

**A.S.D. GOVERNMENT DEGREE COLLEGE FOR
WOMEN (AUTONOMOUS) KAKINADA**

(Under the jurisdiction of Adikavi Nannaya University)

Reaccredited by NAAC with B Grade (3rd Cycle)



BOARD OF STUDIES MEETING

(2022-2023)

26th August 2022

DEPARTMENT OF MICROBIOLOGY

A.S.D Govt. Degree College for Women (A), Kakinada

Course-Wise Syllabus

BSc	MICROBIOLOGY (Semester: I)	Credits: 4
MBT: I	Introduction To Microbiology And Microbial Diversity	Hrs/Wk: 4

Aim and objectives of Course

To understand History & Development of Microbiology, Microscopy, staining and sterilization techniques, Ultra-structure of cell, Different methods of microbial characterization

To study nature of viruses, viral classification, cultivation of viruses and Type study of TMV & HIV

Learning outcomes of Course

Up on completion of the course students able to

1. Explain relationship and apply appropriate terminology relating to the structure, Genetics, metabolism and ecology of prokaryotic microorganisms, Algae, viruses and Fungi.
2. Students will get basics and importance of Microbiology.
3. Demonstrate appropriate laboratory skill and techniques related to isolation, staining, identification and control of microorganisms.

UNIT-I: History of Microbiology & Place of Microorganisms in the living world

History of Microbiology in the context of contributions of Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Ivanowsky, Martinus Beijerinck and Sergei Winogradsky
Importance and applications of microbiology

Place of Microorganisms in the Living World Haeckel's three Kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese

UNIT-II: Prokaryotic microorganisms

No. of hours: 12

Ultra-structure of Prokaryotic cell- Cell Wall, Cell Membrane, Cytoplasm, Nucleoid,

Plasmid, Inclusion Bodies, Flagella Pili, Capsule, Endospore

General characteristics of Bacteria (Size, shape, arrangement, reproduction)

General characteristics of Rickettsia, Mycoplasmas, Cyanobacteria, Archaea

UNIT-III: Viruses and Eukaryotic microorganisms

No. of hours: 12

General characteristics of viruses, Cultivation of Viruses (in brief)

Morphology, Structure and replication of TMV and Lambda Bacteriophage

Fungi - Habitat, nutrition, vegetative structure and modes of reproduction; outline classification

Algae - Habitat, thallus organization, photosynthetic pigments, storage forms of food, reproduction.

Protozoa – Habitat, cell structure, nutrition, locomotion, excretion, reproduction, encystment, outline classification

UNIT-IV: Isolation and Culture of Bacteria and Fungi

No. of hours: 12

Growth media- Natural, synthetic and semi synthetic media. Selective, Enrichment, and Differential media

Pure culture techniques - dilution-plating, Streak-plate, Spread-plate, Pour-Plate and micromanipulator.

Preservation of microbial cultures - sub culturing, overlaying cultures with mineral oils, lyophilization, sand cultures, storage at low temperature.

UNIT-V: Principles of Microscopy, Sterilization and Disinfection No. of hours: 12

Principles of microscopy - Bright field and Electron microscopy (SEM and TEM).

Staining Techniques - Simple and Differential staining techniques (Gram staining, Spore staining).

Sterilization and disinfection techniques –

Physical methods - autoclave, hot- air oven, pressure cooker, laminar air flow, filter sterilization, Radiation methods - UV rays, Gamma rays.

Chemical methods - alcohols, aldehydes, fumigants, phenols, halogens and hypochlorites.

The following topics in UNIT -III are for Internal Assessment only:

- a. Fungi - Habitat, nutrition, vegetative structure and modes of reproduction; outline classification
- b. Algae - Habitat, thallus organization, photosynthetic pigments, storage forms of food, reproduction

MBP- I: Introduction To Microbiology And Microbial Diversity

TOTAL HOURS: 30 CREDITS: 1

1. Microbiology Good Laboratory Practices and Biosafety.
2. Preparation of culture media for cultivation of bacteria- Nutrient broth & Nutrient agar
3. Preparation of culture media for cultivation of fungi – Sabourauds agar
4. Sterilization of medium using Autoclave
5. Sterilization of glassware using Hot Air Oven
6. Light compound microscope and its handling
7. Microscopic observation of bacteria (Gram +ve bacilli and cocci, Gram -ve bacilli), Algae and Fungi.
8. Simple staining
9. Gram's staining
10. Hanging-drop method & temporary wet mount (TWM) for observation of living microorganisms.
11. Isolation of pure cultures of bacteria by serial dilution and Streak/Spread/Pour Plate Method.
12. Preservation of bacterial cultures by Serial subculturing & Slant Preparation with mineral oil overlay.
13. Observation of electron micrographs of bacterial cells

Recommended Text Books & Reference books:

- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. 5th Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
- Dube, R.C. and Maheswari, D.K. (2000) General Microbiology. S Chand, New Delhi. Edition), Himalaya Publishing House, Mumbai.
- Power, C.B. and Dagainawala, H.F. (1986). General Microbiology Vol I & II
- Prescott, M.J., Harley, J.P. and Klein, D.A. (2012). Microbiology. 5th Edition, WCB McGrawHill, New York.
- Reddy, S.M. and Reddy, S.R. (1998). Microbiology □ Practical Manual, 3 rd Edition, Sri Padmavathi Publications, Hyderabad.
- Singh, R.P. (2007). General Microbiology. Kalyani Publishers, New Delhi.
- Stanier, R.Y., Adelberg, E.A. and Ingram, J.L. (1991). General Microbiology, 5th Ed., Prentice Hall of India Pvt. Ltd., New Delhi.
- Microbiology Edited by Prescott
- Jaya Babu (2006). Practical Manual on Microbial Metabolisms and General Microbiology. Kalyani Publishers, New Delhi.
- Gopal Reddy *et al.*, Laboratory Experiments in Microbiology

