DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

CIRCULAR NO.SU/B.Sc./08/2022

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies and Ad-hoc Boards with recommendation of the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the **following syllabi of Bachelor of Science with Regulation under the scheme of Choice Based Credit & Grading System** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Courses	Semester
1.	B.Sc.Electronics(Optional)	Ist and IInd semester (First Year)
2.	B.A./B.Sc.Mathematics(Optional)	Ist and IInd semester (First Year)
3.	B.Sc.Chemistry(Optional)	Ist and IInd semester (First Year)
4.	B.Sc.Physics(Optional)	Ist and IInd semester (First Year)
5.	B.Sc.Analytical Chemistry	Ist and IInd semester (First Year)
6.	B.Sc.Geology (Optional)	Ist to VIth semester (First to Third)

This is effective from the Academic Year 2022-23 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/2022/ 6852-62
Date:- 10.08.2022.

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Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,

2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] The Director, Board of Examinations & Evaluation, Dr.BAMU,A'bad.

2] The Section Officer,[B.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
3] The Programmer [Computer Unit-1] Examinations, Dr.BAMU,A'bad.
4] The Programmer [Computer Unit-2] Examinations, Dr.BAMU,A'bad.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.BAMU,A'bad.
6] The Public Relation Officer, Dr.BAMU,A'bad.
7] The Record Keeper, Dr.BAMU,A'bad.

Dr. Babasaheb Ambedkar Marathwada University
Aurangabad – 431 517 (MS) India

Undergraduate Bachelor Degree Program in Science

(B. Sc.)

Microbiology (Optional Subject)

Course Structure and Curriculum

(Outcome based Curriculum)

Choice Based Credit System

(Effective from Academic Year 2022-23)

6/08/22

Dean
Faculty of Science & Technology
Dr. Babasaheb Ambedkar Marathwada
University, Aurangabad

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1. Preamble

Microbiology is a broad discipline of biology which encompasses five groups of microorganisms i.e. bacteria, protozoa, algae, fungi, viruses. It studies their interaction with their environments as well as how these organisms are harnessed in human endeavour and their impact on society. The study has its extensions in various other conventional and advanced fields of biology by employing microbes as study models. Since inception of microbiology as a branch of science, it has remained an ever-expanding field of active research, broadly categorized as pure and applied science. Microorganisms were discovered over three fifty years ago and it is thought that a huge diversity yet remains to be explored. Knowledge of different aspects of Microbiology has become crucial and indispensable to the society. Study of microbes has become an integral part of education and human progress. There is a continuous demand for microbiologists as work force – education, industry and research. Career opportunities for the graduate students are available in industry and research equally.

Introduction: In the post globalization world higher education has to play a significant role in creation of skilled human resources for the well-being of humanity. The barriers among the academic fields seem to have dissolved. However, the disparities in the field of curriculum aspect, evaluation and mobility exist. With the changing scenario at local and global level, the syllabus restructuring should keep pace with developments in the education sector. Choice Based Credit System (CBCS) is being adopted and implemented to address the issues related to traditional system and it also aims to maintain the best of earlier curriculum. The student is at the centre of CBCS. The present curriculum focuses on students' needs, skill development, interdisciplinary approach to learning and enhancing employability. Microbiology curricula are offered at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible angles. In addition, students are to be trained to apply this knowledge in day-to-day applications and to get a glimpse of research.

Objectives to be achieved:

- To enrich students' knowledge and train them in the pure microbial sciences
- To introduce the concepts of application and research in Microbiology
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

Course Structure:

- For First year: Student has to select 4 different subjects among the subjects offered by the College /Institute.
- For Second year: Student has to select 3 different subjects among 4 subjects chosen in first year.

• For Third year: Student has to select only 1 subject among the 3 subjects opted in second year

• CGPA will be calculated based on core 132 credits only

• Each theory credit is equivalent to 15 clock hours of teaching (12hrs classroom+3hrs of tutorials-active learning method) and each practical credit is equivalent to 30 clock hours of teaching in a semester.

• For the purpose of computation of workload, the following mechanism may be adopted as per UGC guidelines: i) 1 Credit = 1 Theory period of one-hour duration per week ii) 1 Credit = 1 Tutorial period of one-hour duration per week iii) 1 Credit = 1 Practical period of two-hour duration per week

• Each theory Lecture time for FY, SY, TY is of 1 hour = 50 min

• Each practical session time for FY is of 3 hour 15 min = 195 min

• Each practical session time for SY & TY is of 4 hour 20 min = 260 min

Program Educational Objectives (PEOS), Program Ootcomes (POS) & Program Specific Outcomes B.Sc. (MICROBIOLOGY)

Vision

- To be a center of excellence in teaching as well as practical training in Microbiology and
- To serve society by promoting science in institution.

Mission

- To evaluate, add to and transmit Knowledge in the field of Microbiology
- Motivate the students to qualify for good results and prepare the students for independent growth and progressive careers for long – term professional employment.
- To improve upon the quality of education with special emphasis on practical hands

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO 1: To impart fundamental knowledge of the subject
PEO 2: To emphasize on hands on training
PEO 3: To develop research skills

PEO 4: To apply the subject knowledge for human welfare

PROGRAM OUTCOMES (POS)

PO 1: Understanding fundamentals and conceptualizing the facts
PO 2: Improvisation of practical skills
PO 3: Enhancement of research skills
PO 4: Enlightening new thoughts and giving it a modern approach

PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO 1: Apply the fundamental knowledge to succeed in their careers.
PSO 2: Able to develop skills through innovative, non-conventional coursework that stresses inquiry-based learning.
PSO 3: Encourage and provide opportunities for students to participate in research.
PSO 4: A learning environment that excites and informs undergraduates about microbiology and the many ways that it is relevant to everyday life.

Eligibility for Admission:

First Year B.Sc.: a. Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Biology; and two of the science subjects such as Physics, Chemistry, Mathematics, Geography, Geology, etc.

OR

b. Three Years Diploma in Pharmacy Course of Board of Technical Education conducted by Government of Maharashtra or its equivalent.

OR

c.Higher Secondary School Certificate (10+2) Examination with English and vocational subject of + 2 level (MCVC) - Medical Lab. Technician (Subject Code = P1/P2/P3)

Admissions will be given as per the selection procedure / policies adopted by the respective college keeping in accordance with conditions laid down by the University.

Chemistry as one of the optional with Microbiology is essential for admission in M.Sc. (Microbiology).

Reservation and relaxation will be as per the Government rules.

Medium of Instruction: English

Name of the Program : B.Sc. Industrial Microbiology

1. **Duration of the program**: (a) Minimum duration : 03 Years

2. Scheme of examination (Evaluation)

(a) Mid Semester Examination : 10 Marks
(b) Internal Assessment : 10 Marks /paper
(c) End Semester Examination : 40 Marks / paper

4. Assessment:
   1) Internal Assessment:
   2) End Semester Examination

Attendance :

1 A student attending at least 75% of the total number of classes* held shall be allowed to appear at the concerned Semester Examinations subject to fulfillment of other conditions laid down in the regulations.

2. A student attending less than 60% of the total number of classes* held shall not be allowed to appear at the concerned Semester Examinations and he /she has to pursue admission to the same Semester in the very next year for attending the classes and appearing at the said Semester Examination.

*Such attendance will be calculated from the date of commencement of classes or the date of admission, whichever is later.

Semester No.	Paper No.	Course Code	Title of Paper	Theory	Internal assessment	Total Marks	Min Marks
		B.Sc. First Year					
I	I	MCB-111	Fundamentals of Microbiology	(40)	10	(50)	20
	II	MCB-112	Microbial Techniques	(40)	10	(50)	20
	III	MCB-121	Lab course I (based on MCB-111 & MCB-112)			(50)	20
			Total			150	60
II	IV	MCB-211	Microbial Chemistry	(40)	10	(50)	20
	V	MCB-212	Bacterial Cytology and Virology	(40)	10	(50)	20
	VI	MCB-221	Lab course II (based on MCB-211 & MCB-212)			50	20
			Total			150	60
		B.Sc. Second Year					
III	VII	MCB-311	Environmental Microbiology	(40)	10	(50)	20
	VIII	MCB-312	Immunology and Clinical Microbiology	(40)	10	(50)	20
	IX	MCB-321	Lab course 3 (based on MCB-311)			50	20
	X	MCB-322	Lab course 4 (based on MCB-312)			50	20
			Total			200	80
IV	XI	MCB-411	Food and Dairy Microbiology	(40)	10	(50)	20
	XII	MCB-412	Microbial Physiology	(40)	10	(50)	20
	XIII	MCB-421	Lab course 5 (based on MCB-411)			50	20
	XIV	MCB-422	Lab course 6 (based on MCB-412)			50	20
			Total			200	80
		B.Sc. Third Year					
V	XV	MCB-511	Enzymology and Metabolism	(40)	10	(50)	20
	XVI	MCB-512	Microbial Genetics	(40)	10	(50)	20
	XVII	MCB-521	Lab course 7 (based on MCB-511)			50	20

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	XVIII	MCB-522	Lab course 8 (based on MCB-512)			50	20
			Total			200	80
VI	XIX	MCB-611	Molecular Biology& Genetic Engineering	(40)	10	(50)	20
	XX	MCB-612	Industrial Microbiology	(40)	10	(50)	20
	XXXI	MCB-621	Lab course I (based on MCB-611)			50	20
	XXXII	MCB-622	Lab course I (based on MCB-612)			50	20
			Total			200	80
Internal Assessment: Based on Assignment, Seminar, Unit Test & overall attendance and performance of the student							

Dr. V.S. Hamde
Chairman
B.O.S. Microbiology

Course structure of B.Sc. I (Microbiology optional subject)

(Choice Based Credit System)

Semester I (Core Courses and Skill Enhancement Courses)				
Course	**Course Title**	**Teaching time/week**	**Marks**	**Credits**
MCB-111	Fundamentals of Microbiology	2 hours	50(40+10)	2
MCB-112	Microbial Techniques	2hours	50(40+10)	2
MCB-121	Lab course I (based on MCB-111 & MCB-112)	3 hours	50	1.5

Total credits for Semester I : 6 (Theory : 4 ; Laboratory : 2)

Semester I I (Core Courses and Skill Enhancement courses)				
MCB-211	Microbial Chemistry	2 hours	50 (40+10)	2
MCB-212	Bacterial Cytology and Virology	2 hours	50 (40+10)	2
MCB-221	Lab course-2 (based on MCB-211 & MCB-212)	3 hours	50	1.5

Total credits for Semester II : 6 (Theory : 4 ; Laboratory : 2)

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B.Sc. First Year Semester – I

Paper -MCB-111. Fundamentals of Microbiology

Unit:I History of Microbiology (10)

1. Definition and concepts
1. Discovery of microorganisms: Contribution of Antony Van Leeuwenhoek.
2. Spontaneous generationtheory :Aristotles view, Charles Darwin view. Controversy over spontaneous generation
3. Recognition of the microbial role in diseases: Koch's postulates, Koch's direct stimulation theory, Aseptic surgery
4. Discovery of microbial effects on organic and inorganic matter.
5. Recognition of the microbial role in fermentation: Contribution of Louis Pasteur Stahls theory of fermentation,
6. Pure culture concept
7. Patenting of microorganisms : contribution of Louis Pasteur and AnandChakraborty

Unit: II Microscopy(10)

1. Introduction of Magnification, resolving power, depth of focus, focal length, numerical aperture.
1. Electron Microscope: (SEM and TEM).
2. Phase contrast microscope.
3. Dark field microscope.
4. Fluorescence Microscope.
5. Atomic Force Microscope

Unit: III Taxonomy of microorganisms. (10)

1. Taxonomic rank.
2. Major characteristics used in taxonomy (Morphological, Physiological, Immunological, Metabolic).Compositions of proteins, Composition of nucleic acids, Nucleic acids hybridization, Nucleic acid sequencing, 16S rDNA.
3. Classification system
4. Numerical taxonomy.
5. Bergey's manual of systematicBacteriology, General characteristics enlisting all parts with major characters and examples in brief.

Unit:IVGeneralcharacteristics ofMicroorganisms (10)

1. Fungi
2. Actinomycetes
3. Algae
4. Mycoplasma
5. Rickettssia.
6. Archaebacteria
7. Protozoa

Unit : V Tutorials, Seminars and Assignments (05 Periods)

B.Sc. First Year (CBCS)
Paper –MCB-112-Microbial Techniques

Unit– I: Sterilization – contribution of (10)

Richard J.Petri :Petriplates and their types
Schroeder and Dusch : Cotton plug
C. Salomonsen : Hot air oven
Wire loop: Introduction, diameter, Connors transfer loop, Roux and Yersin, Platinum needle.
Agar : Discovery, introduction, structure ,classification of agar and agar gels.Uses of agar.
Agar slant apparatus : Introduction, diagram and angles used in slant preparation.
Incubators : Types of incubator (Anaerobic incubator, Perfusion incubator, Pocket incubator, Thermal gradient incubator)
Pasteurizer: Beer pasteurizing apparatus.
Autoclave :
Hot air oven
Radiations : (Gamma rays, X rays, Ultra violet rays)

Unit II: Sterilization and Disinfection (10)

a. Sterilization- introduction
b. Definition and concept: Disinfection, Germicide, Antiseptics, Bacteriostatic, Bactericidal
b. Chemical sterilizing agents (Spectrum, Mode of action, Application, Limitations)
Phenolic, Alcohols, Halogens , Heavy metals ,Quaternary ammonium Compounds ,Aldehydes.
c. Sterilization using gases (Spectrum, Mode of action, Application, Limitations) :Sulfur dioxide, Ethylene oxide and Beta propiolactone
d. Evaluation of disinfectants : Phenol coefficient

Unit –III Pure Culture Techniques (10)

A. Development of pure culture
B. Single Cell Isolation
C. Methods for isolation of pure culture -
Streak plate method, Pour plate method, Spread plate methods
D. Handling of pathogenic microorganisms
E. Methods for disposal of microbial wastes
F. Techniques for enumeration of microorganisms
Cell count by Direct Microscopic Count, Colony count
Measurement of turbidity, Measurement of cell mass

Cultivation of microorganisms

A. Properties of a good culture medium.
B. Definitionand concept
a. Living media :Embryonated chicken eggs, Tissue culture&Animals
b. Non living media :Natural, Semi-synthetic&Synthetic
C. Types of culture media on the based of their specific use w.r.t. role of media ingredients (with examples)

Selective ,Differential, Enriched , Enrichment, Assay , Minimal , Maintenance and Transport media

D. Role of Buffers in culture media.

E. Media used for cultivation of bacteria, fungi, actinomycetes, yeasts, algae and photosynthetic bacteria (at least two)

F. Techniques for cultivation of anaerobes : John H. Brewer Instrument and Anaerobic Jar closure assembly

G. Method for detecting microscopic organisms using bacteriophage : Kent J. Voorhees Apparatus.

H. Measurement of gas production by Wilkins et al method.

Unit IV – Stains and Staining (10)

A. Fundamentals of microbial staining
   a. Definition : stain, dye, chromogen, chromophore, auxochrome,
   b. Types of stains: Acidic, basic
   c. Staining reagent: Primary stain, Secondary stain, Mordant and Decolorizer
   d. Fixation of Smear: Physical and Chemical methods
   . Physicochemical basis of staining.

