SCHEME OF EXAMINATION

AND

COURSE OF STUDY

IN

DEPARTMENT OF BOTANY & MICORBIOLOGY
GURUKULA KANGRI (DEEMED TO BE UNIVERSITY), HARIDWAR– 249404
(Deemed to University u/s 3 of UGC Act 1956)

M.Sc. MICROBIOLOGY

(w. e. f. Session 2021-22 onward)

Schedule of Semesters

Semester	Duration	Examination
First	July-November	December
Second	January-April	April/May
Third	July-November	December
Fourth	January-April	May/June

There will be one week preparatory leave, but inter-semester breaks between theory and practical examinations shall be for 6 days including holidays.
Practical examinations in first, second and third semesters will be held for 8 hours each carrying 100 marks. In the fourth semester project work/industrial training of 3-4 months duration will be carried out in any National laboratory or Industry (entrepreneurship). Every student has to submit the **Project report** by 15th May in the same session, which will be evaluated by an external examiner through seminar and *viva voce*examination.

17.4.21 17/4/21. 17/4/21

Syllabus w. e. f. Session 2021-22 onward
Gurukula Kangri (Deemed to be University), Hardwar

M.Sc. MICROBIOLOGY

M.Sc. I, II Year

S.N	Paper Code	Paper Title	Period Per Week			Evaluation Scheme					Subject Total
						Sessional				ESE	
			L	T	P	Credit	CT	TA	Total		
M.Sc. I Year											
Semester – I											
1	MMB-C101	Vedic and Modern Microbiology	3	1	-	4	20	10	30	70	100
2	MMB-C102	Virology	3	1	-	4	20	10	30	70	100
3	MMB-C103	Microbial Physiology and Biochemistry	3	1	-	4	20	10	30	70	100
4	MMB-C104	Environmental Microbiology	3	1	-	4	20	10	30	70	100
5	MMB-C151	Lab Course –I : Based on MMB-C101 & MMB- C102	-	-	8	4	20	10	30	70	100
6	MMB-C152	Lab Course –II : Based on MMB-C103 & MMB-C104			8	4	20	10	30	70	100
						24					600
Semester – II											
1	MMB-C201	Molecular Biology and Recombinant DNA Technology	3	1	-	4	20	10	30	70	100
2	MMB-C202	Microbial Genetics & Genomics	3	1	-	4	20	10	30	70	100
3	MMB-C203	Food Microbiology	3	1	-	4	20	10	30	70	100
4	MMB-C204	Industrial Microbiology	3	1	-	4	20	10	30	70	100
5	MMB-C251	Lab Course –III : Based on MMB-C 201 & MMB-C 202	-	-	8	4	20	10	30	70	100
6	MMB-C252	Lab Course –IV : Based on MMB-C 203 & MMB-C204			8	4	20	10	30	70	100
						24					600
										Total	**1200**
M.Sc. II Year											
Semester – III											
1	MMB-C301	Immunology	3	1	-	4	20	10	30	70	100
2	MMB-C302	Medical Microbiology	3	1	-	4	20	10	30	70	100
3	MMB-E301	Elective I Mycology*	3	1	-	4	20	10	30	70	100
4	MMB-E302	Elective II Pharmaceutical Microbiology*	3	1	-	4	20	10	30	70	100
5	MMB-E303	Elective III Cellular Microbiology*	3	1	-						
6	MMB-E304	Elective IV Agricultural Microbiology*	3	1	-						
7	MMB-E305	Elective V Microbial Ecology*	3	1	-						
8	MMB-C351	Lab Course –V: Based on MMB-C 301 & MMB - C302**			8	4	20	10	30	70	100
9	MMB-E352	Lab Course –VI: Based on any two elective papers**			8	4	20	10	30	70	100
						24					600
Semester – IV											
1	MMB-C460	**Industrial Training/Project report** Project Evaluation Seminar Viva-voce				20	-	-	-		 200 100 100
2	MMB-C461	SWAYAM				4					100
						24					500
										Total	**1100**
						94				**G Total**	**2300**

*- -- Select any two electives out of the five electives (MMB-E301 to MMB-E305)
**--- Practical will be based on theory papers.

L = Lecture
T = Tutorial
P = Practical
CT= Cumulative Test
TA= Teacher Assessment
ESE= End Semester Examination

17.4.21

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MM : 100
Time : 3 hrs
L T Credit
3 1 4

Sessional : 30
ESE : 70
Pass Marks : 40

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 five out of ten **short answer questions** (150 words) uniformly distributed from the entire syllabus. In Section B, the student has to answer any four questions out of Eight **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 40 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

M.Sc. MICROBIOLOGY

L = Lecture
CT = Cumulative Test
ESE = End Semester Examination

T = Tutorial

P = Practical
TA = Teacher Assessment

MMB -C101
VEDIC AND MODERN MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

- To understand the Vedic culture in which there is description of different technique related to microorganism and also they will know how earth evolve and also know the landmarks discoveries of microbiology
- To acquire knowledge of different technique to stain microorganism and how they can visualize the microorganism in different types of microscopes.
- 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 cell 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 milestone in the history of microbiology, importance of Vedic microbiology and scope of microbiology
- To understand and know the application of techniques used in the field of Microbiology.
- Identify key constituent prokaryotes cell and their functions.
- To classify the prokaryotic cell by conventional as well as modern methods.
- To stain the bacteria with simple, differential and special stains.