BSc	MICROBIOLOGY (Semester: II)	Credits: 4
MBT: II	Microbial Physiology And Biochemistry	Hrs/Wk: 4

Aim and objectives of Course

To understand different biomolecules, analytical techniques, bacterial nutrition, growth and metabolism

Learning outcomes of Course

Up on completion of this course students should able to:

1. Explain working principle and applications of Colorimetry, Chromatography, Spectrophotometry, Centrifugation and Gel Electrophoresis.
2. Knowledge on Microbial nutrition, bacterial growth, metabolism and Respiration.
3. The student will get first-hand experience on separation methods

UNIT-I: Biomolecules

No. of hours: 12

General characters and outline classification of Carbohydrates (Monosaccharides-Glucose, Fructose, Ribose, Disaccharides- Sucrose, Lactose, Polysaccharides- Starch, glycogen, Cellulose)

General characters and outline classification of fatty acids (Saturated & Unsaturated Fatty Acids) Lipids (Simple & complex lipids)

UNIT-II: Enzymes

No. of hours: 12

Properties and classification of Enzymes.

Biocatalysis- induced fit and lock and key models.

Coenzymes and Cofactors.

Inhibition of enzyme activity- competitive, non-competitive, uncompetitive and allosteric.

Factors effecting enzyme activity

UNIT – III: Analytical Techniques

No. of hours: 12

Principle and applications of -

Colorimetry

Chromatography (paper, thin-layer, and column),

Spectrophotometry (UV & visible),

Centrifugation and

Gel Electrophoresis (Agarose and SDS).

UNIT – IV: Microbial Nutrition and growth

No. of hours: 12

Nutritional requirements of Microorganisms

Nutritional groups of microorganisms- autotrophs, heterotrophs, lithotrophs, organotrophs, phototrophs, chemotrophs

Microbial Growth- different phases of growth in batch cultures; Synchronous, continuous, biphasic growth.

Factors influencing microbial growth

Methods for measuring microbial growth - Direct microscopy, viable count estimates, turbidometry and biomass.

UNIT- V : Microbial metabolism

No. of hours: 12

Aerobic respiration - Glycolysis, TCA cycle, ED Pathway, Electron transport

Oxidative and substrate level phosphorylation.
Anaerobic respiration (Nitrate and sulphate respiration)
Fermentation- lactic acid and ethanol fermentations
Outlines of oxygenic and anoxygenic photosynthesis in bacteria

MBP – II: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

TOTAL HOURS: 30

CREDITS: 1

1. Qualitative Analysis of Carbohydrates.
2. Qualitative Analysis of Aminoacids.
3. Colorimetric estimation of proteins by Biuret / Lowry method.
4. Separation of components of a given mixture using a laboratory scale centrifuge.
5. Separation of mixtures by paper / thin layer chromatography.
6. Demonstration of column packing in any form of column chromatography.
7. Effect of temperature/pH / Salt concentration on bacterial growth
8. Demonstration of electrophoretic technique
9. Study and plot the growth curve of E. coli by turbidimetric and Standard Plate Count methods

Recommended Text Books & Reference books:

Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications, Iowa, USA.

Lehninger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.

Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.

Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman

Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

White, D. (1995). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York.

BSc	MICROBIOLOGY (Semester: III)	Credits: 4
MBT: III	Molecular Biology And Microbial Genetics	Hrs/Wk: 4

Aim and objectives of Course

To understand different biomolecules, analytical techniques, bacterial nutrition, growth and metabolism

Learning outcomes of Course

Up on completion of this course students should able to:

1. Understand the nature of genetic material, process of DNA replication and the role of DNA and RNA.
2. Understand gene structure, genetic code and the process of transcription, translation and regulation of gene expression in bacteria.
3. Define and classify mutations, understand their molecular basis.
4. Familiarize with genetic recombination in bacteria, and Genetic engineering technology

UNIT- I: Nucleic acids

No. of hours: 12

DNA and RNA - Role in heredity-The central dogma

Watson and Crick model of DNA

Types of RNA, structure, and functions

Organization of DNA in prokaryotes

UNIT- II : Genetic material and replication

No. of hours: 12

Experiments which established DNA as genetic material

RNA as genetic material

Mechanism of DNA Replication in Prokaryotes

Proof of semi conservative mechanism of replication (Meselson - Stahl Experiment)

UNIT- III: Gene expression and regulation

No. of hours: 12

Concept of gene - Muton, recon and cistron.

Genetic code

Protein synthesis - Transcription and translation in Prokaryotes

Regulation of gene expression in bacteria - *lac* operon

UNIT- IV: Mutations, damage and repair

No. of hours: 12

Outlines of DNA damage and repair mechanism

Mutations - spontaneous and induced

Chromosomal aberrations - deletions, inversions, tandem duplications, insertions

Point mutations- base pair changes, frame shifts

Mutagens - Physical and Chemical mutagens

Bacterial recombination - Transformation, Conjugation, Transduction (Generalized and specialized transductions)

UNIT- V: Genetic engineering

No. of hours: 12

Basic principles of genetic engineering.

Restriction endonucleases, DNA ligases.

Vectors – plasmids (pBR322), Cosmids, Phagemids, lambda phage vector, M 13 vectors.

Outlines of gene cloning methods.

Polymerase chain reaction. Genomic and cDNA libraries.

General account on application of genetic engineering in industry, agriculture, and medicine.

