File Ref.No.58388/GA - IV - J3/2019/Admn

UNIVERSITY OF CALICUT

Abstract

General & Academic - CBCSS UG Regulations 2019 - Scheme and Syllabus of B.Sc Microbiology programme w.e.f 2020 Admission onwards -Incorporating Outcome Based Education - Implemented - Subject to ratification of Academic Council - Orders Issued.

G & A - IV - J

U.O.No. 5709/2021/Admn Dated, Calicut University.P.O, 29.05.2021

Read:-1) U.O.No. 9836/2019/Admn, Dated 25.07.2019.
2) The email from the Chairperson, Board of Studies, Dated 25.05.2021.
3) Remarks of the Dean, Faculty of Science, Dated 26.05.2021.
4) Orders of the Vice Chancellor in the file of even no, Dated 28.05.2021.

ORDER

1. The scheme and syllabus of B.Sc Microbiology Programme under CBCSS UG Regulations 2019 in the affiliated Colleges of the University, w.e.f 2019 admission onwards has been implemented, vide paper read (1) above.
2. The Chairman, Board of Studies in Microbiology, vide paper read (2) above, has forwarded the scheme and syllabus of B.Sc Microbiology Programme , incorporating Outcome Based Education(OBE) in the existing syllabus in accordance with CBCSS UG Regulations 2019, w.e.f 2020 admission after circulating among the members of the board , as per Chapter 3(34) of Calicut University First Statute, 1976.
3. The scheme and syllabus of B.Sc Microbiology Programme , incorporating Outcome Based Education(OBE), has been approved by the Dean, Faculty of Science, vide paper read (3) above and by the Vice Chancellor, subject to ratification by the Academic Council, vide paper read (4) above.
4. The Scheme and syllabus of B.Sc Microbiology programme (CBCSS) incorporating Outcome Based Education (OBE) in the existing syllabus, in tune with CBCSS UG Regulations 2019, is therefore implemented with effect from 2020 Admission onwards under affiliated colleges of the University, subject to ratification by the Academic Council.
5. Orders are issued accordingly.
6. U.O. No. 9836/2019/Admn Dated 25.07.2019 stands modified to this extend. (Modified syllabus appended)

Arsad M

Assistant Registrar

To

The Principals of all Affiliated Colleges
Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE IV/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

B.SC. MICROBIOLOGY

SYLLABUS

(2020 Admission onwards)

Scheme of Evaluation for B.Sc. Microbiology CBCSS (2020 Admission Onwards)

Semester	Course nature	Course code	Course title	Hours/ week	Credits	Total credits	Scheme of Evaluation (in		
							Interna l (20%)	External (80%)	Total
I	Common English course I	A01		4	4	18	15	60	100
	Common English course ll	A02		5	3		15	60	75
	Additional language course I	A07(3)	Communication skill in the languages other than English for B.Sc alternate pattern	5	4		20	80	100
	Core course I	MBG1B01	General Microbiology	3	3		15	60	75
	Ist Complementary	--1C01		2	2		15	60	75
	Ist Complementary - Practical	--4C08(P)		2					0
	2nd Complementary	MBG1C02	Biostatistics I	4	3		15	60	75
II	Common English course lll	A03		4	4	20	20	80	100
	Common English course lV	A04		5	3		15	60	75
	Additional language course ll	A09(3)	Literature in lanuages other than english for B.Sc. Alternate pattern	5	4		20	80	100
	Core course II	MBG2B02	Microbial Physiology and Taxonomy	3	3		15	60	75
	Ist Complementary	--2C03		2	2		15	60	75
	Ist Complementary - Practical	--4C08(P)		2	*				0
	2nd Complementary	MBG2C04	Biostatistics II	4	3		15	60	75
III	General course I	A11	General Course I (LRP pattern)	4	4	16	20	80	100
	General course ll	A12	General Course II (LRP pattern)	4	4		20	80	100
	Core course III	MBG3B03	Environmental and Sanitation Microbiology	4	4		20	80	100
	Core practical course I	MBG4B05(P)	Microbiology Practical I	3	*				0
	Ist Complementary	--3C05		3	2		15	60	75
	Ist Complementary - Practical	--4C08(P)		2	*				0
	2nd Complementary	MBG3C06		3	2		15	60	75
	2nd Complementary-Practicals	MBG4C10(P)		2	*				0

Semester	Course nature	Course code	Course title	Hours/ week	Credits	Total credits	Scheme of Evaluation (in		
							Interna l (20%)	External (80%)	Total
IV	General course lll	A13	General Course III (LRP pattern)	4	4	26	20	80	100
	General course lV	A14	General Course IV (LRP pattern)	4	4		20	80	100
	Core course IV	MBG4B04	Soil and Agricultural Microbiology	4	4		20	80	100
	Core course Practical I	MBG4B05(P)	Microbiology Practical I	3	4		20	80	100
	Ist Complementary	--4C07		3	2		15	60	75
	Ist Complementary - Practical	--4C08(P)		2	4		20	80	100
	2nd Complementary	MBG4C09		3	2		15	60	75
	2nd Complementary- Practicals	MBG4C10(P)		2	2		15	60	75
V	Core course V	MBG5B06	Industrial Microbiology	4	4	18	20	80	100
	Core course VI	MBG5B07	Food and Dairy Microbiology	4	4		20	80	100
	Core course VII	MBG5B08	Immunology	4	4		20	80	100
	Core course VIII	MBG5B09	Medical Microbiology-I	4	3		15	60	75
	Core course practical II	MBG6B12(P)	Microbiology Practical II	4	*				0
	Project work	MBG6B16 (Pr)	Project Work	3	*				0
	Open course-for other departments	MBG5D01	Open course- for other departments	2	3		15	60	75
		MBG5D02	Open course- for other departments						
		MBG5D03	Open course- for other departments						
VI	Core course IX	MBG6B10	Genetics and genetic engineering	4	4	22	20	80	100
	Core course X	MBG6B11	Medical Microbiology-II	4	4		20	80	100
	Core course practical II	MBG6B12(P)	Microbiology Practical II	4	4		20	80	100
	Core course practical III	MBG6B13 (P)	Microbiology Practical III	4	3		15	60	75
	Core course practical IV	MBG6B14 (P)	Microbiology Practical IV	3	3		15	60	75
	Elective course	MBG6B15 (E1)	Cell and Tissue culture	4	2		15	60	75
		MBG6B15 (E2)	Molecular Biology						
		MBG6B15 (E3)	Bioinstrumentation						
	Project work	MBG6B16 (Pr)	Project work (Examination along with the core practical examination)	2	2		10	40	50
					120	**120**	**635**	**2540**	**3175**

*Credits after exam at the end of semester IV/VI, Ability enhancement courses as per the regulations is mandatory for the completion of the programme

Scheme of Evaluation for B.Sc. Microbiology CBCSS

Distribution of different courses and their credits

Semester	Course type	No.of Courses	Credits	Marks
I and II	Common-English	4	14	325
I and II	Common-Addl language	2	8	200
III and IV	General Common	4	16	400
I to IV	Complementary	11	24	775
I to VI	Core	14	53	1400
V	Open (Other dept.)	1	3	75
V through VI	Project (core)	1	2	50
	Total	37	120	3175
I through IV	Ability enhancement Courses	4	16	

Total common courses offered	:	10
Total core courses offered in the area of specialization (Microbiology) including project work and practical	:	**16**
Total Complementary courses offered including practicals (two complementary subjects)	:	**11**
Total courses offered in 6 semesters	:	**37**
Total credits aquired through class room study	:	**120**
Total credits required for qualifying Degree	:	**140**
Total credits offered for core, complementary and open put together	:	**82**
Total credits required for common courses	:	**38**

General Course offered (Designed by the Board of studies)		
1. General course I - IV for LRP group IV	:	16 credits
Open courses offered to students of other Departments with credits (5th Semester)		
1. Public health and emerging microbial diseases	:	3 credits
2. Environmental Microbiology	:	3 credits
Elective from the parent department with credits (6th Semester)		
1. Cell and tissue culture	:	4 credits
2. Molecular Biology	:	4 credits
3. Bioinstrumentation	:	4 credits

Complementary Courses for B.Sc. Microbiology

1st Complementary -Biochemistry : 12 Credits

2nd Complementary- Biostatistics and Computer Applications : 12 Credits

Scheme of Examination, Evaluation and Grading:

- There shall be University examinations at the end of each semester.
- Practical examinations shall be conducted by the university at the end of even semesters.
- Practical examination, project / dissertation evaluation and viva voce shall be conducted by one external examiner and one internal examiner appointed by the university.
- Project evaluation shall be conducted at the end of 6th semester.
- Each Practical examination shall be conducted in two consecutive days of six hours duration.
- Evaluation and grading are in accordance with the general guidelines given by the university.
- The questions should be answered only in English

SEMESTER III MBG3C06 Computer Applications- Fundamentals*

SEMESTER IV MBG4C09. C-Language, Data Base Management System & SQL*

MBG4C10 (P) Computer Applications Practical II (with exam)*

*The syllabus modification of the 2nd complementary may be done by the BOS of Computer science and Statistics

PROGRAMME OUTCOMES (POS)

PO1 Acquire knowledge about the fundamental principles and scientific theories related to various scientific phenomena in day-to-day life.

PO2 To develop communication skills and get expertise in scientific writing.

PO3 Acquire the skills in handling scientific instruments, planning and performing in laboratory experiments.

Equip them with the skills to think creatively and draw logical inferences from the scientific experiments to draw the objective conclusions or provide new solutions to the problems.

To make them Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.

PO4 To get an awareness of the impact of science on the environment and society.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSO1 Gain integrated knowledge on different aspects of microbiology, biochemistry, biostatistics and computer applications bioinformatics and emerging worldwide microbiological technologies, issues, and perspectives.

PSO2 Acquire skills specific to microbiology and allied fields for converting information to knowledge through hypothesis, design, execution and analysis.

PSO3 Analysis of scientific issues across the spectrum of related disciplines.

PSO4 Enable the students to improve the quality of human lives in relation to the environment with the knowledge in microbiology.

PSO5 Capacity to develop, employ and integrate technical and professional skills as a member of a team upholding the essence of collaboration, cooperation, ethics and integrity.

