SCHEME OF EXAMINATION
AND
COURSE OF STUDY AS PER NEW EDUCATION POLICY (NEP 2022)

IN

MICROBIOLOGY

B.Sc. I, II, III YEAR
(w.e.f. Session 2022-23 onward)

DEPARMENT OF MICORBIOLOGY
SRIDEV SUMAN UTTRAKHAND UNIVERSITY
TEHRI GARHWAL
AUGUST, 2022

COURSE STRUCTURE

NOTE: Questions of theory paper are to be set under two sections i.e., A and B. In section A, the student has to answer any six out of ten **short answer questions** (150 words) uniformly distributed from the entire syllabus. In Section B, the student has to answer any 3 questions out of Six **long answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section B. Section A and B will be of 30, and 45 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper

Subject prerequisite

To study MICROBIOLOGY at undergraduate, a student must have Biology in Class 12.

Programme Objectives (POs)

1. The programme has been designed in such a way so that the students get exposed to strong theoretical and practical background on various domains of Microbiology.
2. The programme includes details of important microorganisms of agricultural, medical and industrial importance, biomolecules, tools and techniques, enzymes, immunology, cell biology, molecular biology genetic engineering to make the study of microbiology for sustainable development of human society.
3. The practical courses have been designed to equip the students with the laboratory skills in microbiology. Students will able to design and conduct experiments, as well as to analyze and interpret scientific data
4. The programme will provide students with the knowledge and skill base that would enable them to undertake further studies in microbiology and related areas or in multidisciplinary areas that involve microbiology, biochemistry, industrial, Pharmaceutical, Dairy, biotechnology and molecular biology and help develop a range of generic skills that are relevant in enhancing entrepreneurship skills among students.
5. The students will be exposed to a wide range of careers that combine microbiology, environment, industry and medical.

Certificate Course in Microbial Techniques
B. Sc. I Programme Specific Outcomes (PSOs)

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PSO1 Students will be able to acquire, articulate, retain, and apply specialized skills and knowledge relevant to microbiology.
PSO2 Students will be able to appreciate the diversity of microorganisms and microbial communities inhabiting a multitude of habitats, understand their pathogenic as well beneficial significance to man and nature.
PSO3 Students will acquire and demonstrate proficiency in good laboratory practices in a microbiological laboratory and be able to explain the theoretical basis and practical skills of the tools/technologies commonly used to study this field.
PSO4 Students will gain fundamental knowledge about the various scopes on agricultural and environmental microbiology and their concepts.
PSO5 The certificate course will enable students to apply for technical positions in government and private labs/institutes.

Diploma in Microbial Technology
B.Sc. II Programme based outcomes
PSO 1 Students will develop familiarity and understanding of the microbiology concepts as relevant to various areas such as biochemistry, microbial physiology, molecular biology and genetics.
PSO 2 Students will exhibit reasonable abilities in the utilization of instruments, advances and techniques common to microbiology, and apply the logical strategy and theory testing in the plan and execution of examinations.
PSO3 Students will be adequately capable to utilize microbiology information and abilities to analyze problems involving microorganisms, articulate these with peers and undertake remedial measures.
PSO4 Students will be able to describe how microorganisms obtain energy, metabolism, reproduction, survival, and interactions with their environment, hosts, and host populations.
PSO5 Students will be able to work in a variety of fields, including biological and medical science in higher education institutions, public health, environmental organizations, and the food, dairy, pharmaceutical, and biotechnology industries.

Degree in Bachelor of Science
B.Sc III Programme Specific Outcomes (PSOs)
PSO1 Students of B.Sc. Microbiology Programme will learn to use scientific logic as they investigate a broad variety of contemporary subjects covering different areas of basic microbiology such as Bacteriology, Virology, Biochemistry, Microbial Physiology, Immunology, Cell Biology, Molecular Biology, Genetics, Immunology, and Microbial Genetics, as well as becoming aware of the importance of environmental microbiology.
PSO2 Students will learn about various biotechnological applications of microorganisms as well as industrially relevant substances developed by microorganisms. They'll learn about the special role microbes play in genetic modification technologies.
PSO3 Students will learn and develop good laboratory practices in a microbiological laboratory, as well as be able to explain the theoretical foundations and practical skills of the tools and technologies widely used in this area. Students can gain proficiency in the quantitative skills needed to analyze biological problems.
PSO4 Students will learn about experimental methods, hypothesis creation and testing, and experiment design and execution. Students can develop their critical thinking skills as well as their ability to read and interpret scientific literature. Via successful presentation of experimental findings as well as workshops, students can acquire good oral and written communication skills.
PSO5 The Degree courses will enable students to go for higher studies in Microbiology and Allied subjects leading to Post Graduation and Ph.D. degrees.

Year/ Programme	Semester	Paper Code	Paper title	Credits	Theory /Practical	Total Number of Classes (in hours)
1st/ Certificate in Microbial Technique	I	BM-C101	DSC-1: General Microbiology	4	Theory	60
		BM-PC102	DSC-P1: Experiments in General Microbiology	2	Practical	60
	II	BM-	DSC-2: Environmental and Agriculture	4	Theory	60

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		C201	Microbiology			
		BM-P C202	DSC-P2: Experiments in Environmental and Agriculture Microbiology	2	Practical	60
2nd/ Microbial Technology	III	BM-C301	C-3: Microbial Physiology and Metabolism	4	Theory	60
		BM-P C302	C-3 Experiments in Microbial Physiology and Metabolism	2	Practical	60
	IV	BM-C401	C-4Molecular biology and Microbial Genetics	4	Theory	60
		BM-P C402	C-4: P Experiments in Molecular biology and Microbial Genetics	2	Practical	60