MBP – III: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

TOTAL HOURS: 30

CREDITS: 1

1. Study of different types of DNA and RNA using micrographs and model / schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of DNA using UV spectrophotometer.
5. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS - PAGE).
7. Problems related to DNA and RNA characteristics, Transcription and Translation.
8. Induction of mutations in bacteria by UV light.
9. Instrumentation in molecular biology - Ultra centrifuge, Transilluminator, PCR

Recommended Text Books & Reference books:

- Freifelder, D. (1990). Microbial Genetics. Narosa Publishing House, New Delhi.
- Freifelder, D. (1997). Essentials of Molecular Biology. Narosa Publishing House, New Delhi.
- Glick, B.P. and Pasternack, J. (1998). Molecular Biotechnology, ASM Press, Washington D.C., USA.
- Lewin, B. (2000). Genes VIII. Oxford University Press, England.
- Maloy, S.R., Cronan, J.E. and Freifelder, D. (1994). Microbial Genetics, Jones and Bartlett Publishers, London.
- Ram Reddy, S., Venkateshwarlu, K. and Krishna Reddy, V. (2007) A text Book of Molecular Biotechnology. Himalaya Publishers, Hyderabad.
- Sinnot E.W., L.C. Dunn and T. Dobzhansky. (1958). Principles of Genetics. 5 th Edition. McGraw Hill, New York.
- Smith, J.E. (1996). Biotechnology, Cambridge University Press.
- Snyder, L. and Champness, W. (1997). Molecular Genetics of Bacteria. ASM press,
- Strickberger, M.W. (1967). Genetics. Oxford & IBH, New Delhi.
- Verma, P.S. and Agarwal, V.K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Co. Ltd., New Delhi.

BSc	MICROBIOLOGY (Semester: IV)	Credits: 4
MBT: IV	Immunology And Medical Microbiology	Hrs/Wk: 4

Aim and objectives of Course

To study types of immunity, immune organs, cells, antibodies and antigen-antibody interactions.

To learn diagnostic and pathogenesis of various diseases. Antimicrobial defense and different toxins and vaccines.

Learning outcomes of Course

Up on completion of the course students able to

1. Explain Non-specific body defence and the immune response
2. Develop knowledge on disease transmission and control
3. Demonstrate on collection and handling of laboratory specimens
4. Develop an information making personal health decision in regard to infectious diseases.
5. Student can safeguard himself & society and can work diagnostics and hospitals.

UNIT-I: Immune System

No. of hours: 12

Concept of Innate and Adaptive immunity

Primary and secondary organs of immune system - thymus, bursa fabricus, bone marrow, spleen, lymph nodes.

Cells of immune system- Identification and function of B and T lymphocytes, null cells, monocytes, macrophages, neutrophils, basophils and eosinophils

Complement system (in brief)

UNIT-II : Immune response

No. of hours: 12

Characteristics of antigen (Foreignness, Molecular size, Heterogeneity and solubility) Haptens.

Antibodies - basic structure and types and functions (Immune complex formation and elimination - Agglutination, Precipitation, Neutralization, Complement fixation, Phagocytosis)

Generation of Humoral Immune Response (Plasma and Memory cells)

Generation of Cell Mediated Immune Response

MHC- Functions of MHC I & II molecules

Hypersensitivity- definition and types (in brief)

Autoimmunity (in brief)

UNIT- III: Microbes in Health and Disease

No. of hours: 12

Normal flora of human body.

Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity,

Opportunistic infections, Nosocomial infections.

General account on microbial diseases – causal organism, pathogenesis, epidemiology, diagnosis, prevention, and control of the following

Bacterial diseases - Tuberculosis, Typhoid.
Fungal diseases - Candidiasis.
Protozoal diseases - Malaria.
Viral Diseases – Corona virus and AIDS

UNIT- IV: Principles of Diagnosis

No. of hours: 12

General principles of diagnostic microbiology- Collection, transport of clinical samples
Identification by Culturing & Biochemical characteristics (IMViC)
Identification by molecular assays (PCR, RT-PCR, DNA probes)
Identification by serological tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation)

UNIT- V: Prevention and Treatment

No. of hours: 12

Vaccines
Monoclonal antibodies- Production and application
Antimicrobial agents- General modes of action of antibacterial (Penicillin), antifungal (Amphotericin), antiviral (Amantadine) agents
Interferons
Tests for antimicrobial susceptibility (Disc diffusion)
Antibiotic resistance in bacteria

RECOMMENDED TEXT BOOKS:

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. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
4. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

REFERENCE BOOKS:

1. Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
2. Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Microbiology. 4th edition. Elsevier Publication.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

MBP -V: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

TOTAL HOURS: 30

CREDITS: 1

1. Identification of human blood groups.
2. Separate serum from the blood sample (demonstration).
3. Immunodiffusion by Ouchterlony method.
4. Identification of any of the bacteria (*E. coli*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, urease production and catalase tests
5. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar
6. Antibacterial sensitivity by Kirby-Bauer method
6. Determination of Minimal Inhibitory Concentration (MIC) of an antibiotic
7. Study symptoms of the diseases with the help of photographs: Anthrax, Polio, Herpes, chicken pox, HPV warts, Dermatomycoses (ring worms)
8. Study of various stages of malarial parasite in RBCs using permanent mounts.
9. Phenol coefficient test
10. Isolation of Normal flora of human body (Hands, Feet, Nostrils, Teeth Surface) by swab method.
11. Evaluation of Hand Sanitizer Effectiveness by Filter Paper Disc Method & thumb impression method.

