

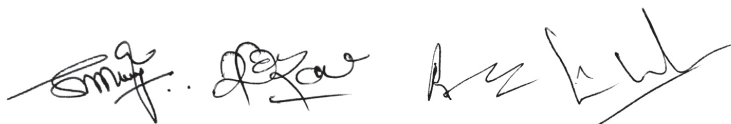
Faculty of Science
B. Sc. MICROBIOLOGY
SEMESTER-WISE SYLLABUS IN CBCS PATTERN

(Medium of Instruction and Examination shall be only in English)

Code	Course Title	Course Type	HPW	Credits
FIRST YEAR SEMESTER -I				
BS104	Introductory Microbiology	DSC-1A	4T + 2P = 6	4+1 = 5
SEMESTER -II				
BS204	Bacteriology	DSC-1B	4T + 2P = 6	4+1 = 5
SECOND YEAR SEMESTER -III				
BS304	Microbial Physiology	DSC-1C	4T + 2P = 6	4+1 = 5
SEMESTER -IV				
BS404	Microbial Genetics	DSC-1D	4T + 2P = 6	4+1 = 5
THIRD YEAR SEMESTER -V				
BS503	Basics of Immunology	DSC-1E	3T + 2P = 5	3+1 = 4
BS506	Instrumentation and Biotechniques	DSE-1E/A	3T + 2P = 5	3+1 = 4
BS506	Biosafety and Intellectual property rights (IPR)	DSE-1E/B	3T + 2P = 5	3+1 = 4
SEMESTER -VI				
BS603	Medical Microbiology	DSC-1F	3T + 2P = 5	3+1 = 4
BS606	Cell Biology	DSE-1F/A	3T + 2P = 5	3+1 = 4
BS606	Industrial Microbiology	DSE-1F/B	3T + 2P = 5	3+1 = 4

DSC: Discipline Specific Course (Core)

DSE: Discipline Specific Elective (Elective)



B. Sc (CBCS) Microbiology – I Year
Semester- I – Paper- I
BS104-DSC-1A: INTRODUCTORY MICROBIOLOGY

Theory syllabus

Credits – 4

UNIT – I

1. Meaning, definition and history of Microbiology. Contributions of Antony von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Iwanowsky, Beijerinck, Winogradsky and Alexander Fleming.
2. The origin of microbial life - Spontaneous generation (abiogenesis), Biogenesis, Germ Theory of disease, Koch's Postulates.
3. Outline classification of living organisms: Heckel, Whittaker and Carl Woese systems. Place of microorganisms in the living world. Outline classification for bacteria as per the second edition of Bergey's Manual of Systematic Bacteriology (up to section level). Scope, importance and applications of Microbiology.

UNIT – II

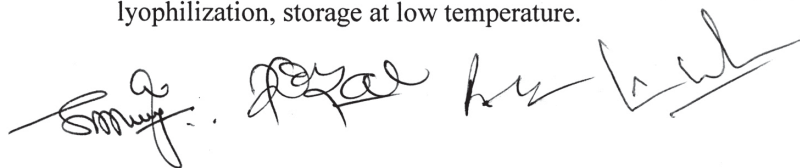
1. Principles of microscopy – bright field, dark field, phase-contrast, fluorescent and electron microscopy.
2. Differentiation of prokaryotes and eukaryotes.
3. Structure and function of Plasma membrane, cell wall, capsule, flagella, nucleod, plasmid, Gram positive and Gram negative bacteria

UNIT – III

1. Principles and types of stains - Simple and differential staining: theories of staining, mordant and its function, Gram staining, acid fast staining; endospore staining, negative staining, capsule staining, flagella staining.
2. Sterilization and disinfection techniques - Principles and methods of sterilization. Physical methods - autoclave, hot-air oven, pressure cooker, laminar air flow, filter sterilization.
3. Radiation methods - UV rays, gamma rays, ultrasonic methods. Chemical methods - Use of alcohols, aldehydes, fumigants, phenols, halogens and hypochlorites. Phenol coefficient.

UNIT - IV

1. Classification and characteristics of fungi, algae, protozoa and viruses.
2. Isolation of pure culture techniques - Enrichment culturing, pour plate, streak-plate, spread plate and micromanipulator.
3. Preservation of microbial cultures – sub culturing, overlaying cultures with mineral oils, lyophilization, storage at low temperature.



B. Sc (CBCS) Microbiology – I Year
Semester- I – Paper- I
BS104-DSC-1A: INTRODUCTORY MICROBIOLOGY

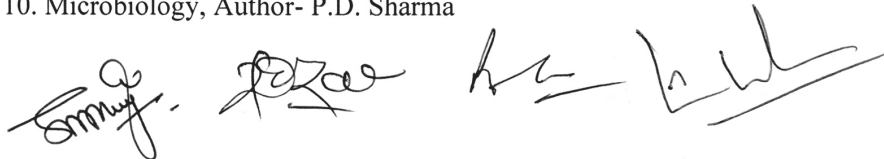
Practical syllabus

Credits – 1

1. Precautions to work in Microbiology laboratory.
2. Sterilization techniques: Autoclaving, hot-air oven and filtration.
3. Aseptic transfer of Microorganisms
4. Isolation of single colonies on solid media.
5. Light, compound microscope and its handling.
6. Microscopic observation of bacteria (Gram +ve bacilli and cocci, Gram –ve bacilli), cyanobacteria (*Nostoc*, *Spirulina*), algae (*Scenedesmus* sp., diatoms), and fungi (*Saccharomyces*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Fusarium*).
7. Calibrations of microscopic measurements (Ocular, stage micrometers).
8. Demonstration of Motility by hanging drop method.
9. Micrometry: Determination of size of Bacteria, yeast. Fungal filaments.

References:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGrawHill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
8. General Microbiology (1993) Authors- Powar and Dagainawala.
9. Microbiology, Author- S.S. Purohit.
10. Microbiology, Author- P.D. Sharma



B. Sc (CBCS) Microbiology – I Year
Semester- II – Paper- II
BS204-DSC-1B: BACTERIOLOGY

Theory syllabus

Credits – 4

UNIT – I

1. Morphology and structure: Bacterial morphology – shape size structure, chemistry and function of cell wall, membrane, capsule, pili, flagella, plasmid, bacterial chromosome. Variant components – Capsule, flagella, fimbriae, endospore and storage granules.
2. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaeobacterial cell wall, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms.
3. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids

UNIT – II

1. Endospore: Structure, formation, stages of sporulation.
2. Nutritional requirements in bacteria and nutritional categories.
3. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.

UNIT – III

1. Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.
2. Aim and principles of classification, Systematic and taxonomy, concept of species, taxa, strain.
3. conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences.

UNIT – IV

1. Archaeobacteria: General characteristics, phylogenetic overview, Morphology, metabolism, ecological significance and economic importance.
2. Eubacteria: Morphology, metabolism, ecological significance and economic importance of Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Gamma proteobacteria, Delta proteobacteria, Epsilon proteobacteria, Zeta proteobacteria
3. Differences between eubacteria and archaeobacteria.



B. Sc (CBCS) Microbiology – I Year
Semester- II – Paper- II
BS204-DSC-1B: BACTERIOLOGY

Practical syllabus

Credits – 1

1. Preparation of different media: Synthetic Media, Complex media (Nutrient Agar, McConkey agar).
2. Simple staining.
3. Negative staining.
4. Gram's staining.
5. Acid fast staining (permanent slide only).
6. Capsule staining.
7. Spore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Estimation of CFU count by spread plate method/pour plate method.
10. Demonstration of Motility by hanging drop method.

References:

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. PrenticeHall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14thedition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition TataMcGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer AcademicPublishers, Dordrecht.
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). GeneralMicrobiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9thedition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
- Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.



B. Sc (CBCS) Microbiology – II Year
Semester-III – Paper-III
BS304-DSC-1C: MICROBIAL PHYSIOLOGY

Theory syllabus

Credits – 4

UNIT – I

1. Microbial nutrition - Nutritional groups of microorganisms - autotrophs, heterotrophs, mixotrophs, methylotrophs. Nutritional requirements and uptake of nutrients by cells
2. Microbial growth – Growth curve, different phases of growth in batch cultures.
3. Factors influencing microbial growth, Synchronous, continuous, biphasic growth. Methods for measuring microbial growth – Direct microscopy, viable count estimates, turbidometry, biomass.

UNIT – II

1. Phototrophy – Diversity of phototrophic organisms. Photosynthetic apparatus in prokaryotes. Outlines of oxygenic and anoxygenic photosynthesis in bacteria.
2. Photosynthetic pigments and their light absorption, photochemistry of PSI and PSII
3. Modes of CO₂ fixation (Calvin cycle, reverse TCA cycle and HP pathway)

UNIT – III

1. Aerobic respiration - Glycolysis, HMP pathway, ED pathway, TCA cycle, electron transport, oxidative and substrate-level phosphorylation. Anaplerotic reactions. β -oxidation of fatty acids.
2. Glyoxylate cycle. Anaerobic respiration (nitrate, sulphate respiration).
3. Fermentations - Common microbial fermentations with special reference to alcohol and lactic acid fermentations.

UNIT – IV

1. Anaerobic respirations – Sulphate, nitrate, carbonate respirations and their ecological significance.
2. Fermentations – Fermentation types, alcohol, lactate, propionate, mixed acid and butanol fermentations and their industrial importance.
3. Concept of primary and secondary metabolism.



B. Sc (CBCS) Microbiology – II Year
Semester-III – Paper-III
BS304-DSC-1C: MICROBIAL PHYSIOLOGY

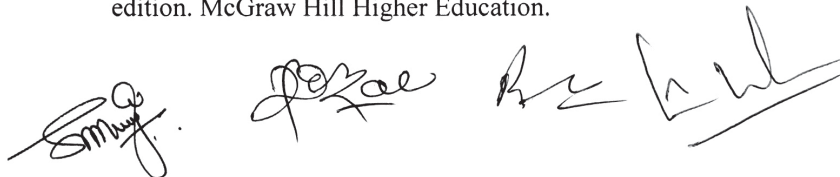
Practical syllabus

Credits – 1

1. Study and plot the growth curve of *E. coli* by turbidometric method.
2. Effect of temperature on growth of *E. coli*.
3. Effect of pH on growth of *E. coli*.
4. Effect of osmotic pressure (salt and sugar concentration) on bacterial growth.
5. Setting and observation of Winogradsky column.
6. The oligodynamic action of heavy metals on bacterial growth.
7. Biochemical tests - Indole test, Methyl red test, Voges Proskauer test, Citrate test
Carbohydrate fermentation & Gas production, Amylase test, H₂S production test, Nitrate reductase test, Starch hydrolysis, catalase test.

References:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.



B. Sc (CBCS) Microbiology – II Year
Semester-IV – Paper-IV
BS404-DSC-1D: MICROBIAL GENETICS

Theory syllabus

Credits – 4

UNIT – I

1. Overview of prokaryotic and eukaryotic cells, cell size and shape, Eukaryotic and prokaryotic Cell organelles, Cell division (mitosis and Meiosis)
2. Fundamentals of genetics - Mendelian laws, alleles, crossing over, and linkage. DNA and RNA as genetic materials.
3. Structure of DNA – Watson and Crick model. Extrachromosomal genetic elements – Plasmids and transposons. Replication of DNA – Semiconservative mechanism.