CORE COURSE

MICROBIOLOGY

COURSES

SEMESTER - I

1. MBG1B01 General Microbiology

SEMESTER - II

2. MBG2B02 Microbial Physiology and Taxonomy

SEMESTER - III

3. MBG3B03 Environmental and Sanitation Microbiology

SEMESTER - IV

4. MBG4B04 Soil and Agricultural Microbiology
5. MBG4B05(P) Microbiology Practical I

SEMESTER - V

6. MBG5B06 Industrial Microbiology
7. MBG5B07 Food and Dairy Microbiology
8. MBG5B08 Immunology
9. MBG5B09 Medical Microbiology-I

SEMESTER - VI

10. MBG6B10 Genetics and genetic engineering
11. MBG6B11 Medical Microbiology-II
12. MBG6B12(P) Microbiology Practical II
13. MBG6B13 (P) Microbiology Practical III
14. MBG6B14 (P) Microbiology Practical IV
15. MBG6B15 (E1) Cell and Tissue culture
16. MBG6B15 (E2) Molecular Biology
17. MBG6B15 (E3 Bioinstrumentation
18. MBG6B16 (Pr) Project work

SEMESTER I
MBG1B01. GENERAL MICROBIOLOGY

3 Hrs /week **3 credits**

Course Objectives: The course contents are designed to gain knowledge about the history of microbiology, eukaryotes and prokaryotes, ultrastructure of bacteria, microscopy and sterilization concepts. The learner will acquire basic knowledge about the microbial world.

Course Outcome

CO1	Sketch the historical events in the developments of Microbiology as a discipline emphasizing the contributions of the scientists.
CO2	Compare the difference between the basic cell types *viz,* Eukaryote, Prokaryote, Virus, Actinomycetes and Archaebacteria.
CO3	Describe the ultra structure of a bacterial cell helping to study the further biochemical and physiological reactions inside the cell.
CO4	Discuss various microscopes and compare the different types of light and electron Microscope.
CO5	Explain the various staining techniques and to distinguish their application in Microbiology.
CO6	Discuss the sterilization procedures and to implement it to maintain a hygienic environment

Unit 1. Scope and history of Microbiology, spontaneous generation vs. biogenesis. Contributions of the following scientists in various areas of Microbiology - Anton van Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman. Beneficial and harmful microbes.

Unit 2. Eukaryote and prokaryote - differences. Differences between archaebacteria and eubacteria. Bacterial forms and arrangement of cells. Actinomycetes, Mold and yeast forms. Viral and bacteriophage forms.

Unit 3. Ultrastructure of bacteria- External structures-glycocalyx, capsule, flagella, fimbriae and pili. Cell-wall: Composition and detailed structure of gram positive and gram negative cell walls, Archaebacterial cell wall, spheroplasts, protoplasts, and L-forms. Effect of penicillin and lysozyme on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 4. Microscopy- bright field, dark field, phase contrast, fluorescent and electron

microscopy. Staining techniques- simple, negative, Grams, spore, flagella, acid fast, volutin, capsule and Feulgen staining.

Unit 5. Sterilisation and disinfection techniques- Physical and chemical methods- flaming, boiling, autoclaving, inspissation, Heat, Filtration, Radiation. Aseptic methods- laminar air flow hood. Disinfectants and its testing.

Suggested Readings

1. Fundamentals of Bacteriology by A.J Salle
2. Microbiology by Pelczar*et al*
3. Fundamentals of Microbiology by Mertus Frobisher
4. General microbiology by Stanier *et al*
5. Textbook of Microbiology by Prescott.
6. Principles of Microbiology by Ronald Atlas
7. Microbiology: An Introduction by Tortora GJ, Funke BR, and Case CL.
8. Microbiology: Principles and Explorations *by Black.*
9. Brock Biology of Microorganisms.
10. Alcamo's Fundamentals of Microbiology

SEMESTER II

MBG2B02. MICROBIAL PHYSIOLOGY AND TAXONOMY

3 Hrs /week **3 credits**

Course Objectives: The objective of this course is to enhance and develop knowledge on microbial growth, culture media, modes of reproduction in bacteria and microbial taxonomy.

Course Outcomes

CO1	Discuss the environmental and nutritional factors affecting the microbial growth and classify them according to these.
CO2	Describe the mechanism of nutrient transportation across the bacterial membranes.
CO3	Explain the preparation of various cultural media and to distinguish them for microbial cultivation
CO4	Differentiate various cultural methods and preservation techniques
CO5	Illustrate the reproduction systems and the growth phases of bacteria and bacteriophages
CO6	Examine various methods for estimation of microbial cells.
CO7	Analyze the taxonomy of microorganisms through the comparative study of various criteria used and classify them into corresponding groups.

Unit 1. Microbial growth: Effect of various parameters and Environmental factors on microbial growth- Temperature, pH, O_2, solute concentration and other factors. Classification based on specific requirements-based on temperature, pH, O_2 and solute concentration. Nutritional requirements of bacteria- C, electron, energy, and minerals. Nutritional types of bacteria- based on the requirement and their combinations. Modes of bacterial nutrition. Transport of nutrients by bacteria- passive, active and group translocation. symport, antiport and uniport, electrogenic and electroneutral transport, transport of Iron.

Unit 2. Culture media-Solid and liquid media, use of agar. Selective, Enrichment, Enriched, differential, selective-differential, indicator media, Transport media, simple and complex, synthetic or defined, Anaerobic media. Culture methods-Streak, spread, pour plate methods, stab culture and lawn culture. Cultivation of aerobic and anaerobic bacteria. Culture preservation strategies.

Unit 3. Modes of reproduction in bacteria- fission, budding, fragmentation, sporulation.

Growth curve and its significance, generation time, steady state culture, synchronous culture and Diauxic culture. Quantitative measurement of bacterial growth by direct and indirect methods. Viral growth- lytic and lysogenic stage. Viral cultivation methods. Viral and bacteriophage quantitation methods- Plaque and pock assay.

Unit 4. Basics of microbial taxonomy- concept of species and taxa and strain. Classification systems- Numerical taxonomy or Adansonian classification, phenetic and phylogenetic Classification. Various criteria used in bacterial classification:- classical, morphological , physiological, metabolic and ecological characteristics. Molecular characteristics- comparison of proteins, nucleic acid base composition, nucleic acid hybridization and nucleic acid sequencing, 16 S rRNA studies.

Suggested Readings

1. Fundamentals of Bacteriology by A.J Salle
2. Microbiology by Pelczar*et al*
3. Fundamentals of Microbiology by Mertus Frobisher
4. General microbiology by Stanier *et al*
5. Textbook of Microbiology by Prescott.
6. Principles of Microbiology by Ronald Atlas
7. Microbiology: An Introduction by Tortora GJ, Funke BR, and Case CL.
8. Microbiology: Principles and Explorations *by Black.*
9. Brock Biology of Microorganisms.
10. Lippincott's illustrated reviews microbiology by Harvey
11. Alcamo's fundamentals of microbiology
12. Moat AG and Foster JW. (2002). *Microbial Physiology.* 4th edition. John Wiley & Sons.
13. Reddy SR and Reddy SM. (2005). *Microbial Physiology.* Scientific Publishers India.

SEMESTER III

MBG3B03. ENVIRONMENTAL AND SANITATION MICROBIOLOGY

4 Hrs /week **4 credits**

Course Objectives: This course aims to communicate the students with basic principles of environmental and sanitation microbiology. Learner acquires basic understanding of air, water and soil microbiology, solid waste management and xenobiotic metabolism.

Course Outcomes

CO1	Describe the organisms in air with their sources and distribution
CO2	Explain the methods of waste water treatment, air sampling , solid waste management, bioremediation and bioleaching
CO3	Discuss the microbial distribution in aquatic environment with special emphasis on factors affecting them
CO4	Compare the water purification procedures and the tests for the microbiological examination of water
CO5	Explain air borne and water borne diseases with their mode of transmission
CO6	Discuss the concept of xenobiotics and related environmental problems

Unit 1. Microbiology of air - atmospheric layers, organisms in air, distribution and sources. Disease forecasting in plants. Indoor and outdoor air. Droplet nuclei, aerosol, infectious dust. Microbiological sampling of air - gravity slide, plate exposure, vertical cylinder, Hirst spore trap, Rotorod sampler, Andersen sampler, hand held air sampler, impingers and filtration. Advantages and disadvantages of these techniques. Brief account of air borne transmission of harmful microbes and air borne infections.

Unit 2. Aquatic Microbiology: Aquatic environment, distribution of microorganisms in aquatic environment - fresh water, estuarine and marine water systems. Factors influencing growth and distributions. Water Purification procedures for single dwelling and municipal water supplies, Concept of indicator organisms, Microbiological examination of water. BOD, COD, Wastewater treatment steps and methods. Eutrophication and algal bloom. Brief account of water borne diseases and transmission.

Unit 3. Solid waste management: Sources and types of solid waste, need for management, Landfills, composting, vermi- composting, anaerobic digesters, methanogenesis and production of biogas. Design and management of biogas plants.

Unit 4. Xenobiotic metabolism - Novel pollutants, persistence and biomagnification,

Recalcitrant halocarbons- nitroaromatic compounds, PCB, alkyl benzene sulphonates, and petroleum hydrocarbons - their biodegradation. Bioremediation of polluted environment - Oil spills, heavy Metals and other xenobiotics. Microbial leaching and corrosion of metals.

Suggested Readings

1. Microbial Ecology by Ronald M. Atlas, Richard Bartha.
2. Microbiology concepts and applications by Pelzar*et a.l*
3. Microbiology by Prescott.
4. Fundamentals of Microbiology by Mertus Frobisher.
5. A Handbook of water and wastewater microbiology by Mara and Niger Horan.
6. Microbiological Examination Methods of Food And Water By Silva
7. Textbook of Biotechnology by BD Singh
8. Textbook of Microbiology by Chakrabarthy
9. Microbial Ecology. John Wiley & Sons.
10. Campbell RE. (1983). *Microbial Ecology.* Blackwell Scientific Publication, Oxford, England.
11. Maier RM, Pepper IL and Gerba CP. (2009). *Environmental Microbiology.* 2nd edition, Academic Press.
12. Stolp H. (1988). *Microbial Ecology: Organisms Habitats Activities.* Cambridge University Press, Cambridge, England.

SEMESTER IV

MBG4B04. SOIL AND AGRICULTURAL MICROBIOLOGY

4 Hrs /week **4 credits**

Course Objectives: This course prepares the student to address pressing environmental challenges by developing a fundamental understanding of the microbial communities and microbial processes in soil. It provides a brief exploration of plant pathogens and biofertilizers.