Recommended Text Books &Reference books:

- Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
- 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.
- Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Microbiology. 4th edition. Elsevier Publication.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

BSc	MICROBIOLOGY (Semester: IV)	Credits: 4
MBT: V	Microbial Ecology And Industrial Microbiology	Hrs/Wk: 4

Aim and objectives of Course

1. To study role of microorganisms in nutrient cycling, microorganism in waste treatment and degradation of xenobiotics
2. To determine the potability of drinking water
3. To study concepts of screening and strain improvement, media, Fermentation, assays with examples of industrially important processes

Learning outcomes of Course

Up on completion of the course students able to

1. Understand fundamental concept in soil microbial diversity, basic concept of biogeochemical cycles and plant growth promotion and plant diseases
2. Understands the role of microorganisms in treatment of solid and liquid waste.
3. Acquire knowledge on application of microorganisms in agro – environmental fields.
4. Get basic information design of fermenter, fermentation processes and Single cell proteins.
5. Self-reliance in the industrial application of Microbiology in life and industry.
6. Entrepreneurship can be established with the gained knowledge.

UNIT - I: Microbial Ecology

No. of hours: 12

Role of microorganisms in Biogeochemical cycles (Carbon, nitrogen, phosphorus)

Microbe-microbe interactions - Synergism, mutualism, commensalism, antagonism, competition, parasitism, predation

Plant- Microbe interactions - Plant growth promoting Microorganisms, Plant pathogens

UNIT - II : Microorganisms in Environment

No. of hours: 12

Microbes in waste management- solid and liquid waste (aerobic and anaerobic)

Microbes in degradation of Xenobiotics

Microbes in drinking water- detection of potability by (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique

Microbes in food - intrinsic and extrinsic parameters that affect microbial growth in food

UNIT - III: Industrial Microbiology

No. of hours: 12

Industrial important Microorganisms- Yeasts & Moulds , Bacteria , Actinomycetes .

Screening techniques.

Strain improvement techniques.

UNIT -IV: Fermentation processes

No. of hours: 12

Design of fermenter (for control of pH, temperature, dissolved oxygen, foaming and aeration)

Types of fermentation processes - solid state, liquid state, batch, fed-batch, continuous.

Fermentation media (Carbon source, nitrogen source, minerals, vitamins & growth factors, Buffers, Precursors, Antifoam agents, water, oxygen)

Examples of Crude media; molasses, corn- steep liquor, sulphite waste liquor, whey.

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.

UNIT - V: Microbial Productions

No. of hours: 12

Microbial production of Industrial products: Citric acid, Ethanol, Penicillin, Glutamic acid, vitamin B12, Amylase, Yogurt

Microbial cells as food- SCP

- a. **Additional Input:** Determination of quality of different water samples by MPN method and Mushroom cultivation

MBP - V: MICROBIAL ECOLOGY AND INDUSTRIAL MICROBIOLOGY

Total hours: 30

Credits: 1

1. Microbial fermentation for the production and estimation of ethanol
2. Isolation of amylase producing microorganisms from soil
3. Isolation of food spoilage microorganisms from spoiled food sample.
4. MPN test
5. Demonstration of fermenter
6. Production of wine from grapes
7. Growth curve and kinetics of any two industrially important microorganisms.
8. Microbial fermentation for the production and estimation of citric acid
9. Preparation of yoghurt.
10. Crowded plate technique
11. Isolation of microorganism from soil
12. Isolation of microorganism from different water samples

Recommended Text Books & Reference books:

- Atlas RM and Bartha R. (2000). **Microbial Ecology: Fundamentals & Applications**. 4th edition. Benjamin/Cummings Science Publishing, USA
- Barton LL & Northup DE (2011). **Microbial Ecology**. 1st edition, Wiley Blackwell, USA
- Campbell RE. (1983). **Microbial Ecology**. Blackwell Scientific Publication, Oxford, England.
- Coyne MS. (2001). **Soil Microbiology: An Exploratory Approach**. Delmar Thomson Learning.
- Lynch JM & Hobbie JE. (1988). **Microorganisms in Action: Concepts & Application in Microbial Ecology**. Blackwell Scientific Publication, U.K.
- Madigan MT, Martinko JM and Parker J. (2014). **Brock Biology of Microorganisms**. 14th edition. Pearson/ Benjamin Cummings
- Maier RM, Pepper IL and Gerba CP. (2009). **Environmental Microbiology**. 2nd edition, Academic Press
- Martin A. (1977). **An Introduction to Soil Microbiology**. 2nd edition. John Wiley & Sons Inc. New York & London. Adams MR and Moss MO. (1995). **Food Microbiology**. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
- Banwart JM. (1987). **Basic Food Microbiology**. 1st edition. CBS Publishers and Distributors, Delhi, India.
- Casida LE. (1991). **Industrial Microbiology**. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). **Biotechnology: A textbook of Industrial Microbiology**. 2nd Edition. Panima Publishing Company, New Delhi
- Frazier WC and Westhoff DC. (1992). **Food Microbiology**. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

A.S.D Govt. Degree College for Women (A), Kakinada

III BSc Microbiology Syllabus (w.e.f:2020-2021A.B)

BSc	Semester: V (Skill Enhancement Course- Elective)	Credits: 2
MB T A1 A- PAIR	Food, Agriculture And Environmental Microbiology	Total hours 40

Aim and objectives of Course

To provide knowledge on important microbes in food, Agriculture and Environmental Microbiology

Learning outcomes of Course

Up on completion of the course students able to

1. **CO1:** Demonstrate with the wide diversity of microbes and their spoilage food, food intoxication and food born infections
2. **CO2:** Able to understand principles of food preservation, fermented foods and microbes as food.
3. **CO3:** The student will acquire knowledge on application of microorganisms in agro – environmental fields
4. **CO4:** Get fundamental concepts in principles of plant disease control an industrial application of Microbiology
5. **CO5:** The student will have fundamental concepts in soil microbiology and soil water and aero microbial diversity and microbial interactions Basic concepts in treatment of drinking water.
6. **CO6:** Understands the role of microorganisms in treatment of solid and liquid waste.