UNIT – I

Vedic Microbiology: Introduction to Vedas- Types and great saying of Vedas; Aryans- definition, indigenous or invaders; Rishi Kanva- the Father of Vedic Microbiology; Cosmogony; Vedic concept of origin of life; Vedic period; Vedic classification of Krimis- classification by Charak; shape and colour of germs (Krimis); occurrence of germs (Krimis)in the environment- on animals, body surface of human, water whey, milk, food grains; knowledge of invisible germs through logic and Devine Eyes; classification of germs (Krimis)- major groups of Krimis- Drishta, Adrishta; Various names of the krimis in Vedas and in Charaka Samhita; colours of Krimis as in Vedic texts; different terms used for microbes- Amīva, Durnāmā, Sunāmā, Yādudhān, Piśāca, etc.

UNIT – II (09 Lectures)

Pathogenic Germs and Diseases: Health and healthy life; prevalence of utensil and food grains; kshudrarog in humans- PanduRoga (jaundice), Galaganda/Gandmala (mumps) and Masurika (smallpox); prophylaxis- changes in eating habit, clothing habit and bathing; destruction of germs- destruction of germs and their progenies, destruction of germs in active (sakriya) and dormant (susupta) phases, destruction by sun rays, viricidal property in sun rays, eradication of microbes by sun rays.

UNIT – III (08 Lectures)

Vedic Technology: Occurrence of diseases- Yakshma on different parts of body, Kushth, etc.; eradication of Krimis by using medicinal herbs- Apāmārga (*Achyranthusaspera*), Ajashringi (*Pergulariadaemia*), Vach (*Acoruscalamus*) and Prishniparni (*Urariapicta*); eradication of Yakshma by Guggual (*Commiphorawightii*) and by Vach (*Acoruscalamus*); eradication of leprosy by Kushtha (*Costusspeciosus*) and by Pṛśniparṇi (*Urariapicta*); Agnihotra (Hawan, Homa)- material used in daily Yajña, effect of Agnihotra on environment, plants and human health.

UNIT – IV (10 Lectures)

Emergence of Modern Microbiology: Spontaneous Vs Biogenesis, Golden era of microbiology, contributions of scientist and Researchers during Golden age of Microbiology, Carl Woese classification,Whittaker five Kingdom classification, Eight Kingdom classification, ribosomal RNA in microbial taxonomy, concept of microbial species; *Bergey's Manual of Determinative Bacteriology*; microscopy- light, dark field, phase-contrast, fluorescence, and electron microscope; staining techniques- flagella, endospore, capsule, Gram staining, Acid fast staining, Negative staining, VAM staining.

UNIT – V (16 Lectures)

Prokaryotic and Eukaryotic cells- structure and function: Difference between Procaryotic cell and Eucaryotic cell, Morphological types– cell size, shape and arrangements; cell walls- Gram-positive bacteria, Gram-negative bacteria- capsules, fimbriae, pili and flagella; plasma membrane, , ribosomes, inclusion bodies, nucleoid; endospores;Bacterial Growth and its mathematical expression, Nutritional types of bacteria, physical and chemical method of sterilization; Media and its type;Archaeal cell wall; Mycoplasma, non proteobacteria- firmicutes; actinobacteria- cell structure, characteristics features; economic importance in agriculture and industry; cyanobacteria- occurrence, heterocyst, economic importance.

(17 Lectures)

Suggested Reading

1. Dubey R.C. 2021,*Vedic Microbiology- A Scientific Approach*, Motilal Banarasidas International, Delhi 110007.
2. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. Cappachino. Microbiology- A laboratory Manual, Pearson Education India ISBN: 978-9332535190
3. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892
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

17-4-21

MMB - C102
VIROLOGY

L T Credit
3 1 4

Learning objectives:

- To acquire knowledge on history, how viral nomenclature will be done, general characters of viruses and how viruses are classified on basis of structure and genetic material.
- To know the different culture techniques of virus cultivation and also different techniques to diagnose viral disease.
- To enhance the knowledge on some important plant and animal diseases caused by different viruses, viruses transmission and control.
- To acquire knowledge of different types bacteriophage and their life cycle

Learning outcomes:

At the end of course student will be able

- To explain the chronology of viral history and able to classify/identify the virus on the basis genetic material and structure
- To isolate and cultivate virus in embryonatedegg , cell culture and cell lines.
- To detect virus on the basis of different serological techniues.
- To correctly differentiate between plant and animal viruses.

UNIT – I

General features –Discovery of viruses, nomenclature and classification, distinctive properties, morphology, ultrastructure, capsid and its arrangements, types of envelops and its composition; viral genomes; viroids– host range, genome and origin of viroids; cynophages- morphology, growth cycle, mycoviruses- types of mycoviruses, replication, example of mycoviruses (mycoviruses of mushrooms and pathogenic fungi); prions- spread of prions and diseases. **(15 Lectures)**

UNIT – II

Diagnostic microbiology – Isolation and cultivation of viruses- in embryonated eggs, cell cultures and cell lines, isolation and cultivation of bacteriophages and cyanophages; serological methods– haemagglutination, complement fixation, immunofluorescent method, ELISA and Radioimmunoassay (RIA); RT-PCR, assay of viruses- infectivity assay (plaque method, end point method); diagnostic techniques used for identification of viruses in seeds, seed stocks and diseased plants (e.g. seed symptomology, serological methods, histochemical tests and fluorescent microscopy) **(15 Lectures)**

UNIT – III

Bacteriophages- Structural organization, multiplication cycle; one step growth curve; DNA replication, eclipse phase, phage production, burst size, lysogenic cycle, bacteriophage typing, M13, Mu, T4, Φx174, phage λ;application of bacteriophages in health- bacteriophage therapy. **(10 Lectures)**

UNIT – IV

Plant Viruses– Classification and nomenclature of plant viruses; disease symptoms- histology, physiology and cytology of plants; common virus disease of paddy, tomato and sugarcane; type species of plant viruses (e.g. TMV, cauliflower mosaic virus, potato virus X, potato virus Y), transmission of plant viruses, indicator plants, prevention of crop-loss using virus-free planting material. **(10 Lectures)**