Course Outcomes:

CO1	Recall different types of soils and soil properties
CO2	Distinguish the different groups of microorganisms present in soil and t factors affecting their growth.
CO3	Describe the concept of ecosystem and its components and concept of biogeochemical cycles and N, S and P cycles.
CO4	Differentiate different types of biological interactions such as microbe-microbe, plant-microbe and animal-microbe
CO5	Explain the symptoms, disease cycle and control measures of different bacterial,viral and fungal diseases of plants
CO6	Discuss the potential of different microorganisms in agriculture as biofertilizers and biopesticides

Unit 1. Introduction to soil Microbiology - Properties of soil (structure, texture, formation). Types of soil microbes, role of microorganisms in soil fertility; Factors affecting microbial population - moisture, pH, temperature, organic matter, agronomic practices etc.; Soil fertility test.

Unit 2. Biogeochemical cycle- Role of microorganisms in Carbon, Phosphorous, Nitrogen and sulfur cycles. Humus formation and its significance.

Unit 3. Biological Interactions - Microbe-Microbe Interactions. Mutualism, Synergism,Commensalism, Competition, Amensalism, Parasitism, Predation. Microbe-PlantInteractions. Roots- Rhizosphere and *Mycorrhizae,* Aerial Plant surfaces, Microbe- Animal Interactions. Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as Symbiont

Unit 4. Plant pathology (symptoms, disease cycle and control measures) - Bacterial diseases - Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus Fungal disease- Wilt of tomato -*Fusariumoxysporum* Red rot of sugarcane -

Colletotrichumfalcatum, Early blight of potato -*Alternariasolani,* Wilt of cotton,Viral diseases- Papaya ringspot, tomato yellow leaf curl, banana bunchy top.

Unit 5. Applications of microbes in agriculture :Biofertilizers. Symbiotic nitrogen fixation - (Rhizobium, Frankia) -Symbiotic nutrient mobilizers - Endomycorrhizae and Ectomycorrizae. Non symbiotic microbes - Azotobacter. Associative Symbiosis - Azospirillum. Cyanobacteria (Nostoc. Gloeocapsa), Azolla-Anabaena System Bio pesticides- bacterial, fungal and viral, Advantages over the chemical counter parts. Effect of pesticides on soil microflora.

Suggested Readings

1. Microbial Ecology. John Wiley & Sons, Inc., New York 2.
2. Introduction to Soil Microbiology by Alexander, M.(1977). John Wiley & Sons, Inc.,
3. Agricultural microbiology, 2nd edition. Rangaswami G., Bagyaraj D. J. Prentice hall of India.
4. Ronald M. Atlas., Richard Bartha. Microbial Ecology. Benjamin Cummings. 1998
5. Robert, L Tate (1995). Soil Microbiology. First edition, John Wiley and Sons, Inc. New York edition. Pearson Education.
6. Rangaswami G and Mahadevan A (2002). Disease of Crop Plants in India. Fourth edition,PHI Learning (P) Ltd., New Delhi.
7. Subba Rao NS (2004). Soil Microbiology. Fourth edition, Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi.
8. Mishra RR (2004). Soil Microbiology. First edition, CBS Publishers and distributors, New Delhi.
9. Devlin RM. (1975). *Plant Physiology.* 3rd edition, Willard Grant Press.
10. *Stolp H. (1988).* Microbial Ecology: Organisms Habitats Activities. *Cambridge University* Press, Cambridge, England.
11. Agrios GN. (2006). *Plant Pathology.* 5th edition. Academic press, San Diego,
12. Lucas JA. (1998). *Plant Pathology and Plant Pathogens.* 3rd edition. Blackwell Science, Oxford.
13. Mehrotra RS. (1994). *Plant Pathology.* Tata McGraw-Hill Limited.
14. Rangaswami G. (2005). *Diseases of Crop Plants in India.* 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
15. Singh RS. (1998). *Plant Diseases Management.* 7th edition. Oxford & IBH, New Delhi.
16. Raina M.Maier. Ian L.Pepper and Charles P.Gerba. (2000)EnvironmentalMicrobiology.Academic press California.UK

MBG4B05(P). MICROBIOLOGY PRACTICAL I

3 Hrs /week **Credit 4**

Course Objectives: Learner acquires basic skills in aseptic techniques, usage of laboratory instruments, microscopy, different staining techniques, microbial cultivation and enumeration techniques.

Course Outcomes

CO1	Familiarize with parts of a microscope and apply light Microscopy in microbiological studies
CO2	Apply the skill of the staining for microscopic visualization
CO3	Acquaint with common methods of sterilization and to apply the sterilization procedures in a microbiology laboratory and similar places where hygiene has to be maintained.
CO4	Prepare different types of media for the cultivation of microorganisms in a microbiological lab.
CO5	Determine the effect of various factors influencing the growth of microorganisms
CO6	Demonstrate techniques for isolation and enumeration of microbes from various samples

1. Introduction to common methods of sterilization and laboratory instruments.
2. Microscope and its maintenance
3. Simple Staining.
4. Gram's staining.
5. Capsule Staining.
6. Spore Staining.
7. Volutin granule staining.
8. Preparation of media (Nutrient broth, Nutrient agar, Blood agar, Chocolate agar, McConkey agar, EMB agar).
9. Motility determination - Hanging drop method, Semisolid agar method
10. Isolation of pure culture by streaking.
11. Enumeration of microbial cells (pour plate and spread plate method).
12. Fungal staining.
13. Fungal culturing.

14. Determination of phenol coefficient.
15. Oligodynamic action of heavy metals on microbes.
16. Effect of temperature on growth of microorganisms.
17. Influence of pH on growth.
18. Bacterial growth curve.
19. Isolation of bacteriophages from sewage.
20. Determination of BOD of water.
21. Air sampling by open plate method.
22. Water quality analysis-preliminary (MPN), confirmed and completed test
23. Isolation of rhizobium and azotobacter.
24. Ammonification and nitrification of organic compounds.
25. Demonstration of pigment production on nutrient agar medium *(Staphylococcus aureus, Pseudomonas aeruginosa and Serratia* species).

SEMESTER V

MBG5B06. INDUSTRIAL MICROBIOLOGY

4 Hrs/Week **4 Credits**

Course Objectives: Learner will Understand the basic concepts of fermentation, fermenter and design, media formulation, sterilization methods and process control parameters in a fermentation process. Imparting Knowledge on isolation, screening, strain development, fermentation and recovery of a product and intellectual property rights.

Course Outcomes

CO1 Describe basic concepts of a fermentation process with various types

CO2 Discuss the media formulations and their significance in fermentation process.

CO3 Explain different methods for screening, isolation, improvement of strain, upstream processing and downstream processing of industrially important microorganisms and products.

CO4 Compare various techniques used for the recovery of fermentation products.

CO5 Demonstrate industrial production of microbial metabolites.

CO6 Discuss different intellectual property rights related to microbial products.

Unit 1. Basic Concepts of Fermentations :- Fermentor - Components, Types of fermentors- Batch, Fed- batch, Continuous, liquid state , Solid State fermentors. Control systems in fermentation - sterilization, pH, Temperature, Oxygen and aeration, agitation, foam. Computer applications in fermentation technology.

Unit 2. Industrially important microorganisms - Screening Techniques- Primary and Secondary - Preservation of cultures - Strain improvement- Development of inoculum for various fermentation processes. Media formulations - Water, carbon and nitrogen source, growth factors, precursors, minerals, buffers, aeration, antifoam agents, inhibitors, precursors and inducers.

Unit 3. Downstream processing- Extraction and purification of intracellular and extracellular products.

Unit 4. Microbial production of Wine, Ethanol. Acetone/ butanol by Clostridium species. Organic acids - Citric acid and Lactic acid, Acetic acid. Enzyme - Alpha amylase by bacteria and fungus. Vitamin B12 by streptomyces sp, Antibiotics - Penicillin. Steroid transformations.

Unit 5. Introduction to intellectual property and intellectual property rights - types:

patents, copyrights, trade marks, design rights, geographical indications - importance of IPR - patentable and non patentable - patenting life - legal protection of biotechnological inventions - world intellectual property rights organization (WIPO).

Suggested Readings

1. Industrial Microbiology by Prescott and Dunns.
2. Principles of Fermentation Technology. Manual of Industrial Microbiology and Biotechnology by Demain and Devis.
3. Principles of Fermentation Technology by Stanbury and Whitaker
4. Crueger W and Crueger A. (2000). *Biotechnology: A textbook of Industrial Microbiology.* 2nd edition.
5. Panima Publishing Co. New Delhi.
6. Comprehensive Biotechnology by Murray and Moo Yung.
7. Sivakumar PK, Joe MM and Sukesh K (2010). An introduction to Industrial Microbiology. First edition,
8. S.Chand& Company Ltd, New Delhi.
9. Agrawal AK and Pradeep Parihar (2006). Industrial Microbiology. Student edition, Jodhpur.
10. Patel AH (2005). Industrial Microbiology. Published by MacMillan India Ltd., Chennai
11. Stanbury PF, Whitaker A and Hall SJ (1997). Principles of Fermentation Technology. Second edition, Pergamon Press.
12. LE Cassida JR (2005). Industrial Microbiology. New Age International (P) Ltd., New Delhi.

MBG5B07. FOOD AND DAIRY MICROBIOLOGY

4 Hrs/Week **4 Credits**

Course Objectives: The learner will get acquainted with the beneficial as well as harmful role of microorganisms associated with food and the significant applications of microbes in the food industry.

Course Outcomes:

CO1	Memorize the types and importance of microbes that exist in different food items and understand different parameters affecting their growth in food.
CO2	Explain major methods to detect microbes in food, with special importance to contaminants
CO3	Illustrate the physical and chemical properties of milk and types of microorganisms present in milk.
CO4	Differentiate different methods used for the microbiological examination of milk.
CO5	Acquire in-depth knowledge about microbial production of fermented dairy and non-dairy food products and understand the health benefits of SCP, probiotics and prebiotics
CO6	Gain an insight to the microbial spoilage of different kinds of foods.

CO7	Discuss major food borne diseases caused by different groups of microorganisms
CO8	Explain preservation of food by various physical and chemical methods
CO9	Discuss the concept of quality control in food, regulatory practices and policies

Unit 1. Food as a substrate for microorganisms. Types of microorganisms in food - Source of contamination - Factors influencing microbial growth in foods (extrinsic and intrinsic) Microbial examination of food- viable colony count, examination of fecal Streptococci.

