Sri Dev Suman Uttarakhand University, Badshahithaul, Tehri (Garhwal), Uttarakhand-249199

NATIONAL EDUCATION POLICY-2020

Syllabus for

Sri Dev Suman Uttarakhand University Campusand

All Affiliated Colleges

STRUCTURE OF UG MICROBIOLOGY HONORS SYLLABUS

NATIONAL EDUCATION POLICY-2020

B.Sc. Microbiology (Honors)

(2022-23)

DEPARTMENT OF

MICROBIOLOGY

FACULTY OF SCIENCE

SRI DEV SUMAN UTTARAKHAND VISHWAVIDYALAYA, BADSHAHITHAUL, TEHRI GARHWAL

S. No.	Name	Designation	Signature
01	Prof. G. K. Dhingra	Dean Science & HOD Microbiology	
02	Dr Prabhat Kumar Singh	Subject Expert	
03	Prof. Pushpa Negi	PG Principal	
04	Prof. Pankaj Pant	PG Principal	
05	Prof. Kuldeep Singh Negi	PG Principal	11.7.2023
06	Prof. Anita Rawat	Director USERC	11.07.23
07	Dr Neelam Negi	Member Expert	11/07/23
08	Shalini Kotiyal	Member	11/07/23

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

IN

MICROBIOLOGY

Bachelor of Science Honors

(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)
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.

BSc 4th Year Honour in Microbiology

PSO1. Students of the B.Sc. (Honours) Microbiology programme will learn to use scientific logic as they explore a wide range of contemporary subjects spanning various aspects of basic microbiology such as Bacteriology, Virology, Biochemistry, Microbial Physiology, Immunology, Cell Biology, Molecular Biology, Genetics, Systems Biology, Immunology and Molecular biology, in addition to becoming aware of the applied aspects of microbiology such as Industrial Microbiology, Food and Dairy Microbiology, Environmental Microbiology and Medical Microbiology to name just a few.

PSO2- Students will appreciate the biological diversity of microbial forms and be able to describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations. They will become aware of the important role microorganisms play in maintenance of a clean and healthy environment. They will learn of the role of microorganisms in plant, animal and human health and disease

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 develop proficiency in the quantitative skills necessary to analyze biological problems (e.g., arithmetic, algebra, and statistical methods as applied to biology)

PSO5- Graduates of the B.Sc. (Honours) Microbiology programme will be informed citizens who can understand and evaluate the impact of new research discoveries in the life sciences, and will be able to pursue a wide range of careers, including biological and medical research in higher education institutions as well as careers in public and global health, scientific writing, environmental organizations, and food, pharmaceuticals and biotechnology industries.

Year	SEMESTER	COURSE OPTED	COURSE NAME	Credit
B.Sc Honors Ist Year ***Certificate in Microbial Technique***	Ist Sem	Ability Enhancement Compulsory Course-I	Koushal vikash	2
		Core course-I	General Microbiology	4
		Core Course-I Practical	Practical	2
		Core course-II	Bacteriology	4
		Core Course -II Practical	Practical	2
		Generic Elective - 1	Other Department	4
		Generic Elective -1 Practical	Practical	2

		Vocational Skill	Tools and Technique	4
		Communication Language	Hindi/ English	2
	IInd Sem	Ability Enhancement Compulsory Course-I	Koushal vikash	2
		Core course-I	Environmental and Agriculture Microbiology	4
		Core Course-I Practical	Practical	2
		Core course-II	Virology	4
		Core Course -II Practical	Practical	2
		Generic Elective - 1	Other Department	4
		Generic Elective -1 Practical	Practical	2
		Vocational Skill	Food fermentation technology	4
		Communication Language	Hindi/ English	2
Bsc Honors II nd Year **Diploma in Microbial Technology**	III Sem	Core course-I	Microbial Metabolism and Physiology	4
		Core Course-I Practical	Practical	2
		Core course-II	Cell Biology	4
		Core Course -II Practical	Practical	2
		Core III	Molecular biology and microbial genetics	4
		Practical s	Practical	2
		Generic Elective - 1	Environmental Sciences	2
		Vocational Skill	Microbiological Analysis of Air and Water	4

	IVth Sem	Core course-I	Microbial Genetics and Genomics	4
		Core Course-I Practical	Practical	2
		Core course-II	Soil Microbiology	4
		Core Course -II Practical	Practical	2
		Core III	Food and Dairy Microbiology	4
		Practical s	Practical	2
		Generic Elective - 1	English Communication/ Personality Development	2
		Vocational Skill	Instrumentation and Biotechniques	4
IIIrd Year **Degree in Bachelor of Science in Microbiology**	Vth Sem	Core course-I	Medical Microbiology and Immunology	4
		Core Course-I Practical	Practical	2
		Core course-II	Microbiology of Air and Water	4
		Core Course -II Practical	Practical	2
		Discipline Specific Elective -1	Pharmaceutical Microbiology	4
		Core Course -III Practical	Practical s	2
		Discipline Specific Elective -2	Microbial biotechnology	4
		Discipline Specific Elective -2 Practical	Practical	2
	VI Sem	Core course-I	Industrial Microbiology	4
		Core Course-I Practical	Practical	2

		Core course-II	Microbial Ecology	4
		Core Course -II Practical	Practical	2
		Discipline Centric Elective -3	Biosafety and Intellectual Property Rights	4
		Practical s	Practicals	2
		Discipline Centric Elective -4	Microbial Diagnosis in Health Clinics	4
		Discipline Specific Elective -2 Practical	Practical	2

BSc Honor /M.Sc I Year In Microbiology	B.Sc7thSem/M.Sc.Ist Semester	BMH T 701	Microbiological Tools and Technique	4
		BMH T 702	Microbial Diversity- Prokaryotes and Viruses	4
		BMH T 703	Algal and Fungal Biology	4
		BMH T 704	Biostatistics, Computer Applications and Bioinformatics	4
		BMH T 705	Practical	4
		BMH DS T 706	History and scope of microbiology	4
	B.Sc8th Sem/M.Sc. IInd Semester	BMH T 801	Microbial Biochemistry	4
		BMH T 802	Techniques of Microbial Genetics and Molecular Biology	4
		BMH T 803	Microbial Environmental Technology	4
		BMH T 804	Recombinant DNA Technology	4
		BMH DS T BMH806	Food borne diseases and food preservation	4
		BMH T 805	Practical	4

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

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
- 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 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 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)**

BMDSC102 Experiments in General Microbiology

Credit 2

1. Good laboratory practice in Microbiology and safety measures.
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.

B.Sc. I Year **Semester – I**

BM -C102

BMDSC-2 BACTERIOLOGY

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

Total Hours: 60

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of bacteriology and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of Bacteriology.