B. Staining methods
   a. Staining (Principle, application and methodology)
      Monochrome staining and Negative staining
   b. Differential staining (Principle, application and methodology)
      Gram's staining and Acid fast staining
   c. Structural/ Special staining procedures
      Cell wall, Capsule, Spore, Flagella, Metachromatic granule,
   d. Staining of Fungi.
   c. Micrometry
   d. Hanging drop technique
   e. Microscopic photograph

Unit : V Tutorials, Seminars and Assignments (05 Periods)

B.Sc. First Year (CBCS)
Paper - MCB-211 .Microbial Chemistry

Unit- I : Basic of atoms and molecules (10)

I. Concepts of Atom, Molecule, pH, Acids, Bases, Buffer, Solvent, Solute, Types of solutions (hypotonic, hypertonic, isotonic) and redox potential
II. Types of Isomers and their importance in biology.
III. Types of bonds and their importance: Electrovalent, covalent, non-covalent, Ester, Phospho-diester, Thio-ester, Peptide, Glycosides

Unit II : Amino acids and Proteins (10)

Amino Acids: Definition, General structure and features of amino acids, amphoteric nature, List of 20 amino acids. Classification of amino acids: based on R-group, Uncommon amino acids and their functions.
Proteins: Definition. Classification of Proteins, Primary, secondary, tertiary, quaternary structures of proteins (outline). Biological significance of proteins. Classification of Proteins, Primary, secondary, tertiary, quaternary structures of proteins . Biological significance of proteins

Unit - III : Carbohydrates (10)

a) Definition and Classification. b] Monosaccharides, Triose, Tetrose, Pentose, Hexose (Examples and structures). c] Disaccharides: Glycoside Linkage (Lactose, Maltose and Sucrose). d] Oligosaccharides: Trisaccharides (Structure of raffinose).
e] Polysaccharides: Homo and heteropolysaccharides, structure of (Starch, Cellulose, Hyluronoc acid)., Biological Significance of carbohydrates.

Unit IV : Lipids and Nucleic acids (12)
Definition and Classification. Types of Lipids: Simple lipids-Triglycerides.
Conjugated Lipids- Phospholipids, Phosphatidic acid, and Cholesterol.
Biological importance of Lipids.
Purine , pyrimidine bases , Ribose and Deoxyribose sugars, phosphodiester bonds, m-RNA, t-RNA and r-RNA.

Unit V Tutorials, Seminars and Assignments (05 Periods)

Paper MCB-212- Bacterial Cytology and Virology

Unit– 1: Bacterial morphology and outer ultra structures of cell. (10)

1. Cytology of a typical bacterial cell. Prokaryotic and Eukaryotic cell structure.
2. Morphology – size and arrangement of bacterial cells.
3. Structure, chemical composition and functions of:
   - i. Capsule and slime layer
   - ii. Flagella : Arrangement, Structure, mechanism of flagellar movement, Chemotaxis, phototaxis, Magnetotaxis.
   - iii. Pili
   - iv. Cell wall : Gram positive and Gram negative bacteria
   - v. Cell membrane /Unit membrane

Unit – 2: Bacterial morphology and inner ultra structures of cell. (10)

- i. Bacterial Endospores: Structure, Formation and Germination process
- ii. Ribosomes.
- iii. Nuclear material
- iv. Mesosomes
- v. Reserved food material: Nitrogenous, Non-nitrogenous (Starch and Glycogen, Poly beta hydroxy butyric acid), polyphosphate, Sulfur granules.

4. Bacterial cell division: Binary fission

Unit -3: Viral Morphology and Genomic structure (10)

1. Introduction and General characteristics
2. Discovery and Early development of Virology
3. Virions, Viroids, Virusoids, Prions.
4. Structure of viruses: Size, Shape, Proteins, Capsids and capsomers.

   i) The structure of filamentous viruses and nucleoproteins
   ii) The structure of isometric viruses (tetrahedron, cube, octahedron, dodecahedron, icosahedrons)
   iii) Enveloped (membrane bound) viruses
   iv) Viruses with head-tail morphology

5. Viral genomes

   i) Positive-Sense Single stranded RNA Viruses
   ii) Negative-Sense Single stranded RNA Viruses
   iii) Double-Stranded RNA Viruses
   iv) Retroviruses
   v) Double-Stranded DNA Viruses
   vi) Single-Stranded DNA Viruses

Unit - 4: Classification, Multiplication, Cultivation and Impact of viruses (10)

1. Classification: ICTV (International Committee on Taxonomy of Viruses), Baltimore and LHT System)

2. Multiplication: Lytic cycle in Animal and Bacteria
3. Lysogeny
4. Cultivation of Viruses: Egg inoculation and Tissue culture
5. List of common viral diseases with causative agents and important symptoms in plants, animals and human beings.
6. Emerging human viruses (Brief)

    i. H1N1 Influenza Virus (Swine Flu)
    ii. Avian Influenza (Bird Flu)
    iii. Ebola Hemorrhagic Fever (Ebola virus disease)
    iv. Chikungunya Virus
    v. Severe acute respiratory syndrome (SARS)
    vi. Nipah virus disease
    vii. Zika virus infection

7. Viruses and cancer
8. Viruses used in Recombinant DNA technology

Unit V : Tutorials, Seminars and Assignments (05 Periods)

B.Sc. First Year
MICROBIOLOGY

Lab Course 1MCB -121

1. Microscopy- Different parts of compound microscope. Use and care of compound microscope
2. Preparation of Standard Operating Procedures (SOPs) for common microbiology laboratory instruments: Introduction to Laboratory equipments, Construction, Operation and utility of laboratory equipments.
   a)Autoclave
   b) Hot air oven
   c) Incubator
   d) pH meter
   e) Centrifuge
   f) Colorimeter/Spectrophotometer
   g) Anaerobic jar
   h) Seitz filter
   i) Laminar air flow
3. Disinfection & discarding techniques in laboratory
4. Introduction of : Wire loop, Agar , Agar slant apparatus , Incubators, Pasteurizer, Autoclave , Hot air oven, Radiations
5. Staining
   a. Simple staining: Monochrome, Negative
   b. Differential : Gram's staining
   c. Structural staining:
      i. Cell wall staining (Chance's method)
      ii. Capsule staining (Maneval's method)
      iii. Spore staining (Schaeffer and Fultons's method)
6. Hanging drop technique.
7. Measurement of size of cells by micrometry
8. Preparation of buffers- Citrate and phosphate buffer
9. Study tour to related laboratories /industries

B.Sc. First Year
MICROBIOLOGY

Lab Course 2MCB-221

1. Cleaning and sterilization of glassware: Preparative procedures for glasswares before sterilization.

2. Study of aseptic techniques: Preparation of cotton plugs for test tubes and pipettes, wrapping of petriplates and pipettes, Methods of inoculum transfer .

3. Preparation of Media: Nutrient broth, Nutrient Agar, MacConkey"s broth and agar, Sabouraud's Agar.

4. Study of bacterial growth curve

5. Study of methods of isolation of bacteria from mixed cultures:

i) Streak plate technique

ii) Spread plate technique

iii) Pour plate technique

6. Morphological , Cultural characterization of isolates.

7. Effect of pH, Temperature & UV on bacterial growth

8. Isolation of Bacteria and Fungi from soil

a) Preparation of serial dilutions.

b) Spread plate and pour plate techniques

11. Qualitative tests for:

I. Carbohydrates- Benedict's test

II. Proteins- Biuret Test

III. Nucleic acids- DNA-Diphenyl amine test and RNA- Orcinol test

Books Recommended for Theory& Practical of B.Sc.I, SEM I & II

1. General Microbiology by Hans G. Schlegel.
2. General Microbiology by R.Y. Stayner.
3. Fundamentals of Microbiology by Crabtree, & Martin Frobisher.
4. Fundamentals of Bacteriology by A.J. Salle
5. A text of Microbiology by Dubey RC and Maheswari DK (2012).
6. GeetaSumbali and Mehrotra RS (2009). Principles of Microbiology.
7. General Microbiology volume 1 and 2 by Powar CB and Daginawala H F.
8. Microbiology by Pelczar TR M J Chan ECS and Kreig N R.
9. Robert F Boyd (1984). General microbiology.
10. Microbiology by Prescott L M, J P Harley and D A Klein.
11. Introduction to Microbiology by Ingraham J.L. and Ingrahm C.A
12. History of Microbiology & Microbiological Methods by A.B. Solunke, V.S. Hamde, R.S. Awasthi& P.R. Thorat.
13. General Microbiology by Hans G. Schlegel.

14. Air Microbiology an environment & Health Prospective by S.C. Aithal, P.S. Wakte& A.V. Manwar.
15. Water Microbiology by S.C. Aithal, & N. Kulkarni.
16. General Microbiology by R.Y. Stayner.
17. A text of Microbiology by Dubey RC and Maheswari DK.
18. Manual of Methods for Pure Culture Study by A.B. Solunke, V.S. Hamde, R.S. Awasthi& P.S. Wakte.
19. Text Book of Microbial Chemistry and Physiology by P.H.Kumbhare&U.V.ThoolRajaniPrakashan, Nagpur.
20. Text Book of Applied Microbiology by P.H.Kumbhare&U.V.Thool, RajaniPrakashan, Nagpur.
21. General Virology by Luria S.E.
22. A textbook of Fungi and Viruses by Dubey H.C.
23. Alcamo Fundamentals of Microbiology
24. Experiments in Microbiology by Aneja K.R.
25. Introduction to Microbial Techniques by Gunasekaran,
26. Elementary Microbiology by Modi H.A.
27. Handbook of Media, Stain and Reagents in Microbiology by Deshmukh A.M.,
28. Biology of Microorganisms by Brock T.D. and Madigan M.T.
29. Biochemistry by J.L. Jain
30. Biochemistry by Zubay
31. Principles of Biochemistry by Nelson David L and Cox Michael M. Lehninger.
32. Disinfectants and Disinfection by A.G. Young
33. Filtration by F.E. Vey
34. Biological Stains by H.J. Conn.

B.Sc. Second Year [Microbiology]
Semester III, PaperMCB-311
Environmental Microbiology

Unit 1:Microbiologyof air: **(10)**

Composition of air.

Numberandkindsofmicroorganismsinair(indooroutdoorDistributionandsourcesofourborne microorganisms.

Air as a carrier of microorganisms

Droplet, droplet nuclei, Dispersal of Microorganisms in air. Techniques for microbiological analysis of air.

Significance of air flora in human health, hospitals, industries.

Air sanitation- dust control, UV radiation, bactericidal vapors, filtration, Laminar airflow system (HEPA filters)

Unit2.MicrobiologyofWaterandWastewater: **(10)**

Sources of microbes in water.

Determining sanitary quality of water indicators of fecal pollution:Fecalandnonfecalcoliforms(IMVIC&elevatedtemperaturetests).

Bacteriologicalexaminationofwater:Presumptive,confirmed,completedtest,SPC,MPNandMembrane filtertechnique.

Waterpurificationmethods:Disinfectionofpotablewatersupplies.Definitionof sewageandchemicalcomposition.

Microbiologyofsewagetreatment:septictank,evapotranspiration,Imhoff'stankMuncipal sewagetreatmentprocess:Primary,Secondary,(aerobicandanaerobicprocess), chemicaltreatment chlorination.

Disposaloftreatedsewage.(Sludgeasfertilizer,imigationanddilution)

Unit3.MicrobiologyofSoil: **(10)**

Soilas an environment,asaculturemedium.

Brief account and definition of microbial interactions with examples.

Symbiosis, mutualism, commensalism, competition, synergism, satellitism, predation, parasitism with example:

I Microbe-microbe interactions (any one example)

II. Plant-microbe interactions (Phyllosphere)

III. Animal-microbe interactions[Rumen; Bioluminescence)

Majorbiogeochemicalcycles:Carbonnitrogen,phosphorus,sulphur(cyclicturnoverwithmicrobiology). General account of microbes used as biofertilizers, phosphatesolubilizers.

(Defination,Types,advantages,disadvantages)Rhizosphere:definition,rhizosphereandnonrhizosph eremicrofloraandR:Sratio,significanceforfertility.

Unit4.EnvironmentalPollution (10)

Airpollutionsources,causes,healthhazards,airbornediseasesany5(listofcausativeagents) Water pollution : sources, causes, health hazards, waterborne diseases any 5(list of causative agents). Waste water pollution: sources, causes, health hazards,Eutrofication and Acid mine drainage :basic concept,
Soil:sources,causes,healthhazards,

Unit V : Tutorials, Seminars and Assignments (05 Periods)

B.Sc. Second Year
MICROBIOLOGY

Lab Course-3 MCB-321

1. Enumeration ofmicrobesfrom:Indoorandoutdoorenvironment.
2. Bacteriologicalexaminationofdrinkingwater:MPN,SPC
3. Qualitativeanalysisofwater:Presumptive,Confirmed,Completedtest
4. Demonstration of Automated water testing methods (The growth direct by Rapidmicro biosystem, Bioburden testing)
5. Dust Fall Jar: Construction and analysis of pollution trend in the selected area.
6. Collection of Data from Internet : Respiratory suspended particulate matter (RSPM) in various metro cities in India
7. Fabrication: Fabricate Sedimentation Tank in the laboratory.
8. Testingof(water&domesticsewage)forphysicochemicalparameterslikechlorine,phosphate,nitrateandBODandCOD,TS, TDS, TSS.
9. Isolationof E.coliandidentificationbyIMVIC
10. Isolationofcoliphagesfromsewage
11. Isolationentericpathogensfromdomesticsewage(salmonellaandshigellaspp)

B.Sc. Second Year
[Microbiology] Semester III
PaperMCB-312 Immunology and Clinical Microbiology

Unit – 1. Normal flora and Immunity(10)

- Normal flora of human body and its significance
- Definition and classification: Innate / Acquired, Barriers and types with examples. Cellular/Humoral immunity, Humoral factors of immunity: complement, interferon.
- Antigens (Immunogens): Definition, determinant's of antigenicity, a) size, b) chemical, c) nature, d) susceptibility to tissue enzymes, foreignness, specificity of antigens. Types of antigens: species specific antigen, Isoantigen, autoantigen, organ specific antigen, MHC antigen, Heterogenetic (Heterophile) antigen, antigens in relation to bacterial cell.
- Antibodies (Immunoglobulins): Structure, classes and functions, Types of antibodies: antitoxin, precipitin, agglutinin, bacteriolysin, bacteriocidin, bacteriotropin, complement fixing, neutralizing.
- Hybridoma Technology and Monoclonal Antibodies

Unit – 2. Immune system, Antigen – Antibody reactions, Vaccines and hypersensitivity (10)

- Immune system: organs and cells involved and functions, types of cells their differentiation and functions.
- General features, Mechanisms , methods & applications of Antigen- Antibody reactions
  - Precipitation
  - Agglutination:
  - Complement fixation
  - Neutralization
  - Immunofluorescence
  - ELISA

- Vaccines and toxoids: types, principles of methods of BCG, TAB, OPV, T.T., DPT, Covid-19 vaccines production, Immunization schedule.
- Hypersensitivity: (Four types with one example in brief)
- Autoimmunity and Autoimmune diseases: Myasthenia gravis and Rheumatoid arthritis

Unit – 3.Study of Human Diseases caused by bacteria (10)

Study of following diseases w. r. t. morphology, classification, staining reactions, cultural & biochemical characters, antigenic structure, pathogenesis, Laboratory diagnosis, epidemiology, prophylaxis and chemotherapy.