UNIT – V

Animal Viruses- Classification, nomenclature, multiplication of animal and human viruses; *RNA viruses*- SARS-CoV2, picornaviruses, orthomixoviruses, paramyxoviruses, arthropod- borne viruses, rhabdoviruses, rotaviruses, HIV and other oncogenic viruses; *DNA viruses* – poxviruses, herpesviruses, adenoviruses, SV40, hepatitis B virus. **(10 Lectures)**

Suggested Reading

1. Mackie and McCartney. Practical Medical Microbiology, Elsevier
2. S. Rajan. Virology, Saras Publication.
3. CKJ Paniker. Test Book of Microbiology, Orient Longman

17.4.21

MMB - C103
MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

L T Credit
3 1 4

Learning objectives:

- To understand howmicrobes carryout catabolism to get energy and metabolism to build structures.
- To understand different metabolic pathway and enzyme involved by which energy will be generated
- To acquire knowledge of classifying enzyme 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

- Explain principles and mechanism of aerobic and anaerobic respiration in microorganisms.
- differentiate between phosphorylation, substrate level phosphorylation and oxidative phosphorylation
- Explainthe concept nitrogen metabolism, assimilation of nitrates, ammonia assimilation. and fixation of nitrogen
- explain the bacterial photosynthesis and also the differentiation between oxygenic and anoxygenic photosynthesis bacteria
- Classify enzyme and demonstrate the mechanism of enzymes and their functions.
- describe the process of nitrogen fixation

UNIT – I

Carbohydrate Metabolism- Oxidation–reduction reactions; anabolism, catabolism, ATP (phosphorylation, oxidative phosphorylation, substrate level phosphorylation),metabolic pathways- glycolysis, pentose phosphate pathway, EntenerDoudoroff pathway, TCA cycle, Glyoxalate cycle.

(13 Lectures)

UNIT – II

Enzymes- Classification, enzyme components, mechanism of enzyme action, types of mechanisms, allosteric enzymes and their mechanism of action.

(8 Lectures)

UNIT – III

Nitrogen Metabolism and Nutrient Transport: Assimilation of nitrates, ammonia assimilation; amino acid biosynthesis- glutamate family, serine family, aspartate family, histidine biosynthesis; nutrient uptakes of solutes into cells, active transport and group translocation; transport of iron.

(10 Lectures)

UNIT – IV

Bacterial Photosynthesis: Classification of photosynthetic bacteria, oxygenic and anoxygenic photosynthetic bacteria, phytosynthetic pigments, bacteriochlorophyll, bacterirhodopsin, phycobilins; metabolism in phytosynthetic bacteria; phytosynthetic electron transport system; mechanism of photosynthesis, cyclic and non-cyclic photophosphorylation, dark reaction (Calvin–Benson cycle).

(14 Lectures)

UNIT – V

Nitrogen Fixation: Symbiotic nitrogen fixation systems- root nodulating symbiotic bacteria, process of root nodule formation, leghemoglobulin; free-living and associative N_2 fixing bacteria, metabolism of N_2 fixation, (anaerobic microorganisms, cyanobacteria, free-living aerobic and symbiotic microorganisms); genetics of nitrogen fixing bacteria, *nif* genes and their regulation, nitrogen fixation mechanisms, nitrogenase types– structure and function; alternative nitrogenase, substrates for nitrogenase, actinorhizal nodules, oxygen protection in nodules.

(15 Lectures)

Suggested Reading

1. Roger Y. Stanier, John L. Ingraham. General Micobiology, Palgrave Macmillan, **ISBN-13:** 978-0333763643
2. 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
3. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892
4. M.T.Madigan, J.M.Mahinko Jack Parkar Brock: Biology of Microorganisms, Pearson Education ISBN 978-9332586864

17.4.21

MMB - C104
ENVIRONMENTAL MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

- To understand howmicroorganism adapt to different environment and their interaction with different habitat and also the spread of microorganisms 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.
- To understand how biological organism can be utilized for remediation of heavy metal as well as industrial pollutant.

Learning outcomes:

At the end of course student will be able to

- Isolate and identify pathogenic microorganism from air, soil and water habitats
- Characterize the waste water and also explain the method that can be utilized in waste water treatment.
- Describe the concept of bioremediation for the remediation of pollutants.

UNIT - 1

Aeromicrobiology : Adaption of microorganism to the air environment, Bioaerosol: Sources, survival and spread, Biological aerosol as a source of human diseases, Droplet nuclei, aerosol, assessment of air quality, brief account of air-borne microbes-bacteria, fungi, viruses, their diseases and preventive measures; phylloplane and phyllospheremicroflora. Detection of microbes in air by microscopic and culture methods.

(10 Lectures)

UNIT – II

Soil Microbiology: Soil-physical and chemical characteristics, soil as a habitat for microorganisms, microbial interactions in soil, microflora of various soil types, rhizosphere and rhizoplanemicroflora and its estimation, root exudates, its composition and effects on soil microorganisms; actinorrhiza; mycorrhizal fungi and its effect on plants; molecular markers for ecological study of soil microorganisms.

(13 Lectures)

UNIT – III

Aquatic Microbiology: Water ecosystems- types, fresh water, (pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents); potability of water as per norms of CPCB and APHA, microbial assessment for water quality, Water Quality Index (WQI), water purification, physical, chemical; microbiological characteristics of sewage.

(10 Lectures)

UNIT – IV

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 filter, activated sludge, oxidation ponds.