UNIT – 1

No. of Hours: 8

Intrinsic and extrinsic parameters that affect microbial growth in food

Microbial spoilage of food - fruits, vegetables, milk, meat, egg, bread and canned foods

Food intoxication (botulism).

Food-borne diseases (salmonellosis) and their detection.

UNIT – II

No. of Hours: 8

Principles of food preservation - Physical and chemical methods.

Fermented Dairy foods – cheese and yogurt.

Microorganisms as food – SCP, edible mushrooms (white button, oyster and paddy straw).

Probiotics and their benefits.

UNIT – III

No. of Hours: 8

Soil Microbiology: Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur.

Biological nitrogen fixation.

Microflora of Rhizosphere and Philosopher microflora, microbes in composting.

Importance of mycorrhizal inoculums, types of mycorrhizae associated plants, mass inoculums. Production of VAM, field applications of Ectomycorrhizae.

UNIT - IV

No. of Hours: 8

Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases.

Plant – Microbe interactions.

Diseases caused by bacteria and fungi to various commercial crops: groundnut rust & Citrus canker and food crops: **Rice Blast** (*Pyriculariaoryzae*) Bacterial blight of rice(*Oryza sativa* and *O. glaberrima*)

UNIT – V

No. of Hours: 12

Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes. Extremophiles.

Concept of single cell proteins, probiotics and their applications. Biodegradation, Biogas production, Biodegradable plastics.

MBP – FOOD, AGRICULTURE AND ENVIRONMENTAL MICROBIOLOGY

Total hours: 40

Credits: 2

1. Isolation of bacteria and fungi spoiled bread / fruits / vegetables
2. Preparation of yogurt / dahi
3. Determination of microbiological quality of milk sample by MBRT
4. Enumeration of bacteria, fungi and actinomycetes from soil
5. Enumeration and identification of rhizosphere micro flora
6. Isolation of rhizobium from root nodules.
7. Isolation of azatobacter from soil.
8. Observation description of any three bacterial and fungal plant diseases
9. Staining and observation of VAM.
10. Analysis of soil - pH, Moisture content and water holding capacity.
11. Study of air flora by petriplate exposure method.
12. Analysis of potable water: SPC, Presumptive, confirmed and completed test, determination of coli form count in water by MPN.
13. Determination of Biological Oxygen Demand (BOD) of waste water samples.

SUGGESTED READINGS:

- Atlas RM and Bartha R. (2000). *Microbial Ecology: Fundamentals & Applications*. 4th edition, Benjamin/Cummings Science Publishing, USA
- Barton LL & Northup DE (2011). *Microbial Ecology*. 1st edition, Wiley Blackwell, USA
- Campbell RE. (1983). *Microbial Ecology*. Blackwell Scientific Publication, Oxford, England.
- Coyne MS. (2001). *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning.
- Lynch JM & Hobbie JE. (1988). *Microorganisms in Action: Concepts & Application in Microbial Ecology*. Blackwell Scientific Publication, U.K.
- Madigan MT, Martinko JM and Parker J. (2014). *Brock Biology of Microorganisms*. 14th edition. Pearson/ Benjamin Cummings.
- Maier RM, Pepper IL and Gerba CP. (2009). *Environmental Microbiology*. 2nd edition, Academic Press.
- Martin A. (1977). *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London.
- Okafor, N (2011). *Environmental Microbiology of Aquatic & Waste systems*. 1st edition, Springer, New York.
- Singh A, Kuhad, RC & Ward OP (2009). *Advances in Applied Bioremediation*. Volume 17, Springer-Verlag, Berlin Hedeilberg
- Stolp H. (1988). *Microbial Ecology: Organisms Habitats Activities*. Cambridge University Press, Cambridge, England.
- Subba Rao NS. (1999). *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013). *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education.

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III B.Sc Microbiology Syllabus

BSc	Semester: V (Skill Enhancement Course- Elective)	Credits: 4
MB T A2 A- PAIR: A2	Management Of Human Microbial Diseases And Diagnosis	Total hours 36

Aim and objectives of Course

To realize the principles of prevention and treatment of microbial diseases and to understand the concepts and development of microbial diseases in animals

Learning outcomes of Course

Up on completion of the course students able to

CO1: Develop knowledge and skills on microbiological laboratory skills for identification of pathogens

CO2: Students will demonstrate the collection of clinical samples

CO3: Students will get knowledge on staining techniques

CO4: Students able to perform diagnostic techniques

CO5: To understand drug resistance

UNIT – I

No.of Hours: 8

Definition and concept of health, disease, infection, and pathogen.

Bacterial Diseases: Cholera, Pneumonia, and Dysentery.

Viral Diseases: Poliomyelitis & Chicken pox

Fungal diseases: Dermatomycosis and Athletes foot.

UNIT- II

No. of hours: 8

Collection of clinical samples (oral cavity, throat, skin, blood, CSF, urine and faeces) and precautions required.

Method of transport of clinical samples to laboratory and storage.

UNIT- III

No. of hours: 8

Mechanism of bacterial pathogenicity, colonization and growth, virulence, virulence factors, exotoxins, enterotoxins, endotoxins and neurotoxins.

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis,

Giemsa-stained thin blood film for malaria.

Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, Mac Conkey agar. Distinct colony properties of various bacterial pathogens.

UNIT- IV

No. of hours: 6

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes.

Diagnosis of Typhoid, Dengue and HIV, Swine flu.

UNIT- V

No. of hours: 6

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method,

Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double

dilution method. Problems of drug resistance and drug sensitivity.

Drug resistance in bacteria.