Unit 2. Physical and chemical properties of milk. Milk as a substrate for microorganisms. Types of microorganisms in Milk- bacteria, fungi and yeast. Sources of microbial contamination of milk. Microbiological analysis of milk. Rapid platform tests- organoleptic, Clot on boiling (COB), turntable acidity alcohol test, DMC, sedimentation test and pH. Standard plate count, MBRT.

Unit 3. Food fermentations: Cheese, bread, yoghurt, idli, fermented pickles and fermented vegetables, Ice cream, - methods and organisms used. SCP, Probiotics and prebiotics.

Unit 4. General principles underlying spoilage, different kinds of foods, cereals and cereal products - sugar and sugar products - vegetable and fruits - meat and meat products - fish and other sea foods - eggs and poultry - dairy and fermentative products (ice cream/milk/bread/wine).

Unit 5. Food Poisoning : food borne infections (a) Bacterial: Staphylococcal, Brucella, Bacillus, Clostridium, Escherichia, Salmonella (b) Fungal : Mycotoxins including aflatoxins, ergotism (c) Viral: Hepatitis, (d) Protozoa - Amoebiasis.

Unit 6. Food preservation : Principles of food preservation - methods of preservation. a. Physical (irradiation, drying, heat processing, pasteurization, chilling and freezing, high pressure and modification of atmosphere) b. Chemical (Sodium benzoate Class I & II). Food Sanitation: Good manufacturing practices - HACCP, Personnel hygiene.

Suggested Readings

1. Food Microbiology by Adams, MR. and Moss, M.O.1995.The Royal Society of Chemistry, Cambridge.
2. Food Microbiology by Frazier, W.C. and Westhoff, D.C.1988.TATA McGraw HillPublishing company ltd., New Delhi.
3. Modern Food Microbiology by Jay, J.M.1987.CBS Publishers and distributors, New Delhi.
4. Basic Food Microbiology by Banwart, G.J.1989.Chapman & Hall New York.
5. A Modern Introduction to Food Microbiology by Board, R.C.1983.Blackwell Scientific Publications, Oxford.
6. Dairy Microbiology by Robinson, R.K.1990. Elsevier Applied Science, London.

7. Food Poisoning and Food Hygiene, Hobbs, B.C. and Roberts, D.1993. Edward Arnold.
8. MICROBIOLOGICAL EXAMINATION METHODS OF FOOD AND WATER by SILVA
9. Lund BM, Baird Parker AC, and Gould GW. (2000). *The Microbiological Safety and Quality of Foods.* Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
10. Gould GW. (1995). *#ew Methods of Food Preservation.* Blackie Academic and Professional, London.

MBG5B08. IMMUNOLOGY

4 Hrs/week **4 Credits**

Course Objectives: Demonstrate an understanding on the history of immunology and structural organization of the human immune system. To understand the salient features of antigen antibody reaction, hybridoma technology etc and its applications. To understand Tumor Immunology and help the students to understand its immunoprophylaxis and immunotherapy including its molecular approach.

Course Outcomes

CO1	Explain the biological functions of various immune cells and organs
CO2	Recognize the cellular coordination in the generation of immune responses
CO3	Illustrate the types, structure and basic features of antigen and antibody.
CO4	Demonstrate the significance of MHC, C system and immunological tolerance.
CO5	Classify antigen-antibody reactions involved in diagnosis of infections.
CO7	Describe the types and mechanisms of hypersensitivity, autoimmunity and graft rejection reactions Discuss the causes, molecular mechanisms, immunological responses and treatment options of tumor development.

Unit 1. Brief History of Immunology: Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff. Structure and function of the lymphoreticular system-composition of blood and lymph and their immunological properties.

Unit 2. Immune Cells and Organs Structure, Functions and Properties of: Immune Cells - Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs - Bone Marrow, Thymus, Lymph Node, Spleen,GALT, MALT, CALT

Unit 3. Concept of innate, acquired immunity, Humoral and cell-mediated, natural and artificial immunity. Brief descriptions on mechanisms of innate immunological barriers-phagocytosis and inflammation.

Unit 4. Antigens - features. Hapten, complete antigen, adjutants, epitope (antigenic

determinants). Factors influencing antigenicity. T dependent and T independent antigens. Role of MHC in antigen presentation- class I and class II, MHC Restriction.

Unit 5. Basic structure of immunoglobulin - Ig G - Different classes of immunoglobulins and their function. Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic). Clonal selection theory. Production of Polyclonal & Monoclonal antibodies & their application. Hybridoma technology. Complement system- activation and functions.

Unit 6. Antigen and Antibody Reactions-Agglutination, Precipitation, Complement fixation test, neutralization, opsonization, Gel diffusion techniques, Immunoelectrophoresis, labeled antibodies -RIA, ELISA, Western blotting, Immunofluorescent techniques.

Unit 7. Hypersensitivity - different types -immediate and delayed - Anaphylaxis, immune complex diseases. Autoimmune diseases - mechanisms and classification. Transplantation immunology- mechanism of graft rejection.

Unit 8. Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Tumor antigens, immune responses to tumors, Cancer Treatment- immunotherapy and molecular approach.

Suggested Readings

1. Abbas AK, Lichtman AH, Pillai S. (2007). *Cellular and Molecular Immunology.* 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006).*Roitt's Essential Immunology.* 11th editionWiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. *(2007).Kuby 's Immunology.* 6th edition W.H. Freemanand Company, New York.
4. Murphy K, Travers P, Walport M. (2008)*Janeway'sImmunobiology.* 7th edition GarlandScience Publishers, New York.
5. Peakman M, and Vergani D. (2009). *Basic and Clinical Immunology.* 2nd edition. ChurchillLivingstone Publishers, Edinberg.
6. Richard C and Geoffrey S. (2009). *Immunology.* 6th edition. Wiley Blackwell Publication.
7. Immunology by Coleman et al
8. Fundamental Immunology by Paul W.E. et al
9. Introduction to Immunology John W Kimbal et al
10. TextBook of Microbiology by Ananthanarayan and Jayaram Paniker.
11. Immunology by Coleman et al
12. Introduction to Immunology John W Kimbalet al

MBG5B09. MEDICAL MICROBIOLOGY I

4 Hrs/Week **3 Credits**

Course Objectives: To impart knowledge of the basic principles of microbial infection. Apart from the mechanism of pathogenesis, morphological, cultural, biochemical, epidemiological and laboratory diagnosis of various bacterial infections also will be studied.

Course Outcomes:

CO1	Explain the concept of infection, its types, sources and the mode of transmission of various diseases.
CO2	Discuss the methods for collection and transportation of clinical samples.
CO3	Compare the morphology, cultural and biochemical characteristics, pathogenesis, laboratory diagnosis, treatment and prophylaxis of various bacterial diseases.

Unit 1. Infection and disease-definition. Types of infections. Various sources of Infection. Methods of transmission of infections. Factors influencing the virulence of pathogens. Definitions of MID, ID50, MLD, LD50, bacteremia, Septicemia, contagious epidemic, endemic, pandemic, sporadic and prosodemic diseases. Epizootic and enzootic.

Unit 2. Collection and transport of clinical specimens for microbiological examinations Normal flora of the human body.

Unit 3. Morphology, culture, biochemical, pathogenicity, laboratory diagnosis and preventionof bacterial diseases - *Staphylococcus aureus, S.pneumoniae, Neisseria gonorrhoeae.*

Unit 4. Morphology, culture, biochemical, pathogenicity, laboratory diagnosis and prevention of bacterial diseases - *Mycobacterium tuberculosis, Corynebacterium diphtheriae, Clostridium tetani, Bacillus anthracis.*

Unit 5. Morphology, culture, biochemical, pathogenicity, laboratory diagnosis and prevention of bacterial diseases - *Salmonella typhi, Vibrio cholerae, Escherichia coli, Pseudomonas aeruginosa*

Unit 6. Morphology, culture, biochemical, pathogenicity, laboratory diagnosis and prevention of bacterial diseases - *Treponema pallidum, Leptospira interrogans,* ,.Rickettsial infections.

Suggested Readings

1. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology.* 7th edition (edited by Paniker CKJ).
2. University Press Publication.

3. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). *Jawetz, Melnick erg's Medical Microbiology.* 24th edition. McGraw Hill Publication.
4. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). *Mims' Medical Microbiology.* 4th edition. Elsevier.
5. Joklik WK, Willett HP and Amos DB (1995). *Zinsser Microbiology.* 19th edition. Appleton- Century-Crofts publication.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology.* 7th edition. McGraw Hill Higher Education.
7. Medical Microbiology : David Greenwood, Slack, Peutherer
8. Satish Gupte (2005). The Short Textbook of Medical Microbiology.Eighth edition, Jaypee Brothers, Medical publishers (P) Ltd., New Delhi.
9. Baron EJ, Peterson LR and Finegold SM (1994). Bailey and Scott's diagnostic Microbiology. 9th edition, Mosby publications.
10. Rajan S (2009). Medical Microbiology. First edition, MJP Publishers, Chennai.
11. Rajesh Bhatia and Ratan Lal Ichhpujani (2004). Essentials of Medical Microbiology. Third edition, Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi.
12. Medical Microbiology by Macie and McCartney

SEMESTER VI

MBG6B10. GENETICS AND GENETIC ENGINEERING

4 Hrs/week **4 Credits**

Course Objectives: The learner gets an opportunity to analyze the molecular concepts of cell cycle and its regulation, recombinant DNA technology & other socio-economically relevant molecular technologies. To give a basic understanding on the scope and importance of genetics by imbibing the principles of hereditary genetic transmission and interactions of genes with the environment.

Course Outcomes:

CO1	Summarize the mendelian and non mendelian concepts inheritance
CO2	Explain the concepts of linkage, crossing over and recombination
CO3	Illustrate the cell cycle events and its regulation mechanisms in eukaryotes
CO4	Demonstrate the recombination frequency as a tool of gene mapping in eukaryotes and gene transfer techniques as a tool in prokaryotes.
CO5	Describe the pathways of cell cycle and their regulation strategies adopted by eukaryotic cells.
CO6	Discuss the molecular mechanisms behind the programmed cell death and the inter-relation of death pathway with the cell cycle and immune response.
CO7	Explain the principle behind rDNA technology, DNA sequencing, PCR and their applications in biological sciences.
CO8	Discuss the development of GMOs and its potential risks and benefits on the environment
CO9	Critical & ethical analysis of application r DNA technology in our society

Unit 1. Mendelian Genetics and its Extension: Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and co dominance, Aneuploidy and Polyploidy, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance. Extra chromosomal inheritance.