UNIT – II

1. Brief account on horizontal gene transfer among bacteria – transformation, transduction and conjugation.
2. Mutations – spontaneous and induced, base pair changes, frameshifts, deletions, inversions, tandem duplications, insertions. Physical and chemical mutagens.
3. Outlines of DNA damage and repair mechanisms.

UNIT – III

1. Concept of gene – Mutton, recon and cistron. One gene-one enzyme, one gene-one polypeptide, one gene-one product hypotheses.
2. Types of RNA and their functions. Outlines of RNA biosynthesis in prokaryotes.
3. Genetic code. Structure of ribosomes and a brief account of protein synthesis.

UNIT – IV

1. Types of genes – structural, constitutive, regulatory. Operon concept. Regulation of gene expression in bacteria – *lac* operon.
2. Basic principles of genetic engineering - restriction endonucleases, DNA polymerases and ligases, vectors. Outlines of gene cloning methods. Genomic and cDNA libraries.
3. General account on application of genetic engineering in industry, agriculture and medicine.



B. Sc (CBCS) Microbiology – II Year
Semester-IV – Paper-IV
BS404-DSC-1D: MICROBIAL GENETICS

Practical syllabus

Credits – 1

1. Estimation DNA by diphenylamine (DPA) method.
2. Estimation of RNA by orcinol method
3. Study of cell division in onion root tip (mitotic divisions)
4. Isolation of DNA from bacteria.
5. Isolation of mutants of bacteria by UV exposure.
6. Problems related to Mendilian laws mono and dihybrid cross (problems)
7. Problems related to gene interactions
8. Problems related to DNA and RNA characteristics, Transcription and Translation.

References:

1. Genes XI, Author- B. Lewin.
2. Principles of Genetics, Authors- Gardner, Simmons and Snustad.
3. Concepts of Genetics, Authors- Klug and Cummings.
4. Microbial Genetics, Authors- Freifelder.
5. Genetics, Authors- Arora and Sandhu.
6. Text of Microbiology, Authors- Ananthanarayanan and Paniker.
7. S R Maloy, D Freifelder and J E Cronan. Microbial Genetics. Jones and Barlett Publishers.



B. Sc (CBCS) Microbiology – III Year
Semester-V – Paper-V (Discipline Specific Course)
BS503-DSC-1E: BASICS OF IMMUNOLOGY

Theory syllabus

Credits – 3

UNIT-I

1. History of Immunology: Contributions of Edward Jenner, Louis Pasteur, Emil Von Behring, Early theories of Immunity.
2. Types of Immunity: Innate and Acquired Immunity, Humoral and cell-mediated immunity, Active and passive immunity
3. Structure and function of the immune system Primary lymphoid organs: Thymus, bone marrow and Bursa Fabricius. Secondary lymphoid organs: spleen and lymph nodes

UNIT-II

1. Cells of the immune system: B and T lymphocytes, null cells, monocytes, macrophages, neutrophils, basophils, eosinophils
2. Antigens – types of antigens, chemical nature of antigens, antigenic determinants, haptens, factors affecting antigenicity. Antibodies: Basic structure of immunoglobulins, types of immunoglobulin (IgG, IgM, IgA, IgE, IgD), Properties and functions of Immunoglobulins
3. Types of antigen-antibody reactions - Agglutinations; Hemagglutinations, Bacterial agglutinations, Passive agglutinations Precipitations: Precipitation reactions in fluids, precipitation reactions in Gels Radial immunodiffusion, Double immunodiffusion (Ouchterlony method), Neutralization and Complement fixation

UNIT - III

1. Antibody labeled immune reactions-ELISA (Enzyme linked immunosorbent assay) RIA (Radio immunoassay) and immunofluorescence
2. Monoclonal antibodies: Production of monoclonal antibodies and their applications
3. Hypersensitivity reactions - Immediate hypersensitivity : Systemic anaphylaxis, Localized anaphylaxis (Allergic rhinitis, asthma), Delayed hypersensitivity: Contact dermatitis



B. Sc (CBCS) Microbiology – III Year
Semester-V – Paper-V (Discipline Specific Course)
BS503-DSC-1E: BASICS OF IMMUNOLOGY

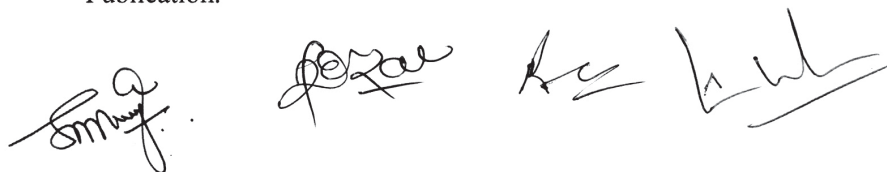
Practical syllabus

Credits – 1

1. Typing of human blood groups-slide agglutination
2. Estimation of hemoglobin content of human blood
3. Preparation of blood smear and different blood cell count
 - i) RBC count
 - ii) WBC count
4. Differential staining of WBC by Leishman's stain
5. Widal-slide agglutination test
6. RPR card test for syphilis
7. Tridot test

References:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.



B. Sc (CBCS) Microbiology – III Year
Semester-V – Paper-VI/A (Discipline Specific Elective)
BS506-DSE-1E/A: INSTRUMENTATION AND BIOTECHNIQUES

Theory syllabus

Credits – 3

UNIT – I

1. Microscopy: Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy.
2. Electron Microscopy (Scanning and Transmission Electron Microscopy).
3. Biophysical Principles: Osmosis, osmotic pressure, Donan equilibrium, diffusion potential, diffusion coefficient, endocytosis & exocytosis, gradient of chemical potential as driving force in transport, membrane potential & ionophores.

