell turbidity, growth influencing factors.

Unit-II: Characteristics, nomenclature, classification and application of enzymes, factor influencing enzymatic activity, mechanism of enzyme action and regulation of enzyme activity.

Unit-III: Structure and function of carbohydrates, proteins and lipids, carbohydrate metabolism; Energy production by aerobic and anaerobic processes, Energy production by photosynthesis.

Unit-IV: Microbial Metabolism: anabolism and catabolism, Metabolism of proteins and biosynthesis of amino acids, proteolysis, Trans-amination and deamination.

Unit-V: Nitrogen metabolism: Nitrogen fixation in symbiotic and free living systems; Photosynthetic bacteria and their classification, involvement of different pathways, electron flow in bacteria; *nif*-genes and nitrogenase enzyme, nod-factor, Oxygen and hydrogen regulation of nitrogen fixation in symbiotic and free living system.

Practical based on above course

1. Demonstration of plasmolysis, Osmosis and Active and Passive transport mechanism.
2. Measurement of ammonium nitrate and nitrate uptake by microorganism.
3. Demonstration of electron donation by DCPIP (dichlorophenol indophenol) reduction test.

4. Effect of inhibitor on DCPIP.
5. Biochemistry:
6. Extraction and identification of lipid by TLC.
7. Estimation of alkaline phosphatase activity.
8. Derivation of Michaelis-Menten constant, V_{max} of alkaline phosphatase, structural analogue methylamine.
9. Estimation of glycogen in bacterial cell.
10. Measurement of competitive inhibition of ammonium uptake using structural analogue-methylamine.
11. Change in protein confirmation due to pH, heat, ionic concentration by observing UV-spectra.
12. Separation of pigments by chromatography.
13. Measurement of relative enzyme activity of cellulose.
14. Measurement of cellulose by reducing sugar assay test
15. Separation of Amino acids.

B.Sc. Part I (Industrial Microbiology)

Paper III: Biostatistics, Tools and Techniques

- Unit-I:** Biostatistics: Basic idea of probability, distribution pattern- Normal and binomial distribution, Sampling methods, Mean, Mode, median, Chi-square test, Analysis of Variance (ANOVA), Exponential and logarithmic fractions, Student 't' test, correlation and Regression.
- Unit-II:** Electrophoresis- separation of proteins and nucleic acids; Chromatography- types and principles of chromatography, chromatographic techniques; paper chromatography, thin layer and gas chromatography.
- Unit-III:** Spectroscopy- principles, procedure and applications of UV-Vis spectroscopy (Lambert-Bear law; Colorimetry; Spectrophotometry); atomic absorption spectroscopy; Centrifugation, principles and application.
- Unit-IV:** Fermentation strategy: designing and operation of fermentors, types of fermentors, sterilization and disinfection; Computer application in microbiology.
- Unit-V:** Molecular techniques: Gel filtration, PCR, Gel documentation and DNA blotting techniques, RFLP and RAPD analysis.

Practical based on above course

1. Biostatistics: Problem on Chi-square test, problems on Mean, Mode, median.
2. Protein estimation by colorimeter with folin's phenol reagent
3. Carbohydrate estimation
4. Paper chromatographic separation of organic acids
5. Measurement of pH of soil sample.
6. Measurement of pH of juice.
7. Electrophoretic separation of protein and pigment.
8. Absorption spectra of protein, nucleic acid and pigments.

B.Sc. Part II (Industrial Microbiology)

Paper I: Microbial Ecology

Unit-I: Microbial Ecology: concept of habitat and microbial niche, different types of habitats such as rumen, deep sea vents, thermal vents, characteristics of microbial ecosystems (Habitat, size, nutrient supply)

Unit-II: Soil Microbiology: Rhizoplane and Rhizosphere regions, Rhizosphere effects, R : S ratio, techniques of study of Rhizosphere microorganisms. Microbial interactions: symbiosis, (symbiotic and non-symbiotic nitrogen fixers- *Rhizobium*, *Frankia*, *Azotobacter* and *Azospirillum*), neutral associations, positive associations and negative associations; Soil fertility and management of agricultural soils; Biogeochemical cycles: Nitrogen cycle, carbon cycle, phosphorous cycle and Sulphur cycle.

Unit-III: Mycorrhizae: Types of mycorrhizal associations, Taxonomy, Occurrence and distribution, Phosphorous nutrition by mycorrhizal fungi, their effect on plant inoculum production of VAM spores, Isolation from stock plants and inoculum production of VAM spore.

Unit-IV: Aero-microbiology: Atmosphere; Droplet nuclei aerosol, types of air samples, assessment of air quality, Phylloplane and Phyllosphere microflora.

Unit-V: Bacterial examination of water for its potability, microorganisms like *E. coli* and *Staphylococcus faecalis* as indicator of pollution. MPN index, IMVIC test, Indol-agar test, Water-borne diseases.