(15 Lectures)

UNIT – V

Bioremediation: Interaction of microorganisms with contaminated soil and groundwater, syntrophism and co-metabolism, Bioremediation as technology, design of bioremediation in practice: in-situ bioremediation and ex-situ bioremediation, Bioaugmentation: principle of bioaugmentation, application of genetic engineering in bioremediation, advantages and disadvantages of bioremediation methods, Bioremediation of inorganic pollutants and organic compounds, degradationof hydrocarbons and xenobiotics.

(10 Lectures)

Suggested Reading

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

17.4.21

MMB - C201
MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

L T Credit
3 1 4

Learning objectives:

- To make student understand about the structure and function of biologically important molecules.
- To know the historical background of DNA structure and its role as genetic material.
- To know about DNA, RNA and the molecular events that govern cell functions.
- Become familiar with different tools and techniques used in genetic engineering and recombinant DNA technology.
- To understand the applications of DNA modifying enzymes, cloning strategies, vector types, and screening of recombinants
- Students will know how genes express and regulate in prokaryotic cells.

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.
- Amplify the DNA using PCR for the diagnosis and DNA fingerprinting.
- Describe how protein synthesis occur in procaryotic cell and enzyme involved in it.

UNIT - I

Nature of Nucleic acids- Nucleic acids as genetic material (evidences from bacteria, bacteriophages, bacterial conjugation, RNA viruses); DNA structure- historical aspects and current concepts, organization of DNA in eukaryotic cell, DNA torsion angles and sugar puckering; types of RNA- rRNA, mRNA (the 5' cap, non-coding region, initiation codon, coding region, termination codon, poly-adenylation); tRNA (structure of tRNA-clover leaf model).

(10 Lectures)

UNIT – II

DNA Replication, Damages and Repair Systems- Watson and Crick's model of DNA replication (experimental evidence), enzyme involved in DNA replication (DNA polymerase I, Pol II, Pol III, DNA ligase); mechanism of DNA replication; DNA damage and repair systems- types of damage (deamination, oxidative damage, alkylation, pyrimidine dimers); repair pathways- methylation -directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair, SOS repair.

(15 Lectures)

UNIT – III

Gene Expression and Regulation- Gene expression- RNA polymerase, site of transcription; transcription- chain initiation, chain elongation, chain termination; post-transcriptional processing of RNAs- methylation, polyadenylation and splicing of mRNA; translation– charging of tRNA, initiation of polypeptide synthesis, elongation of polypeptide chain, termination of polypeptide chain; gene regulation- negative regulation- *lac* operon of *E. coli* promoter, repressor and operator genes, structural gene.

(15 Lectures)

UNIT – IV

Cloning Enzymes and ` Vectors– Essential enzymes used in rDNA technology: nucleases, restriction endonucleases, alkaline phosphatases, DNA polymerase, terminal transferases, ligase, reverse transcriptase; restriction digestion, ligation; cloning vectors - plasmids cosmids, Ti plasmids, BAC vectors, YAC vectors; cloning strategies, gene libraries- cDNA and genomic libraries.

(10 Lectures)

UNIT – V

Blotting Methods and Gene Sequencing– PCR- working principle and applications; electrophoresis; blotting techniques- Southern blotting,Western blotting; Northern blotting,nucleic acid hybridization; gene sequencing methods: Maxam-Gilbert methods, Sanger & Nicolson method, automated gene sequencing.

(10 Lectures)

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

17.4.21

MMB - C202
MICROBIAL GENETICS AND GENOMICS

L T Credit
3 1 4

Learning objectives:

- To know the Genetic constitutents 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.
- To make the students to understand genome analysis, sequence analysis and protein analysis
- To make the students to know the tools used in Bioinformatics

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.
- Use the computational tools used for sequence analysis tools
- Construct phylogenetic tree and how to access NCBI to use BLASTA and FASTA

UNIT - I

Essentials of Genetics: Genetic notations- prototrophs, auxotrophs, diploid, and electroporation; Gene as unit of mutation and recombination, molecular nature of mutation, origin of resistance due to spontaneous mutation.Model organisms and genetic analysis of bacteria and yeast;locating a genes on a DNA molecule. **(14 Lectures)**

UNIT - II

Gene transfer mechanisms-Bacterial transformation (detection of transformation, development of competence, mechanism of transformation, transfection); conjugation- and compatibility, the F-factor, the conjugal transfer process; high frequency recombination (Hfr) strains; the order of chromosome transfer; formation of F prime (F'); transduction - generalized transduction; abortive transduction; specialized transduction, sexduction. **(14 Lectures)**

UNIT - III

Genetic recombination– Mechanism of recombination, Holliday model for general recombination; non-reciprocal general recombination; site specific recombination; transposable elements – classes of transposable elements; nomenclature of transposable elements, insertion sequence (IS elements), transposon family (structure, mechanism of transposition) **(12 Lectures)**

UNIT - IV

Microbial genomics- Introduction - functional and comparative genomics, proteomics, environmental genomics, genome evolution in microbes, phylogenetic trees.,whole genome shotgun sequencing, library construction **(10 Lectures)**

UNIT - V

Bioinformatics - -Introduction, gene anotation, random sequencing, fragment alignment and gap closure, editing;databases, database similarity search BLAST, FASTA, metagenomics: basic concepts, application, bioinformatics. **(10 Lectures)**

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

17.4.24

12/12/24

MMB - C203
FOOD AND DAIRY MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

- To know the spoiling microorganism responsible for food spoilage.
- To learn the preservative technique for the preservation of food commodities.
- To get the knowledge of factor that affect microbial growth in food.
- To understand fermentation technologies in the food processing industry.
- To understand the different food regulatory bodies and their functioning

Learning outcomes:

At the end of course student will be able to

- Use the principles of preservation techniques to preserve the food.
- Detect or isolate food borne pathogen from food contaminated with microorganism.
- Explain the different method of disinfection used in industry and also how to maintain quality of product.
- Prepare and develop dairy products in laboratory.
- Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food

UNIT – I

Food substrates, its spoilage and preservation– Microorganisms and their importance in food microbiology - food-borne molds, yeast, bacteria, general features, principles of food preservation; asepsis- removal of microorganisms (anaerobic conditions, high temperature(D-value, Z-value and F-value), low temperature, drying), Mechanism of chemical preservation, chemicals used as preservative, canning,food additives, concept of modified atmosphere packaging (MAP).

