

DEPARTMENT OF BOTANY AND MICROBIOLOGY

SYLLABUS

B.Sc. (MICROBIOLOGY)



**HNB Garhwal University
(A Central University)
Srinagar-Garhwal, Uttarakhand**

SYLLABUS

HNB GARHWAL UNIVERSITY, SRINAGAR-GARHWAL
DEPARTMENT OF BOTANY & MICROBIOLOGY
Bachelors of Science
MICROBIOLOGY
(Three Year Course- Annual System)
2009 Onwards

MARKS-SCHEME

Class	Paper	Marks Distribution		Total Marks
		Theory	Practical	
I Year	I. Fundamentals of Microbiology	50	50	200
	II. Bacteria, Virus and Protozoa	50		
	III. Algae, Fungi and Plant Pathology	50		
II Year	IV. Microbial Physiology and Biochemistry	50	50	200
	V. Microbial Genetics and Molecular Biology	50		
	VI. Biostatistics, Bioinformatics and Computer application	50		
III Year	VII. Environmental Microbiology	50	50	200
	VIII. Industrial Microbiology	50		
	IX. Medical Microbiology and Immunology	50		

B. Sc. I Year Microbiology
Paper I. General Microbiology

Unit I

History of microbiology, scope and relevance of microbiology, future of microbiology, Outline classification of living organisms: Heckel, Whittaker and Carl Woese systems classification of microbial world; bacteria, cyanobacteria, archaea, actinomycetes, fungi, algae and protozoa.

Unit II

Principle, types and application of microscopes, LAF cabinet, autoclave, oven, colony counter, spectrophotometer, pH meter, anaerobic chamber; Principle, basic apparatus and applications of electrophoresis, thermocycler (PCR), centrifuge, blotting, Chromatography & its types,

Unit III

Isolation, cultivation and Identification techniques for microorganisms, aerobic and anaerobic cultivation, biochemical methods for identifications, culture media & its type, maintenance & preservation of pure cultures.

Unit IV

Study of Morphology of microbes by staining methods- staining, Simple (Leffer's polychrome methylene blue & negative staining) Gram's staining, Ziel-neelson staining, Fluorochrome staining, Leishman's staining, Giemsa's staining, Special staining methods to demonstrate granules, capsules & spores.

Unit V

Principles and methods of sterilization and disinfection; physical method and disinfection, radiation method, chemical method and fumigation. Antibiotics and their mechanisms of action on microbes.

Suggested Readings:

1. Dubey, R.C. & D.K. Maheshwari. A text Book of Microbiology. S. Chand & Co.
2. Pelczar, M.J., E.C.S. Chan & N.R. Kreig. Microbiology. Tata McGraw Hill.
3. Prescott, L.J., J.P.M. Harley & A.D. Klein. Microbiology. Tata McGraw Hill.
4. Sharma B.K. Instrumental Methods of Chemical Analysis. S. Chand & Co.
5. Wilson and Walker. Biochemistry and Molecular Biology. Cambridge.

Paper II. Bacteria, Virus and Protozoa

Unit I

Microbial diversity and evolution, classification of microorganisms- Haeckel's three kingdom concept, Whittaker's five kingdom concept. Modern trends of bacterial taxonomy, Bergey's system of bacterial classification.

Unit II

Morphology and ultra structure of bacteria; structure, properties and function of cell wall, cell membranes, flagella, cilia, pili, gas vesicles, chromosomes, carboxysomes, magnetosomes and phycobilisomes, nucleoid.

Unit III

General Virology: Brief outline of discovery of viruses, nomenclature and classification of viruses. Morphology and ultrastructure, capsids and their arrangements, types of envelopes and their compositions. Viral genome, their types and structures. Virus related organisms (viroids, virusoids and prions). Cynophages: morphology, growth cycle. Mycoviruses

Unit IV

Bacterial viruses: Bacteriophage structural organization, life cycle, one step growth curve, transcription, DNA replication, eclipse phase, phage production, burst size, lysogenic size, bacteriophage typing, application in bacterial genetics, brief details on M13, Mu, T4, Lambda.