Learning Outcome:

- Will have gained knowledge about structure and organisation of different cell components of bacteria. Will be able to differentiate between Gram positive and Gram-negative bacteria; archaebacteria and eubacteria cell wall and cell membrane.
- Will get familiar with various media and techniques used for cultivation and maintenance of different types of bacteria.
- Will also gain insight into different phases of growth in batch culture and binary fission as a method of reproduction.
- Will understand the concept of different types of classification. Will learn about the morphology, ecological significance and economic importance of the various bacterial genera.

UNIT 1 - Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell

walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

UNIT 2 Bacterial Systematics - Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; Bacteriological techniques Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, **Microscopy** Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Scanning and Transmission Electron Microscope

UNIT 3 Growth and nutrition - Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, and enrichment media, *Physical methods of microbial control*: heat, low temperature, high pressure, filtration, osmotic pressure, radiation *Chemical methods of* disinfection, types and mode of action **Reproduction in Bacteria** Sexual, Asexual methods of reproduction, phases of growth, calculation of generation time and specific growth rate.

UNIT 4 Important archaeal groups - Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium, Halococcus*)]

UNIT 5 Important bacteria groups Morphology, metabolism, ecological significance and economic importance of following groups: *Gram Negative:*Non proteobacteria: General characteristics with suitable examples Alpha proteobacteria , Beta proteobacteria , Gamma proteobacteria, Delta proteobacteria, Epsilon proteobacteria: and Zeta proteobacteria, General characteristics with suitable examples *Gram Positive:* Low G+ C (Firmicutes) and High G+C (Actinobacteria) and General characteristics with suitable examples *Cyanobacteria*

BMDSC104 Experiments in Bacteriology
Credit 2

1. Preparation of different media: synthetic media
, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining and Negative staining
3. Control of microbial growth by Heat, Uv and Disinfectant
4. Gram's staining
5. Acid fast staining-permanent slide only.

6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by pour plate , serial dilution and streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.
12 Isolation and identification of Cynobacteria
13. Isolation of Actinomycetese,
14 Demonstrations of Microscopes

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 Voll 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

BMDSC –VC E 105
VC E-105 TOOLS AND TECHNIQUES

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

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.

.

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.

B.Sc. I Year **Semester – II**

BM DSC-202-Environmental and Agriculture Microbiology

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

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)**

BMDSC202 P Experiments in Environmental and Agriculture Microbiology
Credit 2

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)**

B.Sc. I Year **Semester – II**

BM DSC-203 Virology

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

Unit 1-Nature and Properties of Viruses - Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses.Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses.

Unit 2 -Bacteriophages - Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage.

Unit 3- Viral Transmission, Salient features of viral nucleic acids and Replication - Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (Picornavirus), capping and tailing (T2). Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (ϕ X 174, Retroviridae, Vaccinia, Picorna), Assembly with example of Polio virus and T4 phage, maturation and release of virions.

Unit 4- Viruses and Cancer - Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses:Concepts of oncogenes and proto-oncogenes. Prevention & control of viral diseases - Antiviral compounds and their mode of action. Interferon and their mode of action. General principles of viral vaccination.

Unit 5- Applications of Virology - Use of viral vectors in cloning and expression, Gene therapy, Phage display and phage therapy.

BMDSC 204 Experiments in VIROLOGY (PRACTICAL)
TOTAL HOURS: 60 **CREDITS: 2**

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

8. Isolation of Bacteriophage from Ganga water

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/

B.Sc. I Year **Semester – II**

BM DSC-205 - VC FOOD FERMENTATION TECHNOLOGY

MM : 100	Sessional : 25
Time : 3 hrs	ESE : 75
L Credit	Pass Marks : 40

4 4

Learning Objective:
The course aims to provide an advanced understanding of the core principles and topics of Food fermentation techniques.

Learning Outcome:
- Understand the role of different microorganisms in Food undustry
- Learn different fermentation processes used in the food industry
- Understand role of Probiotics in food

Unit 1 Fermented Foods Definition, types, advantages and health benefits
Unit 2 Milk Based Fermented Foods Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process
Unit 3 Grain Based Fermented Foods Soy sauce, Bread, Idli and Dosa: Microorganisms and production process
Unit 4 Vegetable and Non Vegetarian Based Fermented Foods Pickels, Saeurkraut: Microorganisms and production process, **Fermented Meat and Fish** Types, microorganisms involved, fermentation process
Unit 6 Probiotic and Prebiotics Foods Definition, types, microorganisms and health benefits advantage for currant scenario .

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

B.Sc. II Year **Semester – III**

BMD-301 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.

- 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

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 D-302 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)**

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. 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-**
   • https://lipidnanostructuresgroup.weebly.com
   •https://www.labster.com/microbiology-virtual-labs
   •https://www.microbiologybook.org
   •https://www.cpe.rutgers.edu/courses/current/lf0401wa.html
   https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy
   https://www.futurelearn.com/courses/introduction-to-microbiology

B.Sc. II Year **Semester – III**

BM -D303 CELL BIOLOGY (THEORY)

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

Total Hours: 60

Unit 1 Structure and organization of Cell -Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall:

Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules

Unit 2 Nucleus Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus

Unit 3 Protein Sorting and Transport Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein
folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes

Unit 4 Cell Signalling Signalling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway

Unit 5 Cell Cycle, Cell Death and Cell Renewal Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types Programmed cell death Stem cells Embryonic stem cell, induced pleuripotent stem cells

BM -D304 EXPERIMENTS IN CELL BIOLOGY (PRACTICAL)
TOTAL HOURS: 60 **CREDITS: 2**

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs
3. Cytochemical staining of DNA – Feulgen
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis.