UNIT – II

1. Chromatography: Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection.
2. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.
3. Electrophoresis: Principle and applications of native polyacrylamide gel electrophoresis. SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis. Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

UNIT – III

1. Spectrophotometry: Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.
2. Centrifugation: Principle, working and applications of centrifuge. Preparative and analytical centrifugation, fixed angle and swinging bucket rotors.
3. Differential centrifugation, density gradient centrifugation and ultracentrifugation.



B. Sc (CBCS) Microbiology – III Year
Semester-V – Paper-VI/A (Discipline Specific Elective)
BS506-DSE-1E/A: INSTRUMENTATION AND BIOTECHNIQUES

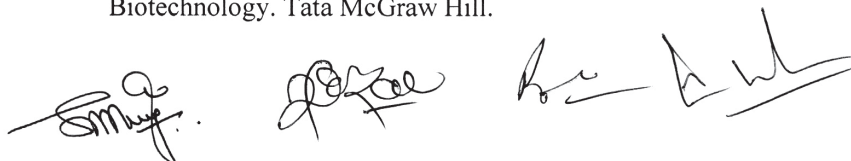
Practical syllabus

Credits – 1

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Separation of mixtures by paper / thin layer chromatography.
3. To demonstrate column packing in any form of column chromatography.
4. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
5. Separation of components of a given mixture using a laboratory scale centrifuge.
6. Understanding density gradient centrifugation with the help of pictures.

References:

1. A.Upadhyay, K.Upadhyay and N. Nath 2006 Biophysical Chemistry, Principles and Techniques Himalaya Pub. House.
2. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
3. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
4. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
5. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
6. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
7. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
8. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.



B. Sc (CBCS) Microbiology – III Year
Semester-V – Paper-VI/B (Discipline Specific Elective)
BS506-DSE-1E/B: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

Theory syllabus

Credits – 3 .

UNIT – I

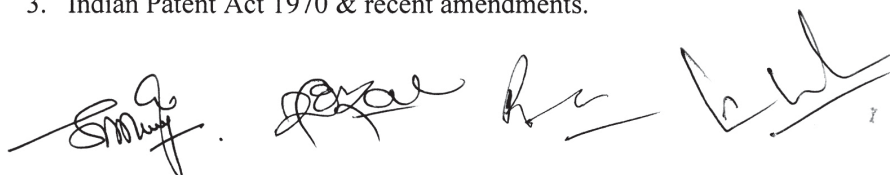
1. Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types. Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.
2. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges.
3. Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

UNIT – II

1. Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge.
2. Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).
3. Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures.

UNIT - III

1. Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.
2. Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties.
3. Indian Patent Act 1970 & recent amendments.



B. Sc (CBCS) Microbiology – III Year
Semester-V – Paper-VI/B (Discipline Specific Elective)
BS506-DSE-1E/B: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

Practical syllabus

Credits – 1

1. Study of components and design of a BSL-III laboratory.
2. Filing applications for approval from biosafety committee (IBSC).
3. Filing primary applications for patents.
4. Study of steps of a patenting process.
5. A case study.

References:

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.



B. Sc (CBCS) Microbiology – III Year
Semester-VI – Paper-VII (Discipline Specific Course)
BS603-DSC-1F: MEDICAL MICROBIOLOGY

Theory syllabus

Credits – 3

UNIT – I

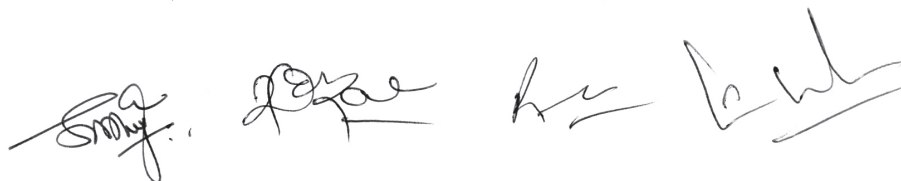
1. Important milestones in medical microbiology. Normal flora of human body and their importance.
2. Definition of infection, non-specific defense mechanisms, mechanical barriers, antagonism of indigenous flora.
3. Air-borne diseases - Tuberculosis, Influenza, Food and water-borne diseases - Cholera, Typhoid, Hepatitis – A, Amoebiasis, Zoonotic diseases - Rabies, Anthrax

UNIT – II

1. Insect-borne diseases - Malaria, Filariasis, Dengue fever
2. Contact diseases - Syphilis, Gonorrhoea
3. Blood-borne diseases - Serum hepatitis, AIDS

UNIT – III

1. Collection, transport and processing of clinical samples
2. General methods of laboratory diagnosis – cultural, biochemical, serological and molecular methods
3. Chemotherapy and antimicrobial agents used to control of pathogens – therapeutic drugs. Drug resistance.



B. Sc (CBCS) Microbiology – III Year
Semester-VI – Paper-VII (Discipline Specific Course)
BS603-DSC-1F: MEDICAL MICROBIOLOGY

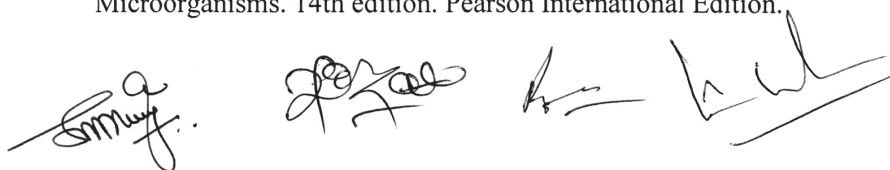
Practical syllabus

Credits – 1

1. Enumeration of RBC and WBC
2. Estimation of blood haemoglobin.
3. Determination of blood groups and Rh typing.
4. Isolation and identification of medically important bacteria by cultural, microscopic and biochemical tests.
5. Antibiotic sensitivity testing – disc diffusion method.
6. Parasites – Malarial parasite, *Entamoeba* (study of permanent slides).
7. Tests for disinfectant (Phenol coefficient).

References:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.



B. Sc (CBCS) Microbiology – III Year
Semester-VI – Paper-VIII/A (Discipline Specific Elective)
BS606-DSE-1F/A: CELL BIOLOGY

Theory syllabus

Credits - 3

UNIT – I

1. Structure of Cell: Plasma membrane: Structure and transport of small molecules.
2. Cell Wall: Eukaryotic cell wall, extracellular matrix and cell matrix interactions, cell-cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects).
3. Mitochondria, chloroplasts and peroxisomes. Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

UNIT - II

1. Nucleus: Nuclear envelope, nuclear pore complex and nuclear lamina. Chromatin – Molecular organization. Nucleolus.
2. Protein targeting and Transport
3. Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus. Lysosomes.

UNIT – III

1. Cell Signalling: Signalling molecules and their receptors. Function of cell surface receptors. Pathways of intracellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway
2. Cell Cycle, Cell Death and Cell Renewal: Eukaryotic cell cycle and its regulation, Mitosis and Meiosis.
3. Development of cancer, causes, types, Diagnosis and therapy. Programmed cell death.



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B. Sc (CBCS) Microbiology – III Year
Semester-VI – Paper-VIII/A (Discipline Specific Elective)
BS606-DSE-1F/A: CELL BIOLOGY

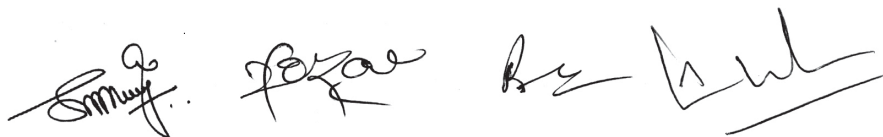
Practical syllabus

Credits – 1

1. Study a representative plant and animal cell by microscopy.
2. Cytochemical staining of DNA – Feulgen.
3. Study of polyploidy in Onion root tip by colchicine treatment.
4. Identification and study of cancer cells by photomicrographs.
5. Study of cell division in onion root tip (mitotic divisions)
6. Study of different stages of Mitosis.
7. Study of different stages of Meiosis by permanent slides.

References:

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.



B. Sc (CBCS) Microbiology – III Year
Semester-VI – Paper-VIII/B (Discipline Specific Elective)
BS606-DSE-1F/B: INDUSTRIAL MICROBIOLOGY

Theory syllabus

Credits - 3

UNIT – I

1. Introduction to industrial microbiology and fermentation processes. Brief history and developments in industrial microbiology.
2. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations.
3. Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters.

UNIT – II

1. Design of typical batch fermentor. Factors affecting fermentor design, Fermentation media. Control of agitation, aeration, pH, temperature and dissolved oxygen.
2. Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.
3. Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains. Screening and isolation of industrially important microorganisms. Outlines of strain improvement.

UNIT – III

1. Types of fermentation – aerobic, anaerobic, batch, continuous, submerged, surface, solid state.
2. Industrial production of alcohols (ethyl alcohol), beverages (beer), enzymes (amylases), antibiotics (penicillin), amino acids (glutamic acid), organic acids (citric acid), vitamins (B12), biofuels (biogas - methane).
3. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).



B. Sc (CBCS) Microbiology – III Year
Semester-VI – Paper-VIII/B (Discipline Specific Elective)
BS606-DSE-1F/B: INDUSTRIAL MICROBIOLOGY

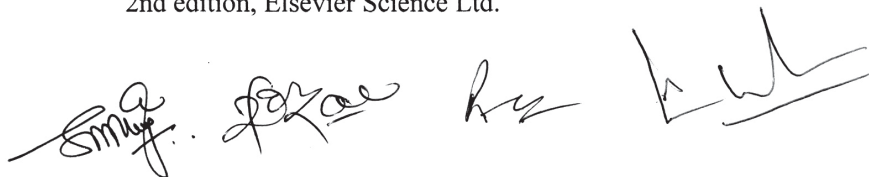
Practical syllabus

Credits – 1

1. Measurement and production of citric acid by *A. niger*.
2. Measurement and production of ethanol by *Saccharomyces*.
3. Measurement of in vitro production of IAA by soil fungi.
4. Isolation of antibiotic producer from soil sample.
5. Estimation of streptomycin.
6. Isolation of amylase producer from soil sample.
7. Immobilization of enzymes

References:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA.
3. Waites M.J., Morgan N.L., Rockey J.S. and Highton G. (2001). Industrial Microbiology: An Introduction. 1st edition, Wiley – Blackwell.
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company.
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.



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Professor, Chairperson BOS
Coordinator, SAP-DRS-III
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Reaccredited with "A" Grade by NAAC

Lr, NO: 241809/KU/2016

Date: 23-05-2016

To
The Registrar
Kakatiya University
Warangal.

Sub : Approval of B.Sc. (Botany) Syllabus for Semester System and CBCS – Reg.

Ref : Lr.No.583/B2/KU/2016, dated 17-05-2016.

- x -

Sir

With reference to the letter cited above, the Board of Studies Meeting (Under Graduate) was held in the Chamber of the Head, Dept. of Botany, KU, on 23-05-2016 at 11.00am, and the syllabus (theory and practical) along with model question paper was approved. I am herewith enclosing a hard copy of the syllabus along with soft copy.

Kindly do the needful.