- *Staphylococcus aureus*

- *Mycobacterium tuberculosis*
- *Salmonella typhi*
- *Streptococcus pneumonae*
- *Clostridium tetani*
- *Treponema Pallidum*
- *Neisseria gonorrhoeae*

Unit – 4.Study of Human Diseases caused by fungi, protozoa and viruses (10)

Study of following diseases w. r. t. morphology, classification,staining reactions, cultural & biochemical characters, antigenic structure, pathogenesis, Laboratory diagnosis, epidemiology, prophylaxis and chemotherapy.

- Fungal diseases - Dermatophytosis and candidiasis
- Protozoal diseases – Malaria, Amoebiasis
- Viral diseases – HIV, Hepatitis, Covid-19, Chikungunya.

Unit – 5 Tutorials, Seminars and Assignments (05 Periods)

Lab course - 4 MCB 322

1. Isolation & study of normal flora of skin/ nose/ throat.
2. Precipitation test: Demonstration.
    I. Single radial immunodiffusion
    II. Immuno electrophoresis.
3. Agglutination tests: (Slide tests)
    I. Blood grouping
    II. Widal test
    III. RA factor test
4. Staining techniques
    I. Acid fast staining
    II. Blood staining (differential WBC count)
    III. Malarial parasites staining
5. Rapid *Test Kit* chromatographic immunoassay tests: - Dengue, Chikungunya, malaria, Covid, HIV, HCV, HBsAg.
6. Demonstration of media for cultivation of pathogenic bacteria
    I. Mannitol salt agar.
    II. Wilson and Blair's medium
    III. Lowenstein- Jenson's medium
    IV. *Sabouraud Dextrose Agar* (SDA)
7. Study bacterial pathogens:

- *Staphylococcus aureus*
- *Mycobacterium tuberculosis*
- *Salmonella typhi*
- *Strptococcus pneumoniae*
- *Clostridium tetani*

8. Isolation & Identification of *Candida albicans*
9. Demonstration of haemolysin & coagulase tests.
10. Determination of antibiotic resistance of bacteria.

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1. A Textbook of Microbiology.Chakraborty P. (2013). 3rd edition. New Central Book Agency. India. ISBN-13: 978-8173818769.
2. Medical Bacteriology Including Medical Mycology and AIDS. Dey N. C., Dey T. K. and Sinha D. (2013). 17th Edition. New Central Book Agency (P) Ltd (Publisher). India.
3. Textbook of Microbiology.Kanungo Reba. (2017). Ananthanarayan and Paniker's 10th edition. The Orient Blackswan Publisher. ISBN-13: 978-9386235251.
4. Microbiology: An introduction. Tortora G. J., Funke B. R. and Case C. L. (2016). 12th Edition, Pearson. ISBN-13: 9780321929150.
5. Medical Microbiology and Immunology. Goering R., Dockrell H., Zuckerman M., Roitt I. and Chiodini P. L. (2018). Mims' 6th Edition. Elsevier. ISBN: 9780702071546.
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7. Immunology.Kuby J. (1996) 3rd Ed. W. H. Freeman and Co, New York.
8. Essentials of Immunology.Roitt M. (1984). P. G. Publishers Pvt. Ltd., New Delhi.
9. Handbook of Immunology, Talwar G. P. (1983). Vikas Publishing Pvt. Ltd. NewDelhi.
10. Immunology - Essential and Fundamental.Pathak S. S. and Palan V. (1997) Pareen Publications Bombay.
11. Medical virology 10th edition by Morag C and Tim bury M C 1994. ChurchilLivingstone , London.
12. Basic Virology, Edward K. Wagner, Martinez J. Hewlett, 3rd edition, Blakwell publication.
13. Introduction to modern virology. 4th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell scientific publications. Oxford.
14. Text Book on Principles of Bacteriology, Virology and Immunology, Topley and Wilson 1995.
15. Virology: principles and applications by John Carter and Venetia Saunders.

B Sc. II year Sem IV
Paper- MCB -411 Food and Dairy Microbiology

Total hours: 45 **Credit: 2**

Unit1: Dairy Microbiology **(No. of hours: 10)**

Definition and composition of milk. Sources of microorganisms in milk.
Desirable and undesirable changes carried out by microorganism in milk.
Types of microorganisms: Biochemical types, temperature characteristic and pathogens (bovine and human origin).
Antimicrobial substances in milk
Microbiological examination of milk: SPC, DMC, Reductase test (MBRT and Resazurin) Phosphatase test.
Pasteurization and sterilization of milk:
National and international microbiological standards for dairy products (BIS, ICMSF, CODEX, Alimentary standards.

Unit 2.Food Microbiology: **(No. of hours: 10)**

Food as a substrate for microorganisms.Major groups of bacteria, fungi, yeasts important in food microbiology.
Sources of contamination of food, factors affecting kind and number of microorganisms in food.
Principles of food preservation: Micro biostatic and microbicidal methods: Asepsis, removal of microorganisms, anaerobic conditions, high temp, low temp, drying, chemical preservatives, high osmotic pressure, radiation, smoking. Microbial spoilage of foods.
Classification of foods by ease of spoilage, chemical changes caused by microorganisms in food.
Types of spoilage of canned and non-canned foods with organisms involved. (Tabular form).

Unit 3.Foodborne Diseases, Intoxication and Quality Assurance (No. of hours: 10)

Food borne diseases: Food infections, indicators of food pathogens associated with food.
Food intoxication: Staphylococcal, Clostridial, Mycotoxins, Salmonellosis and Shigellosis.
Relevance of microbial standards for food safety
Government regulatory practices and policies: FDA, EPA/WHO, HACCP, FSSAI, ISO, ICMSF

Unit 4.Fermented Food and Probiotics(No. of hours: 10)

Cheese: Classification and production

Sauerkraut, Butter, Idli,

Criterion for probiotics: Yoghurt and Curd

Mushroom as SCP.

Unit V : Tutorials, Seminars and Assignments (05 Periods)

SUGGESTED READING:

1. Food Microbiology by William C. Frazier.
2. Basic Food Microbiology by Banwart George J.
3. Food Microbiology: Fundamentals and Frontiers by Dolle
4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
5. Food Microbiology. 2nd Edition By Adams
6. Fundamentals of Dairy Microbiology by Prajapati.
7. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition.
8. Microbiology of Fermented Foods. Volume I and II. By Brian J. Wood.Elsiever Applied Science Publication.
9. Microbiology of Foods by John C. Ayres. J. OrwinMundt. William E. Sandinee. W. H. Freeman and Co.
10. Dairy Microbiology by Robinson. Volume II and I.
11. Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michaell P. Doyle, Larry R.

Beuchat and Thomas I. Montville (Eds.), ASM Publications.

12. Applied dairy microbiology edited by Elmer Marth and James Steele

BSc II year Sem IV
Paper- MCB -412 Microbial Physiology

Unit -1. Bacterial Photosynthesis (10)

i. Photosynthetic bacteria, Photosynthetic apparatus.
ii. Photosynthetic pigments, Organization of photosystem I and II, cyclic and non-cyclic flow of electrons, Z scheme, Hill reaction, photolysis of water and generation of reducing power by cyclic and non cyclic photophosphorylation (Light reactions of photosynthesis).
iii. Electron transport chain (ETC) in photosynthetic bacteria, Carbon dioxide fixation pathways. Oxygenic and Anoxygenic mechanisms.
iv. Calvin cycle (Dark reactions of photosynthesis) and its regulation.

Unit-2. Respiration (10)

i. Laws of thermodynamics, Concepts of free energy, entropy, high energy compounds: Pyrophosphate, enolic phosphates, acyl phosphates, thioester compounds, and guanidinium compounds.
ii. Aerobic and anaerobic Mitochondrial electron transport chain, structure and function of ATPase (bacterial and mitochondrial), generation and maintenance of proton motive force, oxidative phosphorylation.
iii. Anaerobic Respiration: Concept of anaerobic respiration, components of electron transport system and energy generation of bacteria where nitrate, sulfate and carbonate act as terminal electron acceptors, Hydrogen, carbon monoxide, Ammonia, Nitrite, Sulphur, and Iron oxidizing bacteria.
iv. Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation, Ammonia assimilation with respect to glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation.

Unit-3. Membrane Transport (10)

i. The composition and architecture of membranes, Membrane dynamics.
ii. Solute transport across membranes: Passive transport - diffusion, Osmosis, facilitated difussion, Active transport - Active transport systems in bacteria primary and secondary active transport using P, V and F type ATPases.
iii. Group translocation of sugars in bacteria.
iv. Ionophores, Ion mediated transport, transport of ions across membranes (ion pumps).

Unit-4. Bacterial Growth and Sporulation (10)

i. Microbial growth, Growth curve, Mathematical expression of growth.
ii. Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation.
iii. Influence of different factors on sporulation.
i. iv.Cytological and macromolecular changes during sporulation.
iv. Germination of spores.

Unit V : Tutorials, Seminars and Assignments (05 Periods)

Lab Course5 MCB-421

FOOD AND DAIRY MICROBIOLOGY (PRACTICALS)

Semester- IV **Total hours per practical: 03** **Credits: 1.5**

1. Direct microscopic count (DMC)
2. MBRT/ Resazurin test.
3. Isolation of Microorganisms from curd & yogurt.
4. Yoghurt fermentation.
5. Isolation of Coliform from Milk.
6. Isolation of Microorganisms from common food items (bread, pickle).
7. Enumeration & Isolation of Staphylococcus from ready to eat street foods.
8. Effect of cleansing & disinfection on microbial load of fruits & vegetables.
9. Sauerkraut fermentation.
10. Mushroom cultivation.

B. Sc.Second Year
Lab Course 6 MCB 422

1. Demostration of utilization of sugars by oxidation and fermentation techniques.
2. Determination of Iron Oxidation Rate of Thiobacillus ferrooxidans.
3. Determination of Sulfur Oxidation Rate of Thiobacillus thiooxidans.
4. Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on spore germination of Bacillus sp.
5. Enrichment, Isolation, Preparation and Application of Bioinoculants (e.g. Azo-Rhizo / Blue Green Algae (cyanobacteria).
6. Estimation of calcium ions present in sporulating bacteria by EDTA method.
7. Glucose uptake by E. coli / Saccharomyces cerevisiae [Active and Passive diffusion].
8. Isolation and purification of anaerobic respiratory clostridia.
9. Isolation and purification of sulfate reducing bacteria.
10. Isolation of Photosynthetic bacteria.
11. Study principles of osmosis and diffusion using artificial membranes (dialysis membrane).
12. Isolation of Ammonia, Nitrite, Sulphur, and Iron oxidizing bacteria.

References

1. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
2. Applied Microbial Physiology by Rhodes.
3. Bacterial Metabolism by H.W. Doelle
4. Berg Jeremy, Tymoczko John, Stryer Lubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.
5. David A. Hall & Krishna Rao (1999) Photosynthesis (Studies in Biology) 6th Edition, Cambridge University Press, London
6. Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole, Publishing Company, California.
7. Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press
8. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London. .
9. Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark (2012) Brock Biology of Microorganisms, Thirteenth edition, Benjamin Cummings, San Francisco.
10. Microbial Physiology and Metabolism by Caldwell D.R. 1995Brown Publishers.
11. Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wileyand Sons New York.
12. Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.
13. Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000. ASM Press.
14. Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.
15. The Bacteria. Volumes by I.C. Gunsalus and Rogery Stanier, Academic Press.
16. Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York

B.Sc. III year DSE

Papcr-MCB 511 : Enzymology and Metabolism (A1)

Unit :I **(10)**

- *Enzymes:* Definition, properties, specificity, active site, activation of enzymes, Mechanism of action of enzymes (lock and key, Induced fit, ping-pong)
- Nomenclature and classification of enzymes.
- Factors affecting catalytic activity of enzymes (pH, temperature $_s$ enzyme concentration, substrate concentration , metal ions, time)
- Michaelis-Menten equation ; derivation and significance.
- Transformation of Michaelis Menten equation
- Types of enzymes extracellular, intracellular. constitutive and indueible,

Unit:II **(10)**

- Enzyme inhibition: Irreversible, reversible (competitive, uncompetitive, non competitive) and metabolic antagonism; feedback inhibition,
- Co-enzymes and respective enzymes, (NAD, FAD, Lipoic acid. Vitamin B12, Thiamine pyrophosphate)
- Elementary knowledge and uses of *isoenzymes.*
- Commercial uses of enzymes (any five) - (food, leather, textile, environment, pharmaceutics Is and clinical)
- Enzyme Immobilization

Unit :III **(10)**

- Definitions: Metabolism, anabolism. eatabolism, free energy,
- Bioenergetics: chemical links between catabolism and biosynthesis, energy coupling through ATP and through pyridine nucleotides, Central role of ATP-ADP system.
- Modes of energy yielding metabolism: Definition and features of fermentation, Respiration and photosynthesis.
- Fermentation of carbohydrates:
- EMP, HMP, ED, Phospoketolase pathway (pentose, hexose) with structure.
- Alcoholic, homolactic, mixed acid, butanediol, butyric, acetone-butanol femientations,

Unit IV **(10)**

- Aerobic respiration:
- RETC : location functions, components, redox carriers, oxidirtive phosphorylation artificial electron acceptor, bacterial cytochrome systems
- TCA cycle, glyoxylate cycle, anaplerotic *sequences.*
- Catabolism of saturated (16 carbon) and unsaturated fatty adds (16 carbon) by β Oxidation
- Degradation of proteins and amino adds: proteolysis, putrefaction,
- Transformation of amino acids: oxidation, reduction, decarboxylalion, deamination (one example of each).
- Nucleic add catabolism: DNA, RNA depolymenzation, degradation of nitrogenous bases (mention end products without pathway)
- Biosynthesis of nucleotides: Purine and pyrimidine nucleotides, conversion of ribonucleotides to deoxyribonucleotides.

Unit V : Tutorials, Seminars and Assignments (05 Periods)

Lab Course - 8 MCB 521(A1)

1. Preparation of buffers and reagents.

2. Study of enzymes: - a-amylase, caseinase, catalasc, desulfurase, gelatinase, lecithinase, oxidase.

3. Effect of pH, $temp_r$ substrate concentration on α- amylase activity.
4. Demonstration of nitrate reduction

5. Demonstration of decarboxylation of amino acid.

6. Isolation of photosynthetic bacteria by column method

7. Primary screening for:

   i) Starch hydrolyzers.
   ii) Organic acid producers,
   iii) Antibiotic producers.