SUGGESTED READING

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley &
Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott

Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

B.Sc. II Year **Semester – III**
BM -D305

BM D-305 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

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, Mechanisms of initiation, elongation and termination of polypeptides.

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,

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.

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

B.Sc. II Year **Semester – III**

BM-D 306 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
   - http://www.mooc.list.com/tag/molecular-biology
   - 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

Digital links:

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

B.Sc. II Year **Semester – III**

BM D- VC –E307 MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

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

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.

UNIT – II Air Sample Collection and Analysis: Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics.

UNIT – III Control Measures: Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration.

UNIT – IV Microbiological Analysis of Water: Sample Collection, Treatment and safety of drinking (potable) water, methods to detect portability 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.

UNIT – V Control Measures: Precipitation, chemical disinfection, filtration, high temperature, UV light.

+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

B.Sc. II Year **Semester – IV**

BM-D401 - MICROBIAL GENETICS AND GENOMICS

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

Total Hours: 60

Learning Objectives:

The major objective of this course is to develop clear understanding of various aspects of microbial genetics and genomes in relation to microbial survival and propagation and to enable students to better understand courses taught later such as recombinant DNA technology and other allied papers.

Learning Outcomes:

Upon successful completion of the course, the student:

- Will be acquainted with the organization of prokaryotic and eukaryotic genomes and organelle genomes in eukaryotes.
- Will get acquainted with basic and applied aspects of mutations and mutagenesis and their importance and the role of mutator genes. Will learn of the use of a microbial test in detecting the carcinogenic potential of chemicals. Will become aware of different repair mechanisms.
- : Will have learnt the role of plasmids and their types in microorganisms. Will get acquainted with plasmid replication and partitioning as well as aspects related to plasmid copy number, its regulation and plasmid curing.

Unit 1: Genomes and Organelle genomes: Comparative genome organization in *E. coli*, *Saccharomyces cerevisiae*, *Neurospora crassa*. Organelle genomes: chloroplast and mitochondrion.

Unit 2: Mutations, mutagenesis and repair: Definition and types of mutations-base substitutions,frameshifts, deletions, insertions, duplications, inversions. Silent, conditional and lethal mutations.Physical and chemical mutagens. Loss and gain of function mutants. Reversion and suppression: true revertants, intra- and inter-genic suppression. Mutator genes. Uses of mutations. Ames Test. Photoreactivation, mismatch repair, excision repair, NHEJ repair: basic mechanism and enzymes and proteins involved.

Unit 3: Plasmids: Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number, curing of plasmids. Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, yeast 2 μ plasmid.

Unit 4: Mechanisms of Genetic Exchange: Transformation - Discovery, mechanism of natural competence. Conjugation - Discovery, mechanism, Hfr and F' strains, gene mapping by interrupted mating technique. Transduction - Generalized transduction, specialized transduction, mapping by recombination and co-transduction of markers.

Unit 5: Phage Genetics: Genetic basis and regulation of lytic versus lysogenic switch of lambda phage. CRISPR-Cas system as bacterial defense against invading genetic material

B.Sc. II Year **Semester – IV**

BM –D402 Experiments in microbial genetics and genomics

Credit 2

1. Preparation of Master and Replica Plates.
2. Study of the effect of chemical (nitrous acid) and physical (UV) mutagens on bacterial cells.
3. Study of survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Isolation of plasmid DNA from *E.coli*. Study of different conformations of plasmid DNA through

agarose gel electrophoresis.

6. Demonstration of bacterial conjugation.
7. Demonstration of Ames test.

Suggested Reading:

1. Concepts of Genetics by W.S. Klug, M.R. Cummings, C. Spencer and M. Palladino. 12th edition. Pearson Education, USA. 2018.
2. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. 7th edition. Pearson Education, USA. 2017.
3. Molecular Genetics of Bacteria by L. Snyder, J.E. Peters, T.M. Henkin, W. Champness. 4th edition. ASM Press, USA. 2015.

4. Lewin's Essential Genes by J. Krebs, E. Goldstein and S. Kilpatrick. 3rd edition. Jones and Bartlett Learning, USA. 2013.

B.Sc. II Year **Semester – IV**

BM-D 403 Soil Microbiology

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

Unit I Soil as a habitat for microorganisms; Soil microbes – algae, bacteria, actinomycetes, fungi protozoa and nematodes, Microbial balance in soil. Molecular markers for ecological studies of soil micro organisms.

Unit II Rhizosphere and rhizoplane micro organisms; reasons for increased microbial activity in rhizosphere. composition of root exudates factors affecting exudation, rhizosphere microorganisms, rhizosphere effect. Factors affecting microbial community in soil-soil moisture, organic and inorganic chemicals. soil organic matter.

Unit III Organic matter decomposition; Organic matter dynamics in soil- microbial decomposition of cellulose, hemi cellulose, lignin. Factors affecting organic matter decomposition (litter quality, temperature, aeration, soil pH, inorganic chemicals, moisture); Pesticide degradation in soil, effects of pesticides on soil microflora, soil microbial biomass as an index of soil fertility.

Unit IV Microbial interactions; negative interactions. Ammensalism, competition, parasitism and predation (mycoparasitism, mycophagy, namatophagy – predaceous fungi), commensalism positive interactions – mutualism, synergism, associative symbiosis, cyanobacterial bacterial (Rhizobium legume symbiosis), actinomycetes (actinorrhiza –Frankia non root legume symbiosis) and fungal symbiosis – types and significance of mycorrhuza. Concept of beneficial microorganisms.

Unit-V Biogeochemical cycles: C, N, P ,S cycles. Nitrogen fixation- symbiotic and asymbiotic, significance of nitrogenase and nif genes, phosphate solubilization and its mechanism.

