DEPARMENT OF MICROBIOLOGY & BIOTECHNOLOGY

PREAMBLE

The following changes were introduced in the curriculum for the candidates to be enrolled since June 2018-19:

MSc MICROBIOLOGY

Core Papers:

- Few changes and corrections were done in all the core papers.
- The previous subjects Bio molecules and Microbial Physiology were merged together as a single paper (Bio molecules and Microbial Physiology) in Core –II.
- Recombinant DNA Technology is added to core paper (VII).
- Core VIII practical paper, Food & Dairy Microbiology and Environmental & Agricultural Microbiology was merged as a single practical paper.

Elective Papers:

- Few changes were done in all the elective papers.
- Genomics and Proteomics is added as Elective paper – II

Extra credit papers:

- Few corrections were done in the extra credit papers.

BSc MICROBIOLOGY

Core Papers:

- Few corrections and few topics were included in all the core papers.

Allied papers:

- Few topics were added in second allied I (Bioinstrumentation) and second Allied II (Immunology)

Skill based Elective:

- Few corrections were made in Skill based Elective I (Introductory Virology), Skill Based Elective III (Lab course in Medical Lab Technology), Skill Based Elective IV (Lab course in Mushroom Cultivation), Skill Based Elective V (Bioinformatics) and Skill Based Elective VI (Lab course in Aquaculture)

- The title of Skill Based Elective II (Lab course in Vermiculture and Vermicomposting) is changed to Lab course in Vermiculture and few experiments were included.

Elective papers:

- Few corrections were done in Elective II (Biotechnology and Bionanotechnology) and Elective III (Marine Microbiology and Public Health and Hygiene)

General interest course:

- Alterations were done in General interest course I Environmental studies.

Non Major Elective:

- Lab course in Mushroom Cultivation is replaced instead of Microbes in Human Welfare as a Non Major Elective I in third semester.
- Bioethics is replaced by Lab course in Vermiculture as a Non Major Elective II in Fourth Semester.

Extra credit papers:

- The previous Non Major Elective I Course in Microbes in Human Welfare was moved to Extra credit with few corrections included in fourth semester.

MSc. MICROBIOLOGY
(Two Years Regular Programme)
For those who joined since June 2018-19

Programme Outcomes:

PO1: Critical Thinking
PO2: Effective Communication
PO3: Social Interaction
PO4: Effective Citizenships
PO5: Ethics
PO6: Environment and Sustainability

Programme Specific Outcome:

The graduates will be able to

PSO1: Understand the nature of Microbes.
PSO2: Understand the basic concepts and its cellular mechanism.
PSO3: Analyse the relationships among plants, animals and humans.
PSO4: Perform procedures as per laboratory standards in the areas of Biochemistry, Microbiology, Microbial Physiology, Molecular biology, Microbial genetics, Medical

microbiology, Immunology and Immunodiagnostics, Environmental and Agricultural Microbiology, Food and Diary Microbiology.

PSO5: Understand the applications of biological sciences in Environment, Agriculture and Medicine

M.Sc., MICROBIOLOGY
(Two Years Regular Programme)
For those who joined since June 2018-19

Semester	Subject code	Course	Subject Title	H/W	Credit	CIA Marks	ESE Marks	Total Marks
I	GMMBC11	Core I	General Microbiology	6	5	40	60	100
	GMMBC12	Core II	Biomolecules and Microbial Physiology	6	5	40	60	100
	GMMBC13	Core III	Molecular Biology and Microbial Genetics	6	5	40	60	100
	GMMBC14P	Core IV (Practical)	Lab course in General Microbiology, Biomolecules and Microbial Physiology, Molecular Biology and Microbial Genetics	6	5	40	60	100
	GMMBE1A/ GMMBE1B	Elective I	a. Algal Technology/ b.Enzymology	6	5	40	60	100
	GMMBX1/ GMMBX1O	Extra Credit	Life Science for Competitive Examination/*Online Course		2		100	100
	Total			**30**	**25+2**	**200**	**300+100**	**500+100**
II	GMMBC21	Core V	Food and Dairy Microbiology	6	5	40	60	100
	GMMBC22	Core VI	Environmental and Agricultural Microbiology	6	5	40	60	100
	GMMBC23	Core VII	Recombinant DNA Technology	6	5	40	60	100
	GMMBC24P	Core VIII (Practical)	Lab Course in Environmental and Agricultural Microbiology, Food and	6	5	40	60	100

			Dairy Microbiology					
	GMMBE2A/ GMMBE2B	Elective II	a. Genomics and Proteomics/ b.Nanobiotechnology	6	5	40	60	100
	GMMBX2/ GMMBX2O	Extra Credit	Biofertilizer Production/*****Online Course		2		100	100
	Total			**30**	**25+2**	**200**	**300 +100**	**500 +100**
III	GMMBC31	Core IX	Medical Microbiology	6	5	40	60	100
	GMMBC32	Core X	Immunology & Immunodiagnostics	6	5	40	60	100
	GMMBC33	Core XI	Basics of Research Methodology	6	5	40	60	100
	GMMBC34P	Core XII (Practical)	Lab Course in Medical Microbiology, Immunology & Immunodiagnostics	6	5	40	60	100
	GMMBE3A/ GMMBE3B	Elective III	a. Bioethics, Biosafety and IPR/ b. Bioinformatics	6	5	40	60	100
	GMMBX3/ GMMBX3O	Compulsory Extra Credit	Information Technology for Biologists/ *Online Course		2		100	100
	Total			**30**	**25+2**	**200**	**300+100**	**500+100**
IV	GMMBC41PW	Core XIII	Project	25	15	100	100	200
	GMSED4	Compulsory Extra credit	Skills for Employability Development		2	100		100
			Library	5				
	Total			**30**	**15 + 2**	**100+ 100**	**100**	**200+100**
	Grand Total			**120**	**90+8**	**700 + 100**	**1000 + 300**	**1700 + 400**

H/W – Hours / Week, CIA – Continuous Internal Assessment, ESE – End Semester Examination

* For online certification credit alone will be assigned on submission of certificate obtained through appearing for online examination from spoken tutorial, EDX, NPTEL or Coursera and other MHRD MOOCs.

CORE I - GENERAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester: I **Hours per Week: 6**
Sub Code: GMMBC11 **Credit: 5**

Course Outcomes:
Upon completion of this course, the students will able to
CO1: Review the history and classification of microorganisms
CO2: Distinguish the basic groups of microbes - Archaea, Bacteria and Viruses and Eukaryotic microbes.
CO3: Describe the detailed structure and function of prokaryotic cell organelles.
CO4: Acquire basic knowledge on virus appearance and how to cultivate, isolate and identify viruses
CO5: Explore the fungal structure, classification and economical value of fungi
CO6: Improve the knowledge on algal characteristics, importance and its impact on society

Unit I **(18 hours)**

Introduction to Microbiology: History and Development of Microbiology, Classification of Microorganism-Binomial nomenclature, Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese; Principle and Classification of bacteria on the basis of Bergey's manual of Determinative bacteriology; Molecular approaches in microbial classification, Concept of microbial species.

Unit II **(18 hours)**

Bacteriology: Prokaryotic cell morphology-structure and function of flagella, fimbriae, pili; capsule types, composition and function; Cell wall-cell walls of Gram negative, Gram positive, halophiles, L–forms and archaebacteria, cell membrane-fluid mosaic model, membrane functions; Intracytoplasmic inclusions-Nucleoid and extra chromosomal material; gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes; reserve food materials – polyhydroxybutyrate granules, sulphur granules; Sporulation-exospores and endospores

Unit III **(18 hours)**

Virology: Historical developments in virology, general properties of viruses; structure of viruses, lytic and lysogenic life cycle; Classification of viruses – ICTV classification, Baltimore classification, prions, viroids
Techniques in virology – Virus cultivation methods- embryonated eggs, animal models, cell line; viral assay, virus isolation and purification, laboratory identification of viruses, cytopathic effect

Unit IV **(18 hours)**

Mycology: History and development of Mycology, structure and cell differentiation, Criteria for fungal classification: Habitat morphology and reproduction of Slime molds, Oomycetes, Zygomycotina, Ascomycotina, Basidiomycotina, Mastigomycotina and Deuteromycotina, Economic importance of fungi Mycotoxins.

Lichens: classification, physiology and importance

Unit V **(18 hours)**

Phycology: Distribution of algae, classification of algae, thallus organization in algae, reproduction in algae; Brief account of Chlorophyta, Bacillariophyta; Phaeophyta; Rhodophyta; Cyanobacteria and Prochlorons; Algal ecology; Applications of algae in agriculture, biofertilizer, industrial application of algae, medicinal importance, nutritional value, environmental implications.

Protozoa – animal parasites – general characteristics and reproduction

TEXT BOOK

1. Dubey R.C. and Maheswari D.K., **A Textbook of Microbiology**, S. Chand and Company Ltd, New Delhi, 2013.
2. Pelczar Jr. M.J., Chan E.C.S. and Kreig N.R., **Microbiology**, Fifth edition, Mc. Graw Hill, 2004.

REFERENCES:

1. Boyd R.F., **General Microbiology**, Mosby College Publishing, St. Louis, 1998.
2. Barasanti L. and Guaaltieri P., **Algae: Anatomy Biochemistry and Biotechnology,** Taylor and Francis Group, New York, second edition 2010.
3. Sharma O.P., **Textbook of Algae**, Tata McGraw Hill Publishing Co. Ltd, 2005.
4. Prescott L.M., Harley J.P. and Klein D.A., **Microbiology**, WMC, Brown Publishers, Seventh Edition, 2008.

CORE II – BIOMOLECULES AND MICROBIAL PHYSIOLOGY

(For those who joined since 2018-19)

Semester: I **Hours per Week: 6**
Sub Code: GMMBC12 **Credit: 5**

Course Outcomes:

Upon completion of the course, the students will be able to,

CO 1: Reveal about the metabolism and regulations of carbohydrates and lipids
CO 2: Accentuate the metabolism, regulations and to classify the cell organelle.
CO 3: Explore concepts on biochemical components & growth factors of microbial cell
CO 4: Emphasize the nutritional requirements, environmental adaptations and transport mechanisms of microbes

CO 5: Summarize the photosynthetic process carried out during the microbial growth.
CO 6: Illustrate the overall biosynthetic and regulatory metabolism of microorganisms

Unit I (18 hours)

Biomolecules: Carbohydrates – structure and classification, metabolism and its regulation – Glycolysis, TCA cycle, Oxidative phosphorylation, Pentose phosphate pathway and Gluconeogenesis. Lipids – classification – biosynthesis of fatty acids, triglycerides, phospholipids and cholesterol – oxidation of fatty acids

Unit II (18 hours)

Nucleic acids: Biosynthesis and regulation – DNA & RNA; Amino acids–classification and chemical properties.

Proteins – Classification, protein structure – primary structure, secondary structure, tertiary and quaternary structure. Enzymes – nomenclature and classification, physical and chemical properties of enzymes. Vitamins – types of vitamins and their importance

Unit III (18 hours)

Biochemical components of microbial cell: Structure and functions of organelles of microbial cell and Cell wall synthesis, role of Cell wall and Cell membrane in the functions of microbial cells. Microbial growth **–** Different Phase of growth, Factors influencing microbial growth – temperature, pH, pressure, salt concentration, nutrients; synchronous growth and continuous cultivation

Unit IV (18 hours)

Mode of Nutrition: Classification of microorganisms based on nutrition requirements. Transport mechanism – Active and Passive transport, Siderophores - Iron uptake; Physiology and Classification of organisms living in extreme environments – Thermophiles, Halophiles, Psychrophiles and Methanogens

Unit V (18 hours)

Photosynthesis: Photosynthetic pigments, oxygenic and anoxygenic types; Physiology of bacterial photosynthesis – light reactions, Cyclic and non-cyclic photophosphorylation; Effect of light, CO_2, pH and temperature on photosynthesis

TEXT BOOKS:

1. Sathyanarayana U. and Chakrapani U., **Essential of Biochemistry**, ArunabhaSen books and allied (P) Ltd, Kolkata, Second Edition, 2008.
2. Millian Meenakumari S., **Microbial Physiology**, MJP. Publishers, Chennai, 2006 (Unit II to V).

REFERNCES:

1. Washington. Albert G., Moat and John W. Foster., **Microbial Physiology**, A John Wiley and sons, INC Publications, New York, 2004.

2. Donald Voet and Judith G. Voet., **Biochemistry**, John Wiley and Sons, USA, 2004.
3. Jain J.L., Jain S. and Jain N., **Fundamentals of Biochemistry**, S.Chand and company Ltd, New Delhi, 2005.
4. Geoffrey M. Cooper., **The cell - A molecular approach**, Third edition, ASM press, 2004.
5. Rajendra Kausik and Asha Sharma, **Biomolecules structure and functions**, Oxford book company, Jaipur, First Edition, 2009.
6. Pelczar Jr. M.J., Chan E.C.S. and Kreig N.R., **Microbiology**, Mc. Graw Hill, Fifth edition, 2004.
7. Michael M. Cox and David L. Nelson, **Leninger Principles of Biochemistry,** Fifth Edition, 2008.

CORE III - MOLECULAR BIOLOGY AND MICROBIAL GENETICS

(For those who joined since 2018-19)

Semester: I **Hours per Week: 6**
Sub code: GMMBC13 **Credits: 5**

Course Outcomes:
Upon completion of the course, the students will be able to
CO 1: Describe the molecular genetics and the genome organizations in organisms.
CO 2: Understand the mutation and the DNA repair mechanism
CO 3: Describe about the transposons and its molecular mechanism
CO 4: Explain the concept of recombination
CO 5: Critically discuss about the life cycle of phage and its genetics
CO 6: Depict the gene transfer techniques

Unit I **(18 hours)**

Genetic material: DNA and RNA as the genetic material, nucleic acid structure, types of DNA and RNA; Peptide Nucleic Acid (PNA)

DNA replication – Prokaryotic and Eukaryotic DNA replication models

DNA damage and repair – Mutagens – Physical and Chemical; Mechanism of repair – Photo reactivation, Excision repair, Recombination repair; SOS and Adaptive responses and their regulation

Unit II **(18 hours)**

Transcription: Mechanism of transcription in Prokaryotes & Eukaryotes and its regulation, Post transcriptional modification; Genetic code, Wobble hypothesis

Translation – Prokaryotic & Eukaryotic translation, Post translational modifications

Unit III **(18 hours)**

Genetics: Genetic nomenclature, Types of mutants, Isolation and Characterization of mutants, Revertants and reversion; Genetic analysis of mutants

Genetic recombination – Homologous, Non homologous, Site specific recombination, Genetic mapping, Linkage and multifactor crosses, Deletion mapping, Complementation and Intragenic complementation

Unit IV (18 hours)

Genetics of Phage λ: Biology of bacteriophage λ, Lytic growth of phage λ: DNA replication and phage production, Recombination in the λ life cycle, Lysogeny: Immunity and repression, molecular events in lysogeny, Decision between lysis and lysogeny

Unit V (18 hours)

Gene transfer methods: Transformation, Conjugation – *Hfr*, Triparental mating, Transduction – general and specialized;

Transposable elements – Introduction to Transposable elements – Discovery and types; Retrotransposon – Mechanism, SINES and LINES, Transposons of *E.coli* and Yeast

TEXT BOOK:

1. David Freifelder, **Molecular Biology**, Narosa Publishing House, Second edition, 2004.

REFERENCES:

1. Malacinski G. M., **Essentials of Molecular Biology**, Jones & Bartlett Publishers, Fourth edition, 2002.
2. Maloy S.R., CronanJr J. E. and Freifelder D., **Microbial Genetics**, Jones and Bartlett Publishers, 2006.
3. Peter J. Russell, **Genetics – A Molecular Approach**, Benjamin and Cumin Publishers, Second edition, 2006.
4. Gardner E.J. and Snustad D.P., **Principles of Genetics**, Jon Wikey and Sons, New York, 2002.
5. Brown T.A., **Genomes 3**, Garland Science Publishing, New York, Third edition, 2007.

CORE IV – LAB COURSE IN GENERAL MICROBIOLOGY BIOMOLECULES AND MICROBIAL PHYSIOLOGY, MOLECULAR BIOLOGY AND MICROBIAL GENETICS

(For those who joined since 2018-19)

Semester: I **Hours per week: 6**
Sub Code: GMMBC14P **Credits: 5**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Describe the preparation of buffers and molar solution
CO 2: Quantify the amount of biomolecules like carbohydrates, amino acids, lipids, DNA and RNA
CO 3: Estimate the proteins, lipids, DNA and RNA by chemical methods
CO 4: Able to isolate and separate DNA and protein

CO 5: Test antibiotic sensitivity
CO 6: Isolate mutants

List of Experiments:

1. Laboratory Safety measures
2. Pure culture techniques – Pour plate, Spread plate and Streak plate
3. Isolation and enumeration of microorganisms from soil sources
4. Staining methods – Simple Staining, Gram's Staining, Negative staining, Flagella staining, Endospore staining and Lacto phenol Cotton Blue staining
5. Biochemical tests: a. IMVIC, b. Catalase, c. Oxidase, d. TSI test, e. ONPG test, f. Nitrate reduction test, g. Starch hydrolysis, h. Gelatin hydrolysis, i. Casein and j. Urease test.
6. Isolation of Photosynthetic bacteria
7. Preparation of solutions:
    a. pH meter and preparation of buffers of pH range 2 to 11
    b. Molarity and Molality calculation
    c. Preparation of 0.1 N acid and base i) NaOH ii) HCl iii) HNO_3
8. Determination of carbohydrate by DNSA method
9. Estimation of total sugar by Anthrone method
10. Determination of pI value of amino acids
11. Estimation of amino acid by Ninhydrin method
12. Estimation of protein by Lowry's and Bradford's method
13. Estimation of total lipids by Folch method
14. Estimation of DNA by diphenyl amine method
15. Estimation of RNA by orcinol method
16. Isolation of genomic DNA and agarose gel electrophoresis
17. Separation of protein by SDS-PAGE
18. Antibiotic sensitivity assay Kirby Bauer test
19. Separation of amino acid by paper chromatography
20. Separation of lipids by Thin layer chromatography

REFERNCES:

1. Cappuccino J. and Sheeman N., **Microbiology. A laboratory Manual**, Addison Wesley, California, Sixth edition, 2001.
2. Wilson K. and Walker J., **Principles and techniques of Practical Biochemistry**, Cambridge University Press, Cambridge, Fourth edition, 1994.
3. Raja manickam C., **Experimental protocol Basic molecular Biology**, Osho Scientific publication, Madurai, 2001.
4. Kannan K., **Laboratory Manual in General Microbiology**, Panima Publishers, 2002.
5. Talwar G.P. and Gupta S.K., **A handbook of practical and clinical immunology**, CBS publications, Second edition, volume 1 and 2, 2009.
6. Moat A.G. and Foster J. W., **Microbial Physiology**, Wiley,Fourth edition, 2003.
7. Aneja K.R., **Experiments in Microbiology plant pathology and biotechnology**, Newage international publishers, New Delhi, Fourth edition, 2003.

ELECTIVE I: a. ALGAL TECHNOLOGY

(For those who joined since 2018-19)

Semester: I **Hours per Week: 5**
Subject Code: GMMBE1A **Credits: 5**

Course Outcomes:
Upon completion of the course the students will be able to
CO 1: Describe the basic characteristics and classification of algae
CO 2: Emphasize the detailed structure and function of cell organelles
CO 3: Expertise in the discrete cultivation methods of algae
CO 4: Understand the concepts of algal processing
CO 5: Enlighten the impact of algae on society
CO 6: Depicts the economic importance of algae

Unit I **(15 hours)**

Introduction to algae – History of Phycology; Classification of Algae – Fritsch's system, G.M. Smith system; Salient features of major classes: Prochlorophyta, Chlorophyta, Cyanophyta, Charophyta, Xanthophyta, Phaeophyta and Rhodophyta.