Discipline Specific Electives

Papcr-MCB 511 Microbial Biotechnology Theory (B1)

Total hours : 45 **Credits : 2**

Unit I : Basic Principles of Microbial biotechnology and genetic engineering 5 H

- Microbial biotechnology: Scope and applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental and food technology
- Genetically engineered microbes for industrial applications- bacteria and yeast

Unit II : Therapeutic and industrial biotechnology 15 H

- Production of streptokinase
- Hepatitis B vaccine
- COVID 19 vaccines
- Microbial polysaccharides and polypeptides
- Microbial production of bio pesticides , bioplasctics
- Microbial biosensors

Unit III: Application of microbes in biotransformation 10 H

- Microbial products and their recovery- microbial product purification – filtration, ion exchange and affinity chromatography , immobilization methods and their applications
- Microbial based transformation of steroids and sterols
- Production of high fructose syrup
- Production of coca butter substitute

Unit IV: Microbes for bioenergy and environment 10 H

- Bioethanol and biodiesel production: commercial production from lignocellulosic waste and algal biomass
- Hydrogen production using microbial culture
- Microorganisms in degradation of xenobiotics, mineral recovery
- Intellectual Property Rights(IPR)- Patents, Copyright and trademarks

Unit V: Seminar/ Assignment / Presentation/ Tutorial 5 H

Discipline Specific Electives

Microbial Biotechnology (CBCS)

Lab Course MCB-521 (B1)

University exam – 40 Marks

Study tour and report submission – 10 Marks

1. Study of yeast cell immobilization in calcium alginate gel
2. Study of 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 single cell protein

DSE MCB -511 (C1)

B. Sc. III year Bioinstrumentation and Biotechniques

Unit – 1 Basic laboratory Instruments **10**

Principle, working :and applications of following instrumentspH meterColorimeter, L ;aminar air flowand b iosafety cabinetsIncubator Rotary shakers, BOD and COD incubators, ; centrifugt -eypes of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, density gradient centrifugation ;PCR.machine

2 –Unit **Spectroscopy** **10**

Principles and applications ofspectroscopic techniques :turbidometry, nephlometry, luminometry, UV and visiblespectrophotometry , IRand Raman spectroscopy , NMR spectroscopy, fluorescencespectroscopy , atomic absorptionspectrophotometry , mass spectroscopy, Application of NMR spectroscopy for protein and DNA structure determination.

Unit -3 Chromatographic techniques **10**

Theory, principles and applications of paperchromatography , thin layer(chromatography (TLC , gel filtrationchromatography , ion-exchangechromatography , affinitychromatography ,gas-liquid chromatography, high pressure/ performance liquid chromatography (HPLC).

Unit- 4 Electrophoretic techniques, X-ray diffraction and Radio isotopic techniques 10

Basic principles of electrophoresis, theory and application of paper, starch gel, agarose,2-D PAGE, SDS-PAGE, native gels, gradient gel electrophoresis. Pulsed field gel electrophoresis(PFGE), DNA and RNA electrophoresis. Electrophoresis of polysaccharide, glycoprotein, lipoproteins.

Southern, Northern and Western Blotting.
X-ray diffraction analysis and crystallography.
Radio isotopic techniques- nature of radioactivity, methods of detection and measurement,methods of application – tracer, autoradiography.

Unit 5: Seminar/ Assignment / Presentation/ Tutorial **5 H**

Lab course MCB -521 (C1)

Bioinstrumentation and Biotechniques

1) Measurement of pH of different acidic and basic solutions by pH meter.
2) Standardization and calibration of pH meter
3) Studies on pH titration curves of amino acids/ acetic acid and determination of pKavalues and Handerson-Hasselbach equation.
4) Measurement of OD of different colour solutions at different wavelengths by colorimeter.
5) Study the effect of shaking on the degradation of dyes by bacteria using rotary shaker and colorimeter.
6) Separation of bacterial lipids/amino acids/sugars/organic acids by Paper Chromatography.
7) Separation of bacterial lipids/amino acids/sugars/organic acids by Thin Layer Chromatography.
8) Separation of serum protein by horizontal submerged gel electrophoresis.
9) Electrophoretic separation of nucleic acids by agarose and polyacrylamide gelelectrophoresis.
10) Studies on the principles of light spectroscopy – Beer and Lambert`s laws, extinctioncoefficient and molar extinction coefficient.
11) Study of UV absorption spectra of macromolecules (protein, nucleic acid)
12) Demonstration of PCR, DNA sequencer.
13) Demonstration of Density gradient centrifugation

REFERENCES

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.

3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. 1975 by Williams, B.L. and Wilson, K.
4. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
5. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.
6. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
7. Analytical Biochemistry by Holme.
8. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.
9. Spectroscopy by B.P. Straughan and S. Walker.
10. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.
11. Gel Chromatography by Tibor Kremmery. Wiley Publications.
12. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.
13. The use of radioactive isotopes in the life sciences by J.M.Chapman and G.Ayrey, George Allen and Unwin Ltd., London.
14. Analytical biotechnology edited by Thomas G M Schalkhammer.
15. Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata McGraw Hill, India.
16. Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Ansha Publication, India.
17. Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, Nath

Principles and Techniques of Biochemistry and Molecular Biology. Seventh edition. Edited by Keith Wilson and John Walker

Course Code: **MCB-511(D1)**

Nanobiotechnology

Marks: 50 **Periods: 45**

Unit 1: Introduction to nanotechnology and nanobiotechnology 10 Periods

Scope of nanotechnology, brief history of nanotechnology, nanotechnology and ayurveda, nanomaterials and nanoparticles, change in properties of nanoparticles with size, surface area to volume ratio, advantages of nanomaterials over bulk materials, challenges in nanotechnology, natural and man-made nanoparticles, nanotechnology in nature and biomaterials and nanoparticles (fullerenes, DNA, RNA, protein complexes, viruses, flagellar motor in bacteria, ATPase, ribosomes, lotus leaf effect, diatoms frustules, bacterial S-layers, magnetosomes), nanobiotechnology- the interface between nanotechnology and biology, scope of nanobiotechnology.

Unit 2: Nanoparticles 10 Periods

Types of nanoparticles- based on size, shape and structure, chemical nature and properties; synthesis of nanoparticles- top-down and bottom-up approaches, ball milling, electrospray technique, physical vapour deposition, chemical precipitation, chemical vapour deposition, bio-based methods with focus on intracellular synthesis, extracellular synthesis, in-vitro synthesis using biomaterials, bio-inspired synthesis, stabilization of nanoparticles; characterization of nanoparticles- visual, UV-visible spectrophotometry, electron microscopy, atomic force microscopy.

Unit 3: Applications of nanotechnology 10 Periods

Materials science- surface coatings, catalysis, electronics (one or two examples of each); environmental sciences- detection of pollutants, removal of pollutants (one or two examples of each), biomedical sciences- biocompatibility, diagnosis and treatment of diseases (one or two examples of each), targetted drug delivery, food technology- preservation of food, detection of food pathogens (one or two examples of each).

Unit 4: Implications of nanotechnology 10 Periods

Routes of exposure to nanoparticles, nanotoxicology- toxicity of nanoparticles, health hazards, methods of toxicity testing- in-vitro, in-vivo, advantages of biogenic nanoparticles, exponential nanotechnology, industrial/commercial applications of nanotechnology, economical considerations, development of nanotechnology based tools (for visualization, characterization, manipulation, purification and use of nanoparticles), ethical issues in nanotechnology.

Unit 5: Tutorials, seminars, assignments, visit to advanced instruments laboratory. 05 periods

References:

Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Wiley-VCH (2006).

C. Bre´chignac P. Houdy M. Lahmani, Nanomaterials and Nanochemistry, Springer Berlin Heidelberg, Germany (2006).

Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties, Applications, World Scientific Publishing Pvy. Ltd., Singapore 2004

M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.

C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.

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C.S.S.R.Kumar, J.Hormes, C.Leuschner, Nanofabrication towards biomedical applications, Wiley –VCH Verlag GmbH & Co, Weinheim, 2004.

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Michael J. O'Connell, Carbon nanotubes: Properties and Applications, CRC/Taylor & Francis, (2006).

W.R. Fahrner, Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques, Springer, 2005.

Kewal K. Jain , The Handbook of Nanomedicine, Humana Press, (2008).

Zhang, Nanomedicine: A Systems Engineering Approach" 1st Ed., Pan Stanford Publishing, (2005).

Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.

Nanoparticles and Catalysis; D. Astruc, Wiley-VCH, 2008

Mirkin Chad, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley

Nanobiotechnology in Food: Concepts, Applications and Perspectives by J.M. Hoda, Springer

Cato T. Laurencin, Temenoff J. S. and Mikos A. G., Biomaterials: The Intersection of Biology and Materials Science||, Pearson, New Delhi, 2009.

Grassian V.H, "Nanoscience and Nanotechnology – Environmental and health impacts", John Wiley & Sons, 2008

Ram.M, Andreescu.S.E, Hanming.D, "Nanotechnology for Environmental Decontamination", 2011, McGraw Hill

Wiesner M and Bottero J.Y, "Environmental Nanotechnology", McGraw-Hill, 2007.

Geoffrey Hunt and Michael D. Mehta —Nanotechnology: Risk, Ethics and Law, Arthscan/James & James publication (2006)

Mark. R. Weisner and Jean-Yves Bottero —Environmental Nanotechnology applications and impact of nanomaterial, The McGraw-Hill Companies (2007).

Mihail C. Roco and William Sims Bainbridge —Nanotechnology: Societal Implications II, Individual Perspectives, Springer (2007)

Course Code: **MCB-521(D1), Nanobiotechnology-**
Lab course/Practical
Total Credits: 1.5 **Marks: 50**

1) Calculation of surface area to volume ratio for particles of different size
2) Synthesis of silver/gold/iron based nanoparticles by chemical method- any one method
3) Detection of nanoparticles in colloidal suspensions using UV-visible spectrophotometer
4) Stabilization of silver/gold nanoparticles using chemical and/or biological agents and its effect on UV-vis absopriton spectrum/plasmon resonance.
5) Effect of chemicals on the stability of silver/gold nanoparticles (salt, acid/alkali, detergents)
6) Effect of high/low temperature on the stability of silver nanoparticles
7) Green synthesis of silver/gold nanoparticles using bacteria/fungi/yeasts- any one method
8) Green synthesis of silver/gold nanoparticles using plant extract/s
9) Antimicrobial activity of silver nanoparticles on bacteria/fungi
10) Decolorization/removal of dye from solution using nanoparticles
11) Biocompatibity of nanoparticles (hemolytic assay)
12) Analysis of SEM, TEM and AFM images

Paper-MCB 512 MICROBIAL GENETICS (A2)

SEMESTER –V **TOTAL HOURS: 45** **CREDITS: 2**

Unit 1 Genome Organization and Mutations No. of Hours: 10

Genome organization: E. coli, Saccharomyces, Drossophila Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of Mutations. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; replica plating, and fluctuation test. Mutator genes.

Unit 2 Plasmids No. of Hours: 10

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmidincompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

Unit 3 Mechanisms of Genetic Exchange No. of Hours: 10

Transformation - Discovery, mechanism of natural competence. Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time ofnentry mapping. Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers.

Unit 4Transposable elements No. of Hours: 10

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds). Uses of transposons and transposition.

Unit V : Tutorials, Seminars and Assignments (05 Periods)

Lab Course - 8 MCB 522(A2)
SEMESTER –V

1. Study of spontaneous mutation by Replica Plate Technique.
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from E.coli
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

Microbiology- DSE 512 (B2)

Microbial BioControl- QC/QA in Food and Pharmaceutical Industries

TOTAL HOURS: 45 Marks-50 CREDITS: 2

Unit 1 Microbiological Laboratory and Safe Practices No. of Hours: 10

Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples No. of Hours: 10

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water No. of Hours: 10

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Sabraoud's Agar Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards No. of Hours: 10

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

Unit V: Tutorials, Seminars and Assignments ------- No. of hours : 5

SUGGESTED READING

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press

2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.

3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Lab Course- 8

Practicals Microbiology- DSE 522 (B2)

Microbial BioControl- QC/QA in Food and Pharmaceutical Industries

Marks =- 50

1. Antimicrobial sensitivity testing and determination of MIC and quality control.
2. Qualitative/quantitative examination of food samples (Meat, egg, fruits, vegetables, canned foods etc.) for presence/absence and or quantification of food borne pathogens.
3. Microbial Examination of non-sterile products : Microbial Enumeration Test (Membrane filtration, plate count method(Pour Plate and surface spread method) MPN (Most probable number)
4. Microbial Examination of non-sterile products: Test for specified microorganisms *(Staphylococcus aureus , E. coli, Salmonella sp., P. aeruginosa)* by using selective medias
5. Sterility testing of sterile pharmaceutical preparations (Direct inoculation & Membrane Filtration Method)
6. Use of biological indicators for validating the sterilization cycle of Autoclave/Dry Heat Sterilizer (Hot Air Oven)
7. D-value determination test for wild strain of *E.coli / S.aureus / B. subtilis / C. sporogenes*
8. Determination of raw milks quality by MBRT test
9. Disinfectant Efficiency Test (DET) by tube dilution and coupon method
10. Antimicrobial Preservative Efficacy Test
11. Growth Promotion Test For Culture medias (Qualitative/Quantitative)
12. Bacterial Endotoxin Test (Limulus Amoebocyte Lysate) semi-quantitative / quantitative method.

MICROBIOLOGY DSE -MCB-512 (C2)

PHARMACEUTICAL MICROBIOLOGY

Total Hours: 45 Marks:50 Credits: 2

UNIT-I: **10 hrs**

Principles of chemotherapy –General properties of antimicrobial agents, choice of drug, dosage, route of administration, combined/mixed multi drug therapy,control of antibiotic/drug usage, sensitivity testing

UNIT-II **10 hrs**

History of chemotherapy – plants and arsenicals as therapeutics, Paul Ehrlich and hiscontributions, selective toxicity and target sites of drug action in microbes.Over view of development of synthetic drugs.Antibiotics - The origin, development and definition of antibiotics as drugs, types of antibioticsand their classification.

UNIT-III **10 hrs**

Mode of action of important drugs – Cell wall inhibitors (Betalactam – eg. Penicillin),membrane inhibitors (polymyxins), Protein synthesis inhibitors (streptomycin),Nucleic acid synthesis inhibitor (nalidixic acid),antifungal antibiotics (nystatin)

UNIT-IV **10 hrs**

Anti-Microbial Assays: Assay for growth inhibiting substances – Assay for non-medicinalantimicrobials (Phenol coefficient/RWC). Drug sensitivity testing methods and their importance.

Assay for antibiotics – Determination of MIC, the liquid tube assay, solid agar tube assay, agar plate assay (disc diffusion, agar well and cylinders cup method).