Thanking you,

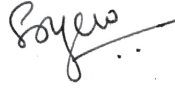



Sincerely yours,

(Prof. A. Ragan)
Chairman
BOS in Botany, KU

Meeting of BOS (Under Graduate) in Botany

Date: 23-05-2016

The Meeting of Board of Studies (Under Graduate) in Botany was held on 23-05-2016 at 11.00am in the chambers of the Head, Department of Botany, KU. The following members were present (*with reference to Lr.No.583/B2/KU/2016, dated 17-05-2016*)

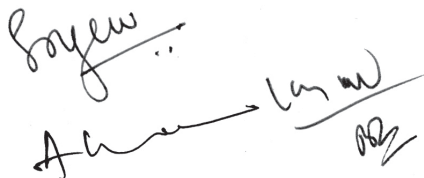
- | | | | |
|---|-----|-------------------------|---|
| 1) Prof. A. Ragan | --- | Chairman, BOS in Botany |  |
| 2) Dr. V. Krishna Reddy | --- | Head |  |
| 3) Dr. B. Lalitha Kumari
Dept. of Botany, UASC, KU, Wgl. | --- | Member |  |
| 4) Dr. D.V. Laxmi Satyavati
Kakatiya Govt. College, Hnk | --- | Member | |
| 5) Dr. A. Chandra Mohan
Govt. Degree College, Mancherial | --- | Member |  |

Resolutions:

- 1) After thorough discussion, it is resolved to approve the syllabus of B.Sc. (Botany) under Semester System and CBCS. The syllabus was approved for the following papers along with practical syllabus and model question papers.

I year I Semester BS 104 (DSC-1A)
I year II Semester BS 204 (DSC-1B)
II year III Semester BS 304 (DSC-1C)
II year IV Semester BS 404 (DSC-1D)
III year V Semester BS 503 (DSC-1E)
III year VI Semester BS 603 (DSC-1F)

- 2) The syllabus for paper BS506 (optional – 1 A/B/C) DSE-1E of III year V Semester and BS606 (optional – 1 A/B/C) DSE-1F of III year VI Semester will be approved in the next BOS meeting and will be communicated at the earliest



Telangana State Council of Higher Education, Govt. of Telangana
B.Sc. CBCS Common Core Syllabi for All Universities in Telangana (wef 2016-'17)

**PROPOSED SCHEME FOR B.Sc. PROGRAMME
UNDER CHOICE BASED CREDIT SYSTEM**

FIRST YEAR SEMESTER-I				
<i>Code</i>	<i>Course Title</i>	<i>Course Type</i>	<i>HPW</i>	<i>Credits</i>
BS101	Communication	AECC-1	2	2
BS102	English	CC-1A	5	5
BS103	Second Language	CC-2A	5	5
BS104	Optional - I	DSC-1A	4 T + 2P = 6	4+1=5
BS105	Optional - II	DSC-2A	4 T + 2P = 6	4+1=5
BS106	Optional - III	DSC-3A	4 T + 2P = 6	4+1=5
			30	27
SEMESTER-II				
BS201	Environmental Studies	AECC-2 ✓	2	2
BS202	English	CC-1B	5	5
BS203	Second Language	CC-2B	5	5
BS204	Optional - I	DSC-1B ✓	4 T + 2P = 6	4+1=5
BS205	Optional - II	DSC-2B	4 T + 2P = 6	4+1=5
BS206	Optional - III	DSC-3B	4 T + 2P = 6	4+1=5
			30	27
SECOND YEAR SEMESTER-III				
BS301	A/B	SEC-1	2	2
BS302	English	CC-1C	5	5
BS303	Second Language	CC-2C	5	5
BS304	Optional - I	DSC-1C ✓	4 T + 2P = 6	4+1=5
BS305	Optional - II	DSC-2C	4 T + 2P = 6	4+1=5
BS306	Optional - III	DSC-3C	4 T + 2P = 6	4+1=5
			30	27
SEMESTER-IV				
BS401	C/D	SEC-2	2	2
BS402	English	CC-1D	5	5
BS403	Second Language	CC-2D	5	5
BS404	Optional - I	DSC-1D ✓	4 T + 2P = 6	4+1=5
BS405	Optional - II	DSC-2D	4 T + 2P = 6	4+1=5
BS406	Optional - III	DSC-3D	4 T + 2P = 6	4+1=5
			30	27

Telangana State Council of Higher Education, Govt. of Telangana
B.Sc. CBCS Common Core Syllabi for All Universities in Telangana (wef 2016-'17)

THIRD YEAR SEMESTER-V				
<i>Code</i>	<i>Course Title</i>	<i>Course Type</i>	<i>HPW</i>	<i>Credits</i>
BS501	E/F	SEC-3	2	2
BS502		GE-1	2 T	2
BS503	Optional - I	DSC-1E	3 T + 2P = 5	3+1=4
BS504	Optional -II	DSC-2E	3 T + 2P = 5	3+1=4
BS505	Optional -III	DSC-3E	3 T + 2P = 5	3+1=4
BS506	Optional -I A/B/C	DSE- 1E	3 T + 2P = 5	3+1=4
BS507	Optional - II A/B/C	DSE-2E	3 T + 2P = 5	3+1=4
BS508	Optional - III A/B/C	DSE-3E	3 T + 2P = 5	3+1=4
			34	28
SEMESTER-VI				
BS601	G/H	SEC-4	2	2
BS602		GE-2	2 T	2
BS603	Optional - I	DSC-1F	3 T + 2P = 5	3+1=4
BS604	Optional -II	DSC-2F	3 T + 2P = 5	3+1=4
BS605	Optional -III	DSC-3F	3 T + 2P = 5	3+1=4
BS606	Optional -I A/B/C	DSE- 1F	3 T + 2P = 5	3+1=4
BS607	Optional - II A/B/C	DSE-2F	3 T + 2P = 5	3+1=4
BS608	Optional - III A/B/C	DSE-3F	3 T + 2P = 5	3+1=4
			34	28
	TOTAL Credits			164