Unit II **(15 hours)**

Algal structure, division and growth – Ultrastructure of Prokaryotic and Eukaryotic algal cells and their components - cell wall, protoplasm, flagella, eye spots, chloroplast, pyrenoid, nucleus, pigments and reserve foods.; reproduction- vegetative, sexual, asexual; Life cycle in algae, eutrophication

Unit III **(15 hours)**

Algal cultivation – Introduction to algal cultivation – indoor cultivation; outdoor cultivation; Nutrients, carbon sources, growth kinetics; Factors affecting algal cultivation- temperature, water, light, culture depth, agitation of algal suspension, oxygen transfer, inoculum size, evaporation , pH

Unit IV **(15 hours)**

Algal Processing – Harvesting – centrifugation; auto flocculation, induced flocculation, filtration, flotation, microstainer, sand filtration, ion exchange method; Drying – electrically heated drum drying, steam heated drum drying, cross flow air drying, vacuum shelf drying, solar drying, Sun drying, yield, chemical composition, storage and packaging; Economics of Algal Industry

Unit V **(15 hours)**

Applications of algae – Therapeutic properties of microalgae; Food, animal feed; fuel; algal system in effluent treatment; Biofertilizer – Physiology of nitrogen fixation, algalization technology and N_2 fixation in symbiosis involving BGA.

Textbooks:

1. Venkataraman L.V., Becker E.W., **Biotechnology & Utilization of Algae - The Indian Experience**, Sharada Press, Mangalore, 1985.

References:

1. Barasanti L. and Guaaltieri P., **Algae: Anatomy Biochemistry and Biotechnology**,Taylor and Francis Group, New York, 2006.
2. Sharma O.P., **Textbook of Algae**, Tata McGraw Hill Publishing Co. Ltd, 2005.
3. Pelczar Jr. M.J., Chan E.C.S. and Kreig N.R., **Microbiology**, Mc. Graw Hill, Fifth edition, 2004.

ELECTIVE I: b. ENZYMOLOGY

(For those who joined since 2018-19)

Semester: I **Hours per Week: 5**
Subject Code: GMMBE1B **Credits: 5**

Course Outcomes:

Upon completion of the course, students will be able to
CO 1: Outcast the basics of enzymes, properties, types and characteristics
CO 2: Describe various methods to isolate and purify enzymes
CO 3: Expertise on enzyme kinetics and mechanism of enzyme action
CO 4: Grasp the concepts of specificity of enzymes and inhibition properties
CO 5: Explore the assorted techniques of immobilization and its applications.
CO 6: Be familiarized on enzymes in drug designing and their future potential.

Unit I **(15 hours)**

Introduction to Enzymes: History and progress of Enzymology, Properties of enzymes, Classification of enzymes, Enzyme nomenclature, and Enzyme Commission numbers; Isolation and extraction of enzymes, Purification of enzymes (precipitation, dialysis, ultrafiltration and chromatographic techniques); free energy, activation energy and transition energy; Coenzymes

Unit II **(15 hours)**

Enzyme Kinetics: Henry and Michaelis Menten plot, significance of K_m and K_{cat} Lineweaver-Burk plot; Active sites features, lock and key model, induced fit model; Enzyme catalysis – general principles, mechanism of action of enzymes (chymotrypsin and lysozyme); Factors

influencing enzyme activity – Temperature, pH, Concentration of enzymes, substrate and product; Role of metal ions in enzyme catalysis

Unit III (15 hours)

Enzyme Specificity & Inhibition: Types of enzyme specificity: Group specific enzymes – relative group and absolute group, Stereospecific enzymes – optical and geometrical; Types of enzyme inhibition: Irreversible inhibitors and Reversible inhibitors – Competitive, Non–competitive & Uncompetitive inhibitions;

Unit IV (15 hours)

Enzyme Immobilization: Immobilized enzymes – Definition, Characteristics – Principles & Techniques of immobilization- adsorption, covalent bonding, entrapment, cross-linking, encapsulation (advantages and disadvantages); Kinetics of immobilized enzyme reactions; Applications of immobilized enzymes

Unit V (15 hours)

Recent advances and future prospects in Enzyme Technology: Enzymes and recombinant DNA technology, Enzyme biosensors; Synthesis of artificial enzymes, Enzymes & bioinformatics, Rational designing of enzymes – site directed mutagenesis

TEXT BOOK:

1. Palanivelu P., **Enzymes, Ribozymes and DNAzymes**, MKU Coop. Press Ltd., Madurai, 2006.
2. Shanmugam S., Sathish kumar T., **Enzyme Technology**, I. K. International Publishing House Pvt. Ltd., New Delhi, Second edition, 2012.

REFERENCES:

1. Jogdand S. N., **Industrial Biotechnology**, Himalaya Publishing House, Mumbai, 2006.
2. Keshav Trehan, **Biotechnology**, New Age International Publishers, New Delhi, Reprint 2002.
3. Nicholes C., **Fundamentals of Enzymology**, Price and Lewis Stevens, Oxford University Press, Third edition, 2009.
4. Allen I. Laskin, **Enzymes and Immobilized Cells in Biotechnology**, The Benjamin /Cummings Publishing Company, INC, California, 1985.
5. Mansi El–Mansi and Charlie Bryce, **Fermentation Microbiology and Biotechnology**, Taylor & Francis Ltd, London, 1999.
6. Eric J. Toone. **Advances in Enzymology and Related Areas of Molecular Biology, Protein Evolution**, John Wiley & Sons, 2010.

EXTRA CREDIT – LIFE SCIENCE FOR COMPETITIVE EXAMINATIONS

(For those who joined since 2018-19)

Semester: I **Hours per Week: -**

Sub Code: GMMBX1 **Credit: 2**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Summarize on overall view on life science

CO 2: Dexterous about the Nucleic acids and proteins synthesis

CO 3: Empathize the heredity and its related variations

CO 4: Grasp on ecosystem and its types

CO 5: Interpret the changes in environment by the pollution & cyclone

CO 6: Perceive the application in Biotechnology

Unit I

Prokaryotic and Eukaryotic cells: Structure and Ultrastructure; Structure and function of organelles – Chloroplast, Mitochondria, Vacuoles, Endoplasmic Reticulum, Golgi Apparatus, Ribosomes & Lysosomes, Nucleus, Nucleolus, Chromatin and Nucleosome; Mitosis and Meiosis

Unit II

Structure and synthesis of DNA: Structure of mRNA, t-RNA & r-RNA; Structure of proteins (Primary, Secondary, Tertiary and Quaternary); General properties of Enzymes and Amino acids

Unit III

Concept of heredity and variation: Mendel's law of inheritance, monohybrid cross, dihybrid cross, test cross – chromosomal basis of inheritance, incomplete dominance, epistasis, mutation-types

Unit IV

Ecosystem: Concept, Structure, Function, Producers, Consumers and Decomposers of ecosystem, Energy flow, Food web and Food chain, Ecological pyramids; Types of ecosystem; Pollution – air, water and land; Global warming and Disaster managements

Unit V

Definition and scope of biotechnology: Restriction enzymes, Plasmid – types, Cloning vectors pBR322, Methods of gene transfer; Application of genetic engineering in the field of Agriculture –herbicide and pest resistance plants & Medicine – production of recombinant vaccines

REFERENCES:

1. Kumaraswamy K., **Environmental Studies,** UGC syllabus, Periyar EVR College, Tiruchirappalli, 2013.
2. Nelson D.L., Cox M.M., & Lehninger, **Principles of Biochemistry**, Macmillan worth Publishers, Sixth edition 2012.

3. Prescott L.M., Harley J.P. and Klein D.A., **Microbiology**, WMC, Brown Publishers, Seventh Edition, 2008.
4. Verma P.S. and Agarwal V.K., **Environment Biology**, S. Chand and Company Ltd, New Delhi, 2000.

CORE V: FOOD AND DAIRY MICROBIOLOGY

(For those who joined since 2018-19)

Semester: II **Hours per Week: 6**
Sub Code: GMMBC21 **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to
CO 1: Enlighten the factors essential for the growth of microorganisms
CO 2: Exploit discrete types of food preservation techniques
CO 3: Explore the kinds of microbes involved in various fermented foods
CO 4: Describes the principles of food spoilage microorganisms
CO 5: Identify the types of illness associated with food poisoning and
CO 6: Retrieve the extra knowledge on food safety and quality

Unit I (18 hours)

Introduction: Food as a substrate for microorganisms, Important Microorganisms of food Microbiology – Bacteria, Yeast, Molds. Factors influencing microbial growth in food, Contamination of foods, General principles underlying spoilage: Chemical changes caused by microorganisms

Unit II (18 hours)

Food Preservation: Physical Methods **–** Asepsis, Drying, Filtration, Chilling and Freezing, Radiation, Pasteurization, Desiccation, Anaerobiosis, Canning, Controlled atmosphere.
Chemical Preservatives **–** Salt, Sugar, Organic acid - Benzoic acid, Sorbic acid, Propionates, Acetic acid & Lactic acid, Nitrites, Nitrates, Sulphur dioxide, Ethylene dioxide, Propylene acid, Wood Smoker & Antibiotics

Unit III (18 hours)

Fermented food products: Dairy products **–** Production of Cheese, Yoghurt, Kefir, Sour cream and Butter milk; Fermented vegetables, Fermented meat, Fermented fish, Fermented Indian foods; Role of microbes in fermented foods; Microbial cells as food – Single cell proteins, Mushroom; Beneficial Microbes as food – Probiotics **–**Potential and therapeutic applications – Lactobacilli – homo and hetero lactic acid fermentation, its nutritive value **–** Prebiotics and Synbiotics

Unit IV (18 hours)

Contamination and spoilage of different groups of foods: Cereals and Cereal Products, Vegetables and fruits, Meat and meat products, Fish and fish products, Milk and milk products, Eggs and poultry, canned food

Unit V (18 hours)

Food borne diseases: Bacterial and Viral food – borne diseases, food – borne important Animal parasites, Mycotoxins

Application of microbes in food industry – Microbial pigments in food industry, Biopreservatives

Indicators of food safety and Quality – Microbiological Criteria of foods and their significance Food Inspection – Hazard analysis critical control point (HACCP)

TEXT BOOK:

1. William C. Frazier & Westhoff D.C, **Food Microbiology**, McGraw Hill Publications, New York, Fourth Edition, 2008.
2. Adams M.R. & Moss M.O., **Food Microbiology**, New Age International P. Ltd. Publications, 1995.

REFERENCES:

1. Michael J. Pelczar I.R., Chan E.C.S and Noel R. Kreig., **Microbiology**, Tata McGraw–Hill, New Delhi, Fifth Edition, 2004.
2. Atlas R.M., **Principles of Microbiology**, WCB / McGraw Hill, NewYork, Second Edition, 1997.
3. Wood J.B., **Microbiology of fermented foods**, Volumes I and II, Elsevier Applied Science Publishers, London, Second Edition, 1998.
4. Banwart G.J., **Basic Food Microbiology**, CBS Publishers & Distributors, New Delhi, Second Edition, 2004.
5. Bensaon H.J., **Microbiological applications**, Crown Publishers, USA, Fifth Edition, 1990.

CORE VI - ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester: II **Hours per Week: 6**
Sub Code: GMMBC22 **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Portray influencing factors on environmental microbes
CO 2: Illustrate assessment of air and water quality
CO 3: Conceive knowledge about marine habitats and coral reefs
CO 4: Describe biogeochemical cycles and microbes involves in each cycles
CO 5: Critically discuss on an Agro Ecosystem
CO 6: Describe how bio pesticides & herbicides are produced by using microbes

Unit I (18 hours)

Environmental Microbiology: Characteristic features of environmental micro flora: Microorganisms and their environment: temperature, oxygen, desiccation, extreme cold, ionic effect, electricity, osmotic pressures, radiant energy, hydrostatic pressures, mechanical Impact, vibration, and surface forces

Unit II (18 hours)

Air and Aquatic Microbiology: Aerobiology – A brief introduction – droplet nucleus – aerosols –air borne transmission of microbes and diseases; assessment of air quality; Aquatic microbiology – A brief introduction – Water borne transmission of microbes and diseases; Assessment of water quality, marine habitats – Estuaries, Deep sea, Hydrothermal vents and Salt pans. Coral reefs – Types, bleaching and their microbial communities

Unit III (18 hours)

Bioremediation and Biodegradation: Bio corrosion and Bio fouling. Bioremediation – Types of bioremediation, Bioremediation of surface soil and sludges. Principles and applications of bioaccumulation, Bio magnification, Biodegradation – Degradation of biopolymers, Xylan, Lignin and Polyhydroxy alkanoates (bio plastics), Microbial degradation of hydrocarbons – Methane alkanes, Microbial degradation of halogenated and suffocated compounds and Biodegradation of pesticides

Unit IV (18 hours)

Agricultural importance of microbes: Agro ecosystems – Populations in agro ecosystems, diversification of agro ecosystems; Agro biodiversity assessment and management; Outline of the threats to agro biodiversity and the need for conservation management: Impact of genetically modified crops. Microbial interactions: Plant & microbe, Microbe & Microbe interactions – Microbes involved in biogeochemical cycles – Nitrogen fixation, Sulphur fixation and Mobilization of nutrients, R: S ratio

Unit V (18 hours)

Biological control of plant pathogens, pests, and weeds: Biopesticide – Characteristics, Advantages, types, formulation of pesticides, Microbial herbicides – Advantages of Herbicides, Formulation of Herbicides and its types, Constraints of Bio herbicides development, bio insecticides – Characteristics, Advantages, Types, Formulation of insecticides

TEXT BOOK:

1. Dubey R.C. and Maheshwari D.K., **A Textbook of microbiology**, S. Chand & Company Ltd, New Delhi, 2013.

REFERENCES:

1. Atlas R.M.and Renk, **Principles of Microbiology**, Mc Graw Hill, USA, Second Edition, 1997.
2. Pelczar M.S., Chan E.C.S., and Kreig N.R., **Microbiology**, Tata Mc Graw Hill, Singapore, Fifth edition, 2004.

3. Prescott L.M., Harley J.P. and Klein D.A., **Microbiology**, WMC, Brown Publishers, Seventh Edition, 2008.
4. Moat A.G., Foster J.W. and Spector M.P., **Microbial Physiology**, John Willey and Sons, New York, Fourth Edition, 2009.
5. Subbha Rao N.S., **Soil microorganisms and plant growth**, Science Publishers, 1995.
6. Rangasami G. and Bagyarai D.J., **Agricultural Microbiology**, Prentice–Hall of India Private Limited, New Delhi, Second Edition, 1993.

CORE VII - RECOMBINANT DNA TECHNOLOGY

(For those who joined since 2018-19)

Semester: II **Hours per Week: 6**

Subject code: GMMBC23 **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to,

CO 1: Comprehend the role of various DNA modifying enzymes and its uses in Molecular Biology

CO 2: Discuss various types of host cells and vectors in gene cloning.

CO 3: Describe the strategies of cloning, extraction and construction of genomic DNA and cDNA libraries

CO 4: Elucidate on the analytical techniques employed in DNA sequencing

CO 5: Demonstrate the Applications of rDNA technology in medicine

Unit I (18 hours)

DNA modifying enzymes and their uses in Molecular Biology: Restriction enzymes, Sticky ends, Blunt ends; DNA Polymerase – Klenow fragment, DNA polymerase I, T4/T7 DNA Polymerase; Reverse Transcriptase; Terminal Transferases; T4 Polynucleotide kinases & Alkaline phosphatase; DNA dependent RNA polymerases; DNA ligases; Homopolymeric tailing; Adapters & linkers; Nucleases Bal31, S1 nucleases, DNase I, Mungbean nucleases, Ribonucleases, EXO III; Thermostable DNA polymerases used in PCR

Unit II (18 Hours)

Host cells and Vectors: Host cell types vectors in gene cloning: pBR322, PUC8, Lambda and M13 vectors, Cosmids, Artificial chromosomes (YACs, PACs, BACs, MACs and HACs)

Unit III (18 Hours)

Cloning strategies: Extraction of DNA – Microorganism, Plant, Animal; Insertion of foreign DNA into Host Cells – Transformation, Electroporation, Lipofection, Microinjection; Construction of genomic DNA libraries and cDNA libraries; Screening and analysis of recombinants; Preparation of radiolabelled / non-radiolabelled DNA & RNA probes; Southern, Northern, Dot blot, Zoo blot, Colony blot; Screening of genomic libraries with DNA probe, Immunological Screening for expressed genes

Unit IV (18 Hours)

PCR: Principle, Types – Normal, Real Time and Reverse Transcriptase PCR – applications. DNA sequencing – Principle of chemical and enzymatic methods, Automated DNA sequencing, Pyro sequencing; DNA foot printing, Chromosome walking

Unit V (18 Hours)

Applications of rDNA technology in medicine: Insulin and interferon production, Molecular diagnosis of diseases – infectious diseases – tuberculosis, malaria & AIDS, genetic diseases – cystic fibrosis, sickle cell anaemia & cancer. Bioethics – Ethical issues in clinical trials

TEXT BOOK:

1. Old and Primrose, **Principles of gene manipulation**, Black well scientific publications, London, Seventh edition, 1990.

REFERENCES:

1. Sandy B. Primrose and Richard M. Twyman, **Principles of Gene Manipulation and Genomics**, Seventh edition, WileyBlackwell publishers, 2006.
2. Ernst Winnacker, **From genes to clones**, Panima publishing corporation, India, 2003.
3. Watson James D., **Recombinant DNA: Genes and Genomes: A Short Course**, W.H. Freeman, Sanfrancisco, Third edition, 2007.
4. Brown T.A., **Genomes 3**, Garland Science Publishing, New York, Third Edition, 2007.
5. Gardner E.J. and Snustad D.P., **Principles of Genetics**, Jon Wikey and Sons, New York, 2002.

CORE VIII - LAB COURSE IN ENVIRONMENTAL AGRICULTURAL MICROBIOLOGY AND FOOD MICROBIOLOGY

(For those who joined 2018 onwards)

Semester: II **Hours per Week: 6**
Sub Code: GMMBC24P **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Check the water quality by MPN technique
CO 2: Enumerate the microorganisms from various sources
CO 3: Estimate the BOD and COD
CO 4: Isolate various nitrogen fixing bacteria from various sources
CO 5: Isolate Cyanobacteria and Drug resistance mutants
CO 6: Examine the various plant diseases & Mycorrhizae
CO 7: Determine the milk quality by various tests
CO 8: Illustrate the methods in the production of Sauerkraut, SCP, amylase & protease
CO 9: Explore the process in the fermentative production of Citric acid and wine
CO10: Attain knowledge about Cell immobilization

CO11: Perform the microbiological analysis of food products and mushroom cultivation

List of Experiments:

1. Assessment of water quality by MPN technique
2. Enumeration of microorganism from air, soil, phyllosphere and milk
3. Estimation of BOD and COD
4. Effect of temperature & pH on microbial growth, techniques for cultivation of anaerobic bacteria
5. Isolation of free living and symbiotic nitrogen fixing bacteria from soil and root nodule.
    i. *Azotobacter*
    ii. *Rhizobium*
    iii. *Phosphate solubilising bacteria*
6. Isolation of *Cyanobacteria*
7. Examination of plant diseases

Bacterial Disease	**Fungal Disease**
Blight of rice	Tikka leaf spot of ground nut
Citrus canker,	Blast of rice
Brown rot of potato	Red rot of sugarcane

8. Staining of vesicular and Arbuscular mycorrhizae from plant
9. Microbiological analysis of food products
10. Determination of the quality of milk sample by Dye Reduction Test, Phosphatase test
11. Detection of calcium and phosphorus in milk.
12. Screening of seafood spoilage microbes.
13. Sauerkraut production.
14. Detection of metanil yellow in a given food sample.
15. Fermentative production of Citric acid and wine.
16. Cell immobilization using sodium alginate
17. Screening of industrially important microbes (Antibiotic and Enzyme producers)
18. Isolation of Drug Resistant Mutants by Gradient Plate Technique
19. Production of SCP (Blue Green Algae)
20. Mushroom Cultivation

REFERENCES:

1. Dubey R.C., and Maheswari D.K., **Practical Microbiology**, S. Chand & Company Ltd., New Delhi, 2007.
2. Aneja K.R., **Experiments in Microbiology, Plant pathology and Biotechnology**, New Age International Publishers, Chennai, Fourth Edition, 2005.
3. Horold J. Benson., **Microbiological Applications. Laboratory Manual in General Microbiology**, WCB McGraw – Hill, Boston, Eighth International Edition, 2002.
4. James G. Cappuccino and Natalie Sherman, **Microbiology, A Laboratory manual**, Published by Pearson Education, Seventh Edition, 2004.