Unit V : Tutorials, Seminars and Assignments (05 Periods)

PRACTICALS MICROBIOLOGY DSE MCB- 522-(C2)
PHARMACEUTICAL MICROBIOLOGY

Marks:50

1. Tests for disinfectants (Phenol coefficient)
2. Determination of antibacterial spectrum of drugs/antibiotics
3. Testing for antibiotic/drug sensitivity/resistance.
4. Determination of MIC value for antimicrobial chemicals
5. Microbiological assays for antibiotics (Liquid tube assay, agar tube assay, agar well assays)
6. Microbiological limit test: Salmonella, Shigella, Staphylococcus, *E.coli,* Pseudomonas
7. SPC of pharmaceutical samples: liquid oral supplements, Lotion/ointment/ Tablets
8. Pyrogen testing samples: Sterile injectables

References:

1. Ananthanarayana, R. and Panicker, C.K.S. (2000). Text Book of Microbiology, 6th Edition, Oriental Longman Publications, USA.
2. Gupte, S. (1995). Short Text Book of Medical Microbiology, 8th Edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.
3. Annadurai, B. (2008). A Textbook of Immunology and Immunotechnology. S. Chand & Co. Ltd., New Delhi.
4. Dey, N., T.K. and Sinha, D. (1999). Medical Bacteriology Including Medical Mycology and AIDS.New Central Book Agency (P) Ltd. Calcutta, India.
5. Shetty, N. (1994). Imuunology – Introductory Textbook. New Age International Pvt. Ltd., New Delhi.
6. Singh, R.P. (2007). Immunology and Medical Microbiology. Kalyani Publishers, New Delhi.
7. Reddy, S.R. and Reddy, K.R. (2006). A Text Book of Microbiology - Immunology and Medical Microbiology, Himalaya Publishing House, Mumbai.
8. Lydyard, P.M., Whelan, A. and Fanger, M.W. (2000). Instant Notes in Immunology, Viva Books Pvt. Ltd., New Delhi.
9. Chakraborty, B. (1998). A Text Book of Microbiology, New Central Book Agency (P) Ltd, Calcutta, India. 12

MCB-512

B. Sc. III year Clinical Pathology (DSE) (D2)

Total Hours : 45 **Credits : 2**

Unit – 1 Clinical Microbiology and Laboratory Diagnosis of Infectious Diseases (10)

- Study of Compound Microscope, Simple and Gram staining, Negative staining, Acid Fast staining, Capsule and endospore staining, hanging drop technique.
- **Types of media : -**
  Bacteriological- Nutrient Agar, MacConkey's Agar, Mueller-Hinton agar, Eosin Methylene blue Agar, CLED Agar (cystine–lactose–electrolyte-deficient agar), Wilson and Blair medium, Kings Agar, Mannitol Salt Agar.
  Mycological- Potato – dextrose agar, Sabouraud's agar, Glucose Yeast Extract agar.
- **Methods of Cultivation:** - Broth, Slant, Stab, Plate.
- **Methods of isolation: -** Streak, Pour and Spread plate methods, enrichment and preservation of cultures.
- **Sterilization and Disinfection: -** Definitions, Physical methods (Heat, Radiation and Filtration), Cleaning, and preparation of glassware for sterilization,
  Chemical Methods (Alcohol, Phenol & phenolic compounds, Chlorine & compounds, Iodine & compounds, Formaldehyde, Ethylene Oxide, β propiolactone),
- **Collection, Preservation , Transport, Processing and disposal of clinical samples**

  Blood, Throat, Sputum, Pus, Urine, Stool, C.S.F, Other body fluids.

- **Short description of diseases caused by and Identification of Microorganisms by morphological, Cultural and biochemical characters.**
  Bacteria (*Escherichia coli, Enterobacter aerogenes, Staphylococcus aureus, Salmonella spp., Mycobacterium tuberculosis, Klebsiella spp., Proteus vulgaris, Pseudomonas aeruginosa)*
  Fungi (Species of Aspergillus, Cryptococcus neoformans, Mucormycetes, Pneumocystis jirovecii, Candida)
  Protozoa: - (*Plasmodium spp, Entamoeba spp, Trichomonas vaginalis, Giardia lamblia)*
  Viruses: - Polio, Hepatitis, Rabies, Influenza, Dengue, Chikungunya, Ebola, Covid-19,

- Antibiotic susceptibility test by disk diffusion technique and Kirby-Bauer method.

- Automated bacterial identification and susceptibility testing system VITEK 2
- Polymerase Chain Reaction (PCR), RTPCR test for Covid-19

UNIT – 2 Immunology **(10)**

Antigen- Antibody Reactions: - Definition, types, Mechanism and examples of

Precipitation: - Slide and tube tests, Immunodiffusion, Immunoelectrophoresis, Electroimmunodiffusion, Slide Flocculation test (VDRL test), Tube flocculation test (Kahn test for syphilis) Standardization of toxins and antitoxins, Lancified grouping of streptococci, Ring test (C-reactive protein)
Agglutination: - Slide test (Blood group by ABO system, Cross matching, Widal test for typhoid), Tube test (Widal test for Typhoid), Coombs test (Detection of haemolytic disease of the newborn due to Rh incompatibility), Passive agglutination test (RA factor determination test / Rose-Waller test), Pregnancy test. Dengue, Chikungunya
Complement fixation test: - (Wasserman test for syphilis)
Immunofluorescence (Direct and indirect)

Enzyme-Linked Immunosorbent Assay (ELISA): - (Detection of Rota virus, polio virus, HIV, Hormones),

RadioImmuneAssay (RIA): - Insulin and other hormones

Rapid *TestKit* **chromatographic immunoassay:** - Urine Pregnancy test, Dengue, Chikungunya, malaria, Covid, HIV, HCV, HBsAg,
Immunological Disorder: - Hypersensitivity, Auto-immunity, Immunodeficiency
Blotting techniques: - Southern, Western, Northern

UNIT-3 Clinical analysis and Biochemistry **(10)**

Urine analysis - Routine Examination -Physical, Chemical & Microscopic, Correlation of urinary findings in various diseases, Automated Urine Analysis & Reagent Strip Method
Stool analysis - Routine - Physical, Chemical & Microscopic Examination of stool, Significance of presence of blood and excess fat in stool, Concentration methods for detection of intestinal parasites
Semen analysis - Physical, Chemical & Microscopic Examination
Crebrospinal Fluid - Physical, Chemical & Microscopic Examination, Correlation of Abnormal C.S.F. findings in various diseases
Histopathological Techniques - Basic concept of tissue processing, Microtomy & Types of Microtome, Principle & Procedure of Staining techniques
Cestodes - Morphology, Life cycle , Mode of infection and Laboratory diagnosis of
Taenia saginata, Echinococcus granulosus
Nematodes - Morphology, Life cycle,Mode of Transmission and Laboratory diagnosis of
Trichuris trichiura, Ascaris lumbricoides, Strongiloides stercoralis, Anchylostoma duodenale etc.
Laboratory Instruments - Acid, Base, pH, Indicators, Buffer and Buffering action, Principle, Component, Operations, Maintenance and Applications of – Balance, pH Meter, Centrifuge, Colorimeter, Spectrophotometer, Biochemistry Auto-Analyzers, Cell counter, ESR tubes, Laminar Air flow, Haemoglobin counter, Haemocytometer, Micropipettes etc.
Biochemical tests - Blood and urine Glucose estimation, Bence-Jones' Proteins and Cryoglobulins, Lipid Profile Tests- cholesterol (LDL, HDL), triglyceride, Lipoproteins, phospholipids and its significance in various disorders, Alkaline Phosphatases, Lactate Dehydrogenases, Amylase, Lipase, Determination of T3, T4, TSH
Function tests: - Liver Function Tests (LFT), Kidney or Renal Function Tests (KFT/RFT), Cardiac Function Tests (CFT)

Electrolytes and vitamins – Sodium, Potassium, Chloride, Calcium, Phosphorus, Iron, Vitamin B12 and D3

UNIT – 4 Haematology and Blood banking **(10)**

Definition, composition and functions of blood, Collection & Storage of blood: venous and capillary, Various equipment used for collection of blood samples,

Anticoagulants: Definition and various types along with their mode of action, uses, methods of preparation merits and demerits of each.

Hb Estimation: Different methods-(a) Colorimetric Method, (b) Sahli's Method, and (c) Specific Gravity Method

RBC count: Normal, abnormal values, and Physiological variations, Morphology of normal and abnormal Red Blood Cells, Reticulocyte count, Erythrocyte Sedimentation Rate (ESR),

Haematocrit: Pack Cell Volume (PCV) and Various Blood indices; their brief description

Total White Blood Cell Count: Normal and abnormal values

Differential WBC Count: - Normal, abnormal values and physiological variation; Preparation of peripheral blood smear, Staining by different methods.

Haemostasis & blood coagulation - Coagulation Factors, Mechanism of Blood Coagulation, Coagulation disorders, Haemophilia A & Haemophilia B

Platelet disorders and Platelet count

Bleeding time (BT), Clotting time(CT), Prothrombin time (PT), Activated Partial Thromo Plastin time (APTT), Thrombin time, Fibrinogen, D- dimer test, Fibrin degradation product.

Blood Banking – ABO and Rh blood Group system, Storage and transportation of blood, Cross matching test.

Component preparation: - (Red cell concentrate, Fresh Frozen Plasma, Cryoprecipitate, Platelet concentrate)

Mandatory screening tests- HIV1&HIV2, HBsAg, HCV, RPR & Malaria.

Automation in Blood collection, Quality control in blood banking

Unit 5: Tutorials , Seminars and Assignments (05 Periods)

Practical -- Clinical Pathology -522 (D2)

1. Simple and Gram staining, Acid fast staining, Endospore and Capsule staining, Plsmodium spp. staining of blood smear, Entamoeba staining of stool sample, Trichomonas staining of vaginal swab.
2. Preparation of media: - Bacteriological- Nutrient Agar, MacConkey's Agar, Mueller- Hinton agar, Eosin Methylene blue Agar, CLED Agar (cystine–lactose–electrolyte-deficient agar), Wilson and Blair medium, Kings Agar, Mannitol Salt Agar.
   Mycological- Potato – dextrose agar, Sabouraud's agar, Glucose Yeast Extract agar.
3. Preparation of Broth, Slant, Stab, Plate, and isolation of microorganisms by Streak, Pour and Spread plate methods, enrichment and preservation of cultures.
4. Antibiotic susceptibility test by disk diffusion technique and Kirby-Bauer method.
5. Automated bacterial identification and susceptibility testing system VITEK 2
6. Polymerase Chain Reaction (PCR), RTPCR test for Covid-19
7. VDRL test for syphilis, Tube flocculation test (Kahn test for syphilis) Standardization of toxins and antitoxins, Ring test (C-reactive protein)
8. Blood group by ABO and Rh system, Cross matching,
9. Widal test for typhoid slide and Tube test
10. Coombs test, RA factor determination test / Rose-Waller test.
11. Rapid *Test Kit* chromatographic immunoassay tests: - Urine Pregnancy test, Dengue, Chikungunya, malaria, Covid, HIV, HCV, HBsAg.
12. Urine analysis - Physical, Chemical & Microscopic, Automated Urine Analysis & Reagent Strip Method.
13. Stool analysis - Routine - Physical, Chemical & Microscopic Examination of stool. Observation of nematodes and cestodes in stool.
14. Semen and CSF analysis - Physical, Chemical & Microscopic Examination.
15. Blood and urine Glucose estimation, Bence-Jones' Proteins and Cryoglobulins,
16. Lipid Profile Tests- cholesterol (LDL, HDL), triglyceride, Lipoproteins, phospholipids and its significance in various disorders, Alkaline Phosphatases,
17. Lactate Dehydrogenases, Amylase, Lipase, Determination of T3, T4, TSH
18. Function tests: - Liver Function Tests (LFT), Kidney or Renal Function Tests (KFT/RFT), Cardiac Function Tests (CFT)
19. Electrolytes and vitamins – Sodium, Potassium, Chloride, Calcium, Phosphorus, Iron, Vitamin B12 and D3
20. Complete Blood Count: - RBC, WBC, Platelets, Hb, Pack Cell Volume (PCV)
21. Bleeding time (BT), Clotting time(CT), Prothrombin time (PT), Activated Partial Thromo Plastin time (APTT), Thrombin time, Fibrinogen, D- dimer test,
22. Blood collection and storage for blood banking.

References

1. Text book of Medical Microiology, Ananthnarayan R. and Jayram Paniker C.K. 5th Edn. Orient Longman, Madras.
2. Microbiology, Prescott M,Harley John P., 8th edition, Lansing, Donald A. Klein, McGraw Hill
3. Text book of Microbiology and immunology, 2nd Edition, Subhash Chandra Parija, ELSEVIER, a division of Reed Elsevier India Private Ltd.
4. Text book of Medical Laboratory Technology, Godkar P B. 2nd Edn.2003 Bhalani Publication.
5. Medical Laboratory Technology, Ramnik Sood, 4th ed., Jaypee Brothers
6. Essential Immunology, Roitt I.M., 6 th Edn. ELBS, London
7. Hand book of Practical Immunology, Talwar G. P.,A 1st Edn. Vikas Publishing House.
8. Immunology, Owen,Judith A., PuntStanford, Sharon A., Jones, Patricia P., Kuby 7th ed. Macmillan Higher education Pub.
9. Parastology: Protozoology and Helthminthology in Relation to Clinical Medicine, Chatterjee K.D. (2009). 13th ed., CBC Publishers & Distributors Pvt Ltd
10. Medical Parasitology, Arora D.R. and Arora B. (2004). 2nd ed., CBC Publishers & Distributors Pvt Ltd.
11. Clinical Haematology, Wintrobe's 14th edition, Lippincott Williams & Wilkins
12. Clinical Haematology in Medical Practice, De Gruchy's Sixth edition, Wiley Publications
13. Modern Blood banking and Transfusion Practices, Denise Harmening , 6th Edition 2012.
14. Blood Transfusion in Clinical Medicine. Mollison PL,Engelfriet CP and Marcela Contreras: 12th edition, Blackwell Science, 2014
15. Technical Manual, American Association of Blood Banks, 2014
16. A Textbook on Laboratory and Clinical Transfusion Medicine. Choudhury Nabajyoti, Bharucha Zarin Soli., Volume 2: Basics of Blood Bank Practices (Process Control), 2017
17. Practical Biochemistry: Principles & Technique, Wilson K. & Walker J., 5 ed., Cambridge University Press.
18. Handbook of Quality Assurance in Laboratory medicine., Tambwekar S., BI
19. Bio Instrumentation, Veerakumari L., MJP.
20. Practical Biochemistry: Principles & Technique, Wilson K. & Walker J., 5 ed., Cambridge University Press.
21. Textbook of Medical Biochemistry, Chatterjea M. N. and Shinde R. 2007. 8th ed., Jaypee Brothers Publishers.
22. Practical Clinical Biochemistry, Harold Varley, 1990, Indian Edition, Anold Heinemann.