Year/ Programme	**Semester**	**Paper Code**	**Paper title**	**Credits**	**Theory /Practical**	**Total Number of Classes (in hours)**
3rd/ Degree in Bachelor of Science in Microbiology	V	BM-D501	D-5: Medical Microbiology and Immunology	4	Theory	60
		BM-S 502	D S-6: Pharmaceutical Microbiology	4	Theory	60
		BM-503	D P-7 Experiments in Medical Microbiology and Immunology and Pharmaceutical Microbiology	2	Practical	60
	VI	BM- D601	D -6: Industrial Microbiology	4	Theory	60
		BM-S602	DS -4: Food and Dairy Microbiology	4	Theory	60
		BM-D 603	D P-6 Experiments in : Industrial Microbiology and Food and Dairy Microbiology	2	Practical	60

Detail Syllabus of
B.Sc. I Year
or
Certificate in Microbial Technique

B.Sc. I Year **Semester – I**

BM -C101
BMDSC-1 GENERAL MICROBIOLOGY

MM : 100
Time : 3 hrs
L Credit
4 4
Total Hours: 60

Sessional : 25
ESE : 75
Pass Marks : 40

Learning objectives:

- To understand the Microorganism in which there is description of different information related to microorganisms and also they will know how earth evolved and also know the landmarks discoveries of microbiology

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- To acquire knowledge of different technique to stain microorganism and how they can visualize the microorganisms in different types of microscope.
- To acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes.
- To become familiar with general characteristic of prokaryotic and Eukaryotic microbes and also acquire Knowledge of cellular organization, life cycle and economic importance of prokaryotic

Learning outcomes:

At the end of course student will be able

- To know the different milestones in the history of microbiology, importance of Vedic microbiology and scope of microbiology
- To understand and know the application of techniques used in the field of Microbiology.
- Identify key constituent prokaryotes cell and their function.
- To classify the prokaryotic cell by conventional as well as modern methods.
- To stain the bacteria with simple, differential and special stain.

UNIT–I

History, scope, spontaneous generation vs biogenesis, golden age of microbiology branches of microbiology and relevance of microbiology; germ theory of disease Contribution of Antony Van Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Ivanowsky, Waksman,. 5 kingdom classification of Whittaker and 3 kingdom classification , 3 Domain System Classification .

(8 Lectures)

UNIT-II

Bacterial morphology Ultrastructure of bacterial cell, cell wall, plasma membrane, capsule, flagella, nucleoid,. General features of Archeobacteria, Rickettsia, Chlamydia, Mollicutes, Actinomycetes and Cynobacteria.

The viruses General properties nomenclature, Classification and Morphology structure of animal viruses: Influenza, HIV; plant viruses: TMV; bacterial viruses: Lambda Phage and T4 bacteriophage; general features of Prions and Viroids. Fungi General characteristics, classification & reproduction of Saccharomyces, Aspergllus. Protozoa General characteristics, classification & reproduction of Giardia, Entamoeba. **(14lecture)**

UNIT III

Techniques in microbiology Principles of microscopy, construction and application ofCompound Microscope Bright field Microscopy, Dark field Microscopy , Electron Microscopy- TEM and SEM, Principles, and application of Autoclave; BOD Incubator & Incubator, ; Laminar flow; Oven & Spectrophotometer (UV&Vis) **(14 Lectures)**

UNIT-IV

Sterilization techniques and control of microorganisms Definitions of terms- sterilization and disinfection; Sterilization by Physical methods- Use of moist heat- heat under pressure(autoclave), pasteurization, Use of dry heat- hot air oven, Filtration- membrane filter, HEPA filter; Radiation- Ionizing and non- ionizing; Chemical methods- (Alcohols, aldehydes, phenols, ethylene oxide). Culture media and its types; Methods for enumeration & isolation of microorganisms using pour plate, spread plate technique, Serial dilution and streak plate; Isolation of anaerobic microorganisms; Maintenance and preservation of pure culture. Staining techniques, principles, procedures and applications of Simple staining, negative staining; Differential staining- Gram's staining, acid fast staining, Leishman's staining, Giemsa's staining, Structural staining capsule, endospore and flagella staining. **(14 Lectures)**

UNIT-V

Biostatistics Introduction to biostatistics – definition statistical methods, biological measurement, kinds of biological data; Measure of central tendency – Mean, median, mode, standard deviation; Collection of data, sampling and sampling design, classification and tabulation, types of representation, graphic bio diagrams. Student T Test **(10 Lectures)**

BMDSC102P Experiments in Basic Microbiology Credit 2

1. Good laboratory practice in Microbiology and safety measures.

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2. Cleaning and sterilization of glassware and equipments
3. Study of aseptic technique- preparation of cotton plug, wrapping of glassware, transfer of media and Inoculum
4. Principles and applications of microbiology laboratory instruments (Autoclave, Laminar Air Flow, Incubator, Hot Air Oven, and Light Microscope).
5. Perform simple and Gram staining of bacteria.
6. Perform Endospore staining of bacteria.
7. Perform Capsule staining by negative staining technique of bacteria.
8. Perform Flagella staining of bacteria.
9. Perform Negative staining of bacteria.
10. Isolation of microorganisms from soil by pour plate method.
11. Isolation of microorganisms from air , water , and soil
12. Effect of radiation.
13. Cultivation of bacteriophages.
14. To prepare the Nutrient Agar Medium.
15. To prepare the Potato Dextrose Agar Medium. **(Lecture-60)**