MB P A2: MANAGEMENT OF HUMAN MICROBIAL DISEASES AND DIAGNOSIS

TOTAL HOURS: 40

CREDITS: 2

1. Collection transport and processing of clinical specimens (Blood, Urine, Stool and Sputum).

Receipts, Labelling, recording and dispatching clinical specimens.

2. Physical, Chemical & microscopic examination of clinical samples – urine, stool, puss, sputum.

3. Isolation and identification of following pathogens from clinical samples: *E.coli*, *Salmonella* and *Pseudomonas*.

4. Demonstration of permanent slides of the following parasites:

a) *Entamoeba histolytica*

b) *Ascaris* spp.

c) *Plasmodium* spp.

d) *Mycobacterium tuberculosis* & *Mycobacterium leprae*

5. Estimation of haemoglobin (Acid haematin and cyan methanoglobin method).

6. ESR and PCV determination.

7. Immuno hematology: Blood group typing by slide test & tube for ABO & Rh systems.

8. Isolation of bacteria in pure culture and Antibiotic sensitivity.

SUGGESTED READING

- Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
- 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.
- Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and McCartney Practical Medical Microbiology, 14th edition, Elsevier.
- Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd.
- Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.

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BSc Microbiology Syllabus

BSc	Semester: V (Skill Enhancement Course- Elective)	Credits: 3
MB T B1 B- PAIR: B1	Microbial Biotechnology and r – DNA Technology	Total hours 36

Aim and objectives of Course

To study applications of microbial biotechnology and r DNA technology.

Learning outcomes of Course

Up on completion of the course students able to

CO1: Students should be able to demonstrate with the wide diversity of microbes and their potential use in medicine, agriculture and industry biotechnology regulation and ethics.

CO2: Students will get knowledge on restriction endonuclease in r DNA technology and selection of transformed cells

CO3: Students will get knowledge on cloning vehicles in r DNA technology

CO4: Student will able to understand gene sequencing methods

CO5: Students will get knowledge on of genetically modified crops. And role of microorganisms in creation of transgenic animals and plants.

UNIT – I

No. of hours: 8

Introduction to microbial biotechnology, Bacterial genes, genomes and genetics. Recombinant microbial biotechnology products, biotechnology regulation and ethics. Biomass and bio fuels Microbial biomass (algal blooms, in fresh and sea water), fungal mushrooms, fermentation waters by yeasts, and bacterial biomass.

UNIT- II

No. of hours: 8

Restriction and Modification: Classification of restriction endonucleases. Enzymes used in molecular cloning; Polymerases, ligases, phosphatases, kinases and nucleases; Advanced Molecular biology techniques: Electrophoresis and Blotting techniques.

Cutting and joining DNA: (cohesive end ligation, methods of blunt end ligation).

Transfection and transformation. Selection of transformed cells. Screening methods (Genetic marker and blue white screening).

UNIT- III

No. of hours: 7

Cloning vehicles - Plasmid, Bacteriophage, Construction of genomic and cDNA libraries.

Advantages of cDNA libraries. Expression of cloned genes in bacteria, yeast, plant and animal cells.

Basic principles and application of biosensors. Nucleic acid probe technology.

UNIT- IV

No. of hours: 7

Methods of gene sequencing – Maxam - Gilberts and Sanger's dideoxy chain termination methods; Polymerase chain reaction technique (Components in PCR and PCR conditions).

Methods of gene transfer in fungi, yeast and higher plants using microinjection, microprojectile bombardment (gene gun method, Electroporation and *Agrobacterium* mediated transformation.

UNIT- V

No. of hours: 7

Concept of genetically modified microorganisms. Bt cotton : production, advantages and limitations.

Probable advantages and disadvantages of genetically modified crops.

Role of microorganisms in creation of transgenic animals and plants.

MBT- BI :MICROBIAL BIOTECHNOLOGY AND r – DNA TECHNOLOGY

TOTALHOURS: 36

CREDITS: 2

1. Culturing of mushrooms
2. Isolation of yeast from grapes.
3. Production of wine
4. Production of ethyl alcohol
5. Isolation of Plasmid DNA from E.coli
6. Tissue culture: callus cultivation
7. Fermentative production of ethyl alcohol
8. Transformation in Bacteria using plasmid.
9. Restriction digestion of DNA and its electrophoretic separation.
10. Ligation of DNA molecules and their testing using electrophoresis.
11. Activity of DNAase and RNAase on DNA and RNA.
12. Isolation of Plasmid DNA.
13. Demonstration of PCR.

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BSc Microbiology Syllabus

BSc	Semester: V (Skill Enhancement Course- Elective)	Credits: 3
MB T B2 B- PAIR: B2	BIostatISTICS AND BIOinformatics	Total hours 36

Aim and objectives of Course

To understand Biostatistics and Bioinformatics

Learning outcomes of Course

Up on completion of the course students able to

CO1: Understand biological data bases

CO2: Summarize Searching sequence data bases

CO3: students able to use appropriate tests for bio variable analysis

CO4: Able to understand analytical tests and Construction of phylogenetic trees by clustering methods

CO5: Able to understand protein modelling methods

UNIT – I

No. of hours: 7

Definition, nature and scope of bioinformatics. Bioinformatics versus computational biology. Branches of bioinformatics. Basic concepts in bioinformatics. Introduction to Biological data bases: NCBI, EMBL, EXPASY, PIR, Pfam. Concept of World Wide Web: HTML, HTTP.

UNIT – II

No. of hours: 7

Searching sequence data bases using BLAST. Multiple sequence alignment– progressive alignment–profiles–multi dimensional dynamic programming. Biostatistics: Measures of Central tendency and distribution–mean, median, mode, range, standard deviation, variance.

UNIT – III

No. of hours: 7

Basic principles of probability theory, Bayes theorem, Normal distribution, statistical inference –Types of errors and levels of significance. Comparison of variance (F-test), small sample test, t-test for comparison of means, chi square test. Analysis of variance–one way and two way, multiple comprises.