Unit 2. Linkage, Crossing Over gene transfer and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence. Gene transfer techniques in prokaryotes and its utility in gene mapping- conjugation, transformation, transduction, interrupted mating techniques.

Unit 3. Cell cycle and its regulation. Mitosis and meiosis. Check points and its significance. Programmed Cell death.

Unit 4. A concise account of methods used in "Recombinant DNA" technology - brief account of cell disruption techniques, Enzymes involved in genetic engineering, vectors, gene transfer techniques, separation techniques and screening strategies.

Unit 5. DNA Sequencing. DNA Amplification- PCR, applications of PCR. Blotting techniques, DNA (Gene) libraries, application of genetic engineering technology- Gene therapy. GM foods, modified plant and animal varieties, terminator gene technology. Ethical problems associated with the use of r DNA technology.

Suggested Readings

1. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM, 1987. The Benjamin/Cummings publishing company.
2. Genes V by Lewin B, 1994. Oxford University press.
3. Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J., 1995. Scientific American Books.
4. Molecular Biology by Freifelder D., 1991 Narosa Publishing Home.
5. Principles of Gene Manipulation, 4th Ed., by R.S. Old and S.B.Primrose. 1989.Blackwell Scientific Publications, London.
6. Biochemistry by Stryer L.,1995. W.H. Freeman and company.
7. Principles of Genetics by Gardner EJ, Simmons MJ, Snustad DP, 1991. John Wiley& Sons.
8. Genes and Genomes by Singer M, Berg P.,1991 University Science Books.
9. Alcamo IE. (2001). *DNA Technology: The Awesome Skill.* 2nd edition. Elsevier Academic Press, Brown TA. (2006). *Gene Cloning and DNA Analysis.* 5th edition. Blackwell Publishing, Oxford,
10. Clark DP and Pazdernik NJ. (2009). *Biotechnology-Applying the Genetic Revolution.* Elsevier Academic Press, USA.
11. Glick BR and Pasternak JJ. (2003). *Molecular Biotechnology.* 3rd edition. ASM PressWashington D.C.
12. *Nigam A andAyyagari A. (2007).* Lab Manual in Biochemistry, Immunology and Biotechnology. *Tata McGraw Hill, India.*
13. *Primrose SB and Twyman RM. (2006).* Principles of Gene Manipulation and Genomics, 7^{th}edition. Blackwell Publishing, Oxford, U.K.
14. Sambrook J, Fritsch EF and Maniatis T. (2001). *Molecular Cloning-A Laboratory Manual.* 3rd edition. Cold Spring Harbor Laboratory Press.
15. Willey JM, Sherwood LM, and Woolverton CJ. (2008) *Prescott, Harley and Klein'sMicrobiology.* 7th edition. McGraw Hill Higher Education.
16. Textbook of biochemistry by Satyanarayana
17. Textbook of Biochemistry by DM. Vasudevan

MBG6B11. MEDICAL MICROBIOLOGY II

4 Hrs/Week **4 Credits**

Course Objectives: The learner acquires knowledge on various viral, fungal and protozoal disease and immune-prophylaxis. Develop a brief understanding of antibiotics and their classification.

Course Outcomes:

CO1	Discuss the important viral diseases including emerging viral diseases, with special emphasis on symptoms, pathogenesis, transmission and prophylaxis.
CO2	Analyze symptoms, pathogenesis, transmission, prophylaxis and control of important fungal diseases of humans including emerging fungal diseases
CO3	Explain important protozoan diseases of humans such as malaria ,amoebiasis and helminth infections and infections caused by flagellates
CO4	Compare different types of vaccines and their routes of administration
CO5	Distinguish antibiotics classes, their mode of action and mechanism of antibiotic resistance.

Unit 1. Viral diseases (with reference to symptoms, pathogenesis, *transmission,* prophylaxis and control) Polio, Chicken pox, Hepatitis, Rabies, Influenza, AIDS , with brief description of bird and swine flu, Dengue. An overview of emerging viral diseases: Japanese Encephalitis, SARS, Chikungunya.

Unit 2. Fungal diseases - brief account on superficial, subcutaneous and deep mycoses (systemic), opportunistic mycoses, Laboratory diagnosis of fungal infections.

Unit 3. Protozoan diseases - amoebiasis and malaria. Helminth infections - Tapeworm -*Taenia solium* and *Taenia saginata,* Hookworm - *Ancylostoma duodenale*, Roundworm - Ascaris lumbricoides and filariasis - Wuchereriabancrofti. Flagellates *Trypanosoma brucei gambiense*, *Giardia lamblia* Laboratory diagnosis of parasitic infections.

Unit 4. Immunoprophylaxis - vaccines - history and development. Different types - live, killed, subUnit, toxoids, bacterial, viral etc. Different routes of administration - oral and parenteral - advantages and disadvantages (eg: BCG, OPV & IPV, DPT, MMR, TAB - brief account).

Unit 5. Antibiotics: Classification of antibiotics, mode of actions. Introduction to various generations of antibiotics, emergence and mechanism of resistance.

Suggested Readings

1. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology.* 7th edition (edited by Paniker CKJ). University Press Publication.
2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). *Jawetz, MelnickandAdelberg's Medical*

*Microbiology.*24th edition. McGraw Hill Publication.

3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). *Mims' Medical Microbiology.* 4th edition. Elsevier.
4. Joklik WK, Willett HP and Amos DB (1995). *Zinsser Microbiology.* 19th edition. Appleton- Century- Crofts publication.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology.* 7th edition. McGraw Hill Higher Education.
6. Medical Microbiology : David Greenwood, Slack, Peutherer
7. Satish Gupte (2005). The Short Textbook of Medical Microbiology.Eighth edition, Jaypee Brothers, Medical publishers (P) Ltd., New Delhi.
8. Baron EJ, Peterson LR and Finegold SM (1994). Bailey and Scott's diagnostic Microbiology. 9th edition, Mosby publications.
9. Rajan S (2009). Medical Microbiology. First edition, MJP Publishers, Chennai.
10. Rajesh Bhatia and Ratan Lal Ichhpujani (2004). Essentials of Medical Microbiology. Third edition, Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi.
11. Medical Microbiology by Macie and McCartney.
12. Viral Ecology ByHurs

MBG6B12 (P). MICROBIOLOGY PRACTICAL II

4 Hrs/week **Credits 4**

Course Objectives: Learner develops skills in biochemical, microscopic and physiological characterization of bacteria and serological studies.

Course Outcomes:

CO1	Apply the biochemical, microscopic and physiological properties of bacteria for the identification of unknown bacteria or clinically relevant bacteria in a patient sample.
CO2	Report variations observed in the blood cell count majorly for clinical or diagnostic purpose
CO3	Perform various serological techniques routinely executed in clinical laboratories.

1. Biochemical reactions for identification of various groups of bacteria.
2. Identification of bacterial isolates from clinical samples.
3. Antibiotic sensitivity test.
4. Differential count of leukocytes.
5. Lymphocyte isolation.

6. Blood grouping.
7. WIDAL agglutination test.
8. ASO latex agglutination test.
9. RA latex agglutination test.
10. RPR test.

MBG6B13 (P). MICROBIOLOGY PRACTICAL III

4 Hrs/week **Credits 3**

Course Objectives: The learner acquires skill in - Isolation and estimation of DNA and RNA, Study on gene transfer mechanisms and isolation of plasmids, Study various molecular techniques etc.

Course Outcomes:

CO1	Apply the knowledge of the learner for the preparation of various solutions and reagents in laboratories with their specific features.
CO2	To demonstrate various stages of mitosis in onion root tip
CO3	Execute the extraction of DNA and RNA and confirm by performing electrophoresis.
CO4	Estimate the amount DNA and RNA in a solution
CO5	Demonstrate the gene transfer experiments like conjugation and transformation
CO6	Perform procedure for induction of beta galactosidase enzyme by means of artificial transformation.
CO7	Demonstrate the Restriction digestion reaction of various enzymes widely employed in rDNA technology.

1. Preparation of buffers
2. Demonstration of mitosis.
3. Isolation of genomic DNA from *E.coli*.
4. Estimation of DNA.
5. Isolation of RNA.
6. Estimation of RNA.
7. P-galactosidase induction.
8. Conjugation
9. Transformation
10. Agarose gel electrophoresis of DNA
11. Restriction digestion of DNA

MBG6B14 (P). MICROBIOLOGY PRACTICAL IV

3 Hrs/week **3 Credits**

Course Objectives:

- To acquire knowledge on various growth patterns, culturing methods and different quantification techniques of microorganisms.
- Develop skills in isolation, screening and strain improvement of industrially important organisms for product development, and their product recovery processes.

Course Outcomes:

CO1	Perform isolation and screening of industrially important microorganisms from soil
CO2	Demonstrate the different fermentation processes-citric acid production, alcohol production and wine production
CO3	Identify sterilization problems with suspended solids in media
CO4	Compare various cell disruption techniques
CO5	Perform cell disruption and salting out
CO6	Perform enrichment of coir pith degraders, pellicle formation, and penicillin assay
CO7	Analyze the aerobic mesophilic count of milk and microbial flora of fermented milk
CO8	Evaluate the microbiological quality of milk by Methylene Blue Reductase test

1. Differences in abrupt and gradual scale up of inoculum.
2. Enrichment of coir pith degrades.
3. Sterilization problems with suspended solids in media.
4. Demonstration of SSF, fixed bed and fluidized bed systems.
5. Pellicle formation.
6. Cell disruption techniques.
7. Salting out.
8. Production of alcohol from fruit juice.
9. Microbiological assay of penicillin.
10. Production of citric acid using Aspergillus.
11. Isolation and screening of industrially important microorganisms from soil/environment - cellulose digesting, amylase producing.
12. Aerobic mesophilic count of milk.
13. Isolation of microbial flora of fermented milk.
14. Production of wine.
15. Methylene blue reduction test.

MBG6B15 (E1). CELL AND TISSUE CULTURE

4 Hrs/Week **2 Credits**

Course Objectives: Learner will understand basics of laboratory cultivation of plant and animal cells and tissue culture. Learners will get a clear cut idea about different types of cell culture. Understand different types of media formulations used for cell cultivation and the role of hormones in plant cell culture.