Suggested Reading

1. Dubey, R.C. 2021. *Vedic microbiology- A Scientific Approach* (English Version), Motilal Banarasidas International, Delhi– 110007.
2. Dubey, R.C. 2020. *Vedic microbiology- Ek Vaijnanik Drishti*(Hindi Version), Aastha Prakashan, Delhi-110053
3. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology.* 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
4. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology.* 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
5. Dubey, R.C. *Advanced Biotechnology.* S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
6. Cappachino. Microbiology- A laboratory Manual, Pearson Education India ISBN: 978-9332535190
7. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892
8. . Suggestive digital platforms web links-
   • https:/www.classcentral.com/tag/microbiology
   • https://cmp.berkeey.edu/bacteria/bacteria.html
   •https://www.livescience.com/53272-what-is-a-virus.html
   https://www.slideshare.net/sardar1109/algae-notes-1
   •https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy
   https://onlinecourses.swayam2.ac.in/cec19_bt11/preview
   •https://microbenotes.com/laminar-flow-hood
   • https://physics.fe.uni-lj.si/students/predavanja/MicroscopyKulkarni.pdf
   Lab Virtual links-
   https://www.classcentral.com/course/basic-concepts-in-microbiology-and-clinical-pharm-32196
   https://www.labster.com/microbiology-virtual-labs/
   •https://www.futurelearn.com/courses/basic-concepts-in-microbiology-and-clinicalpharmacology-of-antimicrobials

B.Sc. I Year **Semester – II**

BM -C201

BM DSC-2 Environmental and Agriculture Microbiology

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

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Total Hours: 60

Learning objectives:

- To understand how microorganism adapt to different environment and their interaction with different habitat and also the spread of microorganism from the environment.
- To know different techniques of detection of air , soil and aquatic
- To acquire knowledge of treating sewage and industrial water through different means.
- Students will learn about positive or negative interaction of microorganisms with soil.
- To impart in-depth information on soil and agriculture.
- To know the importance of biofertilizers and biopesticides.
- To make the students to know about various techniques involved in biofertilizers and biopesticides production

Learning outcomes:

At the end of course student will be able to

- Isolate and identify pathogenic microorganism from air, soil and water habitat
- Characterize the waste water and also explain the method that can be utilized in waste water treatment
- Explain or suggest different biocontrol methodto control pests.
- Develop biofertilizer or biopesticide in lab conditions .
- Isolate *Rhizobium* from the root nodule of leguminous plants.

UNIT - I

Microorganisms in different habitats: brief account of heterogeneous group of microorganisms, different habitats such as soil, water, air; factors affecting microbial population in nature. Water microbiology: type of water, parameters of aquatic environment (temperature, light, pressure, pH, turbidity and organic constituents); Microflora of aquatic environmental, Treatment and safety of drinking water; Methods to detect potability of water sample: Standard qualitative procedure- SPC, MPN test, Presumptive, confirmed and completed test for faecal-coliforms, Membrane filter technique, **(12 Lectures)**

UNIT – II

Microbiology of domestic and waste water: sewage/waste water (physical, chemical and microbiological analysis), BOD and COD; Waste water treatment, Solid waste management: solid waste processing (landfills, composting and anaerobic sludge digestion), Effect of solid waste on public health; Regulation for disposal of bio hazardous materials, **(14 Lectures)**

UNIT - III

Principle of Bioremediation, decomposition and degradation of common organic Matter inorganic matter, biosurfactants. **(10 Lectures)**

UNIT – IV

Microbial Interactions Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: positive-negative interaction; Microbe-Animal interaction: positive-negative interaction; Microorganism of rhizosphere, rhizoplane and phylloplane, mycorrhiza types and its applications **(12 Lectures)**

UNIT -V

Biofertilizer Definition, Types- Bacterial, Fungal, Phosphate solubilizer, BGA & associative; Mode of application; Advantages and Disadvantages of Biofertilizer. Introduction and definition and Types of biopesticides; **(12 Lectures)**

BMDSC102P Experiments in Environmental and Agriculture Microbiology Credit 2

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1. Determination of biological oxygen demand (BOD) of water.
2. Determination of chemical oxygen demand (COD) of water.
3. Water analysis for total bacterial population by standard plate count.
4. Bacterial examination of water by multiple-tube fermentation test or multiple tube tests.
5. Isolation of microorganisms (Bacteria & Fungi) from soil sample at different temperature (28o C & 45o C)
6. Isolation of bacteria and fungi from rhizosphere and rhizoplane.
7. Isolation of bacteria & fungi from air environment by exposure plate method.
8. Isolation of Rhizobium sp. from leguminous root nodule.
9. Bacteriological examination of water by MPN test, presumptive coliform, confirmed coliform and completed coliform test.
10. Isolation and identification of fungi by using Rose Bengal agar Media from Soil and Air,
11. Isolation of root modulating bacteria from leguminous plant.
12. isolation of bacteria inhibiting phytopathogenic fungi

60 **Lectures)**

Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publisher, ISBN: 9781578080700
2. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. P.D. Sharma, Microbiology, Rastogi Publication ISBN:978-8171339358.
4. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
5. Suggestive digital platforms web links-
   - https://www.classcentral.com/tag/microbiology
   - https://www.mooc-list.com/tags/biotechnology
   - https://asm.org/articles/2020/december/virtual-resources-to-teach-microbiology-techniques
   - https://www.futuredirections.org.au/publication/living-soils-role-microorganisms-soil-health
6. Virtual Lab Links-
   - https://vlab.amrita.edu/?sub=3&brch=73
   - https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering
   - https://opentextbc.ca/virtualscienceresources/chapter/environmental-science/

Detail Syllabus of
B.Sc. II Year
or
Diploma in Microbial Technology

B.Sc. II Year **Semester – III**

BM -C301

BM C-3 MICROBIAL PHYSIOLOGY AND METABOLISM

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To understand different phases of bacterial growth and its kinetics
- To understand how microbes do catabolism to get energy to build structure.