Paper MCB- 611 :Molecular Biology And Genetic Engineering (A1)

Total Hours: 45 **Credits: 2**

Unit I: DNA- Molecular structure, properties, replication (No. of hours: 10)

Molecular biology: Definition, concept

Flow of genetic information within a biological system- Central dogma of molecular biology (Francis Crick)

Molecular structure of DNA

Molecularproperties of DNA

Melting, Breathing, Flexibility, Linking number, Major and Minor grooves

DNA replication: Semi conservative mode of DNA replication: Meselson and Stahl experiment

Replication assembly, role of components and process of replication (continuous and discontinuous synthesis of DNA)

DNA polymerases: Types and characteristics

Post replication modification: Methylation

Unit II: Gene expression and regulation (No. of hours: 10)

Salient features of genetic code

Protein synthesis: Central dogmaAssebly, transcription and translation processes

Regulation of gene expression:Lac and Ara operon

Unit III: Tools and processes involved in Genetic Engineering(No. of hours 10)

Genetic engineering: Definition, objectives, steps involved, tools used for cloning

Restriction endonucleases: Types, patterns with examples, respective recognition sequence

Vectors: Properties of a good vector, characteristics of pBR322, pUC19, Bacteriophage ƛ vector, cosmid, BAC, YAC

Processes involved in uptake of DNA: Calcium chloride treatment, electroporation, protoplast fusion, liposome

Selection of recombinant clones: Blue- white script screening

Unit IV: Techniques and Application of genetic engineering (No. of hours10)

Probes: Definition, characteristics, preparation and labeling

Polymerase Chain Reaction (PCR):Components, steps involved, application

Nucleic acid and protein detection techniques: Southern blotting, Western blotting, Northern blotting, Colony hybridization, DNA sequencing by Sanger's/ dideoxy method

Application of genetic engineering in: Agriculture- Bt cotton and Golden rice, Human and animal health- Disease diagnosis and HBV vaccine, Industries- Stain improvement, Insulin, Environment- Superbug and Bioremediation

Ethical issues of genetic engineering

Unit V : Tutorials, Seminars and Assignments **(05 Periods)**

SUGGESTED READINGS

1. Gardner Elden, Simmon Michael and Sneustad Oeter; Principles of Genetics, John Wily and Sons, Newyork
2. Avinash and Kakoli Upadhyay. MOLBIO, Himalays Publications
3. James D. Watson; Molecular Biology of Genes, W.A. Benjamin Inc.
4. Alert L. Lehninger, David L. Nelson and Michael M. Cox: Biochemistry, Kalyani Publishers, New Delhi
5. B.D. Singh; Biotechnology Expanding Horizons, Kalyani Publishers
6. S.N. Jogdand, Gene Biotechnology, Himalaya Publishing House
7. Avinash and Kakoli Upadhyay; Molecular Biology and Genetic Engineering, Himalay Publishing House

Lab Course 9 MCB- 621(A1)

Semester –VI **Total hours/ practical: 03** **Credits: 1.5**

1. Isolation of ***E. coli*** chromosomal DNA
2. Hypochromacity study of chromosomal DNA using UV spectrophotometer
3. Restriction digestion of DNA
4. Isolation of plasmid DNA
5. Separation of plasmid from chromosomal DNA
6. Study of DNA uptake in ***E. coli*** using $CaCl_2$ treatment
7. Selection of recombinant clones on suitable medium
8. Measurement of β-galactosidase activity ***E. coli***
9. Demonstration of Polymerase Chain Reaction
10. Visit to molecular biology laboratory

DSE MCB- 611

Environmental Technology (B1)

Time : 45 hours **Credit : 2**

Unit I- Introduction to Environmental Technology(10L)

Definition and Basic concept: Ecology,Types of ecosysytem, Environment, Structure and function of ecosystems-Terrestrial Environment: Soil profile and soil microflora Benevolent and antagonistic interactions.Development of microbial community in biosphere.Ecological homeostasis and co-evolution.Physiological ecology of microorganisms.Ecology of microorganisms in extreme environments, Biofilm and ecological implication.

Unit II- Bio-deterioration and environmental monitoring (10L)

Air, Water, Soil pollutions: sources, causes, health hazards
General Characteristics of waste:
a) Liquid waste - pH, electrical conductivity, COD, BOD, totul solids, total dissolved solids, total suspended solids, total volatile solids, chlorides, sulphates, oil & grease.
b) Solid waste- pH, electrical conductivity, total volatile solids, ash.
c) Standards as per MPCB.
Eutrophication : Classification of lakes, Sources, Consequences, Control
Acid Mine Drainage Development of acid mine drainage, hazards of water pollution by it.prevention and control of acid mine drainage pollution

Radioactive pollution, pesticides pollution, oil pollution : impacts on environment , Good Laboratory Practices, Bio safety levels (BSL), Environmental monitoring: Definition and purpose, Cleanroom classification, Routine Environmental monitoring programme in pharmaceutical industries- Air monitoring, Surface monitoring and Personnel monitoring, Bioburden test
Environmental Impact Assessment- Concept and Brief introduction

Unit III- Ecological restoration and bioremediation (10L)

Sewage Microbiology and Wastewater treatment anaerobic, aerobic process, methanogenesis, treatment schemes for waste water: dairy, distillery, tannery, sugar, antibiotic industries, solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment) Specific bioremediation technologies: land farming, hiopiles, composting, bioventing, biosparging, pump and treat method, phytoremediation; remediation of degraded ecosystems; advantages and disadvantages; degradation of xenobiotics in environment, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.

UNIT IV: Ecologically safe products and processes(10L)

PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management, development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction, use of bioreactors for bioremediation

Unit V : Tutorials, Seminars and Assignments (05 Periods)

Books Recommended:

1. Environmental Pollution by Chemicals Walker, Hulchiason.
2. Biochemistry and Microbiology of Pollution - Higgins and Burns.
3. Environmental Pollution - Laurent Hodge, Holt.
4. Waste Water Treatment - Datta and Rao (Oxford and IBH)
5.Sewage and waste treatment - Hammer
6. Pollution - Kudesia, PragatiPrakashanMeerat.
7. Environment Chemical Hazards - Ram Kumar (Swarup and Sons, New Delhi).
8. Environment and Metal Pollution - Khan (ABD Pub. Jaipur).
9. Environment Pollution - Timmy Katyal (SatkeAnmol Pub. New Delhi).
10. Ecology of Polluted Water - Vol. II - Anand Kumar (Aph Pub. Co. New Delhi),
11. Microbial Techniques - Pathade and Goel (ABD Pub, Jaipur).
12. Current Topics in Environmental Sciences - Tripathi and Pandey (ABD Pub. Jaipur).
13. Environmental Impact Assessment - R. K. Trivedy
14. Microbial Limit and Bioburden Tests, 2nd edition - Lucia Clontz (CRC Press)
15. Introduction to Biodeterioration by Dennis Allsopp and Kenneth J.Seal, ELBS
16. Environmental Pollution by Chemicals by Walker C
17. Food Industry wastes: Disposal and recovery by Herzika and Booth (editors) 1980, Allied Science Publishers.
18. Water Pollution Vol. I and II by R. Mitchell
19.Microbiology of the Atmosphere by P. H. Gregory 2nd edition Leonard Hill
20. Air Pollution Control Theory by Crawford M
21. Basic Microbiology with applications by Brock and Brock
22. Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2 edition). Wiley-Blackwell Publications.
23. Scagg, A H 2005 Environmental Biotechnology. Oxford University Press
24.Jordening, HJ. & Winter J. 2005 Environmental Biotechnology: Concepts and Applications.John Wiley & Sons.
25. Rittman, B.F. & McCarty, PL., 2001. Environmental Biotechnology.Principles and Applications. McGraw-Hill, New York.
26. Snustad, D.P. & Simmons, MJ. 2011. Principles of Genetics (6th edition). John Wiley &Sons
27. Wainwright, M 1999. An Introduction to Environmental Biotechnology, Springe

Lab Course MCB -621 (B1)

Practical based on Environmental Technology

1. Physical analysis of sewage / industrial effluent by measuring total solids, total dissolved solids and total suspended solids.
2. Determination of indices of pollution by measuring BOD/ COD of different effluents.
3. Bacterial reduction of nitrate from ground waters.
4. Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste].
5.Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures.
6.Microbial dye decolorization / adsorption.

Project

1. Dust Fall Jar: Construction and analysis of pollution trend in the selected area.
2. Collection of Data from Internet : Respiratory suspended particulate matter (RSPM) in various metro cities in India
3. Fabrication: Fabricate Sedimentation Tank in the laboratory.
4. Effluent and Influent: Collect information on Effluent and Influent composition of petrochemical industry.
5. Sample collection: Collect the sample from municipal solid waste.
6. Identify Industry: Identify and list the industries using the solid waste as raw material.
7.ISO Implementation: List and categorize the industries certified with ISO 14000 in India.
8. Environmental Audit: Prepare the sample document for environmental Audit of any Organization.

B.Sc MICROBIOLOGY SEMESTER –VI (DSE) (C1)

MCB- 611 MEDICAL MICROBIOLOGY (THEORY)

Total Hours: 45 Credits: 03

Unit 1 Host pathogen interaction **No. of Hours: 07**

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2 Bacterial diseases **No. of Hours: 15**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control
Respiratory Diseases: Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis Gastrointestinal Diseases: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum

Unit 3 Fungal and Protozoan diseases **No. of Hours: 15**

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention
Cutaneous mycoses: Tinea pedis
(Athlete's foot) Systemic mycoses:
Histoplasmosis Opportunistic
mycoses: Candidiasis
List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control
Malaria, Kala-azar

Unit 4 Antimicrobial agents: General characteristics and mode of action **No. of Hours: 08**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism
Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1
Unit V : Tutorials, Seminars and Assignments **(05 Periods)**

Lab Course MCB -621 (C1)

MEDICAL MICROBIOLOGY (PRACTICAL) CREDITS: 02

1. Identify pathogenic bacteria (any three of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus) 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. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)

6. Study of various stages of Malarial parasite in RBCs using permanent mounts.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, UniversityPress Publication

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier

4. Willey JM, Sherwood LM, and Woolverton CJ.(2013) Prescott, Harley and Klein's Microbiology.9th edition. McGraw Hill Higher Education

5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.*14th edition. Pearson International Edition*

MCB- 611 (D1)
Microbial Ecology

SEMESTER – VI

TOTAL HOURS: 45 CREDITS: 2

Unit I 10

Ecology, Principles, kinds and Eco-factor, Ecological Pyramid.Microbial Landscape.
Soil Microbiology: Microbial groups present in soil, Role of microorganisms in turnover of elements carbon, nitrogen, phosphorus and sulphur, microbes in composting. Importance of mycorrhizal inoculums and types , Production of VAM, and its field applications .

Unit II 10

Beneficial microorganisms in Environment and its interrelationships between Plant ,animals Microbes. Biofertilizer , microbial insecticides.
Microbial agents for control of Plant diseases.
Microbes for Bio-energy and use for sustainable Environment .
Biodegradation, Biogas production, Biodegradable plastics.

Unit III 10

Management of microbiota for maintaining soil fertility.
Convertion of waste lands into fertile lands.
List of Diseases caused by bacteria and fungi with respect to Air, water and soil.
Role of Biological Control in Ecology.
Bioremediation and its strategies ,in situ and Ex situ bioremediation.
Phytoremediation: advantages and disadvantages.

Unit IV 10

Global environmental issues and its solutions: Ozone, Green house effect, Acid Rain, heavy metal pollution, e-waste, Oil pollution, radioactive wastes,etc.

Microorganisms and their Activities as Indicators of soil health and pollution.

Unit V 05 periods

Seminar/ PPT presentation/Assingments/Tutorials.

Lab Course -9 MCB- 621 (D1)
Microbial Ecology

SEMESTER –VI

TOTAL HOURS: CREDITS: 1.5

1. Analysis of soil - pH, Moisture content and water holding capacity.
2. Study of airmicroflora by using sedimentation plate method.
3. Enumeration of bacteria, fungi and actinomycetes from soil.
4. Isolation of antibiotic producing bacteria from soil samples
5. Isolation of Actinomycetes from soil.
6. Identification of antibacterial activity of Actiniomycetes.
7. Isolation and Identification of antibacterial activity of fungi.
8. Isolation of Rhizobium from root nodules.
9. Isolation of Nonsymbiotic nitrogen fixing Azatobcter from soil.
10. Bio-ethanol and bio-diesel production using agricultural waste/ production from lignocellulosic waste
11. Biogas production: Methane / hydrogen production using microbial culture.
12. Use of Microorganisms in bioremediation: removal of heavy metals from aqueous effluents
13. Project related to pollution.

References:

1. Verma, P.S. and Agarwal, V.K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Co. Ltd., New Delhi.

2. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

3. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms.14th edition.Pearson/ Benjamin Cummings.

4. Maier RM, Pepper IL and Gerba CP. (2009).Environmental Microbiology. 2nd edition, Academic Press

5. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc.New York & London.

6. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition.Benjamin/Cummings Science Publishing, USA

7 Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology.9th edition.McGraw Hill Higher Education.

Paper MCB -612 Industrial Microbiology (A2)

B. Sc. Third Year

Total hours : 45 **Credits : 2**

UnitI: Introduction to Industrial Microbiology **10**

- Brief history and developments in Industrial Microbiology
- Lay out of a fermentation Industry- Different units and functions(Stock, production and fermentation, QA, QC , R & D , Packaging)
- Importance of sterility maintenance and checking
- Types of fermentation processes , biorecators and measurement of fermentation- Types of fermentation processes- solid state , liquid state, batch, fed batch and continuous, Design of a typical fermentor, control of pH, temperature , dissolved oxygen , foaming and aeration

Unit II: Isolation of industrially important microbial strains and fermentation media 10

- Sources of industrially important microbes and methods for their Screening and isolation
- Preservation and maintenance of industrial strains
- Strain improvement
- Development of inoculum
- Fermentation media - Crude and synthetic media, molasses, SWL, CSL, whey

Unit III: Down stream processing **6**

- Cell disruption
- Filtration
- Centrifugation
- Solvent Extraction
- Precipitation
- Lyophilization

Unit IV: Microbial production of industrially products (Microorganism involved, media, Fermentation conditions, downstream processing and uses) **14**

- Citric acid production
- Ethanol production
- Wine
- Beer
- Penicillin
- Amylase

Unit V: Seminar/ Assignment / Presentation/ Tutorial **5**

Lab Course 10.Industrial Microbiology (A2)

MCB 622

1. Production, detection and estimation of ethanol using *S.cerevisiae*
2. Production and estimation of citric acid by *Aspergillus* spp.
3. Identification of fermentation product by Paper chromatography and thin layer chromatography- Citric acid
4. Microbiological assay of penicillin
5. Screening of amylase/antibiotic/organic acid producers
6. Production of alpha amylase by *Aspergillus* spp. / *Bacillus* spp.
7. A visit to any educational institute / industry to see an industrial fermentor and other down stream processes and report submission

Study tour and report submission – **10 Marks**

Suggested reading

1. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
2. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
3. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
4. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.Pearson International Edition
5. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
6. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
7. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
8. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
9. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
10. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASMPress,
11. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.
12. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2 nd Edition, ASM Press.
13. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science

Paper MCB -612 Biostatistics and Bioinformatics (B2)

B. Sc Third Year

SEMESTER – VI

TOTAL HOURS: 45 CREDITS: 2

Unit I 10 periods

Biostatistics: Measures of Central value of Dispersion and Frequency Distribution-mean, median, mode, range, standard deviation, variance.
Basic principles of probability theory, Sampling distribution, statistical inference .