(13 Lectures)

UNIT – II

Contamination and Spoilage –Factors influencing microbial growth in food– extrinsic and intrinsic factors; Cereals, sugar products, vegetables, fruits, meat and meat products; milk and milk products, fish and sea food, poultry; spoilage of canned food; detection of spoilage and characterization.Contamination and spoilage of cereals, sugar products, fruits, meat products, milk and milk products, fish and sea food; detection of spoilage and characterization.

(13 Lectures)

UNIT – III

Food-borne infections and intoxications – Bacterial and non- bacterial intoxication (with examples of infective and toxic types)– *Brucella, Bacillus, Clostridium, Escherichia, Shigella, Staphylococcus, Vibrio, Yersinia;* Protozoa, algae, fungi (aflatoxin) and viruses; food borne outbreaks– laboratory testing procedures, preventive measures, food sanitation in manufacturer and retail trade; Food control agencies and its regulations.

.(11 Lectures)

UNIT – IV

Indicators of microbial food quality – brief account of microbes (coliform group, enterobacteriaceae group, enterococcus group) and microbial products that correlate with food quality, control of microbiological quality of foods – training, facilities and operation, equipments, cleaning and disinfection, HACCP concept, hazard analysis, identification of CCPs and establishment of CCP limits .

(10 Lectures)

UNIT – V

Dairy microbiology: Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumis, kefir, dahi and cheese, Probiotics:concept of probiotics, prebiotics, and synbiotics, health benefits, types of microorganisms used, probiotic foods available in market.

(10 Lectures)

Suggested Reading

1. Doyle et al., Food Microbiology: Fundamentals and Frontier, American Society of Microbiology
2. William C Frazier, Food Microbiology, MacGraw Hills Education.
3. Adam and Moss, Food Microbiology, Royal Society of Chemistry

17.4.21

MMB - C204
INDUSTRIAL MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

- To understand the scope and application of industrial microbiology.
- To learn the preservative technique for the preservation of industrially important microorganism.
- To get the knowledge IPR and other law related to industry.
- 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 microorganism.
- Use the principles of preservation techniques to preserve the industrial important microorganism and also how to improve the strain
- Make use of fermentor to produce alcoholic beverage and other fermentation products.
- Explain the different method of disinfection used in industry and also how to maintain quality of product.
- Prepare and develop dairy products in laboratory.
- Describe the component, role, and working of fermentor.

UNIT – I

Introduction: Scope, strategies for selection and improvement of industrial strains; preservation of gene pool in industrial organisms; industrial media and nutrition of industrial organisms; metabolic pathways for the biosynthesis of industrial microbiology products, IPR: Intellectual property right and protection (IPP), forms of protection- patents; copyrights; trade secrets; Trademarks; European Patent convention (EPC), Budapest treaty and Paris convention. **(12 lectures)**

UNIT – II

Fermentors, fermentor designing &operations: Basic functions of fermentors, types of fermentor and construction, fermentor configurations, fed-batch cultivation; design of fermentor on the basis of physiology of organisms-air lift fermentors; pilot plant, surface or solid state fermentors, batch, fed-batch, and continuous fermentation; measurement and control of fermentation parameters, pH, temperature, dissolved oxygen, foaming and aeration, Fermentation economics
(13 lectures)

UNIT – III

Downstream processing of microbial products: Solids (insolubles) removal– filtration, centrifugation, coagulation and flocculation, foam fractionation, whole broth treatment; primary product isolation–cell disruption, liquid extraction, dissociation extraction, ion-exchange adsorption, precipitation; purification– chromatography, carbon decolorization, crystallization; product isolation– crystalline processing, drying.
(12 lectures)

UNIT – IV

Sterility in industrial microbiology: Physical and chemical methods of achieving sterility, sterilization of fermentor and its accessories, media sterilization;viruses (phages) in industrial microbiology – morphological grouping of bacteriophages, lysis of hosts by phages, prevention of phage contamination, use of phage resistant mutants, inhibition of phage with chemicals, use of adequate media conditions.
(12 lectures)

UNIT – V

Fermentation products: Production of beer, wine, organic acids – citric & lactic, amino acids –glutamic acid, yeast – baker's, food, feed, ethyl alcohol, antibiotics– penicillin & cephalosporin,methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase). **(11 lectures)**

Suggested Reading

1. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
2. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
3. A.H.Patel, Industrial Microbiology, Laxmi Publication, **ISBN-10:** 9385750267
4. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10: 8123910010
5. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of Fermentation Technology, II Ed., Pergamon Press.

MMB - C301
IMMUNOLOGY

L T Credit
3 1 4

Learning objectives:

- Student will learn about the components of the immune system as well as their functions and response..
- To develop understanding of innate and adaptive immunity
- To understand different serological reaction for the diagnosis of disease.
- To integrate immunology with medical sciences and enrich the knowledge for tumor immunology, rejection of organ transplant, autoimmune disorders, hypersensitivity reaction..

Learning outcomes:

At the end of course student will be able to

- Explain the different components of immune system and how they provide defense against infection.
- Describe how our immune system protects against foreign pathogens.
- Diagnose the viral and bacterial infection through different serological test .
- Gain knowledge of different diseased conditions generated due abnormalities in immune system.
- Explain antigen antibody reactions and principles of hypersensitivity and also explain how to produce monoclonal antibody.