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- To understand different metabolic pathways and enzymes involved by which energy will be generated
- To acquire knowledge of classifying enzymes and how they functions.
- To understand how the nitrogen is fixed by symbiotic and non-symbiotic nitrogen fixation and genes involved in nitrogen fixation

Learning outcomes:

At the end of course student will be able to

- Calculate generation time and number of generation.
- Explain principles and mechanism of aerobic and anaerobic respiration in microorganisms.
- Explain the concept nitrogen metabolism, assimilation of nitrates, ammonia assimilation. and fixation of nitrogen
- explain the bacterial photosynthesis and also the differentiation between oxygenic and anoxygenic photosynthesis bacteria
- Classify enzymes and demonstrate the mechanism of enzymes and their functions.

UNIT I

Bacterial Growth- Curve Synchronous growth; growth-generation time, microbial growth kinetics in batch cultures; growth measurement: by cell mass, cell count and cell turbidity; factor affecting the growth of microorganism. **(10 lecture)**

Unit II Enzymes: characteristics, nomenclature, classification and application of enzymes; Factors influencing enzymatic activity;Mechanism of enzyme action; Allosteric enzymes. Enzymes kinetics : Michaelis Menton equation for simple enzymes . **(12 lecture)**

Unit III General concepts of respiration and fermentation: aerobic and anaerobic respiration, Autotrophy, Heterotrophy, chemolithotrophy, fermentation; alcoholic fermentation, lactic acid fermentation . **(12 lecture)**

Unit IV Microbial metabolism: General strategy of metabolism, anabolism, catabolism, ATP, Phosphorylation, Oxidative phosphorylation and substrate level phosphorylation, primary metabolic pathway, secondary metabolic pathway, metabolism of carbohydrates glycolysis,PPP, ED, TCA cycle and electron transport chain **(18 lecture)**

Unit V Nitrogen Fixation Nitrogen fixation in symbiotic and free-living microorganisms, root nodule formation, leghaemoglobin, nitrogenase enzyme; Physiology of nitrogen cycle Photosynthetic bacteria and their classification.(Lecture 08)

BM 301 P Experiments in Microbial Physiology and Metabolism **Credit-2**

1. Determination of growth curve of bacteria.
2. Bacterial population count by turbidimetry method
3. Amylase production, H2S production, Urease production test, IMViC test
4. Cellulase production test.
5. Demonstration of carbohydrate fermentation, indole production, catalase test,
6. oxidase test.Demonstration of enzyme activity in given mocroorganism.
7. Detection of number of bacteria in milk by standard plate count technique.
8. Determination of quality of milk sample by MBRT (methylene blue reductase test).
9. Laboratory preparation of sauerkraut.
10. Effect of ultraviolet radiation on bacterial growth.
11. Effect of dyes on bacterial growth.
12. Separation of leaf pigments through paper chromatography on bacterial growth. **(Lecture- 60)**

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Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
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3. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
4. A.H.Patel, Industrial Microbiology, Laxmi Publication, **ISBN-10:** 9385750267
5. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10: 8123910010
6. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
7. **Suggestive digital platforms web links-**
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   •http://www.mooc.list.com/course/microbiology.sayloro https://lipidnanostructuresgroup.weely.com
   •http://www.mooc.list.com/microbial
   • https://open.umn.edu/opentextbooks/textbooks/biochemistry-free-for-all-ahern

B.Sc. II Year **Semester – IV**

BM –C 401
BM C-4 MOLECULAR BIOLOGY AND MICROBIAL GENETICS

MM : 100 Sessional : 25
Time : 3 hrs ESE : 75
L Credit Pass Marks : 40
4 4
Total Hours: 60

Learning objectives:

- To know the Genetic constituents of bacteria with special emphasis on inheritance and mutations
- To know the mechanism of genetic transfers in microbes
- To know the different techniques used to study the microbial genetics and utilizing the microbial phenomenon in different biotechnological applications.

Learning outcomes:

At the end of course student will be able to

- Explain why DNA is the genetic material of bacteria.
- Explain the application of genetic engineering techniques in basic and applied experimental biology.
- Use Plasmids as cloning vector and its applications.

UNIT - I

Experimental evidence of Nucleic acid , DNA structure, Salient features of double helix, Types of DNA, RNA Types and Structure; Replication of DNA, Mechanism of DNA replication and Enzymes and proteins involved in DNA replication **(15 Lectures)**

UNIT - II

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription. Translation-Genetic code, Translational machinery, charging of tRNA, aminoacyl tRNAsynthetases,

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Mechanisms of initiation, elongation and termination of polypeptides. **(15 Lectures)**

UNIT - III

Regulation of gene Expression Principles of transcriptional regulation, Operon-operator theory with examples from *lac* and *trp*operons; Mutations-: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations, **(12 Lectures)**

UNIT - IV

Mechanisms of Genetic Exchange: Transformation - Discovery, mechanism of natural competence Conjugation – Discovery and mechanisms, Hfr and F' strains; Transduction- Generalized transduction, specialized transduction. Plasmids and Transposable Elements: Property and functions of plasmids, Types of plasmids. **(09Lectures)**