Unit II 10 periods

Statistical methods for quality management.Sampling theory, time series, and Index number, Testing of Hypothesis, Types of errors and levels of significance and Degree of freedom.
m Analysis and Comparison of variance (F-test), small sample testbased on t-test, Z- test ; Confidence Interval; Distribution-free test - Chi-square test;. Experimental Designs and Operational Research.Correlation and Linear regression.

Unit III 10 periods

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

Unit IV 10 periods

Comparative Genomics and proteomics: Molecular phylogenetics: Construction of Phytogenetic trees .Clustering methods.UPGMA & neighborjoining. Local and Global Sequence alignment, pairwise and multiple sequence alignment.
Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes
Genome, transcriptome, proteome, 2-D gel electrophoresis, Fragment assembly, peptide sequencing using mass and spectroscopy data.
Major features of completed genomes: *E.coli, S.cerevisiae,* Human.

Unit V 05 periods

Seminar/ PPT presentation/Assingments/Tutorials.

DSE-: **Lab Course 10. MCB- 622 (B2)**

BIOSTATISTICS AND BIOINFORMATICS

SEMESTER –VI

TOTAL HOURS: 3 CREDITS: 1.5

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases : NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Prediction of different features of a functional gene
5. Mean, Median, Mode from grouped and ungrouped Data set
6. Standard Deviation and Coefficient of Variation
7. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Patenting Inventions in Microbiology

Suggested References

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House

2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications

3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International StudentEdition

4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication

5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

6.Mungikar Anil.M.(2003) Biostatistical Analysis. Saraswati Printing Press

7.Rao K. Surya (2010) Biostatistics for Health and Life Sciences. Himalaya Publishing House.

8.N.Gurumani (2005) An Introduction to Biostatistics.MJP Publisher.

9. A. Edmondson and D. Druce(1996) Advanced Biology Statistics, Oxford University Press.

10. W. Danial : Biostatistics (2004)A foundation for Analysis in Health Sciences,John Wiley and Sons.

Paper MCB -612 Agricultural Microbiology (C2)

SEMESTER –VI

TOTAL HOURS: 45CREDITS: 2

Unit 1 Soil Microbiology **No of Hours: 12**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distributionof microorganisms in soil. Microbiological Examination of soil. R:S ratio.

Mineralization of Organic compounds, Degradation of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium.

Unit 2Microbial Activity in Soil and Green House Gases No of Hours: 12

Microbial interactions in soil.Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control.Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbialplant pathogens, Insects, Weeds

Introduction of Plant Pathology : Regional plant/ crop diseases

Unit 3 Biofertilization, Phytostimulation, Bioinsecticides **No of Hours: 11**

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers,algae), Novel combination of microbes as biofertilizers, PGPRs

Unit 4 Secondary Agriculture Biotechnology **No of Hours: 10**

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

GM crops :Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

Agricultural waste management

Unit V Seminar/ PPT presentation/Assingments/Tutorials Hours 05

Lab Course-10 MCB -622
DSE-C2: Agricultural Microbiology

SEMESTER –VI

TOTAL HOURS: 60 CREDITS: 1.5

1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter*as soil inoculants characteristics and field application
5. Isolation and identification of pathogens from infected plants
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management.7th edition.Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009).Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert

MICROBIOLOGY SEMESTER - VI
MB-612- MICROBIAL DIVERSITY (D2)

UNIT 1: INTRODUCTION TO MICROBIAL DIVERSITY **Hours-10,**

1.1 Biodiversity- Microbial evolution and types of diversity

1.2 Introduction and overview of microbial taxonomy, taxonomic ranks of microorganisms and classification systems (Phenetic, phylogenetic and polyphasic classification)

1.3 Major characteristics used in taxonomy: classical and molecular characteristics

1.4 Major divisions of life and groups of microorganisms: study of different classifications and place of microbes

1.5 Introduction and overview of Metagenomics and its applications

UNIT 2: PROKARYOTIC DIVERSITY **Hours-10**

2.1 Introduction and overview of Bergey's Manual and Habitat and distinguishing features of Gram negative & positive bacteria

2.2 Aerobic/ Microaerophilic Gram negative bacteria:

- 2.2.1 Motile, helical & vibrioid
- 2.2.2 Non-motile curved bacteria
- 2.2.3 Rods and cocci

2.3 Facultative anaerobic Gram negative bacteria:

- 2.3.1 Rods, curved and helical bacteria
- 2.3.2 Dissimilatory Sulfate reducers

2.4 Anaerobic Gram negative bacteria:

- 2.4.1 Anaerobic cocci
- 2.4.2 Phototrophic bacteria (Anoxygenic and oxygenic phototrophs)

2. 5 Gram positive bacteria – General features of:

- 2.5.1 Endospore forming rods and cocci
- 2.5.2 Asporogenous rods and cocci
- 2.5.3 Mycobacteria and Actinomycetes

UNIT 3: DIVERSITY OF SOME UNUSVAL PROKATYOTES **Hours-10**

3.1 Bacteria with unusual morphology

- 3.1.1 Budding and appendaged bacteria
- 3.1.2 Sheathed Bacteria
- 3.1.3 Mycoplasma

3.2 Bacteria with gliding motility

3.3 Rickettsia and Chlamydia

3.4 Archaeabacteria

- 3.4.1 Introduction and general features of archaea
- 3.4.2 Types of Extremophilic Microorganisms: over view of Thermophiles, Halophiles, Acidophiles, Alkalophiles, Barophiles and Methanogens

3.5 Importance of prokaryotic microorganisms

UNIT 4: EUKARYOTIC DIVERSITY **Hours-10,**

A: FUNGI
4.1 General characteristics, occurrence, Structure, Reproduction (Mucor and Aspergillus)
4.2 Economic importance of fungi
B: ALGAE 4.3 General Characteristics, Occurrence & Ultra - Structure
4.4 Economic importance of Algae
C: PROTOZOA 4.5 General Characteristics, Occurrence, Ultra - Structure &Economic importance of Protozoa

Unit V Seminar/ PPT presentation/Assignments/Tutorials **Hours-5**

B.Sc Microbiology
Lab Course-10 MCB -622
MICROBIAL DIVERSITY(D2)

Practical Hours – 3hrs/day for 2 days/Week Total Credit –1.5

1) Isolation of Gram negative bacteria from the given sample.

2) Identification of Gram negative bacteria from the given pure culture using biochemical media (*E.coli, Entrobacter aerogens, Proteus, Salmonella*)

3) Isolation of Gram positive bacteria from the given sample.

4) Identification of Gram positive bacteria from the given pure culture using biochemical media (*Bacillus megaterium, Bacillus subtilis, staphylococcus aureus, Streptococcus*)

5) Identification of Fungi on the basis of Morphological Characteristics.

6) Cultivation of yeast from different natural samples and its morphological characterization using microscopic observation.
7) Microscopic observation of different algae from the given samples.
8) Microscopic observation of different protozoa from the given sample.
9) Isolation and cultivation of bacteriophage of E.coli from the given sewage sample.

10) Cultivation of Extremophile (Halophile/thermophile/acidophile/alkalophile/psychophile)

REFERENCE BOOKS

1. Frazier, W.C., Westhoff, D.C. (1978). Food Microbiology. Tata McGraw-Hill Publishing Company.
2. Pelczar, M.J., Chan E.C.S., Krieg, N.R., Microbiology, 5 Edition. Tata McGraw Hill Publication Co. Ltd. New Delhi.
3. Salle, S.J. (1974).Fundamental Principals of Bacteriology, Tata McGraw Hill Publication Co. Ltd. New Delhi.
4. Purohit, S.S., Microbiology-Fundamentals and Applications-6 th Edition, Agrobios Publications, Delhi.
5. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.
6. Stainer, R.Y., Iingraham, J.L., Wheelis, M.L., Painter, R.K. General Microbiology, 5th Edition. MacMillan Press Ltd., London.
7. Modi, H.A. Elementary Microbiology - Vol –I & II, Akta Prakashan, Nadiyad.

8. Tortora, Funke & Case. Microbiology-An Introduction, 8 Edition, Pearson Education, Delhi.
9. Powar and Daginawala, General Microbiology Vol-II. Himalaya Publishing House, Mumbai.
10. Dubey, R.C.and Maheshwari, D.K., A Text Book of Microbiology, S. Chand Publications, New Delhi.
11. Mani, A., Selwaraj, A.M., Narayanan L.M., and Arumngam, N., Microbiology, Saras Publication, Delhi
12. Patel. R.J., Patel. K.R., Experimental Microbiology, Vol-I, Aditya Publications, Ahmedabad, India.
13. Patel. R.J., Patel. K.R., Experimental Microbiology, Vol-II, Aditya Publications, Ahmedabad, India.
14. Dubey. R.C., Maheshwari. D.K., Practical Microbiology, S.Chand & Company Ltd., New Delhi
15. Konika Sharma, Manual of Microbiology – Tools and Techniques , Ane books, Delhi

PROGRAMME OUTCOMES (POs)

The B.Sc. program (Microbiology) has documented measurable outcomes that are based on the needs of the programme's stakeholders. The programme outcomes that the department presently adapts to future graduates are as follows:

PO-1 **Scientific knowledge:** Graduates will acquire microbiology specific knowledge including recent techniques in the respective fields coupled with hands-on skills and leadership skills for a successful career.

PO-2 **Problem analysis:** Graduates will be able to analyse, solve and troubleshoot problems in implementation of biochemistry/biotechnology/ microbiological protocols.

PO-3 **Design/development of solutions:** Graduates will develop creative thinking and cooperate with each other to solve problems in the field of biochemistry/biotechnology/bioinformatics/microbiology.

PO-4 **Conduct investigations of complex problems:** Graduates will acquire practical skills – which help in planning and designing protocols to validate hypothesis and execute experimental techniques independently as well as assimilate, analyse and interpret subsequent data.

PO-5 **Modern tool usage and communication:** Graduates will effectively be able to manage resources and time using ICT and computer enabled devices and accomplish ability to understand and communicate all ideas effectively.

PO-6 **Environment sustainability and Ethics:** Graduates will get adequate knowledge to use information and implement solutions for environmental protection and remediation. Graduates will be aware of their role and responsibility in handling and use of microbes including genetically modified microorganisms.

PO-7 **Lifelong learning:** Graduates will carry on to learn and adapt in a world of constantly evolving technology.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

The overall outcome of graduates specific to B.Sc. Microbiology programme can be summarized as:

PSO1 Microbiologyskills:

The ability to understand the basic concepts related to the relevant fields of microbiology which will enable them to analyse and develop solutions to microbiology related problems.

PSO2 Microbiology related employability skills:

The ability to use the acquired hands-on skills in microbiology, molecular identification, immunodiagnostics, medical microbiology and screening for useful biomolecules to implement, validate and interpret data in protocols within employment areas.

PSO3 Successful Career and Entrepreneurship:

The ability to gainfully become an entrepreneur by using microorganisms to produce biofertilizers, mushrooms and pharmaceutically important biomolecules as well as using practical hands-on training to become employed in diagnostic, industrial, pharmaceutical, food and research and development laboratories.

PSO4 Societal responsibility:

The ability to learn and implement environmentally safe and sustainable Practices by adhering to good microbiological practices, upholding ethical codes and gainful employability

PSO5 Life-long learning:

The ability to learn, assimilate and update by using MOOC platforms and various digital platforms and knowledge resources as a continuous process of life-long learning and knowledge addition

1. Introduction:

In the increasingly globalized society, it is important that the younger generation especially the students are equipped with knowledge, skills, mindsets and behaviours which may enable them to perform their duties in a manner so that they become important contributors to the development of the society. This will also help them to fully utilize their educational training forearning adecentlivingsothattheoverallstandard of their families and surroundings improve leading to development of welfare human societies. To achieve this goal, it is imperative that their educational training is improved such that it incorporates the use ofnewer technologies, use of newer assessment tools for mid-course corrections to make sure that they become competitive individuals to shoulder newer social responsibilities and are capable of undertaking novel innovationsin their areas of expertise. In the face of the developing knowledge society, they are well aware about the resources of self-development using on-line resources of learning which is going to be a major component of learning in the future. The learning should also be a continuous process so that the students are able to re-skill themselves so as to make themselves relevant to the changing needs of the society. In the face of this need, the educational curricula, teaching learning processes, training, assessment methods all need to be improved or even re-invented. The higher educational institutions (HEI) all over the globe are in the grip of this urgent task and India needs to keep pace with all these developments.

2. Learning Outcomes based approach to Curriculum Planning:

Learning Outcome based approach to curriculum planning (LOCF) is almost a paradigm shift in the whole gamut of higher education such that it is based on first and foremost identifying the outcomes of the learning required for a particular subject of study, and then planning all components of higher education so as to achieve these outcomes. The learning outcomes are the focal point of the reference to which all planning and evaluation of the end learning
is compared and further modifications are made to fully optimize the education of the individuals in a particular subject. The outcomes for the subject of Microbiology are defined in terms of the understanding and knowledge of the students in microbiology and the practical skills the students are required to have to be competitive microbiologist so thatthey are able to fulfil their role as microbiologist wherever required in the society such as the diagnosis and monitoring of prognosis of diseases combined with their remedies; the role of microbiologists in the pharmaceutical, food and biotechnology industry and how they may be able to fit the bill in the industry. The students are also trained in such a way that they develop critical thinking and

problem solving as related to the field of microbiology. The developed curriculum emphasizes the teaching and evaluation tasks are designed in such a way that the students are able to apply their knowledge and training of microbiology to solve the problems of microbiology as these exist or appear from time to time in the society. The curriculum envisions that the student, once graduate as specialists in microbiology, have an important role to play in the newer developments and innovations in the future in the subject for advancement of the discipline.

3. QualificationDescriptors:

The following are the important qualification descriptors for a UG degree in Microbiology:

1. Knowledge of the various fields where microbiology isinvolved.
2. Understanding of diverse Microbiological processes.
3. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practicesetc.
4. Moderately advanced skills in working with microbes such as pilot scale culturing, downstream processes, diagnosticsetc.
5. Generation of new knowledge through small researchprojects
6. Ability to participate in team work through small microbiology projects.
7. Ability to present and articulate their knowledge of Microbiology.
8. Knowledge of recent developments in the area of Microbiology.
9. Analysis of data collected through study and small projects.
10. Ability to innovate so as to generate new knowledge.
11. Awareness how some microbiology leads may be developed into enterprise.
12. Awareness of requirements for fruition of a microbiology-related enterprise

Course learning outcomes

Fundamentals of Microbiology (Theory)

Course Objectives: The candidate will gain knowledge about the structure of bacteria, fungi, algae, protozoa and viruses along with the basic principles of microscopy. Control of microbial growth by physical and chemical methods plus the use of antibiotics and their efficacy testing are emphasized. Cultivation of microbes is discussed.