UNIT – I

Immune system and Immunity: History of immunology, structure, composition and function of cells and organs involved in immune system; inflammation, Host-parasite relationships; microbial infection; virulence and host resistance; immune response – naturally acquired immunity; artificially acquired immunity; immunohaematology- blood groups, blood transfusion and Rh incompatibility.

(11 Lectures)

UNIT – II

Antigens and Antibodies- Antigens- structure and properties (types, iso and allo- haptens, adjuvants); antigen specificity; Immunoglobulins (antibodies)- structure, heterogeneity – types and subtypes, properties (physico-chemical and biological); theories of antibody production; complement pathways and biological consequences of complement activation; hybridoma technology- monoclonal antibodies, methods of production; applications of monoclonal antibodies; Immunotoxins; vaccines and toxoids.

(13 Lectures)

UNIT - III

Antigen-Antibody reactions –*In vitro* methods- agglutination, Widal test, haemagglutination, precipitation, complement fixation, immunofluorescence; enzyme linked immunosorbent assay (ELISA), radioimmunoassay; *in vivo* methods – skin test and immune complex tissue demonstrations; application of these methods in diagnosis of microbial diseases.

(12 lectures)

UNIT – IV

Major hisocompatibility complex (MHC) and tumour immunology- Structure and functions of MHC and HLA system; gene regulation and Ir-genes; HLA and tissue transplantation; tissue typing methods for organ and tissue transplantation in humans; graft versus host reaction and rejection; autoimmunity- theories, mechanisms and diseases with its diagnosis; tumour immunology- tumour specific antigens, immune response to tumour, immunodiagnosis of tumour- detection of tumour markers- alpha foetal proteins, carcinoembryonic antigens, etc.

(13 Lectures)

UNIT – V

Hypersensitivity reactions- Antibody-mediated Type I; anaphylaxis: Type II; antibody dependent cell toxicity, Type III; immune complex mediated reactions; Type IV; cell mediated hypersensitivity reactions and the respective disease, immunological methods of their diagnosis; lymphokines and cytokines- its assay methods.

(11 Lectures)

Suggested Reading

1. Janis Kubey, Immunology, W.H.Freeman
2. Peter J Delves, S.J. Martins, D.R. Burtons, Roitts Essential Immunology, Wiley Blackwell
3. C.V.Rao , An Introduction to Immunology, Alpha Science International Ltd , **ISBN** 978-1842650356

17.4.21

MMB - C302
MEDICAL MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

- To know the development and contribution of scientist in microbiology.
- Student will understand the disease caused by the bacteria, fungi, virus and protozoa.
- To know the diagnosis and treatment of bacterial, fungal and viral pathogens.

Learning outcomes:

At the end of course student 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

Basics of medical microbiology- Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline, contribution of early microbiologists; classification of medically important microorganisms; normal microflora of human body, role of resident flora on human health; infection- types of infection, pathogenicity;characteristics of infectious diseases - disease cycle (sources of disease, reservoirs, carriers); transmission of pathogens. **(13 Lectures)**

UNIT – II

Bacterial Diseases: Characteristics of a successful pathogen, virulence factors- entry, adherence, invasiveness, iron sequestering, antiphagocytic factors, host-mediated pathogenesis, antigenic variation,bacterial diseases-characteristic features of causal organisms, symptoms, epidemiology, prophylaxis and treatment of diseases caused by *Salmonella, Vibrio, Mycobacterium, Neisseria, Corynebacterium, Staphylococcus.*

(16 Lectures)

UNIT – III

Viral diseases- Classification, epidemiology, symptoms, pathogenesis, diagnosis and treatment of diseases caused by adenovirus, poxvirus, herpesvirus, hepatitis B virus, influenza virus, SARS COVID-19, paramyxovirus (mumps, measles and rubella viruses), rabdoviruses, retrovirus (HIV) and ebola virus.

(13 Lectures)

UNIT – IV

Fungal diseases- Significance of fungi in human health, mycoses and mycotoxicoses, superficial mycoses (Tineanigra), subcutaneous mycoses (chromoblastomycosis, basidiobolomycosis), dermatophytoses (Tineacapitis, Tineabarbae, Tineacorporis, tineacruris, Tineaunguium, Tineapedis), systemic mycoses (histoplasmosis, candidiasis, aspergillosis). **(13 Lectures)**

UNIT – V

Diagnosis and antimicrobial therapy-Methods of specimen collection, transportation and storage;laboratory diagnosis-identification of pathogens through microscopy, culture, serology and molecular biology; antimicrobial chemotherapy - development of chemotherapy, antimicrobial drugs and their mode of actions, drug resistance, various methods of drug susceptibility testing and its significance, MICs and MBCs, antibiotic assay in body fluids; vaccines- vaccination schedules,

(15 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology.* 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Mackie and McCartney. Practical Medical Microbiology, Elsevier
3. CKJ Paniker. Test Book of Microbiology, Orient Longman
4. D.R.Arora. Medical Mycology, CBS Publisher and Distributors

17.4.21

MMB - E301
ELECTIVE - I MYCOLOGY

L T Credit
3 1 4

Learning objectives:

- Student will know the historical background development and classification of fungi.
- To understand different characteristic of fungal classes.
- Get the knowledge of negative and positive aspect of fungi.
- Learn techniques of identifying fungal pathogen from different samples.
- To get knowledge of economic importance of fungi.

Learning outcomes:

At the end of course student will be able to

- Became familiar of historical background and development of mycology.
- Characterize fungi according to their classes.
- Isolate and identify different fungal species causing plant and animal disease.
- Suggest and use fungi for the industrial purpose.