UNIT – IV

No. of hours: 7

Correlation and Linear regression. Sequence Analysis: Introduction to hidden Markov models. Genomics and proteomics: Molecular phylogenetics: Construction of Phylogenetic trees using parsimony method and branch & bound method. Clustering methods– UPGMA & neighbour-joining. Fragment assembly, peptide sequencing using mass and spectroscopy data. Comparative genomics.

UNIT – V

No. of hours: 8

Modelling: Protein secondary structure prediction–Chou Fasmanrules– Neural networks– discriminate analysis. Prediction of transmembrane segments in Membrane proteins. Protein3D structure prediction– homology– threading – Potential energy functions–energy minimization–molecular dynamics–simulated annealing.

MBP B2 - BIOSTATISTICS AND BIOINFORMATICS

TOTALHOURS: 36

CREDITS: 2

1. Isolation of plasmid DNA from *E.coli* cells
2. Quantitative and qualitative analysis of proteins / DNA by using spectrophotometer.
3. Demonstration of Southern hybridization
4. Demonstration of amplification DNA by PCR.
5. Use of software for sequence analysis of nucleotides and proteins.
6. Problem related to t – test and χ^2 test.
7. Use of Internet/software for sequence analysis of nucleotides and proteins:
8. Studies of public domain data bases for nucleic acid and protein sequences.
9. Determination of protein structure (PDB).
10. Genome sequence analysis
11. Problems related to measures of central tendency, dispersion, t-test and chi Square test.

SUGGESTED READINGS:

1. Daniel, 2006, Biostatistics, Eighth Edition. John Wiley and sons.
2. Durbin, Eddy, Krogh, Mithison, Biological sequence analysis.
3. T.A.AttwoodandD.J.parry-smith, 2001, Introduction of Bioinformatics.
4. A.D.Baxevaris,1998, Bioinformatics:Apracticalguidetotheanalysisof Genes and proteins,(Edited) B.F.Publication.
5. David W, 2005, Bio-informatics;sequenceandGenomeAnalysis,2ndEdition By Mount CB Spublishers.

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BSc Microbiology Syllabus

BSc	Semester: V (Skill Enhancement Course- Elective)	Credits: 3
MB T C1 C- PAIR: C1	Microbial Quality Control, Instrumentation And Techniques	Total hours 36

Aim and objectives of Course

To study quality control in food and pharmaceutical industries and analytical techniques

Learning outcomes of Course

Up on completion of the course students able to

CO1: Develop skills on disinfection of instruments and equipment's in laboratory and Hospitals and documentation

CO2:To understand the working principle of basic laboratory equipments

CO3:To understand the techniques like MPN and direct microscopic methods

CO4:To understand and demonstrate Principles of Microscopy, handling and uses of microscopes

CO5:To understand and demonstrate the various analytical and separation techniques

UNIT – I

No. of hours: 7

Microbial quality control definition, history and introduction. Standard Methods involved in assessment of microbial quality control. Q.A and Q.C definitions and importance. Traditional Microbiological Quality Controlling methods: Sampling methods, TVC, APC and serial dilution techniques. Microbiological criteria. Laboratory facility design for quality control: Sterilization, disinfection and decontamination. Personnel training: Hygiene and handling techniques. Documentation. Good laboratory practices.

UNIT – II

No. of hours: 8

Culture media used in QC and QA: Design of specialized media for identification of pathogens. Good laboratory practices in culture media preparation: raw material, water, pH. Uses of media.

Selective and indicator media used in pharmaceutical and food industries. Instruments associated in QC and QA: Principle involved, working conditions, uses and precautions of Laminar Air Flow (LAF), Autoclave, Incubator, pH meter, Colony counter, Hot air oven, Centrifuges and storage devices.

UNIT – III**No. of hours: 7**

Techniques for enumeration of microorganisms: sample preparation from Aqueous, soluble, insoluble, medical and pasteurized materials. Counting methods: pour plate, spread plate, membrane filtration. Most Probable Number (MPN) and MIC. Turbidometric methods. Staining techniques for identification bacteria and Fungi.

UNIT – IV**No. of hours:7**

Microscopy – Principles of light, phase, fluorescent & electron microscopes; Microscopic techniques: Basic principles and applications of phase – contrast microscopy, fluorescent microscopy and electron microscopy, types of electron microscopy– scanning and transmission. Radio isotopes: radiometric analysis, stable and radioactive isotopes, preparation, labelling, detection and measurement of isotope.

UNIT - V**No. of hours: 7**

Principles of Centrifugation – Centrifugation techniques – preparative and analytical methods, density gradient centrifugation. General principles and applications of chromatography – Paper, Column, Thin layer, Gas, Ion exchange, Affinity chromatography, HPLC, FPLC, GCMS and Gel filtration. Electrophoresis- moving boundary, zone (Paper Gel) electrophoresis. Immuno electrophoresis. Immunoblotting. Isoelectric focusing, 2-Delectrophoresis, Principles of colorimetry

MBP-C1: MICROBIAL INSTRUMENTATION AND BIOTECHNIQUES

Total hours: 36

Credits: 2

1. Isolation and enumeration of bacteria from food / pharmaceutical source.
2. Quality Assurance of water by MPN method.
3. Preparation of any two selective and indicator media commonly used Q.A & Q.C
4. Microbial quality of in and around laboratory conditions.
5. Isolation and Identification of fungi by using selective media and staining procedures.
6. Identification of MIC of any one antibiotic.
7. Colorimetric and spectroscopic estimation of nucleic acids.
8. Microscopic observations of examination of bacteria, fungi and actinomycetes.
9. Separation of cell components by centrifugation technique.
10. Demonstration of immune electrophoresis.
11. Demonstration of HPLC.