Course Outcomes:

CO1	Describe how a plant & animal cell culture lab should be designed and maintained.
CO2	Demonstrate the concept of tissue culture technique for plant regeneration and its application in developing plantlets of specific characteristics.
CO4	Describe methods to determine cell cytotoxicity which in turn can be used to validate drugs and cosmetics for their side effects (toxicity).
CO5	Discuss the basics of stem cells, their characterization and applications

Unit 1. Laboratory cultivation of plant and animal cells and tissue culture. Application of plant and animal cell and tissue culture. Basic laboratory requirements, Maintenance of sterile condition Explant selection, sterilization and inoculation

Unit 2. Different types of culture, Callus culture, Suspension culture, Primary cell culture, Attach dependent cells attach independent cells, Cell lines, Organ culture, Types of media used and its formulations. Role of hormones, Hormones: Auxins, cytokinins, Gibberellins, Abscisic Acid, ethylene. Different media used for plant cells.

Unit 3. Plant regeneration: organogenesis. Somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Clonal propagation, production of pathogen - free virus free plants. Plant regeneration Androgenesis; Anther and pollen culture.

Unit 4. Production of seedless plants, synthetic seeds, Production of secondary metabolites from plant cell suspension culture. Protoplast technology: isolation, culture and plant regeneration, protoplast fusion, identification and characterization of somatic hybrids, applications of protoplast technology. Specific gene transfer: indirect and direct methods.

Unit 5. Animal cell culture as a substitute for animal experiments. Testing the viability of cells, dye exclusion methods, stem-cell culture and its applications, cell markers characterising stem cells.

Suggested Readings

1. Culture of animal cells - R.IanFreshney 4th edition John Wiley and Sons.
2. Genetic engineering,Molecular biology and tissue culture of crop pest and disease management -

P.Vidhyasekaran, Paya Publication.

3. Animal cell reactors - Chesters Hon Daniel IC Wang- Butter worth Heinemann.
4. Plant Molecular Biology 2nd Ed: D. Grierson, S.N. Covey. Chapman & Hall.

MBG6B15 (E2). MOLECULAR BIOLOGY

4 Hrs/Week **2 Credits**

Course Objectives: Understand the properties, structure and function of genes in living organisms at the molecular level. Have a conceptual knowledge about DNA as a genetic material, enzymology and replication strategies. Understand the molecular mechanisms of mutations, gene expression and gene regulation.

Course Outcomes:

CO1	Demonstrate the structure, function and other basic features of DNA and RNA
CO2	Analyze the organization of genetic material by means of proteins and topological properties.
CO3	Conceptualize the theme of central dogma of molecular biology by discussing the events, enzymes and mechanisms of replication, transcription and translation
CO4	Illustrate the gene expression regulation mechanisms in prokaryotes by means of lac and trp operons.

Unit 1. DNA: DNA as the genetic material, Experimental proof. Structure of DNA and RNA, Types and forms - DNA, t-RNA, r-RNA, m-RNA - Definition and functions. Organization of bacterial and eukaryotic chromosomes. Histones and their function.Denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases.

Unit 2. Replication of Prokaryotic and eukaryotic DNA. Semiconservative replication of DNA. Models of replication- D-Loop, rolling circle and theta model. Mutations :Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations-Ames test, Replica plating. Concept of Luria Delbruck experiment. General DNA repair mechanisms.

Unit 3. Transcription- prokaryotic and eukaryotic. Post transcriptional modifications. Translation- prokaryotes and eukaryotes, Genetic code. Post translational modifications. Brief account of gene regulation in prokaryotes - operon concept - lac and trp operon.

Suggested Readings

1. Textbook of Biochemistry by Lehninger
2. Biochemistry by Stryer

3. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA,
4. Weiner AAM, 1987. The Benjamin/Cummings publishing company.
5. Genes V by Lewin B, 1994. Oxford University press.
6. Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P,
7. Darnell J., 1995. Scientific American Books.
8. Molecular Biology by Freifelder D., 1991 Narosa Publishing Home.
9. Principles of Gene Manipulation, 4th Ed., by R.S.Old and S.B.Primrose. 1989. Blackwell Scientific Publications, London
10. Cell biology by Karp

MBG6B15 (E3). BIOINSTRUMENTATION

4 Hrs/Week **2 Credits**

Course Objectives: Develop basic understanding on separation techniques, spectroscopic and Chromatographic techniques, Electrophoresis and radio isotope techniques.

Course Outcomes:

CO1	Describe the principles and applications of various techniques in life sciences such as Spectrophotometer, pH Meter, Electrophoresis, NMR, Biosensors, Centrifugation, Chromatography and Radio Isotope techniques used in the isolation, purification and analysis of biomolecules
CO2	Describe various Spectroscopic and Chromatographic techniques
CO3	Characterize the given sample using bioanalytical techniques
CO4	Apply the concepts of modern analytical and instrumental techniques relevant to quantitative measurements in life sciences

Unit 1. Centrifugation: principle, types, preparative, analytical and ultracentrifuge. Electrochemical techniques: Principles of electrochemical techniques, redox reactions, the pH electrode, Biosensors.

Unit 2. Spectroscopic techniques: Properties of electromagnetic radiation, instrumentation and applications of UV and Visible spectroscopy, Spectrofluorimetry, atomic spectroscopy, NMR spectroscopic, MALDI-TOF, turbidimetry and nephelometry

Unit 3. Chromatographic techniques: Principles, instrumentation and applications of different types of chromatography, HPLC, HPTLC, FPLC, GC-MS, LC-MS,. Spectrophotometry: visible and UV spectrophotometry.

Unit 4. Electrophoresis: Principles, instrumentation and applications of different types of electrophoretic techniques, (gel, agarose, SDS-PAGE, pulse field) Isoelectric focusing.

Unit 5. Radio isotope techniques: The nature of radioactivity, types and rate of radioactive decay, detection and measurement of radioactivity, principle, instrumentation and

applications of Geiger Muller counter, solid and Liquid Scintillation counter autoradiography, Flow Cytometry

Suggested Readings

1. Keith Wilson and John Walker.Practical Biochemistry- principles and techniques; Cambridge University press, London, UK. 2.
2. David T Plummer, Tata McGraw- Hill publishing company limited; McGraw office, New Delhi
3. C.R. Kothari, 2 nd Edition,2004. Research methodology- methods and techniques. New Age International (P) limited publishers, New Delhi.
4. Instrumental methods of chemical analysis - P.K. Sharma
5. Biophysical chemistry - Upadhyay., Upadhyay and Nath 6. A Biologist's guide to principle and techniques of practical biochemistry - Brigan L. Williams.
6. Handbook of Biomedical Instrumentation - R.S. Khandpur, Tata McGraw Hill

COMPLEMENTARY COURSE

MICROBIOLOGY

Scheme for B.Sc. Microbiology Complementary Course (CBCSS)- 2020 Admission Onwards

Semester	Course code	Course title	Hours/ week	Credits	Total credits	Scheme of Evaluation (in marks)		
						Internal (20%)	External (80%)	Total
I	MBG1C01	General Microbiology	2	2	2	15	60	75
	MBG4C05 (P)	Microbiology Practical	2					
II	MBG2C02	Applied Microbiology	2	2	2	15	60	75
	MBG4C05 (P)	Microbiology Practical	2					
III	MBG3C03	Food And Industrial Microbiology	3	2	2	15	60	75
	MBG4C05 (P)	Microbiology Practical	2					
IV	MBG4C04	Immunology And Medical Microbiology	3	2	2	15	60	75
	MBG4C05 (P)	Microbiology Practical	2	4	4	20	80	100

SEMESTER 1

MBG1C01. GENERAL MICROBIOLOGY

2hrs/week **Credit 2**

Course Objectives: To develop an understanding on the basic concepts of microbiology including ultrastructure of bacteria, principles of microscopy, sterilization techniques etc.

Course outcomes

CO1	Summarize the historical developments including contributions of scientists.
CO2	Illustrate the external and internal structures of bacterial cell and archaebacterial cell membrane.
CO3	Analyze various microscopic techniques.
CO4	Explain the mechanism of important staining techniques in Microbiology.
CO5	Illustrate physical and chemical disinfection techniques with additional focus on aseptic methods and disinfectant testing.

Unit 1. Scope and history of Microbiology, spontaneous generation vs. biogenesis.Contributions of the following scientists in various areas of Microbiology - Anton van Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Selman A. Waksman. Beneficial and harmful microbes.

Unit 2. Ultrastructure of bacteria- External structures-glycocalyx, capsule, flagella, fimbriae and pili. Cell-wall: Composition and detailed structure of gram positive and gramnegative cell walls, Archaebacterial cell wall, sphaeroplasts, protoplasts, and L-forms. Effect of penicillin and lysozyme on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 3. Microscopy- bright field, dark field, phase contrast, fluorescent and electron microscopy-SEM and TEM. Staining techniques- simple, negative, Grams, spore, flagella, acid fast, volutin, capsule and Fuelgen staining.

Unit 4. Sterilisation and disinfection techniques- Physical and chemical methods- flaming, boiling, autoclaving, inspissation, Heat, Filtration, Radiation. Aseptic methods- laminar air flow hood. Disinfectants and its testing.

Suggested Readings

1. Fundamentals of Bacteriology by A.J Salle
2. Microbiology by Pelczar*et al*
3. Fundamentals of Microbiology by Mertus Frobisher
4. General microbiology by Stanier *et al*
5. Text book of Microbiology by Prescott.
6. Principles of Microbiology by Ronald Atlas
7. Microbiology: An Introduction by Tortora GJ, Funke BR, and Case CL.
8. Microbiology: Principles and Explorations *by Black.*
9. Brock Biology of Micro-organisms.

SEMESTER II

MBG2C02. APPLIED MICROBIOLOGY

2hrs/week **Credit 2**

Course Objectives: Lerner develop knowledge on the principles of microbial growth, culture media and growth and survival of microbes in air and water.

Course outcome:

CO1	Demonstrate the cultural, metabolic and physiologic characteristics of microorganisms
CO2	Describe the different bacteriological culture media.
CO3	Explain the cultivation of aerobes and anaerobes and different culture preservation strategies.
CO4	Discuss the microbiology of water, air and air borne diseases
CO5	Illustrate different water purification strategies, sewage treatment methods, disinfection techniques.
CO6	Analyze the techniques for water potability and BOD.