Practical based on above course

1. Correlation of soil pH, temperature, humidity and conductivity.
2. Measurement of total phosphate, nitrate, and ammonium in soil.
3. Measurement of organic and inorganic C in soil.
4. Isolation of soil fungi associated with composting for cellulose degradation.
5. Isolation of actinomycetes from soil.
6. Isolation of free living nitrogen fixer from soil.
7. Demonstration of mycorrhizal association in soil.

B.Sc. Part II (Industrial Microbiology)

Paper II: Applied and Environmental Microbiology

Unit I- Wastes- types; solid and liquid waste characterization, treatments, physical, chemical, biological, aerobic-anaerobic, primary, secondary and tertiary; disinfection of potable water.

Unit II- Utilization of solid waste- (food as SCP mycoprotein and yeast), fuel (e.g. ethanol and methane production, composting (fertilizer).

Unit III- Biotechnological programmes and regulations- role of international organizations in biotechnology, Govt. programmes of biotechnological development; Govt. regulation of recombinant DNA research, regulation for disposal of genetically modified organisms(GMO) in environment, rules and regulation of GMO in India, biosafety and its regulation, Intellectual property rights (IPR), Anand Mohan Chakroborty's contribution, patent and Intellectual property rights protection (IPP).

Unit IV- Extremophiles: salient features and examples of Methylotrophs, Methanogens, Halophiles, Barophiles, Thermophiles, Xerophiles, psychrophiles, Alkaliphiles, Acidophiles.

Unit V- Biodeterioration of paper, leather, wood and textiles; mycotoxin hazards in the production of fungal products, carcinogenic; mutagenic and teratogenic biologicals; Biodegradation of xenobiotics compounds; bioremediation: bioaccumulation of metals and detoxification; Use of GMOs in bioremediation.

Practical based on above course

1. Isolation of microorganism from air, soil and water.
2. Isolation and counting of faecal bacteria from water IMVIC test for faecal bacteria.

3. Measurement of chloride, phosphate and nitrate in water sample.
4. Biochemical tests of differentiation of different bacteria for water.
5. Study of inhibitory effect of low temperature on microbial growth.
6. Methylene blue reductase test for microbial contamination of milk.
7. Isolation of Lactobacilli and Staphylococcus from curd
8. Estimation of BOD from water sample.
9. Isolation of total solids and total dissolved solids in water.
10. Isolation of bacteriophages from water sample.
11. Study of some types of disease; *Phytophthora*, *phyllactinia*, *Puccinia graminis*

B.Sc. Part II (Industrial Microbiology)

Paper III: Medical Microbiology and Immunology

Unit-I: Classification of medically important bacteria, characteristics of infectious diseases (Tuberculosis, Diphtheria, Syphilis, Typhoid, Tetanus), sources of diseases, reservoir and carriers.

Unit-II: Classification of medically important fungi, isolation and identification of dermatophytes, superficial and mycoses candidiasis, Mucormycosis and their control, control of mycosis, mycotoxicoses and their control.

Unit-III: Important human viruses, Laboratory diagnosis, control and treatment of viral infections (Hepatitis A, Hepatitis B, Mumps, Measles, Rubella, Dengu and AIDS). Oncogenic viruses and its control measures.

Unit-IV: Immunity, humoral and cell-mediated immunity, cell-surface receptors; Antigens- types, structure and properties; antibodies- types, structure and properties; antigen-antibody reactions, theories of antibody production, monoclonal antibody (MoAb) and hybridoma technology, Application of MoAb in diagnosis and treatment of diseases.

Unit-V: Immunofluorescence, ELISA, Haemagglutination; agar-diffusion method, radioimmunoassay and its applications, lymphokines and cytokines.

Practical based on above course

1. Isolation of microflora from human skin.
2. Isolation of microflora from human throat.
3. Identification of staphylococci by Mannitol agar plate method.
4. Identification of staphylococci by coagulase test method.
5. Determination of staphylococci by Bacitracin test.
6. Urine culture and its microbiological analysis.
7. Determination of antibiotic sensitivity of UTI causing organism.
8. Demonstration of slide agglutination reaction by unknown bacterial culture.
9. Agglutination reaction with reference to blood grouping.
10. Blood examination.

B.Sc. Part III (Industrial Microbiology)

Paper I: Molecular Biology and Microbial Genetics

- Unit-I:** DNA as genetic material, types and structure of DNA and RNA, Watson and Crick's model of DNA replication, Genetic recombination, gene transfer in bacteria, transformation, transduction, conjugation, transposons, insertion sequences, uses of transformation, transduction, conjugation in genetic mapping.
- Unit-II:** Mutations: spontaneous and induced mutation, chemical mutation, chemical mutagens, radiation as mutagens, types of DNA repair system, Ames test, mutant selection in genetic engineering and its uses.
- Unit-III:** Protein synthesis: Central dogma, transcription, translation and *lac* Operon model of gene regulation in prokaryotes; Britton and Davidson model of gene regulation in eukaryotes.
- Unit-IV:** Post transcriptional modification, protein folding, Ramachandran plots, protein engineering and design, growth hormones, Interferon, Insulin, biochips.
- Unit-V:** Genetic Engineering and biotechnology, recombinant DNA Technology- nuclease, cloning vectors, transformation of host cells, selection and screening of recombinant colonies; Achievement and prospects of genetic engineering and biotechnology; ethical issues.