B.Sc. II Year **Semester – IV**

BM –D404 Experiments in Soil Microbiology

Credit - 2

1. Isolation of Rhizobium from Root Nodule.

2.Determination of Soil pH ,Temperature, inorganic chemical and moisture

3 Isolation of Actinomycetes from soil

4. Determination of soil Microflora by using serial dilution Method

5. Isolation of Rhizospere microflora

6. Isolation of Rhizoplane microflora

7. Isolation of starch degrading microflora.

8 Isolation of cellulose degrading micrtoflora

B.Sc. II Year **Semester – IV**

BM D 405 FOOD AND DAIRY MICROBIOLOGY

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

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.

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.

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.

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

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

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 .

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.

B.Sc. II Year **Semester – IV**

BM –D406 Experiments in Industrial and Food and Dairy Microbiology.
Credit 2

1. Isolation of antibiotic producing microorganisms from soil.
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

B.Sc. II Year **Semester – IV**

BMD **VC- 407 INSTRUMENTATION AND BIOTECHNIQUES (THEORY)**

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 1 Microscopy Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 2 Chromatography Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.

Unit 3 Electrophoresis Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit 4 Spectrophotometry Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Unit 5 Centrifugation Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

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

Detail* Degree in Bachelor of Science in Microbiology *Syllabus of

B.Sc. III Year **Semester – V**

BM D- 501 MEDICAL MICROBIOLOGY AND IMMUNOLOGY

MM : 100	Sessional : 25
Time : 3 hrs	ESE : 75

L Credit Pass Marks : 40

4 4

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

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

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.

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,

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.

B.Sc. III Year **Semester – V**

BM –D502 EXPERIMENTS IN MEDICAL MICROBIOLOGY AND IMMUNOLOGY
Credit 2

1. Identify pathogenic bacteria on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
3. Study of bacterial flora of skin by swab method.
4. Perform antibacterial sensitivity by Kirby-Bauer method.
5. Identification of human blood groups.
6. To perform Total Leukocyte Count of the given blood sample.
7. To perform Differential Leukocyte Count of the given blood sample.
8. To separate serum from the blood sample (demonstration).
9. To perform immunodiffusion by Ouchterlony method.

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**

BMD 503 MICROBIOLOGY OF AIR AND WATER

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

Total Hours: 60

UNIT – 1 Aeromicrobiology : Droplet nuclei, aerosol, assessment of air quality, brief account of air-borne microbes- bacteria, fungi, viruses, their diseases and preventive measures; phylloplane and phyllosphere microflora.

UNIT – II Aquatic Microbiology : Water ecosystems- types, fresh water, (pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents); eutrophication, food chain; potability of water, microbial assessment for water quality, water purification, physical, chemical, microbiological characteristics of sewage.

UNIT – III Waste Treatment – Types of wastes–, characterization of solid and liquid wastes, physical, chemical and biological (aerobic, anaerobic- primary, secondary, tertiary) treatment; Solid waste treatment; fuel (methanol, methane), fertilizer (composting); liquid waste treatment- trickling, activated sludge, oxidation ponds, bioremediation of xenobiotics- hydrocarbons; biomagnifications.

UNIT – IV Role of Microbes in Environment: Organic matter decomposition, factors affecting litter decomposition; microbial biomass and soil fertility; biodegradation of paints, building material; Principles and degradation of common pesticides, hydrocarbons (oil spills).

UNIT – V Water Potability Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

B.Sc. III Year **Semester – V**

BMD 504 EXPERIMENTS IN MICROBIOLOGY OF AIR AND WATER
Credit - 2

1. Analysis of soil Aeromicroflora .
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes from water
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of coliforms from sewage
8. Isolation and identification of E coli from water using selective media
9. Determination of Total Microflora by using Membrane filtration, MPN and SPC
10. Confirmed test of fecal treatment of water

B.Sc. III Year **Semester – V**

BM D- 505 PHARMACEUTICAL MICROBIOLOGY

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

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

- 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.

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 .

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.

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

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

B.Sc. III Year **Semester – V**

BM D- 506 Experiments in Pharmaceutical Microbiology

Credit 2

1. Antibiotic sensitivity test and MIC determination
2. Demonstration of antibiotic resistance transfer from resistant to sensitive microorganism
3. Vitamin B12 Assay .
4. Microbial Limit test of Products
5. Determination of nitrate production in nitrite broth soil cultures.
6. Isolation of antibiotic resistant bacteria by gradient plate technique.
7. Determination of preservative efficacy test
8. Fumigation schedule
9. Predict the microorganism on the basis of reaction on TSI slant
10. Perform citrate utilisation test.
11. Antibiotics sensitivity test cy CUP and Disc Diffusion method
12. Determination of efficacy test of Disinfectant.

B.Sc. III Year **Semester – V**

BM D- DS 507 MICROBIAL BIOTECHNOLOGY

MM : 100	Sessional : 25
Time : 3 hrs	ESE : 75

L	Credit	Pass Marks : 40
4	4	

Learning objective: The main aim of this paper is to introduce the students an in-depth view at how microbes and
their metabolic pathways and products can be utilised in biotechnology. The areas of particular concern such as Environmental biotechnology, bioremediation and biomining will also help to grow the interest of the students in the other aspects of biotechnology.

Learning outcome:

- Able to demonstrate a familiarity with the wide diversity of microbes.
- Able to gain knowledge about the potential of microbes for use in microbial biotechnology.
- Able to demonstrate a knowledge of microbial gene.
- Able to describe genome structure and function, and how these can be manipulated.

Unit 1 Microbial Biotechnology and its Applications Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors

Unit 3 Applications of Microbes in Biotransformations Microbial based transformation of steroids and sterols Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Unit 4 Microbial Products and their Recovery Microbial product purification: filtration, ion exchange and affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization

Unit 5 Microbes for Bio-energy and Environment Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics,

B.Sc. III Year **Semester – V**

BM D- 508 MICROBIAL BIOTECHNOLOGY (PRACTICAL)
CREDITS: 2

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*)
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal and fungal Single Cell Proteins
6. Laboratory Preparation of ethanol from waste
7. Isolation of methanogens
8. Isolation of cellulase and amylase producing microorganisms
9. Determination of catalytic activity.

SUGGESTED READING

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc

B .Sc. III Year **Semester – VI**

BM D 601 INDUSTRIAL MICROBIOLOGY

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

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,

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

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.