Unit V

The origin of protozoa. Flagellate protozoa: the Mastigophora, ameboid protozoa: the Rhizopoda, ciliate protozoa: the Ciliophora. Protozoal disease: malaria, Giardiasis, Trichomoniasis, Toxoplasmosis, Pneumocystis pneumonia and disease caused by Leishmania, Trypanosomes.

Suggested Readings:

1. Dubey, R.C. & D.K. Maheshwari. A text Book of Microbiology. S. Chand & Co. New Delhi.
2. Pelczar, M.J., E.C.S. Chan & N.R. Kreig. Microbiology. Tata Mc Graw Hill.
3. Prescott, L.J., J.P.M. Harley & A.D. Klein. Microbiology. Tata McGraw Hill.

Paper III. Algae, Fungi and Plant Pathology

Unit 1

Algae: General account of habitat, cell structure, pigments, flagellum, reserve food. Various systems of classification. Conflicts of taxonomic position of cyanobacteria. Algal growth and reproduction.

Unit II

Cultivation of algae in laboratory. Nitrogen fixation. Biological and economic aspects of algae, algal biotechnology. Fossil records of algae. Algal blooms and eutropication.

Unit III

Fungi: Historical introduction to mycology. Habitat, fungal structure and thallus organization, wall structure, hyphal growth, sexual and asexual reproductive structures, various systems of classification.

Unit IV

Nutrition and reproduction in fungi, Mycorrhiza, Lichens, Heterothallism, sex hormones in fungi. Evolutionary tendencies in lower fungi. Economic importance. Fungal diseases.

Unit V

Concept of plant disease; signs and symptoms associated with microbial plant pathogens. Microbial enzymes, toxins, growth regulators & suppressors of plant defenses in plant diseases, effects of pathogens on plant physiology, concepts of passive and active resistance mechanisms in plants. Concepts of monocyclic & polycyclic diseases, physical, chemical and biological control, integrated eco-friendly approach of plant disease control.

Suggested Readings:

1. Mehrotra, R.S. & K.R. Aneja. 1990. An introduction to mycology. New Age International Publisher.
2. Charlie, M., & S.C. Watkinson. The Fungi. Academic Press.
3. Alexopoulos C.J. & Mims C.J. Mycology. Willey.
4. Sharma, O.P. Algae. Pragati Prakashan.
5. Vashishth B.R. Algae. S. Chand & Co.

Practicals recommended for B. Sc. I Year (Microbiology) course

1. Principle operation and study of various components of Microscopes.
2. Calibration of ocular microscope for different objectives of microscope.
3. Measurement of micro-organism by the use of an ocular micrometer.
4. Demonstration of pH meter.
5. To prepare buffer solution from buffer tablets as well as from reagents.
6. Sterilization techniques for glassware and culture media.
7. Preparation of culture plates and tubes (liquid broth, potato dextrose agar medium, agar deep tubes, agar slants)
8. Demonstration of techniques for isolation of pure culture of bacteria from water and soil samples.
9. Demonstration of techniques for isolation of pure culture of fungi from water and soil samples.
10. Isolation of actinomycetes from soil.
11. Purification of micro-organism by streak plate method.
12. Microbial growth measurement by serial dilution method and standard plate count.
13. Identification of bacteria by simple staining, gram staining, negative staining.
14. Quantification of bacteriophage by plaque assay techniques.
15. Demonstration of preservation techniques for microorganisms.
16. Counting of spores/ cells of microbes.
17. Study of important cyanobacteria and algae, their morphological features, identification and classification.
18. Studies including morphology, symptomatology and identification of plant pathogens (Bacterial, viral, fungal and protozoans)

B. Sc. II Year Microbiology

Paper IV. Microbial Physiology and Biochemistry

Unit I

Structural feature and functions of biological macromolecules; proteins, lipids, carbohydrates, nucleic acids. Prokaryotic genetic material, RNA as genetic material.