Suggested readings:

1. Hand book of Microbial Quality control by Rosamund. M, Baird Norman. A, Hodges and Stephen. P, Denyer. CRC press.
2. The Microbiological Quality of Food, 1st Edition, Editors: Antonio Bevilacqua Maria Rosaria Corbo Milena SinigagliaBook ISBN: 9780081005033 Imprint:Wood head Publishing.
3. Guide to Microbiological Control in Pharmaceuticals and Medical Devices, Second Edition, Stephen P. Denyer, Rosamund M. Baird, CRC Press.
4. WILSON & WALKER, Practical Biochemistry: Principles and techniques, Academic publishers.
5. UPADHYAY, UPADHYAY &NATH, Biophysical Chemistry: Principles and techniques, Himalaya Publishers.

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BSc Microbiology Syllabus

BSc	SEMESTER: V (SKILL ENHANCEMENT COURSE-ELECTIVE)	Credits: 3
MB T C2 C- PAIR	Drug Design, Discovery And Intellectual Property Rights (Ipr)	Total hours 36

Aim and objectives of Course

To study drug design, discovery and IPR

Learning outcomes of Course

Up on completion of the course students able to

CO1:Students should be able to understand approaches for drug design, sources of drugs and molecular mechanism of drugs

CO2:Students should be able to understand drug development process

CO3:Get knowledge on vaccines, gene therapy and gene based vaccines

CO4:Students will get knowledge on outlines of intellectual property rights, ISI and Bio standards

CO5:Students will understand concepts Bio safety and ethics

Unit – I

No. of Hours: 7

Introduction- History of drug design, Current approaches and philosophies in drug design, Molecular mechanisms of diseases and drug action with examples. Pharmaceutical products of microbial origin (antibiotics) animal origin (sex hormones), plant origin (Alkaloids & Morphine).Sources of Drugs- Microbial drugs, Plants as a source of drugs, *E. coli* as a source of recombinant therapeutic proteins.

Unit – II

No. of Hours: 7

Expression of recombinant proteins in yeasts, animal cell culture systems. Rational drug design and Combinatorial approaches to drug discovery. Drug development process- Impact of genomics and related technologies upon drug discovery: Gene chips, Proteomics, Structural genomics and Pharmacogenetics. Drug manufacturing process- Guides to good manufacturing practice.

Unit – III

No. of Hours: 7

Vaccines and adjuvant- Traditional vaccine preparations, Attenuated and inactivated viral and bacterial vaccines, Toxoids.Peptide vaccines.Adjuvant technology. Nucleic acid as drugs- Gene therapy: Basic approach to gene therapy, Vectors used in gene therapy - Manufacture of viral vectors, Non-viral vectors. Gene therapy and genetic disease, cancer, Gene therapy and AIDS. Gene based vaccines.

Unit – IV**No. of Hours: 8**

Introduction: general introduction to IPR (parent, plant breeder's right). Trademarks, industrial design, trade secrets (or) undisclosed information integrated circuit designs.

Patenting principle, international – standards and patent validity (neem and relaxins), recent developments in patent system and patentability of biotechnology, invention IPR issues of the Indian context. Copy right and rights related to copy right, International standards as per WHO, ISI, bio safety and validation.

Unit – V**No. of Hours: 7**

Biotechnology and hunger: challenges for the Indian biotechnological research and industries. Bio safety: the Cartagena protocol on bio safety.

Bio safety management: key to the environmentally responsible use of biotechnology, ethical implications of biotechnology product techniques, social and ethical implications of biological weapons

MBP – C2: DRUG DESIGN, DISCOVERY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

TOTAL HOURS: 40

CREDITS: 3

1. Isolation of antibiotic producing bacteria from soil samples
2. Isolation of drug resistant plasmid from bacteria (E.coli).
3. Isolation of Actinomycetes from soil.
4. Identification of antibacterial activity of actinomycetes.
5. Identification of antibacterial activity of fungi
6. Identification of antagonistic activity of any two fungal species.
7. Assay of any one antibiotic (Penicillin).
8. Determination of MIC of any one antibiotic (penicillin / streptomycin).
9. Study of components and design of a BSL – III laboratory
10. Filing applications for approval from bio safety committee
11. Filing primary applications for patents
12. Study of steps of patenting process
13. A case study of patent.
14. Study of bio safety measures in pharmaceutical industry.
15. Study on QA & QC parameters followed in R&D laboratory.

SUGGESTED READINGS:

1. W.B.Hugo & A.D.Russell, Pharmaceutical Microbiology edited, 6th Edition, Black Well science.
2. Shanson D.C., Microbiology in clinical practice, 2nd edition, London; Wright.
3. T.Sammes Ellis Horwood, opicin Antibiotic chemistry Vol I to V.
4. Wulf Crueger, Biotechnology – A text book of Industrial Microbiology, 2nd Edition, Panima publishers
5. A.H.Patel, 1984, Industrial Microbiology, Macmilan India Limited.
6. Coulson C.J., London; Taylor and Francis, Molecular mechanisms of drug action.
7. Denyes S.P. & Baird R.M. Chichester, Ellis Horwood, Guide to microbiological Control in Pharmaceuticals.
8. Murray S. Cooper, Quality control in the Pharmaceutical Industry - Edt., Vol-II, Academic press, New York.
9. Sydney H. Willin, Murray M. Tuckerman, William S. Hitchings IV, Good Manufacturing practices of pharmaceuticals, second Edt., Merck Dekker NC New York.
10. Rajesh Bhatia, Rattan Lal Iyengar, Quality assurance in Microbiology, CBS Publisher & Distributors, New Delhi.