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

B .Sc. III Year **Semester – VI**

BM D 802 EXPERIMENTS IN INDUSTRIAL MICROBIOLOGY

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative)
3. Enzymes: Amylase and Protease
4. Amino acid: Glutamic acid
5. Organic acid: Citric acid
6. Alcohol: Ethanol

7. production single cell protein
8. Laboratory production of antibiotics
9. production of vinegar
10 Microbial production of vitamins

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**

BMD-603 Microbial Ecology

MM : 100 Sessional : 25
Time : 3 hrs ESE : 75
Pass Marks : 40

L	T	Credits
3	1	4

.

Learning objectives:

- To understand the scope and applications of Microbial Ecology .
- To understand Ecological importance of microorganism and their beneficial effect .

Learning outcomes:

At the end of course student will be able to

- Screen and isolate Ecological important microorganisms.
- Make use of fermentor to produce Methane producing and other waste fermentation products.

UNIT – I Ecological groups of microorganisms: Based on O2 requirement (Aerophile, Microaerophiles, Anaerobic bacteria) requirement, based on C sources (Methanotrophs, Methylotrophs) , temperature, and habitat, Microbial diversity- distribution, ecological niche: plant-microbe interactions

UNIT – II Population interaction- population within biofilm; positive and negative interaction- neutralism, commensalisms, synergism, mutualism, competition, antagonism, parasitism, and predation.

UNIT – III Extremophiles- Psychrophiles, acidophiles, alkaliphiles, thermophiles, barophiles and osmophiles, halophiles- membrane variation, electron transport; Application of extremophiles; methanogens and biogas production; Rumen microbiology- rumen anatomy, rumen microorganisms and action.

UNIT – IV Stress Microbiology: Environmental stress (density-dependent and density-independent) stress, stress sequestration by bacteria and other organisms, heavy metal detoxicants (metal-microbe interaction, biosorption, bioaccumulation and metal scavenging by microbes).

UNIT – V Chemolithotrophs: Methylotrophs; microbial leaching (bioleaching) - microbes and mechanism of bioleaching of iron, copper and uranium; oxidative transformation of metals-sulphur oxidation, iron oxidation, ammonia oxidation, hydrogen oxidation Suggested Reading

Suggested Readings

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. Singh and Purohot, Microbial Ecology, AGROBIOS
3. Atlas. Microbial Ecology, Pearson Education ISBN13: 9788129707710

B.Sc. III Year **Semester – VI**

BMD-604 Experiments in Microbial Ecology

TOTAL HOURS: 60 **CREDITS: 2**

1. Isolation of Soil Microflora

2. Demonstration of biogas plant

3. Isolation of cellulose degrading microorganisms

4. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

5, Effect of temperature on growth of given Bacterial culture

6. Effect of pH on growth of Given Bacteria

7. Effect of carbon and nitrogen sources on growth of *E.coli*

8. Effect of salt on growth of *E. coli*

9 Isolation of Methane producing microorganisms

B.Sc. III Year **Semester – VI**

BM –D605 BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)

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

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

Unit 3 Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications-importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).
Unit 4 Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.
Unit 5 Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

B.Sc. III Year **Semester – VI**
BM –D606

EXPERIMENTS IN BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2
1. Study of components and design of a BSL-III laboratory
2. Filing applications for approval from biosafety committee
3. Filing primary applications for patents
4. Study of steps of a patenting process
5. A case study

Suggested Reading

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

B.Sc. III Year **Semester – VI**

BMD- 607 MICROBIAL DIAGNOSIS IN HEALTH CLINICS

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of clinical microbiology

Learning Outcome:

- Learn basics of infection and the epidemiology of infectious diseases.
- Understand the morphology, pathogenicity and laboratory diagnosis of gram positive and negative organisms.
- Study the morphology, pathogenicity and laboratory diagnosis of acid-fast bacteria.

Unit 1 -Importance of diagnosis of diseases Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, clinical samples for diagnosis of infectious disease.

Unit 2 - Collection of Clinical Samples How to collect clinical samples (oral cavity, throat, skin, Blood, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit 3- Microscopic examination and culture methods. 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 4- Serological and Molecular methods Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. Kits for rapid Detection of Pathogens Typhoid, Dengue and HIV, Swine flu.

Unit 5- Testing for Antibiotic sensitivity in Bacteria Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Kirby method Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.

B.Sc. III Year **Semester – VI**

BMD- 608 Experiments in microbial diagnosis in health clinics

1. Isolation of Microflora from Different human organ (Skin, Nasal, Ear Mouth)
2. Isolation of Microflora from urine sputam and stool
3. Detection opf WBC

4, Quantitative analysis of RBC

5, Identification of Drug Resistant bacteria

6. Determination of blood group and Rh

7 Determination of Hemoglobin

8. Determination of MIC of Antibiotics

Suggested Reading

1. Bruce Alberts. Molecular Biology of the Cells, W.W. Norton and Company, ISBN: 9780815344643
2. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. Harvey, Lodish. Molecular Cell Biology, W.H.Freeman
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

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VII**

BM –E701

BMH-701 Microbiological Tools and Technique

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

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.

.

Unit I:

Principle , Calibration and Application of different instruments of microbiology Lab such as microscopes, hot air oven, autoclave, laminar air flow and BOD incubator , pH Meter, Analytical Balance. Staining Technique Specimen preparation and principles of Simple, Gram's stain, Capsule, Endospore, Flagella, Acid fast and Geimsa's staining.

Unit II:

Aseptic technique: contamination, sterilization (steam sterilization, tyndallization, dry heat, chemicals, radiation sterilization, filter sterilization), sterilization of air. Evaluation of antimicrobial agent effectiveness, evaluation of efficacy of disinfectants, determination of phenol coefficient)

Unit III:

Isolation of industrially important microorganisms, Primary screening (crowded plate technique, enrichment culture technique, streak plate, Serial dilution plate and spread plate), Importance of screening. maintenance of pure cultures; methods of preservation. Maintenance and Cultivation of anaerobic bacteria.