Total credits=164 – 12 (AECC 4 + SEC 8) = 152

AECC: Ability Enhancement Compulsory Course; SEC: Skill Enhancement Course; DSC: Discipline Specific Course; DSE: Discipline Specific Elective; GE: Generic Elective;

SUMMARY OF CREDITS

Sl. No.	Course Category	No. of Courses	Credits Per Course	Credits
1	AECC	2	2	4
2	SEC	4	2	8
3	CC Language	8	5	40
	DSC	12	5	60
	DSC	6	4	24
4	DSE	6	4	24
5	GE	2	2	4
	TOTAL	40		164
	Optionals Total	24		108

Pattern for each Optional in B.Sc Courses

Semester	Course type	Credits-Theory	Teaching hours per week--Theory	Credits—Practicals	Lab hours per week—Practical	Dept workload per week per section
ONE	CORE	4	4	1	2	6
TWO	CORE	4	4	1	2	6
THREE	CORE	4	4	1	2	6
FOUR	CORE	4	4	1	2	6
FIVE	CORE	3	3	1	2	5
	ELECTIVE	3	3	1	2	10 (A +B)
SIX	CORE	3	3	1	2	5
	ELECTIVE	3	3	1	2	10 (A +B)

Syllabus structure:

- Semester One:** One Core paper of 4 units for theory (4 Credits)
One Practical syllabus for 2 hours of Lab work per week (1 Credit)
- Semester Two:** One Core paper of 4 units for theory (4 Credits)
One Practical syllabus for 2 hours of Lab work per week (1 Credit)
- Semester Three:** One Core paper of 4 units for theory (4 Credits)
One Practical syllabus for 2 hours of Lab work per week (1 Credit)
- Semester Four:** One Core paper of 4 units for theory (4 Credits)
One Practical syllabus for 2 hours of Lab work per week (1 Credit)
- Semester Five:** One Core paper of 3 units for theory (3 Credits)
One Practical syllabus for 2 hours of Lab work per week (1 Credit)
✓ Two electives of 3 units for theory; student will opt for any one (3 Credits)
Two Practical syllabi for 2 hours of Lab work/week each; student will opt for one (1 Credit)
✓ One Generic elective of 2 units for students of other depts. (2 Credits)
- Semester Six:** One Core paper of 3 units for theory (3 Credits)
One Practical syllabus for 2 hours of Lab work per week
✓ Two electives of 3 units for theory; student will opt for any one (3 Credits)
Two Practical syllabi for 2 hours of Lab work/week each; student will opt for one (1 Credit)
✓ One Generic elective of 2 units for students of other depts. (2 Credits)

PROPOSED SCHEME FOR B.Sc PROGRAMME
UNDER CHOICE BASED CREDIT SYSTEM

FIRST YEAR SEMESTER-I

Code	Course Title	Course Type	HPW	Crdeits
BS 104	Optional I	D.Sc -A	4 T 2 P = 6	4 + 1 = 5

Paper-I Microbial Diversity of Lower Plants

SEMESTER-II

Code	Course Title	Course Type	HPW	Crdeits
BS 201	Environmental Studies	AECC-2	2	2
BS204	Optional-I	DSC-1B	4 T + 2P = 6	4 + 1 = 5

Paper-II Bryophytes Pteridophytes, Gymnosperms and Palaeobotany

SECOND YEAR SEMESTER-III

Code	Course Title	Course Type	HPW	Crdeits
BS304	Optional-I	DSC-IC	4 T + 2 P = 6	4 + 1 = 5

Paper-III Taxonomy of Angiosperms and Medicinal Botany

SEMESTER-IV

Code	Course Title	Course Type	HPW	Crdeits
BS404 ✓	Optional - I	DSC-ID	4 T + 2P = 6	4 + 1 = 5

Plant Anatomy, Embryology and Palynology

THIRD YEAR SEMESTER-V

Code	Course Title	Course Type	HPW	Crdeits
BS 503	Optional-I	DSC - IE	3 T + 2P = 5	3 + 1 = 4

Paper-V: Cell Biology and Genetics

BS 506	Optional I A/B	DSE-I#	3T + 2P = 5	3 + 1 = 4
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Elective-I Ecology and Biodiversity / Elective II: Horticulture

SEMESTER-VI

Code	Course Title	Course Type	HPW	Crdeits
BS 603	Optional-I	DSC - 1F	3 T + 2P = 5	3 + 1 = 4

Paper-VIII : Plant Physiology

BS 606	Optional A/B/	DSE - IF	3 T + 2P = 5	3 + 1 = 4
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Elective III Tissue Culture and Biotechnology / Elective-IV: Seed Technology

**AECC: Ability Enhancement Compulsory Course: DSC: Discipline Specific Course:
DSE : Discipline Specific Elective**

B.Sc (CBCS) Botany- I year
Semester-I - Paper-I
Microbial Diversity of Lower Plants

DSC - 1A (4 hrs./week)

Theory Syllabus

Credits- 4
(60 hours)

UNIT - I

1. Brief account of Archaeobacteria, Actinomycetes. (4h)
2. Cyanobacteria: General characters, cell structure, thallus organisation and their significance as biofertilizers with special reference to *Oscillatoria*, *Nostoc* and *Anabaena*. (6h)
3. Lichens: Structure and reproduction; ecological and economic importance. (5h)