Unit 1. Microbial growth: Effect of various parameters and Environmental factors on microbial growth- Temperature, pH, O_2, solute concentration and other factors. Classification based on specific requirement-based on temperature, pH, O_2 and solute concentration. Nutritional requirements of bacteria- C, electron, energy, and minerals. Nutritional types of bacteria- based on the requirement and their combinations. Modes of bacterial nutrition. Growth curve and its significance

Unit 2. Culture media-Solid and liquid media, use of agar. Selective, Enrichment, Enriched, differential, selective-differential, indicator media, Transport media, simple and complex, synthetic or defined, Anaerobic media. Culture methods-Streak, spread, pour plate methods, stab culture and lawn culture. Cultivation of aerobic and anaerobic bacteria. Culture preservation strategies.

Unit 3. Air Microbiology: Air microflora-sources, factors affecting air microflora, enumeration of microorganisms in air- settling under gravity, centrifugation, impingement, filtration, electrostatic precipitation, Airborne diseases-bacterial, fungal,viral.

Unit 4. Water Microbiology: Factors affecting microbial population in natural waters - temperature, light, hydrogen concentration, pressure, salinity, nutrients, turbidity. Purification of water-aeration, sedimentation, coagulation, flocculation, sand filtration. waste water treatment-primary, secondary and tertiary stages. Disinfection of drinking water. Bacteriological techniques for examination of water potability. Indicator organisms, BOD

Suggested readings

1. Brock biology of Microorganisms-Madigam
2. Microbial Ecology by Atlas and Bartha
3. Fundamentals of Bacteriology by A.J .Salley
4. Microbiology by Pelczar*et al*
5. Fundamentals of Microbiology by Mertus Frobisher
6. General microbiology by Stanier *et al*
7. Text book of Microbiology by Prescott.
8. Principles of Microbiology by Ronald Atlas
9. Microbiology: An Introduction by Tortora GJ, Funke BR, and Case CL.
10. Microbiology: Principles and Explorations *by Black.*

SEMESTER III

MBG3C03 FOOD AND INDUSTRIAL MICROBIOLOGY

3hrs/week Credit 2

Course Objectives: The learner acquire understanding on importance of microbes and their applications in food microbiology and industrial microbiology

Course outcome:

CO1	Discuss the important microorganisms in food spoilage and fermentation
CO2	Compare the techniques for food preservation
CO3	Demonstrate the concept of fermentation and enlist its different types.
CO4	Explain the production of commercial products.
CO5	Describe steroid biotransformation and downstream processing.

Unit 1. Food Microbiology: Food as a substrate for microorganisms . Microorganisms important in food microbiology -molds, yeast, bacteria. Contamination of foods.

Unit 2. Spoilage of food -chemical changes caused by microorganisms . Spoilage of milk, meat,fish Methods of food preservation: Physical and chemical preservatives. Food poisoning-Bacterial.

Unit 3. Industrial Microbiology: Advantages of microbial process over chemical process, Fermentor-basic functions of a fermentor, structure and working . Batch culture, continuous culture, fed-batch culture. Production of penicillin, vitamin B-12, citric acid and bakers yeast, SCP. Steroid biotransformation. Downstream process.

Suggested readings

1. Industrial Microbiology -A. H. Patel
2. Industrial microbiology -Casida
3. Industrial Microbiology-Prescott & Dunn.
4. Environmental Microbiology- Joseph. C. Daniel
5. Food Microbiology, Fundamentals &Frontiers-Doyle.
6. Food Microbiology-William. C. Frazier

SEMESTER IV

MBG4C04. IMMUNOLOGY AND MEDICAL MICROBIOLOGY

2hrs/week **Credit 2**

Course Objectives: Impart general awareness on basic concepts of immunology, bacterial, viral and fungal diseases.

Course outcome:

CO1 Discuss the basic concepts of immune system, antigens and antibodies.

CO2 Explain the basics of Infection.

CO3 Illustrate the pathogenesis, diagnosis and treatment of major bacterial pathogens.

CO4 Illustrate the pathogenesis, diagnosis and treatment of common and emerging viral diseases.

CO5 Explain various fungal and protozoan diseases.

Unit 1. Antigens-types, epitopes, haptens, Immunuglobulins: basic structure of immunoglobulin and different types.

Unit 2. Types of infection, Source of infection, Modes of transmission, Factors influencing the virulence of pathogens .Definitions of MID, ID50, MLD, LD50, bacteremia, Septicemia, contageous epidemic, endemic, pandemic, sporadic and prosodemic diseases.

Unit 3. Bacterial diseases caused by -*Staphylococcus aureus, Mycobacterium tuberculosis, Clostridium tetani, Clostridium botulinum, Vibrio cholerae, Salmonella typhi.Treponema pallidum*

Unit 4. Viral diseases - Rabies, AIDS, Hepatitis, An overview of emerging viraldiseases: Chikungunya,dengue,H1N1, swine flu.

Unit 5. Fungal diseases- Superficial and deep mycoses, Protozoan diseases- Amoebiasis, Malaria.

Suggested Readings

1. Immunology-Janeway.
2. Immunology-Kuby.
3. Introduction to Microbiology-John. L. Ingraham
4. Introductory Mycology-Alexopoulos.
5. Medical Microbiology-Brooks, Butal, Slack.
6. Medical Microbiology-Ananthanarayanan&Jayaram Panicker.

MBG4C05 (P). MICROBIOLOGY PRACTICAL

2 Hrs/Week in semesters I to IV **Credit 4**

Course Objectives: Learner acquires basic skills in aseptic techniques, usage of laboratory instruments, microscopy, different staining techniques, microbial cultivation and enumeration techniques. Applied skills like isolation of food borne microbes or soil bacteria and identification of bacteria by biochemical reactions are also imparted.

Course Outcomes

CO1	Familiarize with parts of a microscope and apply light Microscopy in microbiological studies
CO2	Apply the skill of the staining for microscopic visualization
CO3	Acquaint with common methods of sterilization and to apply the sterilization procedures in a microbiology laboratory and similar places where hygiene has to be maintained.
CO4	Prepare different types of media for the cultivation of microorganisms in a microbiological lab.
CO5	Determine the effect of various factors influencing the growth of microorganisms
CO6	Demonstrate techniques for isolation and enumeration of microbes from various samples
CO7	Identify the bacteria by means of performing biochemical experiments.
CO8	Analyze the microbiological quality of water
CO9	Perform immunological tests for diagnostic purpose.

1. Cleaning and sterilization of glassware.
2. Introduction to hot air oven, autoclave and incubator.
3. Microscope and its maintenance.
4. Simple Staining.
5. Grams staining.

6. Capsule Staining.
7. Spore Staining.
8. motility- hanging drop method
9. Preparation of media (Nutrient broth, Nutrient agar,)
10. Use of EMB, Mc Conkey and Blood agar in bacterial charecterisation.
11. Isolation of pure culture by streak plate method.
12. Enumeration of microbial cells (pour and spread plate method).
13. Air sampling.
14. Aerobic mesophilic count of fish samples and milk.
15. Methylene blue reduction test.
16. Pellicle formation.
17. Microbiological analysis of drinking water
18. Biochemical reactions for identification of various groups of bacteria.
19. Antibiotic sensitivity test.
20. WIDAL agglutination.
21. RPR

COMPLEMENTARY COURSE

BIOSTATISTICS AND COMPUTER APPLICATIONS

SEMESTER I

MBG1C02. Biostatistics-I

SEMESTERII

MBG4C04. Biostatistics-II

SEMESTER II

MBG3C06. Computer Applications- Fundamentals

SEMESTER IV

MBG4C09. C-Language, Data Base Management System & SQL.

MBG4C10 (P) Computer Applications Practical II (with exam)

SEMESTER I

MBG1C02. BIOSTATISTICS

4 Hrs/Week **3 credits**

Course Objectives: This course gives basic understanding of the scope of biostatistics, measures of central tendency and measures of dispersion, concepts of probability and distributions etc.

Course Outcomes:

	Course Outcome
CO1	Describe various approaches to probability and computation of probabilities
CO2	Explain the applications of theoretical discrete and continuous distributions (binomial, poisson and normal distributions only)
CO3	Demonstrate various sampling distributions and related concepts
CO4	To equip the students with the tools to summarize the experimental data in diagrammatic and graphical way, to obtain descriptive statistics and make possible appropriate interpretations.

Unit 1. Scope of biostatistics - Types of Biological data - Data on Ratio scale - data on interval scale - data on ordinal scale - continuous and discrete data - accuracy and precision. Frequency distribution for a data - Histogram - Frequency Polygon - Cumulative frequency distributions - Ogives. Population and sample - Random sampling - Parameter and Statistics.

Unit 2. Measures of Central Tendency and Measures of Dispersion - Arithmetic mean, Median, Mode, Geometric mean. Range, Mean deviation, Variance, Standard deviation, Quartile deviation, semi-interquartile range, coefficient of variation, indices of diversity.

Unit 3. Probability - Random experiment, sample space, events. Probability of events

mathematical definition - addition theorem and multiplication theorem (No proof expected, only problem solving).

Unit 4. Probability distributions. Bernoulli's distribution, Binomial distribution, Poisson distribution, and normal distribution. Parameters of these distributions, mean and variance (no derivations expected). Fitting of these distributions to real data sets.

Unit 5. Distributions derived from normal distribution - t-distribution, chi-square distribution, and F-distributions and their applications.

Reference Books

1. Zar, J. H. Biostatistical Analysis, Fourth Edition (1999), Pearson Education Inc.
2. Gupta and Kapur. Introduction to Mathematical statistics, Sulthan Chand Publications, New-

Delhi.

SEMESTER II

MBG2C04. BIOSTATISTICS

4 Hrs/Week **3 credits**

Course Objectives: This course euips the learner in testing of hypotheses, performing analysis of variance, regression analysis and correlation.

Course Outcomes:

CO1	Analyze the concept of hypothesis testing
CO2	Identify a suitable test of significance to test a given hypothesis
CO3	Discuss the concept and perform simple, partial and multiple correlation.
CO4	Perform regression analysis for a given data

Unit 1. **Testing of hypotheses:** Statistical hypothesis - Null hypothesis - alternative hypothesis - simple and composite hypothesis. Type I and Type II error. General test procedure - Tests for goodness of fit - contingency table - tests for independence of attributes.

Unit 2. **Analysis of Variance:** One - way and two -way classified data - their mathematical model - analysis of variance - significance testing

Unit 3. **Regression Analysis:** simple linear regression - regression equations -regression coefficients - prediction values of Y - testing the significance of regression - confidence interval in regression - Analysis of variance.