Unit IV:

Principles and applications of Chromatography techniques: paper chromatography, thin layer chromatography, adsorption column chromatography, gas liquid chromatography, HPTLC Principle and Function of UV-Vis spectrophotometry,

Unit V

Principles and applications of Electrophoresis for protein, RNA and DNA; Centrifugation; Ultracentifugation; Lyophilization and Fumigation

Suggested Readings

1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Wilson K. and Walker J. (2013). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. Upadhyaya and Nath (2015) Biophysical chemistry, Himalaya pub. House.
5. T.A.Brown (2016). Gene cloning and DNA analysis, an introduction,Wiley Blackwell pub.
6. B.D.Singh (2015). Biotechnology, Kalyani publication.
7. 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
8.Prescott's Microbiology, 10th Edition, McGraw Hill Publication

9. 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

Experiments in Microbiological Tools and Technique

16. Good laboratory practice in Microbiology and safety measures.
17. Cleaning and sterilization of glassware and equipments
18. Principles and applications of microbiology laboratory instruments (Autoclave, Laminar Air Flow, Incubator, Hot Air Oven, and Light Microscope).
19. Perform simple and Gram staining of bacteria.
20. Perform Endospore staining of bacteria.
21. Perform Capsule staining by negative staining technique of bacteria.
22. Perform Flagella staining of bacteria.
23. Perform Negative staining of bacteria.
24. Isolation of microorganisms from soil by pour plate method.
25. Isolation of microorganisms from air , water , and soil
26. Effect of radiation. on microbial growth
27. Cultivation of bacteriophages.
28. Calibration of Different instruments.
29. To prepare the Potato Dextrose Agar Medium.
30. Separation of DNA by Electrophoresis
31. Separation of Pigments By Chromatography
32. Determination of Environmental Microorganisms
33. . Isolation of Microbial colony from soil, water, air and milk.
34. To determine total viable cells in a bacterial culture by plate count method or serial dilution method.
35. . To carry out thin layer chromatography (mixture of amino acids).
36. Isolation of plasmid DNA from E. coli.
37. . TLC separation of amino acids.

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VII**

BMH -702 Microbial Diversity- Prokaryotes and Viruses

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

Total Hours: 60

Learning objectives:

- To understand the microbes diversity and their role .

To understand the basic concept of prokaryotes, their taxonomy,their differentiation from eukaryotes and biosafety regulatory framework for prokaryotes.

Learning outcomes:

At the end of course students will be able to explain the role of prokaryotes and their role in Microbiology development and what is the scope of the various branches of the subject and other beneficial roles.

- Cultivate viruses , Cyanobacteria in laboratory by different methods

Unit I:

Discovery of microbial world; Introduction to microbial biodiversity distribution, abundance, ecological niche of bacteria and archaea.

Unit II:

Microbial evolution; classification of microorganisms: Haeckel's three kingdoms, Whittaker's five kingdoms, three domains of Carl Woese, ribosomal RNA in microbial taxonomy, concept of microbial species; classification and salient features of bacteria on the basis of *Bergey's Manual of systemic Bacteriology*. General features of important groups of bacteria Protobacteria, Firmicutes , Actinobacteria, Spirochaetes, Rickettisia and Archaebacteria and cyanobacteria .

Unit III:

Extreme environments and extremophiles; Microbial diversity in different ecosystems thermophiles, halophiles, mesophiles, hyper thermophiles, acidophiles, alkalophiles, barophiles and other extremophiles) and their biotechnological applications

Unit IV:

General characters, nomenclature, classification, morphology and ultra-structure of viruses; Capsid and their arrangement; Cultivation of viruses using embryonated eggs, experimental animals and cell cultures , viroids– host range, genome and origin of viroids;); prions- spread of prions and diseases.

Unit V

: Bacteriophages- Structural organization, multiplication cycle; one step growth curve lytic and lysogenic cycle, bacteriophage typing, M13, Mu, T4, Φx174, phage λ; application of bacteriophages in health- bacteriophage therapy. cyanophages- morphology, growth cycle, mycoviruses- replication and types of mycoviruses

Suggested Readings (Latest Editions):

1. Bergey's manual systematic Bacteriology(2011) 2nd edition
2. Prakash S. Bisen (2012). Microbes-concepts and applications, Wiley-Blackwell.
3. J.D.S.Panwar (2012)-Fundamentals of Microbilogy-S.R.S Pub
4. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil

5. Bisen, P.S. (2014). Microbes in Practices, I K international publication house pvt Ltd.
6. Sharma P.D. (2015-16). Microbilogy, 3rd edn, Rastogi publications
7. J.G.Black(2015) –Microbiology, 9th edition, Wiley publication

Experiments in Microbial Diversity- Prokaryotes and Viruses

1. Preparation of various models based on History of Microbiology.
2. Determination of growth of bacteria by spectrophotometrically.
3. Demonstration of pour plate, spread plate and streak plate methods.
4. Preparation of bacterial growth curve.
5. Isolation and characterization of thermophiles.
6. Isolation and characterization of psychrophiles.
7. Isolation and characterization of osmophiles.
8. Isolation and characterization of acidophiles.
9. Isolation and characterization of alkalophiles.
10. Isolation and characterization of halophiles.
11. Isolation and characterization of cyanobacteria.
12. Demonstration of bacteriophage typing.
13. Preparation of various models based on structure of viruses.
14. Study of virus infected plant material
15 Starch hydroloysis
16. Protein degradation-casein degradation
17. Carbohydrate fermentation (different sugars)
18. IMViC Tests: Indole, Methyl red, Vogus Prausker, Citrate utilization test.

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VII**

BMH -703 **Algal and Fungal Biology**

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

Total Hours: 60

Learning objectives:

- To understand the microbes diversity and their role of Fungi and Algae in Ecosystem
- To understand the basic concept of prokaryotes, their taxonomy their differentiation from Prokaryotes and bio safety regulatory framework for Eukaryotes .

Learning outcomes:

At the end of course students will be able to explain the role of Fungi and Algae and their role in Microbiology development and what is the scope of the various field of the subject and other beneficial roles.