UNIT – V

Mutations, mutagenesis and repair Types of mutations, Physical and chemical mutagens. Loss and gain of function mutants. Reversion and suppression, Uses of mutations. Ames Test, DNA repair mechanism **(09 Lectures)**

BM 402 P C 3 Experiments in MOLECULAR BIOLOGY AND MICROBIAL GENETICS

1. Isolation of genomic DNA from E. coli and analysis by agarose gel electrophoresis.
2. Estimation of DNA using diphenylamine reagents.
3. Resolution of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) and visualization using coomassie dye.
4. Replica plating method: Preparation of master and replica plates. Isolation of Histidine auxotrophs
5. Isolation of plasmid DNA from E. coli. Study the different conformations of plasmid DNA through agarose gel electrophoresis
6. Study of the effect of chemical (nitrous acid) and physical (UV) mutagens on bacterial cells.
7. Demonstration of Ames test
8. Isolation of Bacteriophage

(Lecture 60)

Suggested Reading

1. David Friefelder, Microbial Genetics, Narosa Publishing House.
2. Gardner, Principle of Genetics, Wiley
3. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
4. Lehninger, Nelson and Cox. Principles of Biochemistry, WH Freeman; 7th ed, ISBN:978-1319108243
5. **Suggestive digital platforms web links-**
   - https://www.classcentral.com/tag/microbiology
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   - http://www.mooc.list.com/course/microbiology.sayloro
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   - http://www.mooc.list.com/microbial
   - https://open.umn.edu/opentextbooks/textbooks/biochemistry-free-for-all-ahern

   Digital links:
   - https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/amestest

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Detail Syllabus of
B.Sc. III Year
Microbiology

B.Sc. III Year **Semester – V**

BM –D501
BM D-9 MEDICAL MICROBIOLOGY AND IMMUNOLOGY

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- Students will understand the disease caused by the bacteria, fungi, virus and protozoa.
- To know the diagnosis and treatment of bacteria, fungi and viral pathogens.

Learning outcomes:

At the end of course students will be able to

- Understand the development and contribution of different scientist in the field of medical microbiology.
- Describe etiology, pathogenicity, epidemiology and laboratory diagnosis of disease caused by microorganism.
- To isolate and detect the pathogens from the clinical samples.
- Suggest different antimicrobial agent for the treatment of bacterial infections.

UNIT–I

Historical background of medical microbiology, Classification of medically important microorganisms, Normal microflora of the human body and its importance, normal microflora of skin, throat, gastrointestinal tract, and respiratory tract; Disease cycle, transmission of pathogen and its routes. Infection and its type. Host parasite relationship, pathogenicity and virulence in relation with bacteria, Virus fungi **(10 Lectures)**

UNIT -II

Bacterial diseases: symptoms, mode of transmission, prophylaxis, treatment and control of: Respiratory Diseases: *Streptococcus pyogenes*, *Mycobacterium tuberculosis;* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Staphylococcus aureus* **Viral diseases:** Symptoms, mode of transmission, prophylaxis and control of Polio, Herpes, Hepatitis-B, Rabies, Dengue and AIDS **(12 Lectures)**

UNIT –III

Fungal diseases: transmission, symptoms and prevention of cutaneous mycoses: Tineapedis (Athlete's foot); Systemic mycoses: Histoplasmosis; opportunistic mycoses: candidiasis.

Prevention of Microbial Diseases: General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents, antibiotic substances, Major antimicrobial agents, Mode of action of chemotherapeutic and antibiotic substances. Mechanism of antibiotic resistance. **(12 Lectures)**

UNIT–IV

Immunology- Historical background: Humoral and Cellular components of the immune system Concept of Innate and Adaptive immunity; **Antigens and antibodies;** Characteristics of an antigen Haptens; Epitopes Adjuvants; T-cell and B-cell, Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies, Monoclonal and Chimeric antibodies, **(14 Lectures)**

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UNIT–V

Antigen- Antibody reactions(Precipitation, Agglutination, RIA and ELISA, Vaccines: Importance, types of vaccines, Major Histocompatibility Complex; Structure and Functions of MHC I & II molecules; Antigen processing and presentation, Complement System-Components of the Complement system, Biological consequences of complement Activation. **(14 Lectures)**

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Mackie and McCartney. Practical Medical Microbiology, Elsevier
3. CKJ Paniker. Test Book of Microbiology, Orient Longman
4. D.R.Arora. Medical Mycology, CBS Publisher and Distributors
5. Janis Kubey, Immunology, W.H.Freeman
6. Peter J Delves, S.J. Martins, D.R. Burtons, Roitts Essential Immunology, Wiley Blackwell
7. C.V.Rao , An Introduction to Immunology, Alpha Science International Ltd , **ISBN** 978-1842650356
8. **Digital Links**

- https://www.mcgill.ca/microimm/undergraduate-programs/courses
- https://oline.creighton.edu/program/medical-microbiology-and-immunology-ms
- http://www.vlab.co.in
- http://www.vlab.iitb.ac.in
- http://www.onlinelabs.in
- http://www.vlab.amrita.edu
- http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

https://www.futurelearn.com/courses/basic-concepts-in-microbiology-and-clinical-pharmacology-ofantimicrobials
https://vlab.amrita.edu/?sub=3&rch=73
https://www.mooc-list.co/tags/pathology
https://online.creighton.ed/program/medical-microbioogy-and-immunology-ms

B.Sc. III Year **Semester – V**

BM -S502
BM C-3 PHARMACEUTICAL MICROBIOLOGY

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- Students will learn about the basics of pharmaceutical microbiology and important microorganism playing role in pharmaceutics.
- To understand different products of microbial origin playing key role in pharmaceutical applications.
- To understand role of secondary metabolites in pharmaceutical industry.
- To understand good practices and regulation involved in utilizing microbial product for pharmaceutical applications

Learning outcomes:

At the end of course students will be able to

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- Describe how antibiotic work and resistance develop in microorganisms.
- Suggest good practices and regulation involved in utilizing microbial product for pharmaceutical applications.
- Design microbiology laboratory and explain the safety measures used in microbiology laboratory.
- Determine antibiotic sensitivity, MIC, MBC and other quality parameter of microbiology laboratory.