Unit II

Enzymes as biocatalyst, enzymes classification, properties. enzyme kinetics: Michaelis-Menton equation for simple enzymes, Effects of pH and temperature on enzyme action, enzyme inhibition Electron carriers, artificial electron donors, inhibitors, uncouplers, energy bond and phosphorylation.

Unit III

Microbial metabolism: anabolism and catabolism, energy production in aerobic, anaerobic process and photosynthesis, chemiosmotic hypothesis of ATP synthesis. Bacterial electron transport chain. Autotrophy, heterotrophy, chemolithotrophy, fermentation. Transport of nutrients by active and passive transport.

Unit IV

Respiratory metabolism- Glycolysis, EMP Pathway, ED pathway, Glyoxallate pathway, Kreb's cycle-oxidative and substrate level phosphorylation. Reverse TCA cycle- Gluconeogenesis, fermentation and carbohydrates- homo and heterolactic fermentations.

Unit V

Assimilation of nitrogen- dinitrogen, nitrate nitrogen, ammonia assimilation, synthesis of major amino acids, synthesis of polysaccharides- peptidoglycan, bipolymers as cell components.

Suggested Readings:

1. Stryer. 2001. Biochemistry. 5th ed. WH Freeman.
2. Nelson & Cox. 2002. Lehninger Principles of Biochemistry. Worth Publ.
3. Harpers Biochemistry. 1999. Mc Graw Hill.
4. Caldwell, DR. 1995. Microbial Physiology & Metabolism. Brown Publishers.
5. Moat & Foster. Microbial Physiology. 1999. Wiley.

Paper V. Microbial Genetics and Molecular Biology

Unit I

Nucleic acids as genetic information carrier: Experimental evidence. DNA structure, Historical aspects and current concepts. DNA replication, General principles, various modes of replication.

Unit II

Gene as a unit mutation and recombination. Molecular nature of mutations. Mutagens. Spontaneous mutation origin. DNA damage and repair: type of DNA damage (deamination, oxidative damage, alkylation, pyridine dimers). Repair mechanisms- methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair, SOS system.

Unit III

Gene expression and protein synthesis: Structural features of RNA (rRNA, tRNA & mRNA) and relation of function. Transcription: general principles, type of RNA polymerases, steps; initiation, elongation and termination. Inhibitors of RNA synthesis. Polycistronic and monocistronic RNAs. Basic features of genetic code. Protein synthesis and its step; initiation, elongation and termination. Inhibitors of protein synthesis.

Unit IV

Gene transfer mechanisms- transformation, transduction, conjugation and transfection, mechanism and applications. Plasmids: F factor description and their use in genetic analysis. Bacteriophages: Lytic phages- T4. Lysogenic phage- lambda ϕ X174: uses in microbial genetics.

Unit V

Gene conversion, site specific recombination, transposable elements, nomenclature, insertion sequences, transposons.

Suggested Readings:

1. Gardner, Simmons & Snustad. Principles of Genetics. John Wiley & Sons.
2. Friefelder, Jones & Bartlett. Microbial Genetics. Narosa-Panima.
3. Glick, B.R. & J.J. Pasternak. Molecular Biotechnology. Panima.
4. Tamrin. Principles of Genetics. Tata McGraw Hill.

Paper VI. Biostatistics, Bioinformatics and Computer application

Unit I

Introduction: definition of statistics, population and universe, the sample and population, statistical inference, parameter and statistics. Measures of central tendency: Mean median, mode and their relationship, standard deviation, representing the normal curve, Chi-square test, student's t test, goodness of fit.

Unit II

Probability: Random experiment, events, sample space, mutually exclusive events, independent and dependent events. Various definitions of probability, addition and multiplication theorems of probability (only statement), Random variables (discrete and continuous). Probability density functions and its properties. Some probability distributions such as binomial, Poisson and normal (Basic idea about these distributions) and their applications.