- Cultivate Fungi and Algae in laboratory by different methods

Unit 1

Algae: General account of habitat, cell structure, pigments, flagellum, reserve food. . taxonomic position of cyanobacteria. Algal growth and reproduction. Cultivation of algae in laboratory. Nittrogen fixation. Biological and economic aspects of algae, algal biotechnology. Algal blooms and eutropication.

Unit II

Mycology: Thallus morphology and modifications in fungi. Nutrition and physiology of fungi. Reproduction (asexual, sexual and parasexual) characteristics of fungi. Major taxonomic group of fungi with focus on structure, reproduction, life cycle and significance of the following: representatives: i) Gymnomycota (Cellular slime moulds), ii) Mastigomycota (*Phytophthora*), iii) Amastigomycota: a) Zygomyocotina (*Mucor/Rhizopus*), b) Ascomycotina (*Saccharomyces*), c) Basidiomycotina (*Agaricus*), d) Deutromycotina (*Fusarium*). Characteristics and importance of Deuteromycetes. Yeasts: General characteristic, structure, classification, life cycles (important forms), sexual and asexual reproduction of yeast (Saccharomyces cerevisiae)

Unit III

Nutrition and reproduction in fungi, Mycorrhiza, Lichens, Heterothallism, sex hormones in fungi. Evolutionary tendencies in lower fungi. Economic importance. Fungi in ecosystem: contribution of fungi to ecosystems, breakdown of hemicellulose, cellulose, pectins, chitin, starch and glycogen, lignin degradation; flow of nutrients-transport and translocation, secretion of colonizers on a substrate.

UNIT – IV

Fungal pathogens: occurrence, classification, morphology, characteristics features and life cycle of, *Fusarium oxysporum, Alternaria solani*, . Mycoses- superficial , cutaneous, subcutaneous opportunistic and systemic diseases

UNIT – V

Fungal metabolites of industrial importance– industrial alcoholic beverages and organic acids; Fungi as bioinoculant agents, mycotoxins- Aflatoxin ,Rubratoxin, Ochratoxin; fungal enzymes of commercial importance-amylases and cellulases, mycoprotein .

Suggested Readings (Latest Editions):

1. Chatterjee K.D. (2015). Parasitology, Calcutta publication.

2. David Greenwood (2015). Medical Microbiology, 18th edition.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. J.G. Black(2015) –Microbiology, 9th edition, Wiley publication
5. Lee. R. E. (Latest Edition). Phycology, Cambridge University Press, Cambridge.
6. Talaro K.P. & Talaro A. (Latest Edition). Foundations in Microbiology (6th Ed.), McGraw-Hill College Dimensi.
7. Sharma, P.D. (2016). Mycology and Phyotopathology, Rastogi Publications, Meerut

Experiments in Algal and Fungal Biology

1. Preparation of moist chamber for fungal isolation.
2. Isolation of fungi from soil.
3. Isolation of fungi from rhizospehere.
4. Isolation of fungi from different food sources.
5. To isolate fungi present in soil samples and calculate their relative abundance and frequency of occurrence
6. To study the fungal morphology by lactophenol cotton blue staining.
7. To study the fungal morphology by potassium hydroxide mounting.
8. Preparation of permanent fungal mounts.
9. Collection of different types of lichens.
10. Study of dimorphism in yeast.
11. Isolation of various algae from different habitat

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VII**

BMH 704

BMH 704 Biostatistics, Computer Applications and Bioinformatics

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

Total Hours: 60

Learning objectives:

- To understand the statics role in biological and Research industry
- To understand the basic concept biostatics and computer.

Learning outcomes:

At the end of course students will be able to explain the role of computer and statics in Microbiology development and what is the scope of the various field of the subject and other beneficial roles.

Unit I:

Presentation of data; Frequency distributions; Graphical representation of data by histogram, polygon, frequency curves and pie diagram. Measures of central tendency: Mean, median and mode; Measures of dispersion: Mean deviation, standard deviation, coefficient of variation;

Unit II:

Correlation : properties, nature, coefficient of correlation, , significance of correlation Probability: Basic concepts related to probability theory, classical probability. Probability Distributions

Unit III:

Testing of significance: Students t-test for the significance of population mean, Chi square test for population variance, F-test for the equality of two population variance; Analysis of variance-One-way

Unit IV:

Introduction to Computers: Definition, Components of computer, Basics for operating systems Introduction to MS Office (MS-Word, MS-Excel, MS-Power Point); Introduction to Networking Computer application in Microbiological ,fermentation and Pharmaceutical Industry

Unit V:

Introduction to Bioinformatics: Definition and scope; Search engines: tools for web search; Introduction to biological databases (NCBI, EBI, DDBJ, Gen Bank,),Introduction to BLAST and FASTA studies.

Suggested Readings (Latest Editions):

1. Bailey, NT J (2000). Statistical Methods in Biology. English Univ. Press.
2. Campbell R.C (Latest Edition). Statistics for Biologist. Cambridge University Press, UK.
3. Sinha PK (Latest Edition). Fundamentals of computers. BPB Publication, New Delhi
4. Jonathan, P. 2008. Bioinformatics & Functional Genomics.
5. B.D.Singh(2015). Biotechnology, Kalyani Publication.
6. Sharma and Munjal(2015). A test book of Bioinformatics, Rastogi publication

Experiments in Biostatistics, Computer Applications and Bioinformatics

1. Representation of statistical data by 1. Histogram
2. Curves 3. Pie diagrams

2. Determination of averages or Central tendencies (Mean, Mode, Median) 3. Determination of measures of dispersion (Mean deviation, Standard deviation and Coefficient of variation, Quartile deviation)

4. Application of Tests of significance (Chi-Square test, student t-test, Standard error)

5. Applications of computers in biology using MS-office (MS-Word, Excel, Power point)

6. Introduction to LAN Networking

7. Introduction to Internet (E-Mail, File Transfer Protocol, Usenet, Telnet).

8. Introduction to different primary and secondary databases.

9. To access scientific data from Literature data bases (PUBMED, LITDB, Medline) 10. To access nucleic acid databases for retrieval of gene sequence.