UNIT - I

Pharmaceutical industries types Sterile and non sterile, Pharmaceutical premises: selection of area for a pharmaceutical premise, different components of a premise, Govt. norms for a premise. Inspectional Guidance **of microbiology lab** Good manufacturing practices (GMP) and its organization, good laboratory practice (GLP), cGMP; Operation of quality control (QC) and quality assurance (QA) of company. **(10 Lectures)**

UNIT - II

Introduction Principal , Calibration, Validation and Function of different instrument in Microbiology Lab, sterilization of glassware, preparation, validatin and sterilization of media, Discarding Methods, Documents Preparation SOP, COA , Specification, log book. **(12 Lectures)**

UNIT - III

Sterile area and its maintenance, environmental monitoring, types of environmental monitoring, methods of sterilization in pharma, disinfectants and antiseptics, evaluation of disinfectants Fumigation process and its schedule .Water used in pharma, properties, types, specification, microbial limits , Techniques of water testing used in pharmaceutical company . **(16 Lectures)**

UNIT - IV

Microbial limit test (MLT), pyrogen tests, pathogens test for confirmation Bacterial Endotoxin Testing, Antibiotic assay , vitamin B12 Assay , preservative efficacy test. Sterility testing, Antimicrobial Effectiveness Testing, Microbial Examination of sterile and Non-Sterile Products. (16 Lectures)

UNIT - V

Safety and working in microbial laboratory: Biosafety cabinets ; Occurrence of laboratory infections, Microbiology Laboratory Biosafety Guidelines, section in microbiology lab , Disposal of contaminated waste

(10 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. SS Purohit and AK Saluja. Pharmaceutical Microbiology, Agrobios (India), ISBN-13-9788177541939
3. CKJ Paniker. Test Book of Microbiology, Orient Longman
4. Indian Pharmacopeia , USP, BP

1. **Digital Links**
   - https://www.mcgill.ca/microimm/undergraduate-programs/courses
   - https://oline.creighton.edu/program/medical-microbiology-and-immunology-ms
   - http://www.vlab.co.in
   - http://www.vlab.iitb.ac.in
   - http://www.onlinelabs.in
   - http://www.vlab.amrita.edu
   - http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

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1. Blood group determination by slide agglutination method.
2. Preparation of chocolate agar, and other media required for medically important microorganisms
3. Isolation and characterization of skin normal microflora
4. Isolation of bacteria from teeth crevices
5. Demonstration of α and β haemolysis on blood agar medium.
6. Demonstration of serological tests: blood groups, Rh factor determination, pregnancy test, Widal, VDRL, ELISA
7. Demonstration of pathogenic fungi in mycoses lesion
8. Antibiotic sensitivity test and MIC determination
9. Demonstration of antibiotic resistance transfer from resistant to sensitive microorganism
10. Demonstration of bacterial plasmid isolation.
11. Vitamin B12 Assay .
12. Microbial Limit test of Products
13. Determination of nitrate production in nitrite broth soil cultures.
14. Isolation of antibiotic resistant bacteria by gradient plate technique.
15. Water Testing,
16. Determination of preservative efficacy test
17. Fumigation
18. Predict the microorganism on the basis of reaction on TSI slant
19. Perform citrate utilisation test.
20. Determination of titre by slide agglutination method.

B.Sc. III Year **Semester – VI**

BIM –C601
BM D INDUSTRIAL MICROBIOLOGY

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To understand the scope and applications of industrial microbiology.
- To understand fermentation technologies used for the production of industrially important products.
- To understand how different fermentation product are produced, purified and recovered.

Learning outcomes:

At the end of course student will be able to

- Screen and isolate industrially important microorganisms.
- Make use of fermentor to produce alcoholic beverages and other fermentation products.
- Explain the different method of disinfection used in industry and also how to maintain quality of product.

UNIT – I

Isolation of industrially important microbial strains, strain improvement, preservation and maintenance of industrial microbes, scale-up. Metabolite: Primary and secondary screening, strain development strategies, principal of exploitation of microorganism and their products, **(14 Lectures)**

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UNIT – II

Fermentation: Media, Raw material, Antifoaming agents, Buffers. Equipments, Fermenter design. Types of fermentation – Single, Batch, Continuous. Down-stream processing steps: Detection and assay of the product, Recovery and Purification **(10 Lectures)**

UNIT – III

Industrial production of antibiotics : Fermentation and recovery process of penicillin, streptomycin, β – lactam and rifamcyin and tetracycline. **(10 Lectures)**

UNIT - IV

Industrial production of Enzymes and Amino acids: Microbial production and applications of amylases, lipase, protease; pectinase, and cellulases Amino acids: production of L-glutamic acid and L-lysine. **(14 Lectures)**

UNIT - V

Microbial production of Vitamin B-12; Vitamin B2 (riboflavin), Vitamin C; Organic acids: Lactic acid and citric acid (fermentation and recovery). **(08 Lectures)**

Suggested Reading

1. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
2. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
3. A.H.Patel, Industrial Microbiology, Laxmi Publication, ISBN-10: 9385750267
4. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10: 8123910010

Suggestive digital platforms web links

- http://foodhaccp.com/foodsafetymicro/onlineindex.html
- http://www.cpe.rutgers.ed/courses/current/If0401wa.html

B.Sc. III Year **Semester – VI**

BM –S 602
BM D FOOD AND DAIRY MICROBIOLOGY

MM : 100
Time : 3 hrs
L Credit
4 4
Total Hours: 60

Sessional : 25
ESE : 75
Pass Marks : 40

Learning objectives:

- To know the different types of fermented foods available in markets.
- To know about the vegetable and grain based fermented products.