5. Cappucino J. and Sherman N.C., **Microbiology-A Laboratory Manual,** The Benjamin–Cummings Publishers, Ninth edition, 2011.
6. Janarthanan S. and Vincent S., **Practical Biotechnology**, Universities Press India Pvt. Ltd, Hyderabad, 2007

ELECTIVE II : a. GENOMICS AND PROTEOMICS

(For those who joined since 2018-19)

Semester: II **Hours per Week: 6**
Subject code: GMMBE2A **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Explain the structure and organisation of prokaryotic & eukaryotic genome

CO 2: Classify the structural and functional genomics

CO 3: Demonstrate the basic principles and approaches in structural & functional genomics

CO 4: Describes the tools for the separation and identification of protein

CO 5: Understand the concepts and methods in metabolomics

CO 6: Discover about the pharmocogenomics

Unit I **(18 hours)**

Introduction to Genomics: Structure and organization of prokaryotic genomes **–** Nuclear, Mitochondrial and Chloroplast genomes; Recognition of coding and noncoding regions and Annotation of genes, Coding sequences (CDS), Untranslated regions (UTR's), cDNA library, Expressed sequence tags (EST); Mapping of genomes: mapping strategies, linkage maps, slow and high resolution physical mapping, Metagenomics

Unit II **(18 hours)**

Structural Genomics: Gene networks the need for Structural genomics, basic principles and approaches for target selection

Functional genomics: Determination of function of unknown genes, patterns of gene expression SAGE, Microarray technology.

Unit III **(18 hours)**

Proteomics: Introduction to Proteomics, Methods of studying Proteins, Identification of Post Translationally Modified Proteins (2D Gel Electrophoresis), Determining the existence of Protein in complex mixture **–** MALDI – TOF, Establishing protein **–** Protein interactions, Two hybrid analysis, Protein database

Unit IV (18 hours)

Metabolomics: Concepts, Levels of metabolite analysis, Metabolomics in humans, Sample selection and handling, Overview of different methods used for analysis of metabolites; Metabolic regulation network at genome level; Basic concept of metabolic engineering

Unit V (18 hours)

Pharmacogenomics: Definition, Drug Designing – Targets, Characteristics of drugs, Discovery and Validation **–** drug metabolizing enzymes – Cyp 450 genes, Anticipated benefits of Pharmacogenomics, Barriers pharmacogenomics progress, Pharmacogenomics of alcoholism, Ethinicity and Pharmacogenomics

TEXT BOOK:

1. Jonathan Pevsnern, **Bioinformatics and Functional Genomics**, Wiley Blackwell publications, New Jersey, Third edition, 2015.

REFERENCES

1. Arthur M. Lesk, **Introduction to Genomics**, Oxford university Press, Second edition, 2012.
2. Liebler D.C., **Introduction to Proteomics Tools for the New Biology**, John R. Human Press, Totowa, New Jersey, Second edition, 2002.
3. Primrose B. and Twyman, R.M, **Genomics: Applications in Human Biology**, Blackwell Publishing, Singapore, Fourth edition, 2004.
4. Westermeier R. and Naven T., **Proteomics in Practice (A Laboratory Manual of Proteome Analysis)**, Wiley VCH, London, Third Edition, 2002.
5. Primrose S. B. and Twyman R. M., **Principles of Genome Analysis**, Blackwell Publishing, Singapore, Third edition, 2002.
6. Rastogi S.C., NamitaMendiratta and ParagRastogi, **Bioinformatics**, CBS publishers and Distributors, New Delhi, Second edition, 2008.

ELECTIVE II: b. NANOBIOTECHNOLOGY

(For those who joined since 2018-19)

Semester: II **Hours per Week: 6**

Subject code: GMMBE2B **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Demonstrate the biosynthesis and green synthesis of nanomaterials

CO 2: Elucidate the factors involved in the manufacturing process of nanomaterials

CO 3: Explain the process of fabrication, properties and application of Nucleic acid based artificial nanomaterials

CO 4: Discuss the application of Nano drug in medicine

CO 5: Clarify the status of nanotechnology in India and its impacts.

Unit I **(18 hours)**

Introduction to Nanotechnology: Definition, Evolution of Nanoscience, Need of Nanotechnology, Hurdles for Nanotechnology development, Factors involved in the manufacturing process of nanomaterials; Synthesis of nanomaterial **–** Biosynthesis and Green synthesis.

Unit II **(18 hours)**

Tools used in nanotechnology research: Ultra violet – visible spectroscopy; FTIR; XRD; Atomic force microscope, Scanning electron microscope, Transmission electron microscope, Scanning tunneling microscope; Magnetic resonance force microscopy.

Unit III **(18 hours)**

Nucleic acid based nanomaterials: DNA based artificial nanostructures; Fabrication, properties and application; Nucleic acid engineered nanomaterials and their applications; DNA lipoplexes – Lipofection efficiency in vitro and in vivo, Polymer controlled delivery of therapeutic nucleic acid.

Unit IV **(18 hours)**

Nanotechnology for drug development and medical applications: Nanotechnology for drug solubilization and drug delivery – toxicity; Nanomaterials in disease diagnosis; Nanotherapy for cancer, Interior artery expansions and joint replacement.

Unit V **(18 hours)**

Nanotechnology application in Environment: Cleaning the air with Nanotechnology; Nanotechnology for water treatment **–** Microbial nanoparticles; Possible harm from Nanomaterials; Nanoscience in India – Nanoscience education abroad – Looking at ethics and society.

TEXT BOOK:

1. Challa S.S.R. Kumar, **Biological and Pharmaceutical Nanomaterials**, Wiley VCH VerlagGmbh& Co., First Edition, 2006.

REFERENCES:

1. Richard Brooker and Earl Boysen, **Nanotechnology**, Wiley Publishing Inc., India. 2006.
2. David Goodsell S., **Bionanotechnology**, Lessons from Nature, WileyLiss, Inc, First edition 2004.
3. Jain K.K., **Nanobiotechnology in Molecular Diagnostics: Current Techniques and Application**, Horizon Biosciences, First edition, 2006.
4. Duckruix A. and Giege R., **Crystallization of Nucleic acids and Proteins. A practical approach**, Oxford University Press, England, 1992.
5. Mirkin C.A. and Niemeyer C.M., **Nanobiotechnology II: More Concepts and Applications**, Wiley VCH Verlag GmbH &Co.KGaA,Weinheim, 2007.

6. Niemeyer C.M. and Mirkin C.A., **Nanobiotechnology: Concepts, Applications and Perspectives**, Volume I, Wiley VCH Verlag GmbH &Co.KGaA, Weinheim, First edition 2005.

EXTRA CREDIT- BIOFERTILIZER PRODUCTION

(For those who joined since 2018-19)

Semester: II **Hours per Week:-**
Subject code: GMMBX2 **Credit: 2**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Discuss the significance of biofertilizer and cycles associated with the microorganisms

CO 2: Comprehend the nature of biofertilizers

CO 3: Know the importance and association of fungal biofertilizers

CO 4: Demonstrate the perception of biomanures from different agro and poultry wastes

CO 5: Elucidate the significance of vermin and microbial compost by biodegradation

CO 6: Depict the laboratory and field application of biofertilizers and biomanures

Unit I

Biofertilizer – History, importance of fertilizer and their application to crops. Natural cycles associated with microorganisms – Carbon, Nitrogen, Phosphorous and Sulphur.

Unit II

Bacterial Biofertilizers – Free living forms, Characteristic features and nitrogen fixation process of *Azotobacter*, *Azospirillum*, Symbiotic forms – *Rhizobium*, Legume association – *Pseudomonas*, non-legume association; Cyanobacterial biofertilizers – *Nostoc*, *Anabena*, *Gloeocapsa* and *Scytonema*.

Unit III

Fungal Biofertilizer – Ectomicorrhiza and Endomicorrhiza, *Vesicular Arbuscular Mycorrhiza* – *Glomus sp*; *Actinomycetes* as biofertilizers – actinomycetes association – *Frankia sp*.

Unit IV

Biomanures – A general account of manures – molds; composts – farm yard manure, oil seed cakes, castor and neem; green leaf manures – *Gliricidia*, *Sesbania* and *Crotalaria*; Agro industrial wastes – Poultry manure and saw dust; Compost; vermin and microbial compost – pure culture technique, consortium; types of compost pit; Biodegradation of compost.

Unit V

Applications of Biofertilizers and biomanures – a combination of biofertilizer and manure applications with reference to soil, seed and leaf sprays; Laboratory and field application, cost benefit analysis of biofertilizer and bio manure production.

REFERENCES:

1. Dubey R.C. and Maheshwari D.K., **A Textbook of Microbiology**, S.Chand & Company Ltd, New Delhi, 2007.
2. Harley J.L. and Smith S.E., **Mycorrhizal symbiosis**, Academic press, London, 1983.
3. Rangasami G. and Bagyarai D.J., **Agricultural Microbiology**, Prentice-Hall of India Private Limited, New Delhi, Second Edition, 1993.
4. Rao, N.S., Venkatraman G.S. and Kannaiyan S., **Biological N2 Fixation**, ICAR Publications, New Delhi, 1983.
5. Bhatt J.V. and Khambata S.R., **Role of Earthworms in Agriculture**, Indian Council of Agricultural Research, New Delhi, 1959.

CORE IX - MEDICAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester: III **Hours per Week: 6**
Sub Code: GMMBC31 **Credit: 5**

Course outcome:

Upon completion of the course, students will be able to
CO 1: Reveal the basic concept and maintenance of medical laboratory
CO 2: Grasp the different types of diseases, pathogenicity, treatment and laboratory management
CO 3: Learn the bacterial pathogenicity and its retrieval
CO 4: Illustrate the concept of viral infection
CO 5: Elaborate fungal and protozoan infections
CO 6: Interpret the antibiotics and its applications

Unit I **(18 hours)**

Laboratory management: Biomedical Waste Management, Biosafety in containment laboratory; Collection and transport of Clinical samples; Microbiological Examination of Urine, Blood, Faeces, Cerebrospinal Fluid, Throat Swab, Sputum and Pus Sample; Normal Flora of Human Systems – Skin, Respiratory Tract, Gastrointestinal Tract and Genitourinary Tract; Nosocomial infections; Nucleic acid based microbial diagnostic techniques – LCR, NASBA and QBRDA. Host-microbe interaction – Transmissibility of pathogens

Unit II **(18 hours)**

Bacterial Diseases: General characters, Pathogenesis, Laboratory diagnosis, Control measures – *Staphylococcus aureus, Streptococcus pyogenes*, Tuberculosis, Leprosy, Typhoid, Cholera, Anthrax and Meningitis.

Unit III (18 hours)

Viral diseases: Morphology, Pathogenesis, Laboratory diagnosis and Control measures – DNA viruses – Pox virus and Hepatitis A & B virus; RNA viruses – Flavi virus – Dengue, Influenza virus, Zika virus; Retrovirus, Oncogenic viruses.

Unit IV (18 hours)

Fungal diseases: General characters, Pathogenesis, Laboratory diagnosis, Control measures – Mycoses – Superficial mycoses – Black Piedra, Dermatophytosis; Subcutaneous mycoses – Sporotrichosis, Mycetoma; Systemic mycoses – Histoplasmosis, Cutaneous mycoses

Protozoan diseases: General characters, Pathogenesis, Laboratory Diagnosis, Control measures – Amoebiasis, Giardiasis, Malaria, Teania

Unit V (18 hours)

Microbial pharmaceutics: Classification of microbial antibiotics, General properties and drug action of Sulphonamides – Sulphadiazine, Sulphapyridine, Sulpathiazole, Sulphafurazole; Antibacterial chemicals – Bactericidal and Bacteriostatic Agents; Adverse Drug Reactions; Principles of Toxicity, Evaluation and Determination of LD_{50}, ED_{50} and Therapeutic index. Quality for Medicines and formulations

TEXT BOOK:

1. Ananthanarayan R. and Panicker C.K., **Text book of Microbiology**, Orient Longman Ltd, India, Eighth edition, 2009.
2. David Greenwood and Slack C.B., **Medical Microbiology**, Churchill Livingstone, London, Sevententh Edition, 2007.

REFERENCES:

1. Annadurai B., **A Textbook of Immunology and Immunotechnology**, S. Chand limited, 2008.
2. Rajan S., **Medical Microbiology**, MJP publishers, Chennai, 2007.
3. Lehninger, David L.Nelson., **Principles of Biochemistry**, Worth Publishers, NewYork, Fourth edition, 1985.
4. Chakraborty P., **A Text book of Microbiology**, Published by New Central Book Agency (P) Ltd., Kolkata, Second edition, 2003.

CORE X – IMMUNOLOGY AND IMMUNODIAGNOSTICS

(For those who joined since 2018-19)

Semester: III **Hours per Week: 6**
Sub code: GMMBC32 **Credits: 5**

Course outcome:

Upon completion of the course, students will be able to
CO 1: Describes about the immune cells and lymphoid organs
CO 2: Gain knowledge on tumor cells, transplantation immunology
CO 3: Reflect critically about the immunodeficiency disorders

CO 4: Obtain knowledge on autoimmunity and autoimmune diseases
CO 5: Recollect the advanced knowledge on immunodiagnostic methods
CO 6: Obtain knowledge on hybridoma technology

Unit I (18 hours)

Overview of the Immune system and CMI Cells involved in Immune system: Hematopoiesis, Lymphocytes, Mononuclear phagocytes, Antigen presenting cells, Granulocytes

Lymphoid organ: Lymphatic system, Primary and Secondary lymphoid organs; Complement System – Pathways of complement activation, Regulation of complement system, Biological functions of complement system; Pathways of antigen processing and presentation

Cell Mediated Immunity: General properties of effector T cells, Cytotoxic T Cells, Natural Killer cells, Antibody-dependent cell mediated cytotoxicity; T-cell dependent and T-cell independent defense mechanisms.

Unit II (18 hours)

Cancer Immunology: MHC – HLA – Malignant transformation of cells; Oncogenes and cancer induction; Tumor antigens; Immune surveillance theory; Tumor evasion of the immune system; Cancer Immunotherapy

Transplantation Immunology: Immunological basis of graft rejection, Mechanism of graft rejection; Immunosuppressive therapy – General and specific; Clinical transplant; Tolerance – central and peripheral tolerance to self-antigens; Mechanism of induction of natural tolerance; MHC – Types – HLA typing and applications

Unit III (18 hours)

Immunodeficiency disorders: Phagocytic cell defect – Chediak-Higashi syndrome; B-cell deficiency – Bruton's X-linked hypogammaglobulinemia; T-cell deficiency disorder – DiGeorge Syndrome; Combined B-cell & T-cell deficiency disorder – SCID (Severe combined immunodeficiency diseases), Wiskott-Aldrich syndrome; Complement deficiencies and Secondary immunodeficiency conditions carried by drugs, nutritional factors and AIDS

Unit IV (18 hours)

Autoimmunity and autoimmune diseases: General consideration, Etiology, Clinical categories, Diagnosis and treatment; RA(Rheumatoid arthritis); SLE (Systemic Lupus Erythematosus); Mysthenia gravis; Grave's disease; Goodpasture syndrome, Autoimmune haemolytic disease; Pernicious anaemia; Hypersensitivity – Type I, Type II, Type III and Type IV

Unit V (18 hours)

Immunodiagnostics precipitation reactions: Immunodiffusion, Immunoelectrophoresis, Agglutination reactions – Bacterial agglutination, Hemagglutination, Passive agglutination, Reverse passive agglutination and agglutination inhibition; Radioimmuno assay, ELISA, ELI Spot, Western blotting technique, Complement fixation test, Immunofluorescence, Immunoelectron microscopy, Hybridoma technology

TEXT BOOK:

1. Kuby R.A. Goldsby, Thomas J. Kindt and Barbara A. Osborne., **Immunology**, Sixth edition, Freeman & Company, New York, 2006.

REFERENCES:

1. Roderick Nairn and Matthew Helbert, **Immunology for medical students**, First Edition, Mosby International limited, 2002.
2. Kannan I., **Immunology**, MJP Publishers, Chennai, 2007.
3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt., **Essential Immunology**, Twelfth edition, Wiley–Blackwell, 2011.
4. Eli Benjamini, Richard Coico and Geoffrey Sunshine, **Immunology: A Short Course**, Wiley-Liss (first published April 1996), 2000.

CORE XI: BASICS OF RESEARCH METHODOLOGY

(For those who joined from 2018 onwards)

Semester : III **Hours per Week: 6**
Sub Code: GMMBC33 **Credit: 5**

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO 1: Interpret the relationships among living things and solve biological problems among them
CO 2: Research and inquiry
CO3: Existing software to extract information from large database and use the information as computer modelling
CO 4: Ability to develop new algorithms and analysis methods
CO 5: Explains the gene expression
CO 6: Describes the analysis of human genome

Unit I (18 hours)

Research: Selection of problems – stages in the execution of research; preparation of manuscript – report writing – format of journals – proof reading – sources of information; journals, reviews, books, and monographs – bibliography– plagiarism

Unit II (18 hours)

Journals: Standard of research journals – impact factor – citation index, H Index; Information retrieval – access to archives and databases, search engines – google, pubmed – national informatics center network services; Online data base library

Unit III (18 hours)

Measures of dispersion: Sampling methods; random sampling – types of variables; qualitative and quantitative variables – continuous and discontinuous variables – scaling method – mean – standard deviation – standard error – coefficient of variation; elucidation with model sums

Unit IV (18 hours)

Test of Significance: Basic ideas of significant test – Hypothesis testing, significance test and fixing levels of significance – statistical tables and their use –Data analysis using MS Excel, use of statistical software like COSTAT and STATISTICA.

Unit V (18 hours)

Principles and practice of statistical methods in biotechnological research: Simple Correlation and regression analysis; Chi-square test, student's t-test, ANOVA; Multivariate Analysis – Basic principles and applications of multiple regression analysis, Principal component analysis (PCA), Discriminant function analysis (DFA), Cluster analysis.

TEXT BOOKS:

1. Davis G.B. and Parker C.A., **Writing the doctoral dissertation**, Barrons Educational series, Third edition, 2012.
2. Sexena S., **MS office**, Vikas Publishing House Pvt. Ltd., New Delhi, 2007.
3. Snedecor G.W. and Cohran W.G., **Statistical methods**, Oxford and IBH publishing CO Pvt.Ltd, Eighth edition, 1989.

REFERENCE BOOKS:

1. Palaniswamy S. and Manoharan M., **Statistical methods for biologists,** Palani Paramount Publications, Tamilnadu, 2002.
2. Zar J.H., **Biostatistical analysis**, Prentice Hall, Uppar Saddle River, New Jersy, USA, 1996.