11. To access protein databases for retrieval of amino acid sequence of target protein.

12. To perform multiple sequence alignment using BLAST.

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VII**

BMH 706

BMH DS 706 **HISTORY AND SCOPE OF MICROBIOLOGY**

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

Total Hours: 60

Learning objectives:

- To understand the statics role in biological and Research industry
- To understand the basic concept and role of microorganisms as beneficial and harmful .

Learning outcomes:

At the end of course students will be able to explain the role of Microbiology development in different field and what is the scope of the various fields of the subject and other beneficial roles.

Unit 1-

History and Development of microbiology , spontaneous generation vs biogenesis, golden age of microbiology branches of microbiology; germ theory of disease, Scope and relevance of Microbiology; Development of microbiology 20th and 21st century Golden era of Microbiology, , Development of various microbiological techniques, Establishment of fields of medical microbiology and immunology.

Unit 2-

Microbes in Human Health & Environment, Medical microbiology and immunology: List of important human diseases and their causative agents. Environmental microbiology: Definitions and examples of important microbial interactions,

Unit 3

Application of microorganisms: bio-pesticides, bio-fertilizers, biodegradation, bio-deterioration and bioremediation,

Unit 4

Role of microorganisms in fermentation, microbes producing important industrial products through fermentation. Biofuels, Microorganisms in food spoilage and food borne infections.

Unit 5

Concept of ecosystem: Types. Structure and function of ecosystems. Trophic levels: Primary and secondary production. Energy flow: ecological pyramids, food chains and food webs.

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VIII**

BMH 801

BMH 801 Microbial Biochemistry

MM : 100

Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To understand the statics role in biochemistry in microbiology
- To understand the basic concept of macromolecules .

Learning outcomes:

At the end of course students will be able to explain the role of macromolecules in Microbiology development and what is the scope of the various fields of the subject and other beneficial roles.

Unit I

Carbohydrates : Structure and Properties and uses of monosaccharides, oligosaccharides and polysaccharides, glycoproteins, glycolipids, proteoglycans, mutarotation, annomerisation, epimerization, stability of polysaccharides

Unit II

Structure and properties of amino acids, Structure of protein (Primary, Secondary, Tertiary and Quaternary), essential and non-essential amino acids, general reactions of amino acid metabolism, urea cycle, synthesis of various molecules via amino acid metabolism intermediates, non-standard Amino Acids

Unit III

Structure and properties of fatty acids, storage and membrane lipids, phospholipids and cholesterol, Composition and synthesis of lipoproteins and their transport in the body, oxidation of fatty acids (beta & alpha), oxidation of long chain fatty acids, Synthesis of lipids, elongation of fatty acids, desaturation of fatty acids, regulation of fatty acid synthesis, cholesterol metabolism, regulation of cholesterol metabolism.

Unit IV:

Structure, composition and properties of nucleic acids, De-Novo synthesis of purine and pyrimidine nucleotides and its regulation. Synthesis of nucleoside di- and triphosphates, deoxynucleotides and TMP and degradation of purine and pyrimidine nucleotides, salvage pathways of nucleotides synthesis...

Unit V:

Structure,and properties of vitamins, co-enzymes, biochemical action of vitamins and Fat and water soluble vitamins, Biosynthesis of vitamins, role of vitamins in the metabolism.

Suggested Readings (Latest Editions):

1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Voet D and Voet JG. (2013). Principle's of Biochemistry. John Wiley and sons New York.
3. Moat AG and Foster J W (Latest Edition). Microbial Physiology. John Wiley and Sons, New York.
4. Stryer. L (2003). Biochemistry. W. H. Freeman and Co.
5. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
6. J.L. Jain(2015).Fundamentals of Biochemistry, S. Chand and Co.
7. U. Satyanarayan(2015). Biochemistry, Elsevier

Experiments in Microbial Biochemistry

1. To carry out qualitative analysis of Carbohydrates
2. To carry out qualitative analysis of Lipids
3. To carry out qualitative analysis of amino acids

4. To carry out qualitative analysis of Proteins
5. To perform biochemical test of starch hydrolysis.
6. To perform biochemical test of casein hydrolysis.
7. To carry out estimation of DNA by Diphenylamine method
8. To carry out estimation of RNA by Orcinol method
9. To carry out estimation of protein by Biuret method.
10. To carry out separation of amino acid by Paper Chromatography and determination of Rf value TLC of fatty acids/lipids
11. To detect presence of reducing sugar using Benedict's test.
12. Determination of absorption maxima of given sample using spectrophotometer.
13. To demonstrate carbohydrate metabolism (oxidation and fermentation of Glucose) in microorganisms
14. To demonstrate Fat hydrolysis (lipase activity) by bacteria
15. To study ability of microorganisms to hydrolyze gelatin
16. To demonstrate degradation of sulphur containing amino acids by bacteri

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VIII**

BMH 802

BMH 802 Techniques of Microbial Genetics and Molecular Biology

MM : 100

Sessional : 25

Time : 3 hrs

ESE : 75

L Credit

Pass Marks : 40

4 4

Total Hours: 60

Learning objectives:

- To understand the Microbial technology and Molecular biology.
- To understand the basic concept genetic material;.

Learning outcomes:

At the end of course students will be able to explain the role of gene and genetic material and microbial technology and what is the scope of the various fields of the subject and other beneficial roles.

Unit I-

Nucleic acids as genetic information carriers, DNA structure, types of DNA. DNA replication in prokaryotes and eukaryotes. Structural features of RNA (mRNA, tRNA, rRNA). Transcription in prokaryotes and eukaryotes.

Unit II-

B.Sc Honor Microbiology

BSc 4th Year / M.Sc. I Year **Semester – VIII**

BHM –806
BMH 805- FOOD BORNE DISEASES AND FOOD PRESERVATION

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 25
ESE : 75
Pass Marks : 40

Total Hours: 60

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.

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.

UNIT - III

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

UNIT – IV

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

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.

Subject expert committee:

Prof. Gulshan Kumar Dhingra (Head and Dean)

Department of Microbiology, Faculty of Science SDSUU Campus Rishikesh

Dr. Prabhat Kumar Singh (Convener)

(Head, Department of Microbiology; Chaman Lal Mahavihyalya, Landhaura, Haridwar)