UNIT – I

Introduction – History and development of mycology, structure and criteria used in classification/identification of fungi, various fungal classification system; *Myxomycota* – general account only; brief account of Chytridiomycetes, Oomycetes; Zygomycotina-Evolution of conidium.

(12 Lectures)

UNIT – II

General Features of Fungal Classes: Ascomycotia – Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, Laboulbeniomycetes, Laculoascomycetes; Basidiomycotia- Teliomycetes, Hymenomycetes, Gasteromycetes; Deuteromycotia-Hyphomycetes, Coelomycetes, Blastomycetes.

(12 Lectures)

UNIT – III

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.

(12 Lectures)

UNIT – IV

Fungalplant pathogens: occurrence, classification, morphology, characteristics features and life cycle of *Sclerotiumrolfsii*,*Melamsporalini*., *Erysiphegraminis*, *Fusariumoxysporum*, *Alternariasolani*, *Phytophthorainfestans*, *Taphrinadeformans*, *Venturianiaegualis*.

(12 Lectures)

UNIT – V

Fungal metabolites of industrial importance–industrial alcoholic beverages and organic acids; Fungi as bioinoculant agents, mycotoxins- Aflatoxins, rubratoxin, ochratoxin; fungal enzymes of commercial importance-amylases and cellulases, mycoprotein (quorn).

(12 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. CKJ Paniker. Test Book of Microbiology, Orient Longman
3. D.R.Arora. Medical Mycology, CBS Publisher and Distributors
4. Alexopoulos, C.J. and Mims, C.W. (1979). Introductory Mycology, John Wiley, New York.
5. Pelczar, Jr., Michael, E. C. S. Chan and Noel Kreig. (2000). Microbiology. V Ed. Tata McGraw Hill Book Company.

17.4.21

MMB - E302
ELECTIVE - II PHARMACEUTICAL MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

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

Learning outcomes:

At the end of course student will be able to

- Explain the different components of immune system and how they provide defense against infection.
- Describe how antibiotic work and resistance develop in microorganism.
- suggest good practices and regulation involved in utilizing microbial product for pharmaceutical application.
- 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

Non-medicinal antimicrobial agents:- Bacteriostatic and bactericidal agents, factors affecting antimicrobial activity;non medicinal antimicrobial chemicals - sanitizers, disinfectants, antiseptics, antimicrobial action of phenols and phenolic compounds, alcohols, halogens, heavy metals, dyes, aldehydes, detergents, sources and preservation of microorganisms

(11 Lectures)

UNIT – II

Medicinal antimicrobial agents: History of chemotherapy – plants and arsenicals as therapeutics, Paul Ehrlich and his contributions, selective toxicity and target sites of drug action in microbes. Development ofsynthetic drugs – Sulphanamides, antitubercular compounds, nitrofurons, nalidixic acid, metronidazole group of drugs.Routes of drug administration: Merits and Demerits, First pass metabolism, Transport of drugs, Bioavailability, Adverse drug reaction. **(11 Lectures)**

UNIT – III

The ecology of microorganisms affecting pharmaceutical industry – The atmosphere, water, skin & respiratory flora of personnel, raw-materials, packing, equipments, building, utensils; types of microorganisms occurring in pharmaceutical products;microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants);sterilisation method: Steam sterilization, dry heat, radiation, gaseous, filteration, biological indicators

(13 Lectures)

UNIT – IV

Antibiotic sensitivity and drug resistance–Antibiotics – History and definition of antibiotics as drugs, types of antibiotics and their classification. Non-medical uses of antibiotics, Drug resistance, mechanism of drug resistance in bacteria,nutritional mutants and their importance, vitamin assay, amino acid assay, assay for growth inhibiting substances – assay for non-medicinal antimicrobials ;drug sensitivity testing methods, determination of MIC, E-test; Introduction to pharmacokinetics.

(13 Lectures)

UNIT – V

Quality control, quality assurance and validation: Good manufacturing practices (GMP) and good laboratory practices (GLP) in pharmaceutical industry;regulatory aspects of quality control; Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification;safety in microbiology laboratory, Enumeration of Microorganism, Pharmacopoeial methods for the detection of specified micro-organisms, Sterility testing, MLT, Endotoxin test (LAL test), pyrogen test.

(12 Lectures)

Suggested Reading

1. S.S.Purohit, Pharmaceutical Microbiology, AGROBIOS
2. 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
3. ChandrakantKokare. Pharmaceutical Microbiology, Nirali Publisher

MMB - E303
ELECTIVE - III CELLULAR MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

- Student will learn about Host parasite interaction
- To understand the mechanism of cell signaling in prokaryotic and eukaryotic cells.
- To know about quorum sensing.
- To understand different virulence factor responsible for the initiation of disease

Learning outcomes:

At the end of course student will be able to

- Explain the mechanism of pathogenicity
- Describe how our immune system protects against foreign pathogens.
- Explain how different kind cellular component involved in pathogenesis.
- Develop some therapeutic product from microbial metabolite.