CORE XII - LAB COURSE IN MEDICAL MICROBIOLOGY, IMMUNOLOGY AND IMMUNODIAGNOSTICS

(For those who joined since 2018-19)

Semester: III **Hours per Week: 5**
Sub code: GMMBC34P **Credits: 5**

Course Outcomes:

Upon completion of the subject, students will be able to

CO 1: Learn to collect the blood sample from various parts
CO 2: Get the thorough knowledge on separation of different types of blood cells
CO 3: Acquire knowledge on the antigen-antibody interaction
CO 4: Isolate antibody from blood serum
CO 5: Attain knowledge on the types of blood cells

CO 6: Perform various immunodiagnostic methods

List of Experiments:

1. Blood Collection and Blood grouping
2. Blood smear identification of leucocytes by Giemsa stain
3. Separation of leucocytes by dextran method
4. Separation of mononuclear cells by lymphoprep
5. Separation and characterization of lymphocytes from blood and demonstration of lymphocyte population
6. Immunodiffusion – Simple, Double and Radial
7. Immunoelectrophoresis
8. Australian latex antigen test.
9. Agglutination Test (ASO, CRP & RA)
10. Card Test (HBsAg & Pregnancy test).
11. RPR (rapid plasma reagin) test.
12. *Treponema pallidum* Hemagglutination test
13. Preparation of Single cell suspension from goat spleen
14. Immunoblotting
15. Widal (slide and tube) tests.
16. Demonstration of ELISA

REFERENCES:

1. Monica Cheesbrough, **District laboratory practice in tropical countries**, Part 1, and Cambridge University press, Second Edition, 2006.
2. Monica Cheesbrough, **District laboratory practice in Tropical countries**, Part 2, Cambridge University Press, Second Edition, 2006.
3. Talwar G.P. and Gupta S.K., **A handbook of practical and clinical immunology**, vol 1 and 2, CBS publications, Second edition, 2009.
4. Harlow and David Lane, **Antibodies: A Laboratory Manual**, Cold Spring harbors Laboratory, 1988.
5. Aneja K.R., **Experiments in Microbiology, Plant Pathology and Biotechnology**, New Age International Publishers, New Delhi, Fourth edition, 2003.
6. Cappuccino J. and Sheeman N., **Microbiology-a laboratory Manual**, Addison Wesley, California, Fourth edition, 2000.

ELECTIVE III : a. BIOETHICS, BIOSAFETY & IPR

(For those who joined since 2018-19)

Semester: III **Hours per week: 5**
Sub Code: GMMBE3A **Credits: 5**

Course Outcome:

Upon completion of the course, students will be able to
CO1: Describes overall concepts of Bioethics

CO2: Promote ethical concerns regarding human cloning
CO3: Apply gene therapy for research
CO4: Defend from risky hazards
CO5: Implement biosafety for drug products
CO6: Explain in detail about IPR

Unit I (15 hours)

Bioethics: Introduction and principles of Bioethics; The use of nature; Different views of nature; Dynamic nature; Interfering with nature; Integrity of species; Reducing genetic diversity; Biological warfare; Public perception of science, General issues related to environmental release of genetically modified microorganisms

Unit II (15 hours)

Ethics in Human Cloning: Introduction – Existing limits in human cloning – The realistic uses of human cloning – Ethical concerns regarding human cloning – The need for international regulations; Stem cell therapy and its related ethical issues in research

Unit III (15 hours)

Biosafety: Introduction – Different levels of biosafety; Concept and issues, rational vs subjective perceptions of risks and benefits – relationship between risk hazard, exposure, and safe guards – biosafety concerns at the level of individuals, institutions, society, region country and the world – Lab associated infections

Unit IV (15 hours)

Biosafety assessment (BSA): BSA of biotechnology and pharmaceutical products such as drugs – Vaccines – Biomolecules; Good Laboratory Practices (GLP); Containments – Types; Basic Laboratory and Maximum Containment Laboratory

Unit V (15 hours)

IPR: GATT and IPR, forms of IPR, IPR in India, WTO Act, and Convention on Biodiversity (CBD), Patent Co-operation Treaty (PCT), forms of patents and patentability, process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting of biological material, GLP, GMP

TEXT BOOK:

1. Shaleesha A. Stanley, **Bioethics**, Wisdom Educational Service, Chennai, 2008.

REFERENCES:

1. Mittal D.P., **Indian Patents Law**, Taxmann Allied Services (p) Ltd, 1999.
2. Dr Christian Lenk, Dr Roberto Andorno, Mr Nils Hoppe, **Ethics and Law of Intellectual Property*:* Current Problems in Politics, Science and Technology**, Ashgate Publishing Ltd, 2013.

3. Frederic H. Erbisch and Karim M. Maredia, **Intellectual Property Rights in Agricultural Biotechnology**, CABI Publisher, 2004.
4. **Recombinant DNA safety guidelines** (January1990), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
5. **Revised guidelines for research in Transgenic plants** (August 1998), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.

ELECTIVE III: b. BIOINFORMATICS

(For those who joined from 2018 onwards)

Semester: II **Hours per Week: 5**
Sub Code: GMMBE3B **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Understands the general definition of Bioinformatics and Networks

CO 2: Identify the biological databases

CO 3: Familiar with gene and protein prediction tools

CO 4: Explains about the structure prediction tools

CO 5: Discuss about the molecular interaction

CO 6: Explains DNA sequencing software and proteomics tools

Unit I **(15 hours)**

Introduction to Bioinformatics: Definition and Aims, Basic concepts – Fundamentals of internet, HTML, URLs, Browsers, Netscape/Opera/ Explorers, Network topologies, Operating systems, Intranet, Finding scientific articles – Pubmed – Public biological databases

Unit II **(15 hours)**

Biological Database: Retrieving information and sequences from databases, Submission of nucleotide sequences in Gene Bank; Sequence alignment – Global vs local alignment, Pair wise alignment – ClustalW & Clustal Omega; Principles of sequence similarity search algorithms, Similarity searching using FASTA and BLAST

Unit III **(15 hours)**

Gene Prediction: Multiple sequence alignment – Methods and applications; Phylogenetic analysis – Ninja & RAxML; Distance matrix and Character based Methods; Prediction of Genes – GENSCAN and Regulatory sequences in DNA

Unit IV **(15 hours)**

Protein Structure: Introduction to protein structure – secondary structure prediction – YASPIN, tertiary structure prediction – I-TASSER, Protein modelling – Principles of homology and comparative modelling; Sequence based prediction methods; Visualization of macromolecules using RASMOL and Swiss PDB Viewer

Unit V **(15 hours)**

DNA Sequencing and Molecular Interaction: DNA sequencing chemistry and software needed; Sequence assembly and finishing; Computing in Proteomics. Drug designing concepts; RNA structure analysis; Applications – Molecular docking, Autodoc

TEXT BOOKS:

1. Arthur M. Lesk., **Introduction to Genomics**, Oxford university Press, 2008.
2. Attwood T.K. and ParrySmith D.J., **Introduction to Bioinformatics**, Pearson Education Asia, 2006.
3. Cibas C. and Jambeck P., **Developing Bioinformatics Computer Skills**, O'Reilly Publications, First edition, 2001.
4. Higgins D. and Taylor W., **Bioinformatics Sequence, Structure and Databanks**, Oxford University Press, New Delhi, 2000.
5. Fry J.C., **Biological Data Analysis. A practical Approach**, IRL Press, Oxford, 1993.

REFERENCE BOOKS:

1. David W. Mount, **Bioinformatics Sequence and Genome Analysis**, Cold Spring Harbor Laboratory Press, 2001.
2. Baxevanis A.D. and Francis Ouellette B.F., **Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins,** Wiley Student Ed., Third Edition, 2005.

EXTRA CREDIT- INFORMATION TECHNOLOGY FOR BIOLOGISTS

(For those who joined 2018 onwards)

Semester: III **Hours per Week: -**
Sub Code: GMMBX3 **Credit: 2**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Summarize the complete information on computer.
CO 2: Reveal about the operating systems and softwares.
CO 3: Exemplify about Computer networking and Computer viruses
CO 4: Discuss the detailed informations about Internet.
CO 5: Explore the knowledge on Basic computer applications

Unit I

Overview and organization of a computer system, storage, devices, memory, etc., parallel and cluster computing.

Unit II

Operating systems: Introduction, Process management, Memory management, File management, Device management and security; Introduction to proprietary software, Free and Open Source Software (FOSS)

Unit III

Computer Networking: Topologies and protocols, design networks, Networking gadgets (Router, Switch, etc); Communication Links – Wire pairs, Coaxial cables, Fiber optics, Microwave, Satellite, etc.; Data security fundamentals and protection mechanism; An overview of Computer viruses and worms

Unit IV

Internet: The Internet and its resources, Internet protocols and services; Web browsers and browser add-ons; Internet programming language – HTML; Basics in Web designing

Unit V

Basic use of office applications: Toolbar buttons, Entering and editing texts, Formatting, Inserting and editing images, Orientation, Borders and shading, Bullets and numbering, Creating and modifying tables; Basics of a spreadsheet – Columns, rows, cells; Tools using formulas, Formatting, Creating charts and graphs; Presentation utilities: Creating, Editing presentations, Adding images, Charts, Motion and sound, Printing.

TEXTBOOKS:

1. Peter Norton, **Introduction to Computers**, Sixth Edition, Tata McGraw Hill, 2005.
2. Andrew S. Tanenbaum, **Computer Network**, Fourth Edition, Prentice Hall, 2003.
3. John R. Levine, Margare Levine Young and Carol Baroudi, **The Internet for Dummies**, Eleventh Edition, Willy Publishing Inc. 2007.

REFERENCE BOOKS:

1. Govindarajalu IBM Pc and Clones Hardware, **Troubleshooting and Maintenance**, Second Edition, Tata McGraw Hill, 2002.
2. Thomas Powell, **HTML The Complete Reference,** Third Edition, Tata McGraw Hill, 2001.

Project

(For those who joined 2018 onwards)

Semester: IV **Hours/Week: -**
Sub Code: GMMBC41PW **Credit: 15**

Upon completion of the course, students will be able to,
CO1: Describe the methodological information on the area of research
CO2: Apply microbiological concepts
CO3: Improve the abilities in interpretation for their findings

CO4: Develop the skills in publications.

A Project work to be done individually by the students in the department laboratory/ other institutions; the project work help the students to create research attitude, apply theory and practical that they have learnt throughout the course

B.Sc., MICROBIOLOGY
(Three Years Regular Programme)
For those who joined since June 2018-19

Programme Outcomes:

PO1: Critical Thinking
PO2: Effective Communication
PO3: Social Interaction
PO4: Effective Citizenships
PO5: Ethics
PO6: Environment and Sustainability

Programme Specific Outcome:

The graduates will be able to

PSO1: Establish the understanding on Microbes
PSO2: Enrich Student's knowledge on infectious diseases in humans, animals and plants
PSO3: Understand the basic concepts of Molecular Biology and Microbial Genetics.
PSO4: Perform procedures as per laboratory standards in the areas of Microbiology.
PSO5: Understand the applications of Microbiology in Environment, Agriculture, Mushroom Cultivation, Aquaculture, Vermiculture and Medical laboratory techniques.

B.Sc., MICROBIOLOGY – Programme Structure

Sem	Subject code	Part	Course	Subject Title	H /W	Credi	CIA	ESE	Total Marks
I	GBLT11/ GBLA11/ GBLIA11/ GBLH11	I	Language I	Tamil I / Arabic I – Basic Arabic I / Intermediate Arabic I / Hindi I	6	6	40	60	**100**
	GBLF12/ GBLG12	II	Language II	English I – Functional / English I – General	6	6	40	60	**100**

	GBMBC11	III	Core I	Fundamentals of Microbiology	5	4	40	60	**100**
	GBMBC12P	III	Core II (Practical)	Lab Course in Fundamentals of Microbiology	5	4	40	60	**100**
	GBMBA13	III	First Allied I	Biochemistry I	6	5	40	60	**100**
	GBMBE14	IV	Skill Based Elective I	Introductory Virology	2	2	–	50	**50**
	Total				**30**	**27**	**200**	**350**	**550**
II	GBLT21/ GBLA21/ GBLIA21/ GBLH21	I	Language I	Tamil II / Arabic II – Basic Arabic II / Intermediate Arabic II / Hindi II	6	6	40	60	**100**
	GBLF22/ GBLG22	II	Language II	English II – Functional / English II – General	6	6	40	60	**100**
	GBMBC21	III	Core III	Microbial Physiology	4	3	40	60	**100**
	GBMBC22P	III	Core IV (Practical)	Lab Course in Microbial Physiology	4	3	40	60	**100**
	GBMBA23	III	First Allied II	Biochemistry II	6	5	40	60	**100**
	GBMBE24P	IV	Skill Based Elective II (Practical)	Lab Course in Vermiculture	2	2	–	50	**50**
	GBES2	IV	General Interest Course I	Environmental Studies	2	2	–	50	**50**
	GBMBX2/ GBMBX2O		Extra Credit	Developmental Biology/*Online Course	–	2	–	100	**100**
	Total				**30**	**27 + 2**	**200**	**400 +100**	**600 + 100**
III	GBMBC31	III	Core V	Molecular Biology	6	4	40	60	**100**
	GBMBC32P	III	Core VI (Practical)	Lab Course in Molecular Biology	6	4	40	60	**100**
	GBMBA33	III	Second Allied I	Bioinstrumentation	6	5	40	60	**100**
		IV	Non Major Elective I		4	2	–	50	**50**
	GBMBE34P	IV	Skill Based Elective III (Practical)	Lab Course in Medical Lab Technology	3	2	–	50	**50**

	GBHR3	IV	General Interest Course II	Human Rights	3	2	–	50	**50**
	GBXTN3	V	Extension Activities	NSS/CSS	2	2	100	–	**100**
	GBMBX3/ GBMBX3O		Extra Credit	Cell Biology/*Online Course	–	2	–	100	**100**
				Total	**30**	**21 + 2**	**220**	**330+ 100**	**550 + 100**
IV	GBMBC41	III	Core VII	Microbial Genetics	5	4	40	60	**100**
	GBMBC42P	III	Core VIII (Practical)	Lab Course in Microbial Genetics	5	4	40	60	**100**
	GBMBC43	III	Core IX	Medical Microbiology	5	4	40	60	**100**
	GBMBA44	III	Second Allied II	Immunology	6	5	40	60	**100**
		IV	Non Major Elective II		4	2	–	50	**50**
	GBVE4	IV	General Interest Course III	Values and Ethics	2	2	–	50	**50**
	GBMBE45P	IV	Skill Based Elective IV (Practical)	Lab Course in Mushroom Cultivation	3	2	–	50	**50**
	GBMBX4/ GBMBX4O		Extra Credit	Microbes in Human Welfare /*Online Course	–	2	–	100	**100**
	Total				**30**	**23 + 2**	**160**	**390 + 100**	**550 + 100**
V	GBMBC51	III	Core X	Environmental and Agricultural Microbiology	4	3	40	60	**100**
	GBMBC52P	III	Core XI (Practical)	Lab Course in Medical Microbiology	4	3	40	60	**100**
	GBMBC53P	III	Core XII (Practical)	Lab Course in Environmental and Agricultural Microbiology and Biostatistics	5	4	40	60	**100**
	GBMBE5A/ GBMBE5B	III	Elective I	a. Biostatistics / b. Computer Application in Biology	5	5	40	60	**100**
	GBMBE5C/ GBMBE5D	III	Elective II	a. Biotechnology / b. Bionanotechnology	5	5	40	60	**100**

	GBMBE54	IV	Skill based Elective V	Bioinformatics	3	2	–	50	**50**
	GBWS5	IV	General Interest Course IV	Women Studies	3	2	–	50	**50**
				Library	1	–	–	–	**–**
	GBMBX5/ GBMBX5O		Extra Credit	Life Science for Competitive Examination/*Online Course		2		100	**100**
	Total				**30**	**24 + 2**	**200**	**400 + 100**	**600 + 100**
VI	GBMBC61	III	Core XIII	Food Microbiology	4	3	40	60	**100**
	GBMBC62	III	Core XIV	Industrial Microbiology	5	4	40	60	**100**
	GBMBC63P	III	Core XV (Practical)	Lab Course in Food and Industrial Microbiology	5	4	40	60	**100**
	GBMBC64PW	III	Core XVI	Project	6	5	40	60	**100**
	GBMBE6A/ GBMBE6B	III	Elective III	a. Marine Microbiology/ b. Public Health and Hygiene	5	5	40	60	**100**
	GBMBE65P	IV	Skill Based Elective VI	Lab Course in Aquaculture	3	2	–	50	**50**
				Library	2	–	–	–	**–**
	GBSED6/ GBMBX6O		Extra Credit	Skills for Employability Development/*Online Course	–	2	100	–	**100**
Total					**30**	**23 + 2**	**200**	**350 + 100**	**550 + 100**
Grand total					**180**	**145 + 10**	**1280**	**2120 + 500**	**3400 + 500**

Non major Elective Students other than BSc Microbiology:

Semester	Elective	Subject code	Subject title	H/W	Credit	CIA	ESE	Total
III	Non Major Elective I	GBNM3MB	Lab Course in Mushroom Cultivation	**4**	**2**	**-**	**50**	**50**
IV	Non Major Elective II	GBNM4MB	Lab Course in Vermiculture	**4**	**2**	**-**	**50**	**50**

H/W – Hours / Week, CIA – Continuous Internal Assessment, ESE – End Semester Examination

* For online certification credit alone will be assigned on submission of certificate obtained through appearing for online examination from spoken tutorial, EDX, NPTEL or Coursera and other MHRD MOOCs.

CORE I – FUNDAMENTALS OF MICROBIOLOGY

(For those who joined since 2018-19)

Semester: I **Hours per Week: 5**
Sub.Code: GBMBC11 **Credit: 4**

Course Outcomes:
Upon completion of the course, students will be able to
CO 1: Discuss the history and basic concepts of Microbiology.
CO 2: Illustrate the concepts of the microscopy and microbial classification.
CO 3: Demonstrate the structure and functions of Prokaryotes.
CO 4: Summarize the morphology, characteristics and economical importances of Fungi.
CO 5: Accentuate the morphology, characteristics and economical importances of Algae.

Unit I **(15 hours)**
Introduction – Definition, Scope and History of Microbiology. Classification of Microorganisms **–** General Principles and Nomenclature – Haeckel's three kingdom concept, Whittaker's five kingdom concept. Contributions of Anton Von Leeuwenhoek, Edward Jenner, Spallanzani, Robert Hook, Louis Pasteur, Robert Koch and John Needham.

Unit II **(15 hours)**
Microscopy – Simple, and Bright field, Dark field, Phase contrast, Fluorescence and Electron Microscope**.** Introduction about *Bergey's Manual* – Archaea, Bacteria, Eukarya and Actinomycetes.

Unit III **(15 hours)**
Prokaryotes – Anatomy of prokaryotes, Ultra structure and function of capsule, slime layer, cell wall, Cytoplasmic membrane, Cilia, Flagella, Pili, Endospore, Genetic material and Plasmid. Difference between Prokaryotic and Eukaryotic cell.

Unit IV **(15 hours)**
Mycology – General characteristic of fungi, Habit, Habitat, Morphology, Reproduction and Fruiting bodies, types of spores produced. Biological and economic importance of fungi. (*Aspergillus niger)*

Unit V **(15 hours)**
Phycology – General characteristics of algae, Habit, Habitat, Morphology, Pigments and Reproduction. Biological and economic importance of algae (*Cyanobacteria*). Brief introduction on lichens, Cultivation of fresh water and marine algae

Text Books:

1. Prescott L.M., Harley J.P. and Klein D.A., **Microbiology**, WMC, Brown Publishers, Second Edition, 2009.[Chapter 1, 2, 3,4 & 25]
2. Dubey R.C. and Maheshwari D.K., **A Text book of Microbiology**, S. Chand & Company Ltd, New Delhi, First Edition, 2008.[Chapter 2 & 28]

References Books:

1. Pelczar Jr. M.J., Chan E.C.S. and Kreig N.R., **Microbiology,** reprint2008Mcgraw–Hill Inc: New York, Fifth Edition, 1993.
2. Bhatia A.L., **Hand Book of Microbiology,** Pointer Publications, First Edition, 2005.
3. Stanier R.V., Ingraham J.L., Wheetes K. L. and Painter P.R., **General Microbiology**, Macmillan Education Ltd, London,1986.
4. Sullia S. B. and Shantharan S., **General Microbiology**, Oxford & IBH Publications, Second Edition (Revised), 2005.
5. Michael T. Madigan and John M. Martinko, **Brock Biology of Microorganisms**, Pearson prentice hall, Fourteenth Edition, 2017.