Learning outcomes:

At the end of course student will be able to

- Prepare the fermented foods from milk, grain and vegetables.
- Prevent and control the bacterial infection through various techniques.

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UNIT-I

Microorganisms important in food microbiology- Molds,Yeasts and Bacteria- general characteristics, classification and importance. Principles, physical methods of food preservation: temperature (low, high, canning and drying), irradiation, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. Fermented Foods: Definition, types, advantages and health benefits of fermented foods. **(10 Lectures)**

UNIT- II

Microflora of raw milk ; Sources of contamination of milk; Nutritional and therapeutic benefits of fermented milk products; Dahi/Yogurt, Buttermilk (Chhach), Shrikhand and Cheese: Preparation of inoculum and production process. Probiotic foods; Spoilage of fermented dairy products; Quality control in dairy industry.

(16 Lectures)

UNIT-III

Food fermentations; bread, vinegar, fermented vegetables; prevention and spoilage of cereals, vegetables, fruits, meat and meat products fish and sea products. Industrial enzymes and their uses in food industry – amylases, proteases, cellulases; Oriental foods – Mycoprotein, Tempeh, soya sauce; Traditional foods

(16 Lectures)

UNIT–IV

Microbial cells as food single cell proteins, Mushroom cultivation, Probiotic Foods: History, definition, types, microorganisms and health benefits in supply of vitamins, Immunomodulation, control of pathogenic bacteria

(08 Lectures)

UNIT–V

Food borne infections and intoxifications; Bacterial diseases with examples of infective and toxic types – Brucella, Bacillus clostridium, Escherichia, Pseudomonas , Salmonella, Shigella, Staphylococcus, Vibrio, fungi Aflatoxins - structures and functions; Food borne out breaks – laboratory testing procedures; Preventive measures – Sanitation in manufacture; Food control agencies and its regulations, HACCP, ISO standards and FSSAI .

(10 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
3. Doyle et al., Food Microbiology: Fundamentals and Frontier, American Society of Microbiology
4. William C Frazier, Food Microbiology, MacGraw Hills Education.
5. Adam and Moss, Food Microbiology, Royal Society of Chemistry
6. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.

BM 603 P C Experiments in Industrial and Food and Dairy Microbiology. **Credit 2**

1. Isolation of antibiotic producing microorganisms from soil.

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2. Laboratory production of alcohol from Grape Juice/Sugarcane Juice.
3. Demonstration of vinegar production in laboratory.
4. Bioassay of vitamin B_{12}.
5. Fat hydrolysis (lipase activity) by a given bacterial culture.
6. Demonstration of fermentation by yeast.
7. Isolation of *Azotobacter* from garden soil.
8. Isolation of VAM (Vascular ArbuscularMycorrihizal spore from soil.
9. Isolation of phosphate solubilising microorganisms from soil.
10. Antibiotic sensitivity of UTI causing bacteria.
11. Slide agglutination reaction of unknown bacterial culture.
12. Demonstration of antigen-antibody reaction.
13. Study of Bioreactor & its essential parts
14. Necessity & procedure of writing SOPs for instruments used in large scale production
15. Isolation and characterization of microorganism used in Dairy industry
16. Isolation and characterization of Yeast used in Bakery/distillery/winery
17. Bacteriological analysis of food products
17. Preservation methods

Suggested Reading

1. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

Vocational/Skill Enhancement Courses in Microbiology for First 4 Semester

BM –VC E 101
VC E-101 TOOLS AND TECHNIQUES

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To get the knowledge of sophisticated and common instruments used in the microbiology laboratory
- To know aseptic techniques to keep the instrument and media sterile.

Learning outcomes:

At the end of course students will be able to

- Maintain the sterility of glassware, utensils and medium by different physical and chemical procedure.
- Operate the different sophisticated instruments available in the laboratory.

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UNIT–I

Industrial microbiology- Definition and scope, history of industrial microbiology, industrial microbiology in present scenario, development of industrial microbiology in India. **(06 Lectures)**

UNIT-II

Basic knowledge of different instruments and their applications in microbiology such as microscope , micrometry, hot air oven, autoclave, laminar air flow and BOD incubator.

(10 Lectures)

UNIT–III

Isolation of industrially important microorganisms, Primary screening (crowded plate technique, auxanography technique, enrichment culture technique, differential culture technique), Importance of screening.

(14 Lectures)

UNIT–IV

Aseptic technique: contamination, sterilization (heating, steam sterilization, tyndallization, dry heat, chemicals, radiation sterilization, filter sterilization), sterilization of air. **(14 Lectures)**

UNIT–V

Chromatography techniques: paper chromatography, thin layer chromatography, adsorption column chromatography, gas liquid chromatography, gel permeation, ion exchange and affinity chromatography, gel electrophoresis.

(16 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Prescott's Microbiology, 10th Edition, McGraw Hill Publication
3. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
4. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.