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UNIT – I

Introduction – Bacterial diseases - mutualism, commensalism, and parasitism, bacteria and idiopathic diseases; emergence of cellular microbiology, cellular biology underlying prokaryotic and eukaryotic interactions- ultrasturucture, cytoskeleton, vesicular transport pathways, exocytosis, endocytosis, genomic expression, pathogenecity island, cell cycle and apoptosis.**(12 Lectures)**

UNIT – II

Prokaryotic and eukaryotic signalling mechanism – Eukaryotic cell to cell signalling, endocrine signalling, cytokines signalling, prokaryotic cell to cell signalling; quorum sensing and bacterial pheromones; intracellular signalling-prokaryotic signalling mechanisms and eukaryotic signalling pathways, outcomes of activation of signalling pathways. **(12 Lectures)**

UNIT – III

Infection and cell-cell interaction – Bacterial adherence, basic principles, molecular mechanisms of adhesion, bacterial strustures involved, bacterial adhesins, effect of adhesion on bacteria, effect of adhesion on host cells, bacterial invasion of host cells – mechanism, consequences of invasion, survival and growth after invasion. **(13 Lectures)**

UNIT – IV

Bacterial protein toxins: classification of toxins on the basis of activity, biological effects of toxin action- cell death, nerve transmission, signal transduction, interaction with cytokines; origin and evolution of toxin genes, therapeutic uses of toxins. **(11 Lectures)**

UNIT – V

Cellular microbiology future directions –prokaryotic and eukaryotic interactions in bacterial growth, effect of bacteria on eukaryotic growth and survival, bacterial control of eukaryotic cell cycle and apoptosis, commensal microflora in cellular conversation, application of cellular microbiology to the generation of novel therapeutics, cellular microbiology and idiopathic diseases. **(13 Lectures)**

Suggested Reading

1. CKJ Paniker. Test Book of Microbiology, Orient Longman
2. Henderson. Cellular Microbiolgy, Wiley
3. Warran Levinson .Medical Microbiology and Immunology, Appleton &Lange;**ISBN**978-0071382175.
4. Cossart P, Boquet P, Normark S, Rappuoli R. Cellular Microbiology eds. 2nd edition. American Society for Microbiology Press. 2005.

17.4.24

MMB - E304
ELECTIVE - IV AGRICULTURAL MICROBIOLOGY

L T Credit
3 1 4

Learning objectives:

- Student will learn about positive or negative interaction or association of microorganism 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

- Describe the positive and negative aspect of microbes in soil fertility.
- Explain or suggest different biocontrol methodto control pests.
- Develop biofertilizer or biopesticde in lab condition. .
- Isolate rhizobium from the root nodule of leguminous plants.

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UNIT – I

Soil- Physico-chemical properties, soil fertility, Soil genesis: formation of soil and soil factors: climate, bed rock, temperature, vegetation and precipitation; factors affecting soil properties., soil enzymatic activity, Distribution of soil microorganisms in soil., factors influencing the soil microflora., Interactions among microorganisms- antibiosis, mutualisms, commensalism, competition, amensalism, parasitism, predation.

(10 Lectures)

UNIT – II

Interactions between microbes and plants,microflora of rhizosphere and phyllosphere, microbes in composting; characteristics features of the following beneficial organisms in agriculture- Bacteria-*Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia, Cyanobacteria-Anabaena, Nostoc, Hapalosiphon*. Fungi: *Glomus*. **(13 Lectures)**

UNIT – III

Microbial biomass, Microbial transformations of carbon, nitrogen, phosphorus and sulphur. Biological nitrogen fixation, mechanism, ammonification, nitrification, denitrification and microorganisms involved in such processes. **(11 Lectures)**

UNIT – IV

Biofertilizer-bacterial ,cyanobacterial and mycorrhizal (Ecto and endomycorrhiza) , production methods of biofertilizers – significance, storage, shelf life, quality control of biofertilizers, Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer. Algal and other biofertilizers, endophytic biofertilizers.

(13 Lectures)

UNIT – V

Biological control- microbial agents for control of plant disease, production of microbial insecticides, Pseudomonads and bacillus (*B. thuringiensis*, toxin production etc.), Entomopathogenic fungi, biological control of nematodes and fungal pathogens.

(13 lectures)

Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publishers.
2. M.K.Rai, Handbook of Microbial Fertilizers, Internation Book Distributing Co.
3. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
4. Rangaswami,G. Agriculture Microbiolgy, Prentice Hall Indian Learning Ltd

17.4.21

12/4/21

MMB - E305
ELECTIVE - V MICROBIAL ECOLOGY

L T Credit
3 1 4

Learning objectives:

- To learn about classification of microorganism on the basis of oxygen and carbon source.
- To understand plant-microbes interactions.
- To provide a framework for understanding the relationship between microorganisms and their role in biogeochemical cycling in natural communities.
- To understand the technical aspect of biogas production.

Learning outcomes:

At the end of course student will be able to

- Classify the bacteria on the basis of oxygen and carbon requirement.
- Differentiate positive and negative association of microbes with plants.
- Explain the application of Extremophile.
- Explain setting up of a biogas plant.

UNIT - I

Ecological groups of microorganisms: Based on O_2 requirement (aerophile, microaerophiles, Anaerobic bacteria) requirement, based on C sources (methanotrophs, methylotrophs) , temperature, and habitat, Microbial diversity- distribution, ecological niche: plant-microbe interactions

(12 Lectures)

UNIT – II

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

(10 Lectures)

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.

(14 Lectures)

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).

(12 Lectures)

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.

(12 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Singh and Purohot, Microbial Ecology, AGROBIOS
3. Atlas. Microbial Ecology, Pearson Education ISBN13: 9788129707710.
4. Osborn A.M. Smith CCJ (2005). Molecular microbial ecology, Taylor & Francis US.

17.4.21

M.Sc. II Year

Semester – IV

MMB – C460
INDUSTRIAL TRAINING/ PROJECT REPORT
PROJECT EVALUATION
SEMINAR
VIVA-VOCE

MM : 400
Credits: 20

Project evaluation : 200
Seminar : 100
Viva-voce : 100

17.4.21

M.Sc. II Year

Semester – IV

MMB – C461
SWAYAM

Credits: 04

MM : 100

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It is mandatory for all students to submit SWAYAM certificate in the Department. The credits/marks for the course done on SWAYAM will be transferred on to the Marksheet (DMC) of the students.

17.4.21