CORE II – LAB COURSE IN FUNDAMENTALS OF MICROBIOLOGY

(For those who joined since 2018-19)

Semester: I **Hours per Week: 5**
Sub.Code: GBMBC12P **Credit: 4**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Explains the fundamental procedures & techniques of Microbiology
CO 2: Demonstrates the types of culture media & sterilization technique
CO 3: Able to gain aseptic and pure culture techniques, preparation and viewing of sample under the microscope
CO 4: Appropriate methods to identify the microorganisms

List of Experiments:

1. Rules and precautions for microbiology laboratory
2. Equipment needed for microbiology laboratory
3. Types of culture media
4. Sterilization methods: Heat, Moist, radiation and chemical
5. Preparation of media for the culture of microorganisms:
    5.1 Liquid (Nutrient Broth) and
    5.2 Solid (Stab and slant)
6. Pure culture methods:
    6.1 Pour plate
    6.2 Spread plate
    6.3 Streak plate – quadrant and radiant.
7. Cultural characters of Bacteria.
8. Serial dilution technique

9. General Isolation of Bacteria & Fungi
10. Isolation of Cyanobacteria.
11. Staining procedures for microorganisms:
11.1 Simple staining
11.2 Gram's staining
11.3 Capsular staining
11.4 Lacto phenol cotton blue staining
11.5 Acid fast staining
12. Bacterial motility – Hanging drop method
13. Observation of permanent slides to study the structural characteristics of

Algae – *Cyanobacteria, Oscillatoria, Nostoc, Anabaena*

Fungi – *Aspergillus, Penicillium, Rhizopus, Yeast.*

Reference Books:

1. Aneja K. R., **Experiments in Microbiology**, **Plant pathology and Tissue culture technique**, Wishwa Prakashan, New Delhi, Fourth Edition, 2003.
2. Cappuccino J. and Sheeman N., **Microbiology – A Laboratory Manual**, Addison Wesley, California, Fourth Edition, 2000.
3. Dubey R.C. and Maheshwari D.K, **Practical Microbiology**, S. Chand Publication, New Delhi, 2007.
4. Fischbach F.T. and Dunning M.B., **A Manual of Laboratory and Diagnostic Tests**, Lippinocott Williams and Wilkins, Baltimore, 2002.

SKILL BASED ELECTIVE I – INTRODUCTORY VIROLOGY

(For those who joined since 2018-19)

Semester: I **Hours per Week:2**
Sub.Code: GBMBE14 **Credit: 2**

Course Outcomes:
Upon completion of the course, students will be able to,
CO 1: Review the concepts of structure and classification of virus
CO 2: Expertise their knowledge on viral quantification methods
CO 3: Insight the facts of replication of virus
CO 4: Conceptualize about various plant, animal and human viral infections – its pathogenesis and treatment.

Unit I **(6 hours)**
Basics of virus – History of virology, General properties of viruses, Cultivation of viruses, Structure of viruses, Classification of viruses – ICTV and Baltimore classification, Prions, Viroids.

Unit II (6 hours)

Quantification of Virus – Purification of viruses, Measurement of infectious units – Electron microscopy, Plaque assay, Haeagglutination assay, Fluorescent focus assay, Endpoint dilution assay.

Unit III (6 hours)

Bacterial viruses – Structure of bacteriophage – T_4 bacteriophages, Life cycle – Lytic (T even phages) and Lysogenic (phage lambda) life cycle.

Plant Viruses – Common plant viral diseases: TMV, Bunchy top of banana, Satellite virus, CaMv

Unit IV (6 hours)

Animal viruses – Morphology, Symptoms, Pathogenesis and Laboratory diagnosis of Rinder pest, Blue tongue, Ranikhet virus, Foot and mouth disease.

Unit V (6 Hours)

Human Viruses – Herpes, HIV, Hepatitis, HPV, SARS, Dengue.

Text Books:

1. Pelczar Jr. M.J., Chan E.C.S. and Kreig N.R., **Microbiology**, Mc graw–Hill Inc: New York, Fifth Edition, reprint 2008.
2. Prescott L.M., Harley J.P. and Klein D.A., **Microbiology**, WMC, Brown Publishers, Seventh Edition, 2008.

Reference Books:

1. Alan J. Cann., **Principles of Molecular virology**, Academic press, California, Sixth Edition, 2015.
2. Ann Giudici Fettner, **The Science of Viruses,** Quill, William Marrow, New York, 1990.
3. Dubey R.C. and Maheshwari D.K., **A Textbook of Microbiology,** S.Chand and Company Ltd, New Delhi, 2005.
4. Bhatia A.L., **Handbook of Microbiology**, Pointer Publications, First Edition, 2005.
5. Dimmock N.J. and Primrose S.B., **Introduction to Modern Virology,** Blackwell Scientific Publications, Oxford, Sixth Edition, 2005.

CORE III – MICROBIAL PHYSIOLOGY

(For those who joined since 2018-19)

Semester: II **Hours per Week: 4**
Sub.Code: GBMBC21 **Credit: 3**

Course Outcomes:

Upon completion of the course, students will be able to,

CO 1: Critically discuss on the growth curve and how the environmental factors that affect bacterial growth
CO 2: Portray the cell membrane structure and its usage
CO 3: Describe the transport mechanism of membrane
CO 4: Understand how the photosynthesis occur in cyanobacteria
CO 5: Discuss an overall understanding of the structure, function, energy metabolism, growth and regulatory mechanisms of microorganisms.

Unit I **(12 hours)**

Microbial Growth – Different Phase of growth – growth curve; generation time, Factors influencing microbial growth – Temperature, pH, Pressure, Salt concentration, Nutrients; Synchronous growth and continuous cultivation, Diauxic growth.

Unit II **(12 hours)**

Nutrition – Nutritional requirements of microorganisms – Autotrophs, Heterotrophs, Photoautotrophs, Chemo-organotrophs, Chemolithotrophs, Physiology of organism living in extreme environments – Thermopiles, Halophiles, Psychrophiles and Methanogens

Unit III **(12 hours)**

Physiological phenomenon involved in membrane transport – Biochemical properties of membrane model, Osmosis, Plasmolysis, Passive diffusion. Transport mechanisms – active, passive, facilitated diffusions – uniport, symport, antiport; Nernst equation – chelating transport system – siderophores

Unit IV **(12 hours)**

Photosynthesis – Photosynthetic pigments, oxygenic and anoxygenic types; Light reaction in aerobic oxygenic phototropic bacteria (Cyanobacteria); Effect of light, CO_2, pH and temperature on photosynthesis

Unit V **(12 hours)**

Coupling of chemical reactions – Autotrophic generation of ATP; Fixation of CO_2 – Calvin cycle, C_3 – C_4 pathways; Respiratory metabolism – EMP, HMP, ED pathways, Electron Transport Chain – Oxidative and Substrate level phosphorylation

Text Books:

1. Albert G., Moat and John W. Foster, **Microbial Physiology**, A John Wiley and sons, INC publications, New York, 2004.
2. Millian Meenakumari S., **Microbial Physiology**, MJP Publishers, Chennai, 2006.

Reference Books:

1. Dubey R.C. and Maheshwari D.K., **A Text Book of Microbiology**, Chand & Company Ltd. New Delhi, 2009.
2. Geoffrey M. Cooper., **The Cell, A Molecular Approach**, ASM press, Washington, Seventh Edition, 2015.

3. Pelczar Jr. M.J., Chan E.C.S. and Kreig N.R., **Microbiology**, Mc. Graw Hill, Fifth Edition, 2004.

CORE IV – LAB COURSE IN MICROBIAL PHYSIOLOGY

(For those who joined since 2018-19)

Semester: II **Hours per Week: 4**
Sub.Code: GBMBC22P **Credits: 3**

Course Outcomes:

On successful completion of this course, the students will be able to identify the genus of the bacteria through various biochemical tests:

CO 1: Measure the bacterial cells by micrometry method.
CO 2: Describe concepts and methods in the enumeration of bacteria.
CO 3: Determine the microbial growth.
CO 4: Isolate the cellulolytic bacteria.
CO 5: Reflect about the carbohydrate fermenting and nitrate reducing activity of bacteria.
CO 6: Integrate informations about hydrolysis by bacteria.
CO 7: Appreciate the concepts about the oxidase and catalase possessing bacteria
CO 8: Identify the structural characteristics of algae and fungi.

List of experiments:

1. Micrometry
2. Enumeration of bacteria - Haemocytometer
3. Determination of microbial growth curve - Turbidity method

Biochemical Test for Bacterial Identification:

4. Isolation of Cellulolytic bacteria.
5. Carbohydrate fermentation tests.
6. Nitrate Reduction test
7. Starch hydrolysis
8. Gelatin hydrolysis
9. Lipid hydrolysis
10. Casein hydrolysis
11. Oxidase test
12. Catalase test
13. IMViC test
14. TSI test
15. Urease test

Reference Books:

1. Aneja K.R., **Experiments in Microbiology, Plant pathology and Tissue culture technique**, Vishwa Prakashan, New Delhi, Fourth Edition, 2003.
2. Cappuccino J. and Sheeman N., **Microbiology – A Laboratory Manual,** Addison Wesley, California, Fourth Edition, 2000.

3. Dubey R.C. and Maheshwari D.K., **Practical Microbiology**, S. Chand Publication, New Delhi, 2007.
4. Fischbach F.T. and Dunning M.B., **A Manual of Laboratory and Diagnostic Tests.** Lippincott Williams and Wilkins, Baltimore, 2002.

SKI LL BASED ELECTIVE II – LAB COURSE IN VERMICULTURE

(For those who joined since 2018-19)

Semester: II **Hours per Week: 2**
Sub Code: GBMBE24P **Credit: 2**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Demonstrate the core concepts about ecology.
CO 2: Classify the types of earthworms.
CO 3: Identify the local earthworms and their collection.
CO 4: Reflect critically about endemic & exotic earthworm composting.
CO 5: Utilize the wastes and paper as substrates for vermicomposting in a limited space.
CO 6: Reveal about aerobic & anaerobic composting.
CO 7: Exhibit the methods involved in the preparation of vermiwash.
CO 8: Emphasize knowledge about the issues in the life cycle of earthworms.
CO 9: Apply the vermiwash and vermicompost in fields
CO 10: Explore the knowledge on Vermicomposting and gain entrepreneur ideas through field trip.

List of Experiments:

1. Introduction to Ecology and Environment.
2. Earthworms and types (ecological strategies).
3. Collection of local Earthworm sample.
4. Compost using endemic & exotic varieties of earthworms.
5. Compost using Paper, Cardboard and Vegetable wastes.
6. Aerobic & Anaerobic composting.
7. Preparations of Vermiwash.
8. Life cycle of earthworms and related issues.
9. Effect of vermicomposting and vermiwash in the growth of *Trigonella foenum-graecum* (Fenugreek) seeds.
10. Field trip to Vermicomposting site.

Reference Books:

1. Sultan Ahmed Ismail, **The Earthworm Book,** Edition 2, reprint, Other India Press, 2005
2. Katheem K.S, Mahamad H.I, Shlrene Quaik, Sultan Ahmed Ismail., **Prospects of Organic Waste Management and the Significance of Earthworms,** Springer international publishing Switzerland, 2016.

3. Bhatt J.V. and Khambata S.R., **Role of Earthworms in Agriculture,** Indian Council of Agricultural Research, New Delhi, 1959.
4. Dash M.C., Senapati B.K. and Mishra P.C., **Verms and Vermicomposting,** Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5–8, 1984, (Part B), School of Life Sciences, Sambalpur University, Jyoti Vihar, Orissa, 1980.
5. Edwards C.A. and Lofty J.R., **Biology of Earthworms,** Chapman and Hall Ltd., London, 1977.
6. Lee K.E., **Earthworms: Their ecology and Relationship with Soils and Land Use** Academic Press, Sydney, 1985.

EXTRA CREDIT – DEVELOPMENTAL BIOLOGY

(For those who joined since 2018-19)

Semester: II **Hours per Week: -**
Sub.Code: GBMBX2 **Credit: 2**

Course Outcomes:
Upon completion of the course, students will be able to
CO 1: Describe about spermatogenesis and oogenesis
CO 2: Critical contribution of sperm and egg to the zygote
CO 3: Reflect critically about fertilization and Gastrulation
CO 4: Conceive knowledge of gastrulation and its function

Unit I
Gametogenesis – Spermatogenesis and Oogenesis in mammals, menstrual cycle, monitoring of menstrus cycle, sperm banking

Unit II
Cleavage and Gastrulation – interaction of sperm and egg – Sequence of events in sperm entry – Egg surface changes. Cell cleavage – pattern of cleavage, germ layers, Gastrulation mammals

Unit III
Morphogenesis and organogenesis – Cell aggregation and differentiation in mammals, organogenesis – development of eye, ear, kidney and heart.

Unit IV
Modern Embryology – In-vitro fertilization, artificial insemination, super ovulation.

Unit V
Contraception – planned Parenthood, birth control devices – hormonal birth control – Birth Control Pill, Injection Method, Intrauterine Device (IUD) and Intrauterine System (IUS), Emergency Contraceptive Pill (ECP), Barrier Methods of Birth Control

Reference Books:
1. Gilbert Scott, **Developmental Biology,** Sinauer Association, Inc., Publishers, Tenth Edition, 2013.
2. Balinsky B.I., **An Introduction to Embryology,** W. B. Saunders Co, Philadelphia, Seventh Edition, 2007.
3. Hake S. and Wilt F., **Principles of Developmental Biology**, W.W. Norton & Co, 2003.
4. Wolpert L.R., Beddington Jessell T., Lawrence P., Mayerowitz E. and Smith J., **Principles of Development**, Oxford University Press, UK, 2002.
5. Verma P.S., Agarwal V.K. and Tyagi, **Chordate Embryology,** S. Chand & Co, Reprinted, 2006.

CORE V – MOLECULAR BIOLOGY

(For those who joined since 2018-19)

Semester: III **Hours per Week: 6**
Sub.Code: GBMBC31 **Credit: 4**

Course Outcomes: Upon completion of the course, students will be able to
CO 1: Describe about genome organization and structure of Nucleic acid
CO 2: Obtain clear knowledge about DNA replication, transcription & translation
CO 3: Know about post transcription & post translational modification
CO 4: Understand operons and how gene regulation occur in both prokaryotes and eukaryotes
CO 5: Reflect critically about gene regulation in both prokaryotes and eukaryotes

Unit I **(18 hours)**

Nucleic acids – Structure of nucleic acids – Watson and Crick's double helix structure, types of DNA (A, B and Z forms), types of RNA – Structure of mRNA, t-RNA and r-RNA.
Proof that DNA as genetic material (Griffith, Avery, Hershey and Chase experiments), Proof that RNA as a genetic material (Frannenkel and Conrat experiments).

Unit II **(18 hours)**

Replication – Central dogma of molecular biology – DNA Replication – Enzymes involved in DNA replication, Prokaryotic DNA and Eukaryotic telomere and its replication, Mode of DNA replication – semi conservative mode, theta mode and rolling circle mode, DNA Repair – Photo reactivation and Excision repair

Unit III **(18 hours)**

Transcription – Prokaryotic transcription and Eukaryotic transcription, Enzymes involved in Transcription, Transcriptional and post transcriptional modifications – 5' cap formation, 3' end processing and poly adenylation, splicing, editing

Unit IV **(18 hours)**

Translation – Genetic code – properties of genetic code, Wobble hypothesis, Prokaryotes and Eukaryotic translation, the translation machinery, Mechanism of initiation, elongation and termination, posttranslational modifications of proteins

Unit V **(18 hours)**

Regulation of Gene expression – prokaryotes – The operon model **–** *Lac* operon and catabolic repression, *Trp* – operon (Repressible system) and attenuation, Regulation of gene expression in eukaryotes – transcriptional activation, galactose metabolism in yeast, gene silencing – RNAi

Text Books:

1. Prakash S. Lohar., **Cell and Molecular biology**, MJP publishers, Chennai, Reprint 2007. [chapter – 10, 11&12]
2. Gardner E.J., Simmons M.J. and Snustad D.P., **Principles of Genetics**, Eighth Edition, Wiley–India, 2008. [chapter – 10, 11&12]

References Books:

1. Friefelder David., **Molecular Biology**, MacMillan Pvt India Ltd, New Delhi, Second Edition, Reprint 2004.
2. Lewin B., **Genes VII**, Oxford University Press Inc, New York, 2000.
3. Turner P.C., Bates A.D. and White M.R.H., **Instant notes in Molecular Biology**, Viva Books Limited, New Delhi, 1999.
4. Klug W.S. and Cummings M.R., **Essential of Genetics**, Prentice Hall and New Jersey, Seventh Edition, 2010.

CORE VI - LAB COURSE IN MOLECULAR BIOLOGY

(For those who joined since 2018-19)

Semester: III **Hours per Week: 6**
Sub.Code: GBMBC32P **Credit: 4**

Course Outcomes:

Upon completion of the course, students will be able to,

CO 1: Explain various techniques involved in molecular biology
CO 2: Elucidate and perform the isolation of Chromosomal DNA from *E. coli* and yeast
CO 3: Understand the preparation of solutions and buffers
CO 4: Explain the isolation and separation of Plasmid DNA
CO 5: Understand the separation of protein

List of Experiments:

1. Preparation of solutions and buffers – Molar and Normal solution
2. Isolation of chromosomal DNA from *E. coli*
3. Isolation of DNA from Yeast
4. Estimation of DNA by DPA method
5. Isolation of plasmid DNA by alkaline lysis method

6. Separation of DNA by Agarose Gel Electrophoresis
7. Isolation of RNA
8. Estimation of RNA by Orcinol method
9. Separation of Protein by SDS-PAGE

Reference Books:

1. Aurubels, **Current protocols in Molecular Biology**, John Wiley, 1998.
2. Sambrook J., Fritsch E. F. and Maniatis T., **Molecular cloning – A Laboratory Manual,** Cold Spring Harbor Laboratory press, USA, Second Edition, 1989.
3. Aneja K.R., **Experiments in Microbiology**, *Plant pathology and Tissue culture technique,* WishwaPrakashan, New Delhi, 1983.
4. Monica Cheesbrough, **District Laboratory Practice in Tropical Countries, Part 1**, Cambridge University Press, Second Edition, 2006.
5. Monica Cheesbrough, **District Laboratory Practice in Tropical Countries, Part 2,** Cambridge University Press, Second Edition, 2006.

SECOND ALLIED I – BIO INSTRUMENTATION

(For those who joined since 2018-19)

Semester: III **Hours per week: 6**
Sub.Code: GBMBA33 **Credits: 5**

Course Outcomes:

Upon completion of the course, students will be able to
CO 1: Gain knowledge on the instruments used in the field of biology
CO 2: Describes the working principle of microscopy
CO 3: Conceptualize the principles and working techniques of chromatography and its types
CO 4: Explains about spectrophotometer, Atomic Absorption Spectroscopy
CO 5: Illustrate the centrifugation and the basic principles involved in the sedimentation.
CO 6: Elucidate the electrophoretic technique, AGE, PAGE.

Unit I (18hours)

Microscopy – General principles – Light, Dark and Bright field microscopy, Phase contrast microscopy, Electron microscopy – Transmission and Scanning, Micrometry.