BM –VC 201
VC - 2 BIOFERTILIZERS

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To understand the beneficial plant-microbes interaction and their role as biofertilizer.
- To understand Symbiotic and non-symbiotic nitrogen fixation.

Learning outcomes:

At the end of course students will be able to

- Explain the role of microorganism in nitrogen fixation, phosphate solubilisation and other beneficial roles.
- Cultivate cyanobacteria in laboratory by different methods

UNIT–I

Biofertilizers; General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic Nitrogen fixers: *Rhizobium* - Isolation, characteristics, types, Inoculum production and Mass cultivation; Field applications; Carrier materials.

(16 Lectures)

UNIT-II

Non - symbiotic Nitrogen Fixers; Free living *Azospirillum*, *Azotobacter*- isolation, characteristics, mass inoculum, production and field application.

(08 Lectures)

UNIT–III

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Phosphate Solubilizers; Phosphate solubilizing microbes - isolation, characterization, mass inoculum production, field applications. **(08 Lectures)**

UNIT–IV

Mycorrhizal Biofertilizers: Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Inoculum production and Mass production of VAM; field applications of Ectomycorrhizae and VAM.

(16 Lectures)

UNIT –V

Cyanobacteria: *Nostoc/ Anabena*; cultivation methods (tray and pit methods); applications in field. *Azolla*:isolation, characterization, mass multiplication, role in rice cultivation, crop response, field Application

(12 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. N.S. SubbhaRao, Soil Microbiology, Science Publishers.
3. M.K.Rai, Handbook of Microbial Fertilizers, Internation Book Distributing Co.
4. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
5. Rangaswami,G. Agriculture Microbiolgy, Prentice Hall Indian Learning Ltd
6. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

BM –VC 301
VC- 301 FOOD BORNE DISEASES AND FOOD PRESERVATION

MM : 100
Time : 3 hrs
L Credit
4 4
Total Hours: 60

Sessional : 25
ESE : 75
Pass Marks : 40

Learning objectives:

- To understand the prevalence of bacteria in food commodities.
- To understand the occurrence of food-borne diseases.
- To know the different test for the detection of food-borne infection.

Learning outcomes:

At the end of course student will be able to

- Explain the role of microorganism in food commodities.
- Explain the factor responsible for the growth of bacteria.
- Perform the different microbiological test to determine the quality of food.

UNIT – I

Food spoilage: Microbes in food, factors affecting microbial growth in foods: Extrinsic and intrinsic, microbial spoilage of foods, microbial spoilage of food – milk and milk products, fruits and vegetables, meat products, canned foods.

(15 Lectures)

UNIT – II

Food preservation methods: Aseptic handling, temperature treatment, dehydration, lyophilization, osmotic pressure, radiations canning, chemical preservatives (salt and sugars, organic acids, propylene oxide, wood smoke and antibiotics), mechanism of chemical preservatives.

(09 Lectures)

UNIT - III

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Food-borne diseases (Bacteria and Virus): Food poisoning (food intoxication and food infections);Bacterial food poisoning (*Clostridium, Bacillus cereus* and *Staphylococcus);* Viral infections:Rotavirus, Hepatitis A & C

(12 Lectures)

UNIT – IV

Food-borne diseases (Fungus and protozoans): Fungal food poisoning (*Aspergillus* and *Penicillium*), health hazards of mycotoxins; Protozonal infections; *Entamoebahistolytica, Teniasolium, Fasciola hepatica* **(12 Lectures)**

UNIT - V

Methods for microbiological examination of food and quality control: Indicator organisms for assuring the suitability of food products, methods of microbiological examination, direct culture technique, enumeration methods (plate count and MPN), alternative methods (dye reduction tests), electrical methods, quality criteria, sampling schemes.

(12 Lectures)

Suggested Reading

1. Doyle et al., Food Microbiology: Fundamentals and Frontier, American Society of Microbiology
2. William C Frazier, Food Microbiology, MacGraw Hills Education.
3. Adam and Moss, Food Microbiology, Royal Society of Chemistry
4. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
5. Mackie and McCartney. Practical Medical Microbiology, Elsevier
6. CKJ Paniker. Test Book of Microbiology, Orient Longman

BM –E401

VC 401 - MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To understand how microorganisms adapt to different environments and their interaction with different habitat and also the spread of microorganism from the environment.
- To know different techniques of detection of microorganism from air,soil, and aquatic environment.
- To acquire knowledge of treating polluted water.

Learning outcomes:

At the end of course student will be able to

- Perform and demonstrate different methods used to determine the quality of water and air.
- Purify the household water through physical, chemical and biological method.

UNIT - I

Aeromicrobiology: Bioaerosols, Air borne microorganisms (bacteria, viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens. **(16 Lectures)**

UNIT - II

Air Sample Collection and Analysis: Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics. **(14 Lectures)**

UNIT - III

Control Measures: Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration. **(08 Lectures)**

UNIT - IV

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Microbiological Analysis of Water: Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

(16 Lectures)

UNIT - V

Control Measures: Precipitation, chemical disinfection, filtration, high temperature, UV light. **(06 Lectures)**

+Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publisher, ISBN: 9781578080700
2. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. P.D. Sharma, Microbiology, Rastogi Publication ISBN:978-8171339358.
4. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3

Subject expert committee:

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Ms. Apoorva Saini (Member)

(M.Sc Microbiology, Shree Sanatan Dharm Prakash Chand Kanya Mahavidhyhlya Roorkee, Haridwar)

Dr. Pooja Arora (Member)

(HOD Zoology and Microbiology; K.L. DAV P.G College Roorkee)

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