Unit III

Analysis of variance: Analysis of co-variance; Introduction, procedure and tests, multiple comparisons. Correlation and regression and line fitting through graph points; standard curves; correlation, linear regression (fitting of best line through a series of points), Multiple colinearity. Standard curves and interpolation of unknown Y-values.

Unit IV

What is bioinformatics, Importance of bioinformatics, Biological database; primary and secondary database. DNA sequence database. DNA sequence analysis, pair wise alignment, multiple sequence alignment.

Unit V

Computer Basics: Component of computer system. Memory: primary and secondary. CPU, Operating system: definition, importance, Disc Operating System. Network: Types of network, Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Air Network (MAN). Internet: basic idea.

Suggested Readings:

1. Ron White. How Computer Work. 2000. Techmedia.
2. Preston Gralla. How Internet Work. 2000. Techmedia.
3. Bliss, C.I.K. 1977. Statistics in Biology. Vol.I. Mc Graw Hill, New York.
4. Campbell R.C. 1974. Statistics for biologists. Cambridge University Press.
5. Wardlaw, A.C. 1985. Practical Statistics for Experimental Biologists. John Wiley & Sons.
6. Glover. An Introduction Biostatistics.
7. Mishra & Mishra. An Introduction Biostatistics. Kalyani Publication.

Practicals recommended for B. Sc. II Year (Microbiology) course

1. Analysis of carbohydrates in given samples.
2. Estimation of protein in given samples.
3. Analysis and estimation of lipid in given samples.
4. Blood group and Rh factor determination.
5. Demonstration of WIDAL test.
6. Isolation of normal micro flora of skin and mouth teeth crevices.
7. Testing of antimicrobial activity of the skin on bacteria.
8. Microscopic observation of infected tissues for pathogenic fungi and bacteria in plants and animal.
9. Determination of quality of milk samples by Methylene Blue Reduction test.
10. Microbiological examination of food samples.
11. Microscopic observation of starter culture for curd.
12. Observation of eutrophication in stagnant water and its microscopic study.
13. Microscopic observation of root nodules of leguminous plants for nitrogen fixing bacteria.
14. Visit of waste water treatment plant.

B. Sc. III Year Microbiology

Paper VII. Environmental Microbiology

Unit I

Air Pollution: Sources, types, effect of pollutants, control measures brief account of air born transmission of microbes; viruses, bacteria and fungi, their diseases and preventive measures. Aeroallergy and aeroallergens. assessment of air quality.

Unit II

Aquatic microbiology: water ecosystem and its type, marine microorganisms and their importance, eutrophication, brief account of major water born diseases and their control measures.

Unit III

Soil microbiology: classification of soil, physical and chemical characteristics, micro flora of various soil types, brief account of microbial interactions, symbiosis-mutualism, commensalisms, competition, amensalism, synergism, parasitism, predation.

Unit IV

Biogeochemical cycles and the microorganisms- carbon, nitrogen, phosphorous and sulfur; biofertilizer; Vesicular Arbuscular Micorrhizae (VAM); ecto, endo, ectendo mycorrhizae.

Unit V

Water treatment- wastes, types, solid and liquid wastes characterization, primary, secondary, tertiary solid waste treatment, Bioaccumulation, Bioremediation, Bioleaching of copper and uranium, Environmental impact assessment: Introduction, Assessment & Control.

Suggested Readings:

1. Atlas & Bartha. Microbial Ecology. 2007. Pearson Education.
2. Paul & Clark. Soil Microbiology & Biochemistry. Academic Press.
3. Jogdand S.N. Environmental Biotechnology. Himalaya Publishing House.
4. Powar & Dagainawala. Microbiology. Himalaya Publishing House.
5. Dubey R.C. & D.K. Maheshwari. A text Book of Microbiology. S. Chand & Co.

Paper VIII. Industrial Microbiology

Unit I

Isolation of industrially important microbial strains, strain improvement, preservation and maintenance of industrial microbes, scale-up. Criteria used for selection of microorganisms for fermentation. Growth kinetics of industrially important microorganisms.