UNIT- II

4. Viruses: Structure, replication and transmission; plant diseases caused by viruses and their control with reference to Tobacco Mosaic and Rice Tungro. (7h)
- 5.. Bacteria: Structure, nutrition, reproduction and economic importance. An outline of plant diseases of important crop plants caused by bacteria and their control with reference to Angular leaf spot of cotton and Bacterial blight of Rice. (8h)
6. General account of Mycoplasma with reference to Little leaf of brinjal and Papaya leaf curl

UNIT-III

7. General characters, structure, reproduction and classification of algae (Fritsch) and thallus organization in algae. (3h)
8. Structure and reproduction of the following:
Chlorophyceae- *Volvox*, *Oedogonium* and *Chara*. (5h)
Phaeophyceae- *Ectocarpus* (2h)
Rhodophyceae- *Polysiphonia*. (3h)
9. Economic importance of algae in Agriculture and Industry. (2h)

UNIT-IV

10. General characters and classification of fungi (Ainsworth). (3h)
11. Structure and reproduction of the following:
(a) Mastigomycotina- *Albugo*
(b) Zygomycotina- *Mucor*
(c) Ascomycotina- *Saccharomyces* and *Penicillium*.
(d) Basidiomycotina- *Puccinia*
(e) Deuteromycotina- *Cercospora*. (10h)
12. Economic importance of fungi in relation to mycorrhizae and mushrooms. General account of mushroom cultivation (2h)

Soyus
A. C. ei

M. L. M.

References:

1. Alexopolous, J. and W. M. Charles. 1988. Introduction to Mycology. Wiley Eastern, New Delhi.
2. Mckane, L. and K. Judy. 1996. Microbiology – Essentials and Applications. McGraw Hill, New York.
3. Pandey, B. P. 2001. College Botany, Vol. I: Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S. Chand & Company Ltd, New Delhi.
4. Pandey, B. P. 2007. Botany for Degree Students: Diversity of Microbes, Cryptogams, Cell Biology and Genetics. S. Chand & Company Ltd, New Delhi.
5. Sambamurthy, A. V. S. S. 2006. A Textbook of Plant Pathology. I. K. International Pvt. Ltd., New Delhi.
6. Sambamurthy, A. V. S. S. 2006. A Textbook of Algae. I. K. International Pvt. Ltd., New Delhi.
7. Sharma, O. P. 1992. Textbook of Thallophyta. McGraw Hill Publishing Co., New Delhi.
8. Thakur, A. K. and S. K. Bassi. 2008. A Textbook of Botany: Diversity of Microbes and Cryptogams. S. Chand & Company Ltd, New Delhi.
9. Vashishta, B. R., A. K. Sinha and V. P. Singh. 2008. Botany for Degree Students: Algae. S. Chand & Company Ltd, New Delhi.
10. Vashishta, B. R. 1990. Botany for Degree Students: Fungi, S. Chand & Company Ltd, New Delhi.
11. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.

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A C *me* *(m w)*

**B.Sc (CBCS) Botany-I year
Semester-I - Paper-I
Microbial Diversity of Lower Plants**

Theory Model Question Paper

Time : 2 hrs

Max. Marks: 40

Draw well-labeled diagrams wherever necessary.

1. Write short notes on any FOUR of the following: -

4 X 2 = 8M

- a. Heterocyst.
- b. Citrus Canker.
- c. Nucule
- d. Cleistothecium.
- e. Mycoplasma
- f. *Mucor*

II. Essay Questions:

4 X 8 = 32M

- 1. a. Briefly describe the structure and reproduction of *Oscillatoria*.
(OR)
b. Describe the cyanophycean cell structure.
- 2. a. Describe the structure and modes of transmission of plant viruses.
(OR)
b. Write an essay on economic importance of Bacteria.
- 3. a. Describe the life cycle of *Oedogonium* with the help of well- labelled diagram .
(OR)
b. Give an account on thallus organization in algae.
- 4. a. Describe the life cycle of *Albugo* with the help of well-labelled diagram
(OR)
b. Give a brief account on Mushroom cultivation.

Praveen
A. K. S. *B. S.* *(L. M. S.)*

B.Sc (CBCS) Botany-I year
Semester-I - Paper-I
Microbial Diversity of Lower Plants

Practical Syllabus

(45 hours)

1. Study of viruses and bacteria using electron micrographs (photographs). (3h)
2. Gram staining of Bacteria. (3h)
3. Study of symptoms of plant diseases caused by viruses, bacteria, Mycoplasma and fungi:
Viruses: Tobacco mosaic
Bacteria: Angular leaf spot of cotton and Rice tungro.
Mycoplasma: Little leaf of Brinjal and Leaf curl of papaya (3h)
Fungi: White rust on Crucifers, Rust on wheat & Tikka disease of Groundnut. (6h)
4. Vegetative and reproductive structures of the following taxa:
Algae: *Oscillatoria*, *Nostoc*, *Volvox*, *Oedogonium*, *Chara*, *Ectocarpus* and *Polysiphonia*. (6 h)
Fungi: *Albugo*, *Mucor*, *Saccharomyces*, *Penicillium*, *Puccinia* and *Cercospora* (6h)
5. Section cutting of diseased material infected by Fungi and identification of pathogens as per theory syllabus. White rust of Crucifers, Rust on wheat & Tikka disease of Groundnut. (9h)
6. Lichens: Different types of thalli and their external morphology (3 h).
7. Examination of important microbial, fungal and algal products:
Biofertilizers, protein capsules, antibiotics, mushrooms, Agar-agar etc. (3h)
8. Field visits to places of algal / microbial / fungal interest (e.g. Mushroom cultivation, water bodies). (3h)

Boyer
A. K.

PN

(M. M.)