Unit II (18hours)

Chromatography – General principles and definitions, R*f* value. Paper chromatography – Descending and 2-D, TLC, Adsorption chromatography, Gas Liquid Chromatography – Mass Spectrometry, Gel filtration, Affinity Chromatography, Ion-exchange Chromatography, HPLC

Unit III (18hours)

Spectrophotometry – Principle and applications of spectrophotometer – visible, ultra violet and infra-red; Atomic Absorption Spectroscopy. Colorimetry, turbidometry, pH meter, FTIR.
Filters – Seitz, HEPA, Membrane. Lyophilizer.

Unit IV (18 hours)

Separation Techniques – Centrifugation – Basic principles of sedimentation, RCF and sedimentation coefficient, types of centrifuges – Preparative and analytical centrifugation; rotors – fixed angle and swinging bucket rotors, differential centrifugation, density gradient centrifugation and ultracentrifugation, sonicator and sonication

Unit V (18 hours)

Electrophoretic Techniques – Electrophoresis – Principle and application of AGE, SDS –PAGE, Isoelectric focusing, Pulsed field Electrophoresis and 2-D Gel Electrophoresis.

Text Books:

1. Palanivelu, **Analytical Biochemistry and Separation Techniques,** Twenty First Century Publications, Madurai, Third Edition, 2004.
2. Brown D.R., **Chromatography,** Publishing House, New Delhi, 2005.
3. Marimuthu R., **Microscopy and Micro Technique,** MJP Publishers, Chennai, 2008.

Reference Books:

1. Plummer D., **An Introduction to Practical Biochemistry,** Tata MC Graw – Hill Publishing Company Ltd, New Delhi, 1987.
2. Wilson K. and Walker J., **Principles and Techniques of Biochemistry and Molecular Biology,** Cambridge Press, London, Seventh Edition, 2010.
3. John G., Webster, **Bioinstrumentation**, John Wiley and Sons, Inc, New York, 2004.

SKILL BASED ELECTIVE III – LAB COURSE IN MEDICAL LAB TECHNOLOGY

(For those who joined since 2018-19)

Semester: III **Hours per Week: 3**
Sub.Code: GBMBE34P **Credit: 2**

Course Outcomes:

Upon completion of the course, students will be able to,
CO 1: Get hands on training on various techniques used in clinical laboratory.
CO 2: Describes various sample collection methods
CO 3: Explains different diagnostic methods
CO 4: Gain ideas about the various microbial tests through hospital visit.

List of Experiments:

1. Medical Laboratory technician Code – personal safety measures – Care in the Laboratory
2. Common Causes of Accidents in laboratory

3. Blood Sample collection, Separation and Transportation
4. Blood grouping– A,B,O,AB,H
5. Bleeding Time and Clotting Time
6. Total WBC and Total RBC
7. Differential Cell count
8. Estimation of Hemoglobin
9. Estimation of Blood Sugar, Urine Sugar, Urine Albumin and Deposits
10. Estimation of Bile Salt and Bile pigment (BSBP)
11. Erythrocytes Sedimentation Rate (E.S.R)
12. Agglutination test (ASO, CRP, RF)
13. WIDAL slide agglutination and tube dilution
14. Thyriod Profile - ELISA
15. Microscopic Examination of Sputum for Acid Fast Staining
16. Microscopic Examination of Malarial Parasites (Pf & Pv)
17. Microscopic Examination of Stool for Ova and Cyst
18. Rapid Lab Diagnosis:
    Blood: HIV, HBAgs, HCV
    Urine: Urine Pregnancy Test (UPT)
19. Biomedical Waste Management
20. Hospital Visit

Reference Books:

1. Monica Cheesbrough, **District laboratory practice in tropical countries,** Part 1, and Cambridge University press, Second Edition, 2006.
2. Monica Cheesbrough, **District laboratory practice in Tropical countries**, Part 2, Cambridge University Press, Second Edition, 2006.
3. Rajan S. and Selvi Chrity R., **Experimental procedures in Life Science**, Anjanaa Book House, Chennai, First Edition, 2010.
4. Mukerjee L.K., **Medical Laboratory Technology**, Third volume, Hill publishing Ltd, New Delhi, Second Edition, 1988.
5. Sood R., **Medical Laboratory Technology,** Methods Interpretation, Jaypee Brothers Medical publishers Limited, New Delhi, India, Fifth Edition, 1999.

EXTRA CREDIT – CELL BIOLOGY

(For those who joined since 2018-19)

Semester: III **Hours per Week: -**
Sub.Code: GBMBX3 **Credit: 2**

Course Outcomes:

On successful completion of this course, the students will be able to,

CO 1: Discuss the structural and functional aspects of the cell.
CO 2: Explain the complete informations on Plasma membrane.

CO 3: Reflect critically about the knowledge on structure and functions involved in cell organelles.
CO 4: Demonstrate about the cell cycle and regulation.
CO 5: Master the core concepts about the structures involved in the motility of microorganisms.

Unit I (12 hours)
Introduction – Structure of Prokaryotic and Eukaryotic cell, Structure and function of Nucleus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast and Lysosomes; Organization of Nucleus and nuclear transport, Cytoskeletons (Microfilaments, Intermediate filaments, Microtubules and associated proteins).

Unit II (12 hours)
Ultra structure of plasma membrane – Transport processes – active transport, ionophores and ion channels; Exo and endocytosis, Phago and pinocytosis; General morphology and functions of endoplasmic reticulum, Signal hypothesis; Ribosomes – Eukaryotic and Prokaryotic, Ribosomal proteins, Lysosomes and peroxisomes, Cell – cell interaction.

Unit III (12 hours)
Mitochondria – structure and biogenesis; Organization of Mitochondrial respiratory chain, mechanism of oxidative of Phosphorylation; Ultra structure of the Chloroplast, Photosynthesis – Photophosphorylation; Carbon dioxide fixation in C_3, C_4 and CAM plants, Photorespiration.

Unit IV (12 hours)
Cell cycle – Molecular events including cell cycle check points and CDK – Cyclin complexes and their role in cell cycle regulation, Cell Division – Amitosis, Mitosis & Meiosis, Apoptosis.

Unit V (12 hours)
Motile systems – Microtubules based motility, fast axonal transport, Cilia & Flagella; Actin based cell movement (Myosins), Filament based movement (muscle), Phototaxis and Chemotaxis.

Text Books:
1. Alberts, Johnson, Lewis Raff, Roberts and Walter, **Molecular Biology of the Cell,** Garland Publications Incorporation, Sixth Edition, 2014.
2. Karp G., **Cell and Molecular biology:** Concepts and Experiments, John Wiley & Sons Inc., New York, Seventh Edition, 2013.

Reference Books:
1. De Robertis E.D.P. and De Robertis E.M.F., **Cell and Molecular Biology,** Lippincott Williams & Wilkins, USA, Eight Edition, 2001.
2. Becker and Kleinsmith Hardin, **The World of The Cell,** Pearson Education Publication, Eightth Edition, 2012.
3. Geoffrey M. Cooper and Robert E., Hausman, The **Cell & Molecular approach**, Sinauer Associates, Inc, Sixthth Edition, 2013.

CORE VII – MICROBIAL GENETICS

(For those who joined since 2018-19)

Semester: IV **Hours per Week: 5**
Sub.Code:GBMBC41 **Credits: 4**

Upon completion of the course, students will be able to
CO 1: Grasp knowledge about gene organization in prokaryotes as well as eukaryotes
CO 2: Establish why mutation and recombination is important to the genetic diversity
CO 3: Reflect how bacteria exchange or obtain new gene from other livings
CO 4: Describe about transposable elements both in prokaryotes and eukaryotes
CO 5: Portray life cycle of phage and its advantage and disadvantage

Unit I **(15 hours)**

Gene organization and mutation – Gene organization in Prokaryotes and Eukaryotes; Concept of mutations and mutagenesis, mutants, spontaneous mutation, induced mutation, DNA repair mechanism

Unit II **(15 hours)**

Recombination and plasmids – Recombination – reciprocal recombination (Holliday model) and non-reciprocal recombination, site specific recombination
Plasmids – types- fertility factors, resistance factors, col plasmid, stringent and relaxed type replication

Unit III **(15 hours)**

Gene transfer techniques – Conjugation – F+, F- mating, Hfr mating, F' conjugation. Transformation – competent cells – mechanism, transduction – generalised and specialized.

Unit IV **(15 hours)**

Transposable elements – Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Eukaryotic transposable elements – Yeast (Ty retro transposon), Uses of transposons and transposition

Unit V **(15 hours)**

Phage genetics – viruses: T_4 bacteriophage- characters, lifecycle of phages – lytic and lysogenic cycle, induction of lysogen

Text Books:

1. Prakash S. Lohar, **Cell and Molecular biology**, MJP publishers, Chennai, Reprint2007.[chapter 5]
2. Gardner E.J., Simmons M.J. and Snustad D.P., **Principles of Genetics,** Eighth Edition, Wiley–India, 2008.[chapter 14,16, &18]

Reference Books:

1. Desmond S.T.Nicholl., **An Introduction to genetic Engineering**, Cambridge University Press, Second Edition, reprint 2006.
2. Stanley R. Maloy, John E. Cronan and David Freifelder, **Microbial Genetics**, Narosa Publishing House, Second Edition, 2008.
3. Peter J. Russell, **Fundamentals of Genetics**, Benjamin / Cummings Publishers, Fifth Edition, 2000.
4. Flint S.J., Enquist L.W., Racanielo V.R. and Skalka A.M., **Principles of Virology**, ASM Press, Washington, Second Edition, 2004.
5. Turner P.C., McLennan A.G., Bates A.D. and White M.R.H., **Instant Notes Molecular Biology**, Viva books Pvt Ltd, 2002.
6. Hancock J.T., **Molecular Genetics**, Viva books Pvt Ltd, 2008.

CORE VIII: LAB COURSE IN MICROBIAL GENETICS

(For those who joined since 2018-19)

Semester: IV **Hours per Week: 5**
Sub.Code: GBMBC42P **Credit: 4**

Course Outcomes:
Upon completion of the course, students will be able to,
CO 1: Explains the process behind the mutation
CO 2: Elaborates the basic and common methods in Microbial Genetics
CO 3: Clarifies the relationship between Phenotype and Genotype
CO 4: Understand the gene transfer mechanism

List of Experiments:
1. Restriction digestion
2. UV irradiation and photoreactivation
3. Isolation of antibiotic resistant mutant by gradient plate method
4. Isolation of antibiotic resistance mutant by replica plating
5. Isolation of auxotrophic mutants
6. Preparation of competent cells
7. Gene transfer by conjugation
8. Gene transfer by transduction
9. AMES Test

Reference Books:

1. Aneja K.R., **Experiments in Microbiology, Plant Pathology and Tissue Culture Technique**, WishwaPrakashan, New Delhi, 1983.

2. Mukherjee K. and Ghosh S., **Medical Laboratory Technology Procedure Manual for Routine Diagnostic Tests**, volume-3, Tata McGraw Hill education private limited, New Delhi, Second edition, 2010.
3. Dubey R.C. and Maheshwari D.K., **Practical Microbiology**, S. Chand & company Ltd, New Delhi, 2007

CORE IX – MEDICAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester: IV **Hours per Week: 5**
Sub.Code: GBMBC43 **Credit: 4**

Course Outcomes:
Upon completion of the course, students will be able to,
CO 1: Understand the difference between normal flora and pathogenic microorganism
CO 2: Cognizant knowledge on bacterial pathogenicity.
CO 3: Attain knowledge on viral infection and its retrieval
CO 4: Interpret the fungal and protozoan infections.
CO 5: Understand the contagious infection and use of antibiotics.

Unit I **(15 hours)**

Introduction – History and Developments in medical microbiology, Classification of Pathogenic and non-pathogenic Microorganisms**.** Normal flora of the human body (Skin, Eye, Respiratory Tract, Oral cavity, Gastro-intestinal Tract, Genito-urinary Tract, External ear); Host microbe interaction: Transmissibility of pathogens – Air borne pathogens, Contact transmission, Vector-borne transmission, Carrier transmission, Water and Food borne transmission

Unit II **(15 hours)**

Common bacterial diseases – Tuberculosis, Plague, Anthrax, Meningitis, Typhoid, Tetanus – infection, infection establishment, pathogenesis, symptoms, diagnosis, treatment

Unit III **(15 hours)**

Viral diseases – Hepatitis, Dengue, Rabies, Pox Virus, Rubella, Ebola, Zika – Infection, Infection establishment, pathogenesis, symptoms, diagnosis, treatment.

Unit IV **(15 hours)**

Communicable fungal diseases – Mycoses – Dermatophytosis, Histoplasmosis, Cryptococcosis, Aspergillosis Pathogenesis, Diagnosis, and treatment.
Protozoan Infections – Amoebiasis, Giardiasis, Malaria – infection, infection establishment, pathogenesis, symptoms, diagnosis, treatment

Unit V **(15 hours)**

Nosocomial infections – Important pathogens (Influenza), Source of pathogens, Methods to avoid and Control of nosocomial infections.

Disease Control Methods – Antibiotics – Classification of microbial antibiotics based on mode of action, Determination of the level of antimicrobial activity

Text Books:

1. Rajan S., **Medical Microbiology**, MJP publishers, Chennai, 2007.

Reference Books:

1. David Greenwood and Slack C.B., **Medical Microbiology**, Churchill Livingstone, London, Sixteenth and Fifteenth Edition, 2003.
2. Ananthanarayan R. and Panicker C.K., **Text Book of Microbiology**, Orient Longman Ltd, India, 2000.

SECOND ALLIED II – IMMUNOLOGY

(For those who joined since 2018-19)

Semester: IV **Hours per Week: 6**
Sub.Code: GBMBA44 **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to
CO 1: An overview of the immune system including Primary & Secondary lymphoid organs.
CO 2: Describes the role of Immunoglobulins
CO 3: Explains the complement activation after the entry of antigen.
CO 4: Describes the molecular basis of antigen
CO 5: Immune response to viral and bacterial infections
CO 6: Elaborates monoclonal antibodies and their applications
CO 7: Introduction to vaccination

Unit I **(18 hours)**

History of Immunology – Contributions of following scientists in the field of immunology – Edward Jenner, Robert Koch, Paul Ehrlich, Louis Pasteur, Peter Medawar, Elie Metchnikoff, Joseph Lister and Susumu Tonegawa

Immune Cells and Organs – Structure, Functions and properties of immune cells – Stem cell, T cell, B cell, NK cell, Macrophage. Granulocytic cells – Neutrophil, Eosinophil, Basophil. Mast cell, Dendritic cell; and Immune Organs – Primary lymphoid Organs – Bone Marrow, Thymus. Secondary lymphoid organs – Lymph node, Spleen. GALT, MALT, CALT

Unit II **(18 hours)**

Antigen & Antibody – Characteristics of an Antigen, Haptens, Adjuvant, Epitopes; Structure & function of Immunoglobulins – IgG, IgA, IgM, IgD, IgE. Antigen and Antibody Interaction. Immune response – Primary & Secondary immune response. Elements of immunity – introduction, innate immunity, acquired immunity

Unit III **(18 hours)**

Complement and Effectors mechanisms – Complement – Classical and Alternative pathways; Major Histocompatibility Complex – Structure and types of MHC molecules (HLA); Hypersensitivity reactions – Type I, II, III, IV, Auto immunity – Myasthenia Gravis.

Unit IV **(18 hours)**

Transplantation & Tumour immunology – Transplantation; Mechanism of graft rejection versus host rejection, clinical manifestation. Immunodeficiency; Immunosuppressive therapy; Tumor antigen – TATAs, TSTAs, Immune response to tumours

Unit V **(18 hours)**

Immunodeficiencies and Vaccines – Primary – SCID – B & T cell deficiencies, Secondary – AIDS. Types of Vaccines – Attenuated, Killed, Subunit vaccines, DNA Vaccines, Recombinant vector vaccines, Monoclonal antibodies production by using hybridoma technology & its application

Immunological Techniques – Immunodiffusion, Immunoelectrophoresis, ELISA, PCR

Text Books:

1. Kuby R.A Goldsby, Thomas J. Kindt and Barbara A. Osborne., **Immunology,** Sixth edition, Freeman & Company, New York, 2002.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt., **Roitt's Essential Immunology,** Thirteenth Edition, Wiley-Blackwell, 2017.
3. Janis Kuby., **Immunology**, Third Edition, W.H.Freeman and Company, 1997.
4. Ashim K Chakravarty**, Immunology and Immunotechnology,** Oxford University Press India Publisher, 1999.

Reference Books:

1.Kannan I., **Immunology,** M.J.P Publishers, Chennai, 2007.
2. Richard Coico and Geoffrey Sunshine, **Immunology**, Willey – Liss, California, Fifth Edition, 2003.

SKILL BASED ELECTIVE IV – LAB COURSE IN MUSHROOM CULTIVATION

(For those who joined since 2018-19)

Semester: IV **Hours per Week: 3**
Sub.Code: GBMBE45P **Credit: 2**

Course Outcomes:

Mushroom cultivation lab facets the hands-on training for students to
CO 1: Describe the basic types of mushroom and its economic importance
CO 2: Expertise in various mushroom cultivation techniques
CO 3: Setup an own unit of mushroom cultivation firm

CO 4: Intend the candidates to go for self–employment.

List of Experiments:

1. Introduction & types of mushroom
2. Key to differentiate edible and poisonous mushrooms
3. Nutritional values & global status of mushroom
4. Preparation of culture, Mother spawn production and multiplication of spawn
5. Cultivation techniques of Oyster Mushroom
6. Cultivation techniques of Milky Mushroom
7. Harvesting and post-harvest handling techniques
8. Constraints in production: adverse environmental factors, Pests and pathogens
9. Industrial cum study tour to mushroom cultivation farms
10. Principles of marketing and marketing potentials

REFERENCE BOOKS:

1. Suman B.C. and Sharma V.P., **Mushroom Cultivation, Processing And Uses**, Agrobios. 2007.
2. Suman,B.C. and Sharma V.P., **Mushroom cultivation in India**, Eastern Book Corporation, 2007.
3. Shu–ting, Chang and Philip.G Miles, **Mushrooms: Cultivation, Nutritional value, Medicinal Effect and Environmental Impact**, CRC press, Washington, 2004.
4. Pathak Yadav Gour, **Mushroom Production and Processing Technology,** Agrobios (India), 2010.
5. EIRI, **Handbook of Mushroom Cultivation, Processing and Packaging,** Engineers India research institute.

EXTRA CREDIT – MICROBES IN HUMAN WELFARE

(For those who joined since 2018-19)

Semester: IV **Hours per week: -**
Sub.Code: GBMBX4 **Credits: 2**

Course Outcomes:

The Microbes in human welfare course provides the basic knowledge of microbes involved in day to day activities of human beings, where the students able to

CO 1: Highlights beneficial uses of microbes as food.
CO 2: Describes the applications of microbial products in medical field.
CO 3: Enlighten in the area of biofertilizers and biopesticides.
CO 4: Bxplore the concepts of biogas and other economically important microbial products.

Unit I

Microbes as food products – Fermented Indian foods, Single cell protein, mushroom and food spoilage organisms; Role of Yeast, Lactobacilli in fermented foods

Unit II

Pharmaceuticals – Production of antibiotics, vaccines, hormones, vitamins, steroids, enzymes and amino acids; role of transformed microorganisms in pharmaceuticals

Unit III

Agriculture – Biofertilizer, biocontrol of microbial pathogens – fungicides, biopesticides, plant growth promotors, secondary metabolites.

Unit IV

Microbes in industries – Biopreservatives, waste water recycling, industrial effluent treatment. Dairy industries – importance of microbe in dairy and dairy products; Industrial enzymes – application in food, leather, textile, paper, detergent

UNIT V

Microbial products – production of bread, cheese, yoghurt, soy sauce, wine and beer, biogas.