Unit 4. **Simple Correlation:** Simple correlation - calculation of simple correlation from raw data - calculation of correlation from regression coefficients - Testing the presence of correlation - Applications of correlation - Spearman's Rank correlation.

Unit 5. **Partial and Multiple correlations:** The concept of partial and multiple correlations - its applications. Calculating partial correlation of order one from simple correlations.

Reference Books

1. Zar, J. H**.** Biostatistical Analysis, Fourth Edition (1999), Pearson Education Inc.
2. Gupta and Kapur**.** Introduction to Mathematical statistics, Sulthan Chand Publications, New-Delhi.

OPEN COURSE

MICROBIOLOGY

MBG5D01. PUBLIC HEALTH AND EMERGING MICROBIAL DISEASES

2 Hrs/Week **3 Credits**

Course Objectives:

This course is designed to impart a basic understanding of the theories and practices in public health in general and microbial diseases in particular.

Course Outcome:

CO1	Discuss the basic concepts in public health parameters from state, national and international perspective.
CO2	Describe the types, epidemiology and symptomatology of various diseases of public health concern.
CO3	Explain the sources and transmission of diseases

Unit 1. Concept of health, Dimensions of health, Human development index, Human poverty index, Gender related development index and gender empowerment measure. Determinants of health. Responsibility for health- Individual,Community, State and International responsibility. Indicators of health.

Unit 2. Infectious disease epidemiology. Definition of terms:-infection (primary, secondary, cross, nosocomial, iatrogenic, exogenous, endogenous, clinical , subclinical), contamination, infestation, host, infectious disease, communicable disease, epidemic, pandemic, endemic, sporadic, exotic, zoonotic, epizootic enzootic and epornithic diseases. Sources of infection and modes of transmission. Reservoirs, carriers and vectors of communicable diseases. Role of WHO in pandemic alerts.

Unit 3. Symptomatology, epidemiology, preventive measures of disease- Hepatitis,-A,B,E, HIV, Tuberculosis, Enteric fever, Weil's disease, microbial food poisonings. Emerging diseases- Dengue fever, Chikungunya, Swine flu. Bio-terrorism.

Suggested Readings

1. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology.* 7th edition (edited by Paniker CKJ). University Press Publication.
2. Brooks GF, Carroll KC, Butel JS and Morse SA. *(2007)Jawetz, Melnick andAdelberg's Medical Microbiology.* 24th edition. McGraw Hill Publication.
3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). *Mims' Medical Microbiology.4th* edition. Elsevier.
4. Joklik WK, Willett HP and Amos DB (1995). *Zinsser Microbiology.* 19th edition. Appleton- Centuary- Crofts publication.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein'sMicrobiology.* 7th edition. McGraw Hill Higher Education.
6. Medical Microbiology : David Greenwood, Slack, Peutherer
7. Satish Gupte (2005). The Short Textbook of Medical Microbiology. Eighth edition, Jaypee Brothers, Medical publishers (P) Ltd., New Delhi.
8. Baron EJ, Peterson LR and Finegold SM (1994). Bailey and Scotts diagnostic Microbiology. 9th edition, Mosby publications.
9. Rajan S (2009). Medical Microbiology. First edition, MJP Publishers, Chennai.
10. Abbas AK, Lichtman AH, Pillai S. (2007). *Cellular and Molecular Immunology.* 6thedition aunders Publication, Philadelphia.
11. Delves P, Martin S, Burton D, Roitt IM. (2006). *Roitt's Essential Immunology.* 11th editionWiley- Blackwell Scientific Publication, Oxford.
12. Goldsby RA, Kindt TJ, Osborne BA. (2007). *Kuby's Immunology.* 6th edition W.H.Freeman and Company, New York.

MBG5D02. ENVIRONMENTAL MICROBIOLOGY

2 Hrs/Week **3 Credits**

Course Objectives:

- To understand the relationship between microorganisms and the environment.
- To learn the role of microorganisms in nitrogen cycle, diseases and pollution.
- To understand the basic environmental problems.

Course Outcome:

CO1	Explain the role of microorganisms in nitrogen cycle, vermi-composting and biogas production
CO2	Describe the methods used for microbiological examination of water, purification of water and sewage treatment
CO3	Discuss the problems associated with environmental protection.
CO4	Discuss the diseases spreading through air.

Unit 1. Soil Microbiology: Humus, Microflora of soil, Nitrogen cycle - Nitrogen fixation, nitrification,denitrification. Rhizosphere - Rhizosphere microorganisms.

Unit 2. Faecal pollution of water - waterborne diseases, indicator organisms. Microbiological examination of water. Water purification- aeration, sedimentation, coagulation, flocculation, sand filtration . Disinfection of drinking water , Sewage treatment.

Unit 3. Dispersal of airborne microorganisms,.indoor outdoor air Droplet nuclei, aerosol, Air borne diseases.

Unit 4. Global environmental problems: ozone depletion, green house effect and acid rain, their impacts and biotechnological approaches for management. Definition of xenobiotics and biomagnification. Composting, vermicomposting and biogas production.

Suggested Readings

1. Microbial Ecology by Ronald M. Atlas, Richard Bartha.
2. Microbiology concepts and applications by Pelzar*et a.l*
3. Microbiology by Prescott.
4. Fundamentals of Microbiology by Mertus Frobisher.
5. Hand book of water and waste water microbiology by Mara and Niger Horan.
6. Microbiological Examination Methods Of Food And Water By Silva
7. Text book of Biotechnology by BD Singh
8. Text book of Microbiology by Chakrabarthy
9. Microbial Ecology. John Wiley & Sons.
10. Campbell RE. (1983). *Microbial Ecology.* Blackwell Scientific Publication,Oxford, England.
11. Maier RM, Pepper IL and Gerba CP. (2009). *Environmental Microbiology.* 2nd edition, Academic Press.
12. *Stolp H. (1988).* Microbial Ecology: Organisms Habitats Activities. *Cambridge*University Press, Cambridge, England.

MODEL QUESTION PAPER
MBG3B03. ENVIRONMENTAL AND SANITATION MICROBIOLOGY

Time: 2.5 Hrs. Maximum: 80 Marks

Wherever needed answers must be supported by structural illustrations and diagrams

Section A

*Short answer type questions: Answer **all** questions*
Each question carries 2 marks

Write briefly on:- (Maximum: 25 marks)

1. Superbug
2. BOD
3. Droplet nuclei
4. Andersen sampler
5. Recalcitrants
6. Trickling filters
7. Bioleaching
8. Coliforms
9. Methanogenesis
10. Biofiltration
11. EMB agar
12. Sulfur-reducing bacteria (SRB)
13. Imhoff tank
14. Aeroallergen
15. MPN

Section B

*Paragraph type questions: Answer **all** questions*
Each question carries 5 marks

Write notes on:- (Maximum: 35 marks)

1. Microbiology of the composting process
2. Role of activated sludge in wastewater treatment process
3. Microbial degradation of Xenobiotics
4. Biogas technology
5. Plant disease forecasting
6. Aerobiology and its role in the transmission of infectious diseases
7. Escherichia coli as an indicator of bacteriological quality of water
8. Air sampling procedures to evaluate microbial contamination

Section C

*Essay type questions: Answer **any two** questions*
Each question carries 10 marks

Write essay on:- (Maximum: 2 x 10 = 20 marks)

1. Write the primary, secondary and tertiary treatment process used in wastewater treatment
2. Elaborate on the principle and procedures of microbial analysis of water
3. Explain in detail the process of bioremediation
4. What is solid waste management? Explain in detail the sources and methods of solid waste management.

MODEL QUESTION PAPER
MBG5B08. IMMUNOLOGY

Time: 2.5 Hrs. Maximum: 80 Marks

Wherever needed answers must be supported by structural illustrations and diagrams

Section A

*Short answer type questions: Answer **all** questions*
Each question carries 2 marks

Write briefly on:- (Maximum: 25 marks)

1. ADCC
2. Opsonization
3. Anaphylaxis
4. Ouchterlony immunodiffusion
5. Autoantigens
6. Hematopoiesis
7. Isograft and allograft
8. T Cell receptor
9. Hapten
10. Complement fixation test
11. Oncogenes
12. Epitope and paratope
13. Interferon (IFNs)
14. NK cell
15. Adaptive Immunity

Section B

*Paragraph type questions: Answer **all** questions*
Each question carries 5 marks

Write notes on:- (Maximum: 35 marks)

1. Role of MHC in antigen presentation
2. Describe the production of monoclonal antibodies by hybridoma technology.
3. Explain agglutination reaction reactions and its applications
4. Immunology of graft rejection
5. Describe major factors that influence antigenicity
6. Describe the classical pathway of complement activation
7. Explain the process of B-cell activation and differentiation
8. Briefly describe the major organs of the immune system & their function

Section C

*Essay type questions: Answer **any two** questions*
Each question carries 10 marks

Write essay on:- (Maximum: 2 x 10 = 20 marks)

1. Describe the structure and biological activities of the immunoglobulin classes
2. Define and classify immunity. Explain the mechanism of innate innate immunity
3. Give an account of autoimmune diseases
4. Discuss in detail on different hypersensitivity reactions

MODEL QUESTION PAPER
MBG6B15 (E2). MOLECULAR BIOLOGY

Time: 2 Hrs. Maximum: 60 Marks

Wherever needed answers must be supported by structural illustrations and diagrams

Section A

*Short answer type questions: Answer **all** questions*
Each question carries 2 marks

Write briefly on:- (Maximum: 20 marks)

1. TATA box
2. Cot analysis
3. Z-DNA
4. Okazaki fragments
5. Palindromic sequence
6. mRNA capping
7. Ames test
8. Suppressor mutations
9. SOS repair
10. Plasmid
11. D-loop replication
12. t- RNA

Section B

*Paragraph type questions: Answer **all** questions*
Each question carries 5 marks

Write notes on:- (Maximum: 30 marks)

1. Genetic code and its properties
2. Describe in detail the role of enzymes in DNA replication
3. Post transcriptional modifications
4. Explain the steps involved in prokaryotic translation process
5. Histons and the role of Histone in DNA packaging
6. Hershey-Chase experiment
7. Different types of RNAs and their functions

Section C

*Essay type questions: Answer **any one** question*
Question carries 10 marks

Write essay on:- (Maximum: 1 x 10 = 10 marks)

1. Explain the mechanism of regulation of gene expression in bacteria related to *lac-operon*.
2. Describe DNA damage and repair mechanisms