Unit II

Fermentation processes: Batch, fed-batch and continuous fermentations; solid state and submerged fermentations. Components in a typical bioreactor and types. Maintenance of pH, temperature, dissolved oxygen and aeration.

Unit III

Substrate for industrial fermentation: Molasses, corn steep liquor, sulfite waste liquor, whey, yeast extract. Detection and assay of fermentation product. Down Stream Processing, immobilization & its applications. Antifoams.

Unit IV

Microbial production of industrial products; citric acid, ethanol, acetone, penicillin, streptomycin, vitamin B12, riboflavin, amylase, single cell protein. Biofertilizers, bioinsecticides.

Unit V

Food as a substrate for micro-organisms, microbial spoilage of different food-stuffs, principles and methods of food preservation. Microbiology of milk, dairy products and fermented foods. Single cell protein. Food-borne diseases. Mycotoxins with reference to aflatoxins.

Suggested Readings:

1. Crueger & Crueger. Biotechnology. Panima Publ.
2. Adams M.R. & M.O. Moss. 1995. Food Microbiology. Cambridge.
3. Frazier W.C. & D.C. Westhoff. 1988. Food Microbiology. Tata McGraw Hill.
4. Stanbuty, P.F., & S.J. Hall. 1995. Principles of Fermentation Technology. Pergamon Press.

Paper IX. Medical Microbiology and Immunology

Unit I

Historical background of medical microbiology, Classification of medically important microorganisms. Disease cycle, transmission of pathogen and its routes. Infection and its type. Host-parasite relationships, pathogenicity and virulence in relation with bacteria, virus fungi and parasites

Unit II

Silent features of the diseases caused bacteria: *Clostridium*, *Bacillus*, *Staphylococcus*, *Streptococcus*, *E.coli*, *Klebsiella*, *Salmonella*, *Pseudomonas*, *Vibrio*, *Neisseria*, Mycobacteria. Viral disease- Hepatitis, HIV, dengue fever, small pox, polio. Protozoan disease- Malaria & Amoebiasis.

Unit III

Protein toxins- types and disease, early diagnosis and detection of disease by serological methods- RIA, ELISA, complement fixation, agglutination; chemotherapy- types and action mechanisms of antimicrobials; antimicrobial assay and drug resistance; vaccines; interferon.

Unit IV

History of immunology, composition and functions of cells and organs involved in immune system; Immune response and its type- innate (non specific), acquired (cell mediated and humoral) immunity.

Unit V

Antigens- structure and properties, Immunoglobulin- structures, properties & functions, Antigen-antibody reactions-ELISA, RIA, Agglutination & precipitate; Complements- Structure and functions; Major Histocompatibility Complex (MHC): Structure and functions; Autoimmunity and Hypersensitivity reactions.

Suggested Readings:

1. Ananthanarayan & Panicker. 1997. Text Book of Microbiology. Oriental Longman.
2. Dubey R.C. & D.K. Maheshwari. A text Book of Microbiology. S. Chand & Co.
3. Prescott L.J., J.P.M. Harley & A.D. Klein. Microbiology. Tata McGraw Hill.
4. Kuby J. 1994. Immunology. W.H. Freeman & Company, New York.
5. Baron E.J., Peterson L.R., Finegold, S.M. Mosby. 1990. Bailey & Scott's Diagnostic Microbiology.
6. Chakrabarty. Immunology & Immunotechnology. Oxford.

Practicals recommended for B. Sc. III Year (Microbiology) course

1. Two to three different exercises in biostatics.
2. Two to three different exercises for demonstration of hardware, software and internet.
3. Isolation of crude bacterial DNA.
4. Demonstration of electrophoresis.
5. Demonstration of PCR.
6. Demonstration of lethal effect of UV (to explain the UV induced mutation).
7. Demonstration of Indole production by bacterial culture.
8. Demonstration of Methyl Red and Voges-Proskauer test.
9. Demonstration of Citrate utilization test.
10. Demonstration of Catalase test.
11. Demonstration of amylase production by bacterial cultures.