Text Books:

1. William C. Frazier & Westhoff D.C, *Food Microbiology*, McGraw Hill Publications, New York, Fourth Edition, 2008.
2. Adams MR & Moss MO, *Food Microbiology*, New Age International P. Ltd. Publications, 1995.

Reference Books:

1. Michael J. Pelczar I.R., Chan E.C.S and Noel R. Kreieg., **Microbiology,** Tata McGraw–Hill, New Delhi, Fifth Edition, 2004.
2. Atlas R.M., **Principles of Microbiology,** WCB / McGraw Hill, NewYork, Second Edition, 1997.
3. Wood J.B., **Microbiology of fermented foods, Volumes I and II**, Elsevier Applied Science Publishers, London, Second Edition, 1998.
4. Banwart G.J., **Basic Food Microbiology**, CBS Publishers & Distributors, New Delhi, Second Edition, 2004.
5. Bensaon H.J., **Microbiological applications**, Crown Publishers, USA, Fifth Edition, 1990.

CORE X – ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester: V **Hours per Week: 4**
Sub.Code: GBMBC51 **Credit: 3**

Course Outcomes:

Upon completion of the course, students will be able to
CO1: Describe the distribution of microorganism and its role in environment
CO 2: Reflect critically about the biogeochemical cycles
CO 3: Conceive knowledge about waste water treatment

CO 4: Critically clarify the application of microbes in agriculture like biofertilizers

Unit I **(12 hours)**

Ecosystem – Ecological hierarchy – Ecological succession of microorganism – Homeostasis – Adaptive mechanism among microorganisms – interaction between microbes, plants and animals.

Microbial contamination of air – Sources of contamination – Biological indicators of air pollution. Enumeration of bacteria from air, Air sampling devices. Significance of air micro flora, Outline of Airborne diseases (Bacterial, Fungal and Viral), Air sanitation. Effect of Air pollution for plants and Humans

Unit II **(12 hours)**

Waste water (sewage and industrial effluents) treatments – Primary, Secondary (Trickling Filter, Activated Sludge) and Tertiary treatments. Anaerobic treatment of industrial effluents: Hydrolysis, Fermentation and Methonogenesis. Conventional methods of waste water treatment– (Aerobic and Facultative ponds, AMS, Thin film technique and Sand filter)

Unit III **(12 hours)**

Biodegradation and bioremediation – **Solid waste management –** Landfills, Composting and Earthworm treatment. Recycling and processing of organic residues – Biodegradation of Xenobiotic compounds – Organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides and surfactants – Microbial treatment of oil pollution. Xenobiotics degradation – Superbugs (Heavy metals, Radionuclides, Recalcitrants, Halogenated compounds).

Unit IV **(12 hours)**

Soil microbiology – Structure, Types, Physical and Chemical properties; Soil microbes (Types and Enumeration) – Weathering and humus formation, Soil pollution – Sources. Bio-geo chemical cycles – Carbon cycle, Nitrogen cycle, Sulphur cycle, Iron cycle

Unit V **(12 hours)**

Agricultural microbiology – Biological nitrogen fixation – diazotrophs – free living, aerobic, symbiotic bacteria and cyanobacteria. Microbial interactions, interaction of microbes with plants and insects.

Biofertilizers – Microbes used as Biofertilizers, Mass multiplication, field application and crop response.

Biopesticide – Bacterial, Fungal and Viral. Recent advances in biological pest control

Text Books:

1. Dubey R.C. and Maheshwari D.K., **A Textbook of Microbiology**, S.Chand & Company Ltd, New Delhi, 2007.

Reference Books:

1.Moat A.G., Foster J.W. and Spector M.P., *Microbial Physiology,* John Willey and Sons, New York, Fourth Edition, 2009.
2.Martin Alexander, *Introduction to Soil Microbiology*, 1997.
3.Subbha Rao M.S., *Soil Microorganisms and Plant Growth,* 1995**.**
4. Rangasami G. and Bagyarai D.J., *Agricultural Microbiology*. Prentice–Hall of India Private Limited, New Delhi, Second Edition, 1993.
5.Mitchell R., *Introduction to Environmental Microbiology*, 1974.
6.Atlas R.M., *Principles of Microbiology,* WEB McGraw Hill–Co, USA, Second Edition1997.
7. Pelczar M.S., Chan E.C.S., and Kreig N.R., *Microbiology,* Tara McGraw Hill–Co, Singapore, Fifth Edition, 2004.
8.Presscott Harley Klein, *Microbiology*, McGraw Hill–Co, USA, Sixth Edition, 2004.

CORE XI – LAB COURSE IN MEDICAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester: V **Hours per Week: 4**
Sub.Code: GBMBC52P **Credit: 3**

Course Outcomes:

Upon completion of the course, students will be able to
CO 1: Empathize the collection and processing of various medical samples.
CO 2: Get hands on training on the various techniques
CO 3: Describes the isolation and identification of microorganisms from human samples
CO 4: Find out the efficiency and MIC of antibiotics.

List of Experiments:

1. Collection and processing of medical samples
2. Isolation of normal flora of skin, nose, throat.
3. Testing of antimicrobial activity of the bacteria on skin
4. Preparation of blood agar and demonstration of hemolysis
5. Isolation of microflora of the mouth–teeth crevices
6. Isolation and identification of *E.coli* from urine sample
7. Isolation and Identification of *Klebsiella* from Sputum sample
8. Isolation and Identification of *Staphylococcus aureus* from pus sample
9. Determination of the effectiveness of certain antibiotics (Antibiotic Sensitivity Test)
10. Determination of Minimal Inhibitory Concentration (E-test).

Reference Books:

1. Monica Cheesbrough, *District laboratory practice in tropical countries,* Part 1, and Cambridge University press, Second Edition, 2006.
2. Monica Cheesbrough, *District laboratory practice in Tropical countries,* Part 2, Cambridge University Press, Second Edition, 2006.

3. Sood R., *Concise Book of Medical Laboratory Technology – Methods and Interpretation,* Jaypee, New Delhi, First Edition, 2009.

CORE XII – LAB COURSE IN ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY AND BIOSTATISTICS

(For those who joined since 2018-19)

Semester : V **Hours per Week : 5**
Sub Code : GBMBC53P **Credit : 4**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Explain the procedure to isolate *Azotobacter, Cyanobacteria, Rhizobium*

CO 2: Explores the bacterial examination of water

CO 3: Determines the BOD and COD of water sample

CO 4: Elucidate the microbes present in air

CO 5: Illustrate the collection of data, sampling design and tabulation

CO 6: Explore the mean, median, mode and standard deviation

List of Experiments:

1. Isolation of free – living nitrogen fixing bacteria from soil – Azotobacter
2. Isolation of Symbiotic nitrogen fixing bacteria from root nodule – Rhizobium
3. Isolation of *Azospirillum, Cyanobacteria* from soil/ roots/water
4. Isolation of bacterial pathogens and fungal pathogens from infected plants
5. Isolation of phosphate solubilizing microorganisms from soil
6. Bacterial examination of water – MPN
7. Determination of Biological Oxygen Demand(BOD)
8. Determination of Chemical Oxygen Demand(COD)
9. Microbial assessment of air quality – open plate method and air sampler technique
10. Isolation and counting of fecal bacteria from water
11. Collection of data, sampling designs, tabulation and graphic representation using biological materials.
12. To find mean, median, mode and standard deviation using biological materials

REFERENCE BOOKS

1. Atlas R.M., Brown A.E. and Parks, Mosby, St. Louis, **Laboratory Manual of Experimental Microbiology,** 1995.
2. Kannan N., **Laboratory Manual in General Microbiology**, Panima Publishers, 2002.
3. SundarRao P.S.S., and Richard J., **an Introduction to Biostatistics a Manual for Students in Health Sciences,** Prentice Hall and India.
4. Aneja K.R., **Experiments in Microbiology, Plant Pathology and Biotechnology**, New Age International Publishers, Revised Fourth Edition, 2005.
5. Dubey R.C. and Maheshwari D.K., **Practical Microbiology,** S.Chand & Company Ltd, New Delhi, 2002.

ELECTIVE I: a. BIOSTATISTICS

(For those who joined since 2018-19)

Semester: V **Hours per Week: 5**
Sub.Code: GBMBE5A **Credit: 5**

Course Outcomes:

On successful completion of this course, the students will be able to,

CO 1: Discuss the functions & limitations on biostatistics.
CO 2: Appreciate key concepts about the Data collection and presentation of data.
CO 3: Measure the general tendency from a group of observations using central tendency.
CO 4: Evaluate the variation among the observations using measures of dispersion.
CO 5: Emphasize the basics of biostatistical inference using the science of Probability.
CO 6: To apply the statistical analysis for their research.

Unit I **(15 hours)**

Introduction to biostatistics – Definition, Statistical methods, Biological measurements, Kinds of biological data (Primary & secondary data), Function of statistics and limitation of statistics.

Unit II **(15 hours)**

Data Collection methods and presentations –Types of data **–** qualitative and quantitative data, discrete and continuous data, frequency and non-frequency data; Sampling and sampling design – Presentation of data (Diagrammatic, Tabular and Graphical representation).

Unit III **(15 hours)**

Measures of central tendency – Mean, Median, Mode, Geometric mean, Harmonic mean, Frequency distribution.

Unit IV **(15 hours)**

Measures of dispersion – Introduction **–** quartiles, deciles, percentiles, Standard deviation, Quartile deviation **–** correlation and regression.

Unit V **(15 hours)**

Probability distribution – Types of Probability **(**Binomial, Normal, Poisson) – Theorems of probability – student T- test – Null and alternate hypothesis, type I and II errors, testing significance – use of statistical tables and levels of significance.

Text Books:

1. SundarRao P.S.S. and Richard J., **Introduction to Biostatistics and Research Methods**, Prentice Hall of India Pvt Ltd, New Delhi, Fifth Edition, 2012.
2. Arumugam & Issac, **Statistics,** New Gamma Publishing House, Chennai, 2009.
3. Negi K.S.**, Biostatistics with latest MCQs,** A.T.I.B.S Publishers, India, 2008.

Reference Books

1. Arora P.N. and Malhan P.K., **Biostatistics,** Himalaya publishing House, Mumbai, 2007.
2. Palaniswamy S. and Manoharan M., **Statistical methods for biologists,** Palani Paramount Publications, Tamilnadu, 2002.

ELECTIVE I: b. COMPUTER APPLICATIONS IN BIOLOGY

(For those who joined since 2018-19)

Semester: V **Hours per Week: 5**
Sub.Code: GBMBE5B **Credit: 5**

Course Outcomes:
On successful completion of this course, the students will be able to,
CO 1: Illustrate the key concepts on the generations & components of Computer.
CO 2: Reveal about the Internet and its applications.
CO 3: Emphasize the basic knowledge about the Programming in C.
CO 4: Explain the basic knowledge about Web designing.
CO 5: Discuss about the applications of computer in Microbiology.

Unit I **(15 hours)**
Introduction to Computers – History of Computers – its developing technology and generation of Computers – Components of computers (Input and Output Devices) – Operating Systems – Windows, Unix – Hardware, Software, disc operating systems

Unit II **(15 hours)**
Working of Internet – Local area and wide area network – Types of files – HTML, TXT, and PDF – Search engines and its types and applications

Unit III **(15 hours)**
Programming in C (Basic) – Introduction, Simple programs, Decision making and looping, functions, structures, input and output filing system

Unit IV **(15 hours)**
Basic of WEB Design using HTML – Basic HTML, text styles, list and special characters, adding pointers and links, adding pictures, backgrounds and music, tables and frames

Unit V **(15 hours)**
Computers in Taxonomy and Systemic Data Analysis in Microbiology – Computers in clinical microbiology – Computer applications in fermentation – Technology Computers in Drug – Designing using various softwares in Drug designing.

Text Books:
1. Dave Taylor, **HTML,** Tata McGraw –Hill Publishing Company Ltd, New Delhi, 1995.

2. Paul Mc Fedries, **Microsoft office 97**, Sams Publishing Techmedia, New Delhi 1997.
3. Rajagopalan, **Understanding Computers,** Tata McGraw –Hill Publishing Company Ltd, New Delhi, 1987.
4. Sharon Crawford, **Windows 98** No Experience Required. BPB publications, New Delhi, 1998.
5. Yashwant Canetrar, Let us C. BPP Publishers, New Delhi, 1980.

REFERENCES:

1. Norman T.J. Bailey, **Statistical methods in Biology,**– Cambridge Edition.
2. S.A. Glanty, **Primer for Biostatistics**, –McGraw Hill Publishing Company Ltd, New Delhi.

ELECTIVE II : a. BIOTECHNOLOGY

(For those who joined since 2018-19)

Semester: V **Hours per Week: 5**
Sub.Code: GBMBE5C **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to:
CO 1: Explain the applications of DNA modifying enzymes
CO 2: Demonstrate the Identification of DNA, RNA and protein
CO 3: Write down the application of genetic engineering in animals, plants and human
CO 4: Elucidate the fundamental principles of nanotechnology and their application
CO 5: Discuss knowledge on the biosafety regulations and ethical concepts in biotechnology

Unit I **(15 hours)**

Introduction to biotechnology – Definition, Concept and Scope – History and achievements. Basic principles in rDNA technology. Restriction Enzymes – Types, Nomenclature, Mechanism of action. Cloning vectors – Plasmid – pBR322, pUC8; Viral vectors – M13, SV40, Cosmid, Phagemid, Shuttle vectors and its application

Unit II **(15 hours)**

Methods in biotechnology – Isolation of genomic and plasmid DNA, Agarose gel electrophoresis, 2D gel electrophoresis, Polyacrylamide gel electrophoresis, Blotting techniques – Southern, Northern and Western. Polymerase chain reaction – types, methods, application. DNA sequencing methods

Unit III **(15 hours)**

Plant biotechnology – Plant tissue culture – Definition, Culture medium – MS and B5, Culture methods – Callus, Protoplast, Meristem culture and Embryo (somatic embryogenesis)
Animal biotechnology – Transgenic Animal – Definition, Methods involved in the production of transgenic animals; Cloning **–** Mice, Fish, Sheep; Applications of transgenic animals in therapeutic protein production – Insulin and Interferon.

Unit IV **(15 hours)**

Nanobiotechnology – Introduction, types and synthesis of nanomaterials, Protein-based nanostructures, DNA-based nano structures, Applications of nanomaterial – Nanobiosensors, Drug and gene delivery, Disease nanodiagnostics and therapy, Risk potential of nanomaterials

Unit V **(15 hours)**

Biosafety & Intellectual property rights – Biosafety – definition &levels. GATT ,TRIPS and IPR, Different forms of IPR, IPR in India, Patent co–operation treaty, Forms of patents, Process of patenting, Indian and international agencies involved in patenting, Patenting biological materials

Text Books:

1. Dubey R.C., **A Textbook of Biotechnology**, S.Chand & Company Ltd, New Delhi, Reprint 2012.[chapter 1,3,4,5,6 & 26]
2. Satyanarayana U., **Biotechnology**, Arunabha sen Books & Allied P(Ltd), Kolkata, Reprint 2011.[chapter 15,41,42,43,44,47]

Reference Books:

1. Niemeyer C.M. and Mirkin C.A., **Nanobiotechnology: Concepts, applications and perspectives**, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim,2004
2. Gupta P.K., **Elements of biotechnology**, Rastogi and Co, Meerut 2004.
3. Primrose S.B., **Molecular Biotechnology**, Panima Publishing Corporation,New Delhi second Edition, 2001.
4. Mick Wilson and Kamali Kannangara, **Nanotechnology: Basic Science and Emerging Technologies.** Overseas Press, 2005.
5. Bull A.T., Hol G. and Lilly M.D., **Biotechnology International Trends and Perspective**, Oxford and IBH, 1982.
6. Jogdan S.N., **Gene Biotechnology**, Himalaya Publishing House, New Delhi, 1997.
7. Old R.W. and Primrose S.B., **Principles of gene manipulation,** Blackwell Scientific, London, Seventh Edition, 2006.

ELECTIVE II: b. BIONANOTECHNOLOGY

(For those who joined since 2018-19)

Semester: V **Hours per Week: 5**
Sub.Code: GBMBE5D **Credit: 5**

Course Outcomes:

Upon completion of the course, students will be able to:

CO 1: Explain the history and classification of nanostructures
CO 2: Demonstrate functional principles of Bionanotechnology
CO 3: Describe the synthesis of biomolecules based Nano structures
CO 4: Elucidate the analytical techniques involved in characterization of nanoparticles.

CO 5: Discuss the applications of nanoparticles as drugs in therapeutics and diagnosis.

Unit I **(15 hours)**

Nanostructure and biomaterial – Bionanotechnology – Definition, History of bionanotechnology – Richard Feynman and his contributions. Classification of Nanostructures – 1D, 2D and 3D.

Unit II **(15 hours)**

Functional principles of bionanotechnology – Information storage – Nucleic acid, Ribosomes as assembler to construct proteins. Energetics – Energy from Light, electron transport pathways, electrochemical gradient. Biocatalysts – Enzymes and its regulation

Unit III **(15 hours)**

Biosynthesis of Nanoparticles – Green Synthesis of Nanoparticles, Microbial Nanoparticle production. Biomineralization, DNA based nanostructures. Protein based nano structures.

Unit IV **(15 hours)**

Characterisation of Nanoparticles – UV-Spectroscopy, FTIR, XRD, SEM, TEM, Atomic force Microscopy.

Unit V **(15 hours)**

Nano medicine – Developing of Nanomedicines, protocols for nanodrug administration, Nanotechnology in diagnostics applications, materials used in diagnostics and therapeutic applications.

Text Books:

1. David Goodsell S., **Bionanotechnology**, Lessons from Nature, Wiley–Liss, Inc, 2004.[chapter 3,5 and 6]
2. Bandyopadhyay A.K., **Nano materials**. New Age International Publishers, 2007.[chapter 5]
3. Mark Ratner and Daniel Ratner, **Nanotechnology**, Prentice Hall,2002.[chapter 1]

Reference Books:

1. Hillery A.M., **Drug Delivery and Targeting**, CRC Press, 2002.
2. Manasi Karkare, **Nanotechnology,I.K.,** International Publishing House Pvt. Ltd, 2008.
3. Shanmugam S., **Nanotechnology,** MJP publishers, 2011.

SKILL BASED ELECTIVE V – BIOINFORMATICS

(For those who joined since 2018-19)

Semester: V **Hours per Week: 3**
Sub.Code: GBMBE54 **Credits: 2**

Course Outcomes:

Upon completion of the course, students will be able to,

CO 1: Define bio informatics, its scope and application

CO 2: Discuss the databases related to genome and proteome

CO 3: Explain software to extract information from database and sequencing tools

CO 4: Describes the development of phylogenetic trees

Unit I **(9 hours)**

Bioinformatics – Introduction, Definition, Scope, Applications of bioinformatics, Emerging areas of Bioinformatics

Unit II **(9 hours)**

Biological databases and its types – Nucleic acid databases, Protein databases (Primary, Composite and Secondary), Specialized Genome databases: (SGD, TIGR, and ACeDB), Structural databases (CATH, SCOP, and PDBsum), The International Nucleotide Sequence Database Collaboration (INSDC)

Practicals: Nucleic acid databases (NCBI, DDBJ, and EMBL) and Protein databases (Swissprot and Uniprot)

Unit III **(9 hours)**

Sequence alignment – Dot matrix, local alignment (Smith & Waterman algorithm), Global alignment (Needleman & Wunsch algorithm), similarity searching using FASTA and BLAST

Practicals: Expasy, FASTA and BLAST

Unit IV **(9 hours)**

Multiple sequence alignment – Progressive and Iterative methods, alignment viewers, applications of multiple sequence alignment

Practicals: Clustal Omega, MUSCLE and T-Coffee

Unit V **(9 hours)**

Phylogenetic analysis – Phylogenetic trees, Distance based and character based methods, automated tools for Phylogenetic analysis

Practicals: Phylogene and eshadow

Text Books:

1. David W. Mount., **Bioinformatics, Sequence and Genome Analysis**, Cold Spring Harbor Laboratory Press, 2001.
2. Teresa K. Attwoods., Parry – Smith D.J., **Introduction to Bioinformatics**, Pearson Education Asia, 2006.
3. Pevsner J., **Bioinformatics and Functional Genomics**, Second Edition. John Wiley & Sons, 2009.