Course Outcome

At the end of the course, learners will be able to:

CO1: Gain knowledge on various classes of microorganisms; their structure-extracellular and intracellular components, cultural characteristics and their growth conditions.

CO2:Knowaboutthedifferentpartsandworkingmechanismsofbasiclightmicroscope uptoelectronmicroscopeswithdeepknowledgeonthesamplepreparationandstaining techniques.

CO3: Acquire knowledge on sterilization techniques with adequate information on sterile, aseptic conditions.

CO4: Know about different classes of antibiotics and their mode of actions, treatment strategies and detection of resistant forms of bacteria from clinical settings.

CO5: Microbial culture media and pure culture techniques for aerobic and anaerobic cultivation methods for bacteria.

Microbial Techniques (Practical)

Course Objectives: The candidate will gain hands-on knowledge and acquire adequate skillrequiredtosterilizemediaandtoprepare,inoculateobserveanddistinguishthegrowth patterns in differentmedia.

1. Cleaning and Sterilization ofGlassware.
2. Preparation and growth of Bacteria in Basal Media – Nutrient Broth, Peptone Water, NutrientAgar.
3. Preparation and growth of Bacteria in – MacConkey Agar and CetrimideAgar.

4. Preparation and growth of Bacteria in Carbohydrate FermentationMedia.
5. Filter sterilization ofSerum.
6. Simple staining – positive and negativestaining.
7. Gram staining ofBacteria.
8. Capsulestaining.
9. Sporestaining.
10. Cultivation of fungi in SDA and LPCB mount and microscopy ofgrowth.
11. Cultivation of Algae and Identification of Spirogyra, Chlamydomonas, Anabaenaand Nostoc.
12. Antibiotic sensitivity test – Kirby BauerMethod.

Lab Course Outcome

At the end of the course, learners will be able to:

CO1: Perform cleaning & sterilization of glassware

CO2: Competently prepare and cultivate bacteria in different types of media.

CO3: Gain knowledge on filter sterilization techniques

CO4: Know how to grow algae in the lab

Microbial Chemistry

Course Objectives: The candidate will gain knowledge about the structure, properties and functions of carbohydrates, proteins, lipids and nucleic acids. Basic biochemical techniques are also dealt with.

Course Outcome

At the end of the course, learners will be able to:

CO1: Basic understanding of carbohydrates and its metabolism

CO2: Obtain knowledge on structure, classification & biological roles of proteins

CO3: Obtaining in-depth information on lipids and their classification. **CO4**: Assimilate knowledge on biosynthesis and metabolism of lipids **CO5**: Gain the knowledge on different chromatographic methods.

Microbial Chemistry Practical

Course Objectives: The candidate will gain knowledge and skills required detecting carbohydrates, amino acids, and also estimating the amount on biomolecules in the given solutions.

Bacterial Cytology and Virology

CO1.Explain diagrammatically the ultrastructure of eukaryotic cells. Outline the cellular signalling mechanisms in higher organisms at the molecular level.

CO 2. Illustrate the effect of fundamental activities such as homeostasis and morphogen gradients on the process of cellular development

CO 3. Explain diagrammatically trafficking of biomolecules in the compartments of eukaryotic cells

CO4 : List the various emerging, re-emerging viral diseases and their causative agents. State the reasons for their emergence and re-emergence.

CO 5: Illustrate the structure of viruses. Explain the methods for cultivating viruses.

Environmental Microbiology(Theory)

CourseObjectives: Thecandidatewillgainknowledgeaboutmicrobesinair,airsanitation and quality assessment. Types of water ecosystems and water-borne diseases. Effluent treatment and parameters – BOD, COD. Extremophiles in the environment.

Course Outcome

At the end of the course, learners will be able to:

CO1: Gain knowledge on the role and infections caused by microbes in air.

CO2: Obtain detailed information on aquatic ecosystems and Assimilate knowledge on Water borne diseases.

CO3: Get detailed knowledge on Waste water treatment and its different methods.

CO4: Basic understanding on different types of microbes present in the environment and itsuses.

CO5: Acquire knowledge on Biodegradation, of xenobiotic compounds and Understand of Biomagnification and Bioremediation.

Environmental Microbiology(Practical)

CourseObjectives: Thecandidatewillgainhands-onknowledgeandacquireadequateskill required to evaluate the quality of milk, curd and spoilage organisms. Microbiological evaluation of water and air will bepracticed.

Immunology and Clinical Microbiology (Theory)

Course Objectives: The candidate will gain knowledge about immunity, organs of immunity and cells involved. Types of antigens and immunoglobulins. Antigen- antibody reactions and assays. MHC and its significance.

Course Outcome

At the end of the course, learners will be able to:

CO1: Understand the fundamental concepts of immunity, contributions of the organs and cells in immune responses.

CO2: Understand the antigens & their characters; the different types antibodies & their properties

CO3: Understand the mechanisms involved in antigen-antibody reactions

CO4: Differentiate the humoral and cell mediated immune mechanisms

CO5:Comprehendtheoverallreactionbyourimmunesystemleadingtohypersensitive conditions and its consequences. Know how MHC functions in the immune system; Gain knowledge on vaccines, toxoids andimmunotherapy

Immunology and Clinical microbiology (Practical)

CourseObjectives: The candidate will gain hands-on knowledge and acquire adequates skill required to identify lymphocytes, various agglutination and precipitation reactions. Perform and interpret ELISA tests and Immuno-electrophoresis as well as purify immune globulins.

Course Outcome

The students will be able to

CO1: Identify various immune cells and enumerate them

CO2: Competently perform serological diagnostic tests such as RF, ASO, CRP.

CO3: Identify blood groups and types

CO4: Diagnose syphilis by performing TPHA test

CO5: Analyze and quantify the antigens / Abs by performing immunoelectrophoresis, chromatography techniques & ELISA

Food and Dairy Microbiology(Theory)

Course Objectives: The candidate will gain knowledge about food preservation, spoilage. Sanitation requirements and in-plant mechanism with documentation – GMP, HACCP. Dairy microbiology – cheese, Yogurt. Food-borne diseases and its control.

Course Outcome

At the end of the course, learners will be able to:

CO1: Gain knowledge on various interactions between food and microorganisms.

CO2: Know about the different methods of food preservation.

CO3: Acquire knowledge on spoilage of foods.

CO4: Explain about the microbial production of dairy and non-dairy products

CO5: Classify bacterial and non-bacterial food borne diseases

Food and Dairy Microbiology (Practical)

CourseObjectives: Thecandidatewillgainhands-onknowledgeandacquireadequateskill required to evaluate the quality of milk, curd and spoilage organisms. Microbiological evaluation of water and air will bepracticed.

Microbial Genetics (Theory)

Course Objectives: The candidate will gain knowledge about the structure, shape and significance of DNA, RNA. Synthesis of RNA and proteins along with its control. Role of genes as basic units of expression.

Course Outcome

At the end of the course, learners will be able to:

CO1:UnderstandtheflowofinformationfromDNAtoProtein.Knowindetailthestructure ofDNA&RNAandreplication ofDNA.

CO2: Grasp the replication of single-stranded DNA molecules and the various features of retrovirus replication.

CO3: Appreciate the various cellular mechanisms involved in the control of transcription. **CO4**: Basic understanding of control methods for gene expression. Understanding the language for communication in cells.

CO5: Molecular basis of heritable changes in cells along with insights about evolutionary methods to overcome change. Firm grasp of E.coli gene mapping methods as well as those of yeast

CC6: Microbial Genetics (Practical)

CourseObjectives: Thecandidatewillgainhands-onknowledgeandacquireadequateskill required to separate and observe chromosomal DNA, RNA, amino acids, lipids as well as estimate nucleicacids.

Course Outcome

At the end of the course, learners will be able to:

CO1: Understand the concept of plasmid isolation and characterization

CO2: Know how to purify bacterial chromosomal DNA

CO3: Gain knowledge on methods of DNA & RNA estimation

Molecular Biology Genetic Engineering (Theory)

Course Objectives:

- The candidates will understand the structures of DNA and RNA, replication of DNA and transcription, translation, gene regulation, mutations and genetic exchange.
- The candidates will understand the development genetic engineering, vectors, DNA amplification and DNA sequencing, application of genetic engineering and biotechnology.

Course Outcome

At the end of the course, learners will be able to:

CO1: Attain knowledge about the structure of Nucleic acid.

CO2: Know about the mechanism of DNA replication, transcription and translation processes in organisms.

CO3: Gain knowledge in the mechanisms of gene expression and its regulations in organisms.

CO4: Achieve knowledge about the mutations and DNA repair mechanisms in organisms.

CO5: Realize knowledge about the transposable elements, types of plasmids and its applications.

CC7: Industrial Microbiology(Theory)

Course Outcome

At the end of the course, learners will be able to:

CO1: Realize the importance of microbial products over chemically synthesized products

CO2: Gain knowledge on important microbial strains and fermentation media

CO3: Understand fermenters and fermentation processes.

CO4: Gain knowledge in downstream processing and industrial production of various products.

CO5: Gain knowledge on Microbial production of industrial products

CC13: Medical Microbiology(Theory)

Course Objectives: The candidates will acquire knowledge about viruses of medical importance, their classification and characteristics. They will also learn in detail about the infections and their treatments. They will also study about the medically important bacteria and infections caused by them and their therapeutic options. They will also gain knowledge on fungal and parasitic pathogens, fungal infections and parasitic diseases and their diagnosis and treatment.

CC14: MedicalMicrobiology(Practical)

CourseObjectives: Thecandidatewillgainknowledgeaboutmicrobesinair,airsanitation and quality assessment. Types of water ecosystems and water-borne diseases. Effluent treatment and parameters – BOD, COD. Extremophiles in the environment.

CC15: Molecular Biology and Genetic Engineering(Theory)

Course Objectives: The candidates will understand rDNA technology and strategies involved in genetic manipulations. The candidates will also gain knowledge on ethical issues involved in the system. Studying nanomicrobiology, the students will get necessary background information on nanotechnology in microbiological perspective and gain knowledge on nanoprocesses.

Course Outcome

At the end of the course, learners will be able to:

CO1: Identify the aspects of various techniques for manipulation of nucleic acids.

CO2: Infer the details about hosts and vectors in gene cloning.

CO3: Apply the knowledge on gene transfer and screening of recombinants. **CO4**: List out the characteristics of clone selection and ethical issues of cloning. **CO5**: Identify the process and characters of nanoparticles.

Bioinstrumentation and Biotechniques

Course Objectives: The candidate will gain knowledge about the principles, uses, advantages and disadvantages of devices and instruments routinely used in biological labs such as LAF cabinets, Centrifuges, HPLC, GC, Spectroscopy – NMR, UV–Vis, IR. Significance and use of radioisotopes.

Course Outcome

At the end of the course, learners will be able to:

CO1: Gain knowledge on principle and working of various laboratory equipment and can able to use them with theoretical knowledge.

CO2: Learn on the theory, principles and applications of different chromatographic techniques like paper, thin layer, gel filtration, ion exchange, affinity, gas liquid, high pressure/ performance liquid chromatography (HPLC)
CO3: Learn the different techniques of gel electrophoresis where they can separate DNA, proteinsandcompounds.

CO4: Comprehend the usage of spectroscopic techniques with UV, Visible, IR, NMR, Fluorescence,Atomic Absorption, Mass, Raman Spectroscopy.
CO5: Learn the principle & will have a wide knowledge to use the radioisotopes in life sciences and radioactive labeling.

Bioinstrumentation and Biotechniques(Practical)

Course Objectives: The candidate will gain knowledge and skills required to separate amino acids, serum, haemoglobin.

Biostatistics and Bioinformatics

Course Objectives:

The candidates will gain knowledge in the statistical approach of scientific methods. The students will develop analytical and problem solving skills in addition to the design of experiments.

The candidate will gain knowledge about the computerization of biological information – data analysis and retrieval systems: NCBI, DDBJan, EMBL, SGD,TIGR and ACeDB.

Course Outcome

At the end of the course, learners will be able to:

CO1: Basic understanding of Biostatistics.

CO2: Grasp the information on kinds of biological data and collection of data

CO3: Basic understanding of Computers & programming languages **CO4**: Grasp the information on input & output devices of a computer **CO5**: Gain basic knowledge on Bioinformatics
CO6: Obtain knowledge on biomolecules

CO7: Obtaining in-depth information on biological databases and assimilate knowledge on genome and structure database

Biostatistics and Bioinformatics(Practical)

Course Objectives: The candidate will gain knowledge and skills required to compare, retrieve and gain accurate 3D structure predictions using various softwares.

Course Outcome

CO3: Obtain knowledge on sampling, sampling design and in-depth information on Correlation

CO4: Assimilate knowledge on Regression its types and Deviations

CO5: Gain the knowledge on graphicrepresentations

Microbial Biotechnology(Theory)

Course Objectives: The candidates will be aware of the wide applications of microorganismsinindustries,appreciatetheuseofmicrobesinbiotransformationproce sses
andproductionofindustriallyimportantproducts,andunderstandthepotentialsofmicro bes in rDNA technology to manufacture genetically engineeredtherapeutics.

Course Outcome

At the end of the course, learners will be able to:

CO1: Gain knowledge on Industrially important microbes and its applications in Industries

CO2: Obtain detailed knowledge on Biotransformation reactions

CO3:AcquireclearviewaboutMicrobialproductionofOrganicsolvents,Vitamins,Foods , Applications & Microbial production of Antibiotics and Alcoholicbeverages

CO4: Conquer knowledge on Applications of Genetic Engineering & rDNAtechnology

CO5: Accomplish knowledge on production of vaccines, Hormones and Bloodproteins.

Environmental Technology (Theory)

Course Objectives: The candidates will understand microbial interactions with environment and their association with diseases. The students will also appreciate the role of microbes in waste treatment and biodeterioration.

Course Outcome

At the end of the course, learners will be able to:

CO1: Gain knowledge about the role and infections caused in air.

CO2: Obtain complete knowledge on Microorganism inhabiting extreme environments.

CO3: Gain detailed knowledge on aquatic ecosystems and Water borne diseases

CO4: Acquire detailed knowledge on solid and liquid wastes, Solid waste treatment, Utilization of solid wastes, Waste water treatment and its different methods.
CO5: Attain information on Biodeterioration.

Enzymology and Microbial Metabolism

Course Objectives: The candidates will understand the basic bioprocesses and the potentials of biomolecules in cell stability and survival. Students will gain knowledge on metabolic pathways of microbes with emphasis on prokaryotic photosynthesis.

Course Outcome

At the end of the course, learners will be able to:

CO1: Gain knowledge about the basic bioprocesses and the potentials of bio molecules in cell stability.
CO2: Learn about the generation and maintenance of membrane potential.

CO3: Understand various types of lipid metabolism and nucleic acid biosynthesis. **CO4**: Gain knowledge in the biosynthesis of various bio molecules and fermentation **CO5**: Learn about the photosynthesis in prokaryotic system

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