Practical based on above course

1. Isolation of antibiotic resistant bacteria.
2. Effect of UV light on mutation frequency in bacteria.
3. Determination of staphylococci by Bacitracin test
4. Replica plate technique for isolation of mutant.
5. Measurement of mutation frequency in bacteria.
6. Demonstration of lysogeny in *E. coli*.
7. Isolation and Purification of DNA and RNA.
8. Demonstration of photo-repair mechanism in bacteria.

B.Sc. Part III (Industrial Microbiology)

Paper II: Microbial Technology

- Unit-I:** Cultivation of bacteria: aerobic and anaerobic, various technique used for isolation of microorganisms from soil, water and air; Pure cultures technique; cultural characteristics; Maintenance and preservation of pure cultures; Staining techniques, different type of stains, simple, negative and differential staining techniques, staining of flagella, spores and capsule; Wet mount technique, hanging drop technique.
- Unit-II:** History and development of industrial fermentation processes, Fermentation equipment and its use, design of fermentors, Construction material, aeration and agitation, control of pH, temperature and foaming; biosensors.
- Unit-III:** Fermentation media and its preparation, sterilization methods of apparatus and culture media, inoculums preparation; Down stream processing, types of fermentation: batch, fed batch, continuous, dual or multiple, surface, submerged and solid state fermentation.
- Unit-IV:** Food Microbiology: Microbial spoilage of foods, methods of preservation of foods, microbial examination of milk, grading of milk, fermented microbial foods; bread, cheese, fermented dairy products, single cell protein and mycoprotein, Probiotics and its application; Food poisoning by microorganisms: methods of diagnosis, causes and control of food poisoning.
- Unit-V:** Agricultural Microbiology: Plant growth promoting rhizobacteria (PGPR); N₂ fixers and phosphate solubilizers, Production of bioinoculants- cyanobacteria, bacteria and fungi; use of carriers, quality control of bioinoculants, methods of seed bacterization.

Practical based on above course

1. Examination of cultures for motility by hanging drop method.
2. Demonstration of different methods of culture preservation.
3. Isolation of *Rhizobium* from root nodules of legumes plants.

4. Counting of number of nodules from legume plants
5. Biochemical characterization of Rhizobium using Hoffer's alkaline broth.
6. Biochemical characterization of Rhizobium by keto -Lactose production test
7. Demonstration of nitrogen fixing ability of bacteria in nitrogen deficient media.
8. Demonstration of cyanobacterial growth for nitrogen fixation and measurement of heterocyst frequency.
9. Demonstration of nitrogen fixation by Gas Chromatography.

B.Sc. Part III (Industrial Microbiology)

Paper III: INDUSTRIAL MICROBIOLOGY

Unit I: Principles of exploitation of microorganisms and their products, screening of microorganisms, primary and secondary screening; strain development strategies, immobilization methods, adsorption, covalent linkages- advantages and disadvantages.

Unit II: Antibiotics- Penicillin (fermentation and recovery), streptomycin (production and recovery) and tetracycline; Production and recovery of Industrial alcohol, beer, wines, whiskey, rum and brandy; Commercial production of vinegar.

Unit III: Vitamin B12, Vitamin B2 (riboflavin), Vitamin C, Organic acids- Lactic acid and citric acid (fermentation and recovery); Yeast and Baker's yeast, Ayurvedic asava and arishta- history, constituents and method of preparation.

Unit IV: Enzymes- Amylases, Cellulases, lipase and protease their production and uses. Amino acids: Production of L-glutamic acid and L-lysine.

Unit V: Production of Biofertilizer- History of biofertilizer in India, *Rhizobium*, *Azolla* and Cyanobacteria. (BGA), *Frankia*.; Quality control of biofertilizers and biopesticides in India, Integrated pest management (IPM); Biopesticides- viral, bacterial and fungal preparations and mass application.

Practical based on above course

1. Isolation of *Aspergillus niger*
2. Measurement and production of oxalic acid by *Aspergillus niger* by descending paper chromatography.
3. Demonstration of IAA production by soil fungi.
4. Demonstration for the cultivation of mushroom.
5. Measurement of *in vitro* production of IAA by soil fungi.
6. Demonstration for the identification of mushroom by spore print.
7. Demonstration for the production of amino acids by the soil fungi.
8. Production of alcohol.