Reference Books:

1. Higginns D. and Taylor W., **Bioinformatics, Sequence, Structure and databanks – A Practical Approach** by Oxford University Press, 2000.
2. Rastogi S.C., Mendiratta N. and Rastogi P., **Bioinformatics: methods and applications, genomics, proteomics and drug discovery**, Prentice Hall India Publication, Second Edition, 2007.

EXTRA CREDIT – LIFE SCIENCE FOR COMPETITIVE EXAMINATIONS

(For those who joined since 2018-19)

Semester: V **Hours per Week: -**
Sub.Code:GBMBX5 **Credit : 2**

Course Outcomes:
Upon completion of the course, students will be able to,
CO 1: sympathize on cell organelles.
CO 2: Discuss about the structure and synthesis of Nucleic acids and proteins.
CO 3: Appreciate the overall concept of heredity
CO 4: Reveal basic knowledge of ecosystem
CO 5: Explore the recent application in Biotechnology

Unit I
Prokaryotic and Eukaryotic cells – Structure and Ultrastructure. Structure and function of organelles – Chloroplast, Mitochondria, Vacuoles, Endoplasmic Reticulum, Golgi Apparatus, Ribosomes & Lysosomes, Nucleus, Nucleolus, Chromatin and Nucleosome. Mitosis and Meiosis

Unit II
Structure and synthesis of DNA – Structure of mRNA, t-RNA & r-RNA; Structure of proteins (Primary, Secondary, Tertiary and Quaternary). General properties of Enzymes and Amino acids

Unit III
Concept of heredity and variation – Mendel's law of inheritance, monohybrid cross, dihybrid cross, test cross – chromosomal basis of inheritance, incomplete dominance, epistasis, mutation-types

Unit IV
Ecosystem – concept, structure, function, producers, consumers and decomposers of ecosystem, energy flow, food web and food chain, ecological pyramids. Types of ecosystem. Pollution: air, water and land. Global warming.

Unit V
Definition and scope of biotechnology – Restriction enzymes, plasmid – types, Cloning vectors pBR322, methods of gene transfer. Application of genetic engineering in the field of agriculture (herbicide and pest resistance plants) & medicine (production of recombinant vaccines)

Reference Books:

1. Wiley, Sherwood and Woolverton, Presscott, **Harley and Klein's Microbiology**, McGraw – Hill International edition Nelson, Seventh Edition, 2008.
2. D.L. Nelson and M.M. Cox, Lehninger, **Principles of Biochemistry**, Macmillan worth Publishers, 2006.
3. Kumaraswamy K., **Environmental Studies**, UGC syllabus, Periyar EVR College, Tiruchirappalli, 2013.
4. Verma P.S. and Agarwal V.K., **Environment Biology**, S. Chand and Company Ltd, New Delhi, 2000.

CORE XIII – FOOD MICROBIOLOGY

(For those who joined since 2018-19)

Semester: VI **Hours per Week: 4**
Sub.Code: GBMBC61 **Credit: 3**

Course Outcomes:

Upon completion of the course, student will be able to
CO 1: Comprehend the general principles of food Microbiology.
CO 2: Covers the pathogenic organisms involved in the spoilage & normal flora of the food
CO 3: Describes the economically important Bacteria, Yeasts and Molds.
CO 4: Explains the fermentation technology behind the fermented food
CO 5: Clarifies the examination of food and microbiological quality control.

Unit I **(12 hours)**

Food as a substrate for microorganisms – Microorganisms important in food Microbiology – bacteria, yeast, molds. Factors affecting the growth of microorganisms in food – pH, Moisture, Oxidation – Reduction potential, Nutrient content and Inhibitory substances and Biological structure.

Unit II **(12 hours)**

Food Preservation – Principles of food preservation. Physical Methods – Asepsis, drying, Filtration, chilling and freezing, Radiation, Pasteurization, Desiccation, Anaerobiosis, Canning controlled Atmosphere. Chemical Methods **–** Salt, Sugar, Organic acid (Benzoic acid, Sorbic acid, Propionates, Acetic acid & Lactic acid), Nitrites, Nitrates, Sulphur dioxide, Ethylene dioxide, Propylene acid, Wood Smoker & Antibiotics.

Unit III **(12 hours)**

Contamination and Spoilage – Milk and Milk product, Cereals and Cereal Products, Vegetables and fruits, Meat and Meat products, Eggs and Poultry, Fish, Canned Food

Unit IV **(12 hours)**

Microbial products – Fermented dairy products – Cheese, yoghurt, kefir & acidophilus milk, Fermented vegetables – Sauerkraut, pickled cucumber, Fermented Meat – Sausages. Role of microbes in beverages.

Unit V **(12 hours)**

Food borne infection and intoxication – Bacterial – *Staphylococcus*, *Clostridium*, *Vibrio*, *Escherichia coli* and *Salmonella*, Viral – Hepatitis, Protozoa – Giardiasis, Amoebiosis and Mycotoxins. Concept of Probiotics.

Quality control aspects – Good Manufacturing Practices, Hazard Analysis Critical Control Points, Indian Standard Organisation and its procedure. Microbiological Quality Standards – FDA, HACCP,ISI.

Text Books:

1. Adams M.R. and Moss M.O., **Food Microbiology**, Second edition, Panima Publishing House, New Delhi 2004.
2. Bensaon H.J., **Microbiological applications**, Crown Publishers, USA, Fifth Edition, 1990.
3. Banwart G.J., **Basic Food Microbiology**, CBS Publishers & Distributors, New Delhi,Second Edition, 2004.
4. William C. Frazier & Westhoff D.C., **Food Microbiology**, McGraw Hill Publications, New York,Fourth Edition, 2008.

Reference Books:

1. Michael J. Pelczar I.R., Chan E.C.S. and Noel R. Kreieg, **Microbiology**, Tata McGraw–Hill, New Delhi,Fifth Edition, 2004.
2. Atlas R.M., **Principles of Microbiology**, WCB / McGraw Hill, New York, SecondEdition, 1997.
3. Wood J.B., **Microbiology of fermented foods**, Volumes I and II, Elsevier Applied Science Publishers, London, England,SecondEdition, 1998.

CORE XIV – INDUSTRIAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester:V **Hours per Week: 5**
Sub.Code: GBMBC62 **Credits: 4**

Course Outcomes:

Upon completion of the course, students will be able to

CO 1: Improve the skills in screening of industrially important microbes
CO 2: Design the type of fermenter needed for large scale production.
CO 3: Describes the concepts of upstream and downstream processing of fermentation technology
CO 4: Expertise on the production of economical important microbial products.
CO 5: Discuss about the bioreactors and controlling parameters
CO 6: Explains the role of microorganism in bioprocess technology

Unit I **(15 hours)**

Introduction to industrial microbiology – Brief history and developments in industrial microbiology; Isolation and Characterization of industrially important microbial strains – Strategies in selecting strain; Primary and Secondary screening, Strain improvement – mutation and recombinant DNA technology, preservation and maintenance of industrial strains

Unit II **(15 hours)**

Fermentation media – Media and ingredients for industrial fermentations **–** Crude and synthetic Media – Carbon, Nitrogen, Vitamin and Mineral Sources, Role of buffers, Precursors, Inhibitors, Inducers and Antifoams

Types of fermentation process – Batch, fed–batch and continuous fermentation

Sterilization: Sterilization of Instruments, Medium and Air

Unit III **(15 hours)**

Bioreactors – Components (design) of typical fermenter, types of fermenters- stirred tank, bubble column, airlift, packed bed, fluidized bed, tower and Photo bioreactor;

Measurement and control of fermentation parameters – Control and monitoring of different parameters in fermenters – pH, Temperature, Dissolved oxygen, Foaming and Aeration and Computer automation

Unit IV **(5 hours)**

Down–Stream Processing – Filtration, Centrifugation, Cell disruption, Solvent extraction, Precipitation, Chromatography, Ultrafiltration, Lyophilization and Spray drying

Unit V **(15 hours)**

Microbial Production of Industrial Products – Citric acid, Acetic acid (vinegar), Ethanol, Penicillin, Lysine, Riboflavin, Cyanocobolamine, Amylase, Cellulase, Wine and Beer. Enzyme immobilization **–** Methods of immobilization, Advantages of immobilization, Large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

Text Books:

1.Patel A.H (1985), **Text book of industrial microbiology,** MacMillan India Ltd, reprint 1996.

2.Stanbury P.F., Whitaker A. and Hall S.J (2005), (**Principles of fermentation technology**, Butterworth–Heinemann, An imprint of Elsevier, Burlington, Second Edition, reprint 2009.

Reference Books:

1. Atlas R.M., **Principles of Microbiology**, WCB / McGraw Hill, New York, Second Edition, 1997.

2.Casida L.E., **Industrial microbiology**, Wiley Eastern Ltd, New Delhi, 1963.

3. Dubey R.C. and Maheshwari D.K., **A Textbook of Microbiology**, S.Chand & Company Ltd, New Delhi, 2005.

4.Prescott L.M, Harley J.P. and Klein D.A., **Microbiology,** McGraw Hill, Boston, 2002.

CORE XV – LAB COURSE IN FOOD AND INDUSTRIAL MICROBIOLOGY

(For those who joined since 2018-19)

Semester: VI **Hours per Week: 5**
Sub.Code: GBMBC63P **Credit: 4**

Course Outcomes:

Upon completion of the course, students will be able to,

CO 1: Describe isolation of microorganism from spoiled food products
CO 2: Check the quality of food product and adultery
CO 3: to get knowledge on the industrially important techniques
CO 4: Acquire knowledge about spoilage mechanisms in foods
CO 5: Discuss the basis of food safety regulations
CO 6: Conceive knowledge about role of microorganism in fermentation

List of Experiments:

1. Enumeration of microorganisms from food product
2. Isolation of bacteria and fungi from spoiled food
3. Enumeration of microorganisms from milk
4. Determination of the quality of milk sample by Dye Reduction Test, Phosphatase test and Turbidity test
5. Detection of $NaHCO_3$ (chalk) in flour
6. Test the presence of sugar in honey
7. Portability analysis of drinking water
8. Sauerkraut production
9. Screening of antibiotic producing microorganisms
10. Screening of enzyme producing microorganisms (protease, amylase and cellulase)
11. Immobilization of yeast using sodium alginate
12. Alcohol fermentation by yeast
13. Estimation of alcohol

Reference Books:

1. Aneja K.R., Experiments in Microbiology, **Plant Pathology and Biotechnology**, New Age International Publishers, Revised Fourth Edition, 2005.
2. Atlas R.M., Brown A.E., Dobra K.W. and Millen L., **Experimental microbiology – Fundamentals and application,** Mac Millan Publishing Company, New York, Second Edition, 1998.
3. Gunasekaran P., **Laboratory Manual in Microbiology**, New Age international Pvt Ltd Publisher, New Delhi, 2009.
4. Cappuccino and James G., **Microbiology a Laboratory Manual,** Addison Wesley Publishing Company Inc., England, California. Fourth Edition, 1996.

CORE – XVI PROJECT

(For those who joined since 2018-19)

Semester: VI **Hours per Week: 6**
Sub.Code: GBMBC64PW **Credit: 5**

Upon completion of the course, students will be able to
CO 1: Implement the innovative ideas in research
CO 2: Experience the research in the field of microbiology
CO 3: Designing the project to overcome the environmental problems.

Project shall be a group project (Team maximum of Six Only) shall be done individually. Project internal is evaluated on the basis of presentation of the project in the review meeting for 35 marks and attendance of 5 marks being computed as per other papers.

ELECTIVE III – a. MARINE MICROBIOLOGY

(For those who joined since 2018-19)

Semester: VI **Hours per Week: 5**
Sub.Code: GBMBE6A **Credit: 5**

Course Outcomes:
Upon completion of the course, students will be able to:
CO 1: Explain on major forms of life in the marine environment,
CO 2: Identify and classify the marine Microbes
CO 3: Describe the preservation methods of marine microbes
CO4: Elucidate the microbial resources and its role in different biogeochemical cycles.
CO 5: Discuss the economic importance of Seaweeds and mangroves
CO 6: Clarify the microbial interaction associated with fish (food) and its prevention.

Unit I **(5 hours)**

Introduction to marine environment–Marine microbial habitats (estuaries, salt marshes, coastal ecosystems, coral reefs, water column, sediments).Marine Flora and Fauna – Phytoplankton and Zooplankton, sea grasses and mangroves – their characteristics features – Types of marine microbes and their morphology –Bacteria, Fungi, Algae, Protozoa and Actinomycetes.

Unit II **(5 hours)**

Microbial assessment–Methods of studying the marine microorganisms – collection, isolation, culture & identification based on morphological, physiological, biochemical characteristics and metagenomics; Preservation of marine microbes; Culture collection Centres (MTCC, ATCC, IMTECH, UTEX). Microbial nutrition – influence of environment factors on microbial growth, activity and distribution

Unit III **(5 hours)**

Role of Microbes in Marine Environment – Microbial nitrogen fixation; Carbon, nitrogen and phosphorus cycle; Decomposition of organic matter; role of Hyperthermophilic and barophilic microorganism, Bioleaching and Biodeteroriation of natural and synthetic materials

Unit IV **(5 hours)**

Seaweeds, Mangroves and their importance – Seaweeds: types – green, red, brown algae, economical importance of seaweeds, seaweeds as a source of polysaccharides, seaweeds for removal of heavy metals. Mangroves – types and economical importance of mangroves.

Unit V **(5 hours)**

Microbial Interaction – Seafood microbiology; normal genera associated with fish, food spoilage, fish & human pathogens; Indicator of pollution – faecal coliforms; Prevention & control

Text Books:

1. Munn C., **Marine Microbiology: Ecology and Applications,** Garland Science, New York, Second Edition, 2011.

Reference Books:

1. Michael J., Pelczar I.R., Chan E.C.S. and Noel R. Kreieg, **Microbiology**, Tata McGRAW–Hill, New Delhi, Fifth Edition, 2004.
2. Madigan M.T. and Martinko J.M., **Biology of Microorganisms**, Pearson Prentice Hall, USA, Eleventh Edition, 2006.
3. Elay A.R**., Microbial food poisoning**, Chapman and Hall, London, Second Edition, 1996.
4. Krichman D.L., **Microbial Ecology of the Oceans**, Wiley – liss, New York, 2000.

ELECTIVE III – b. PUBLIC HEALTH AND HYGIENE

(For those who joined since 2018-19)

Semester: VI **Hours per Week: 5**
Sub.Code: GBMBE6B **Credits: 5**

Course Outcomes:

Upon completion of the course, students will be able to,
CO 1: Attain knowledge in personal care health
CO 2: Reveal the environmental condition in human health
CO 3: Impact of public hygiene in environmental pollution
CO 4: Sympathize the public action against healthy environment.
CO 5: Acquainted with health service policies for public health
CO 6: Interpret the issues related to environment affecting health and sustainable development

Unit I **(15 hours)**

Personal Health – WHO definition of health – Personal hygiene: Cleanliness, habits, balanced diet – Life style and health – exercise – fitness practise, Yoga: aim, asanas, disease concept, basics about meditation for holistic health.

Unit II **(15 hours)**

Pollution and Health – Effects of air pollutants and health of man – Acid rain, automobile and industrial pollution : effect of oxides of carbon, sulphur and nitrogen. Water pollution and Soil Pollution – Effect of fertilizers, Pesticides, and Heavy metals on human health – Eutrophication – Sewage – disposal and treatment. Solid wastes management and Composting.

Unit III **(15 hours)**

Environment and disease –Water and air borne disease – Tuberculosis and respiratory infections, skin infections, cholera, Amoebiasis, Helminthiasis – diagnosis, precautions and remedial measures, Vector borne diseases – malaria, dengue, Chikungunya disease related to dietary deficiency – Measures to prevent manifestation of ill health: provision of clean drinking water

Unit IV **(15 hours)**

Population and health–Population explosion – Urbanization and its impacts –occupational health hazards – Food contamination and additives – Measures to prevent manifestation of ill health: provision to provide clean drinking water, demerits of pesticides application of biopesticides and biofertilizers, proper diet with supplementation – Impact of junk food on human health and its manifestations

Unit V **(15 hours)**

Health services and policies – Understanding, need and goals for various policies related to public health and organization – Health policy, nutritional policy, women policy, child policy; Union Ministry of Health and Family Welfare – objectives; schemes; implementation

Text Books:

1. Ronald Bayer, **Public Health Ethics: Theory, Policy and Practice**, Oxford University Press, USA, 2008.

Reference Books:

1. Norman G., Marriott and Robert B. Gravani, **Principles Of Food Sanitation**, Springer, Chapter 6, pp 83–98, Fifth Edition,2006.
2. Schmidt R.H. and Rodrick G.E., **Food Safety Handbook, Part 2: Prevalence of foodborne pathogens**, Wiley, First Edition, 2002.
3. Turk and Turk, **Environmental Science**, Saunders Company, USA, 1995.
4. Yash pal Bedi, **Hygiene and Public Health**, Anand Publishing Co, gali No. 1, NawanKot Amritsar, 1976.
5. Publications of World Health Organization on Health and Diseases.

SKILL BASED ELECTIVE VI – LAB COURSE IN AQUACULTURE

(For those who joined since 2018-19)

Semester: VI **Hours per Week: 3**
Sub.Code: GBMBC65P **Credit: 2**

Course Outcomes:

CO 1: Provide a basic understanding of aquarium setting
CO 2: Preparation of fish feeds
CO 3: Maintenance of aquarium for breeding
CO 4: Enlighten the entrepreneurial skills

List of Experiments:

1. Visit to marine ornamental fish aquarium and hatchery unit in CMFRI
2. Describing nutritional requirements of fish and common aquarium fishes
3. Setting up of aquarium
4. Fish feeds – live and artificial feeds
5. Breeding of live breeding fish and egg layers – Zebra fish, Guppies fish, Mollies fish and Bubble nest
6. Isolation of bacteria from fishes and water
7. Gram staining of bacteria
8. Water quality management in aquarium
9. Visit to coastal area aquaculture, seaweed farms and fish preservation units

Text Books:

1. Brian Andrews, **Ornamental Fish Farming: Miscellaneous Fish Farming Techniques,** BookBaby, 2013.
2. Ramanathan et al., **Tropical freshwater ornamental fish culture,** Department of fisheries farm management, Veterinary and animal sciences University, Tamil Nadu, 2000.
3. Murthi V.S., **Marine ornamental Fishes of Lakshadweep CMFRI**, Special publication, 2002.
4. Pillay T. V. R., Kutty M. N., **Aquaculture: Principles and Practices**, Wiley, 2005.

Reference Books:

1. Hertrampf J.W., Piedad-Pascual F., **Handbook on Ingredients for Aquaculture Feeds,** Springer Science & Business Media, 2003.
2. Claude E. Boyd, Tucker C.S., **Pond Aquaculture Water Quality Management,**Springer Science & Business Media, 2012.
3. Dey V.K., **Hand book of aqua farming**, MPEDA India, 1995.
4. Jameson J.D., Srinivasan A. and Venkataramanujam, **Ornamental fish culture technology**, TANUVAS publication Chennai, 1995.
5. Jameson J.D., and Santhanam R., **Manual of ornamental fishes and farming technologies Peejay**, Thoothukkudi, 1996.

NON MAJOR ELECTIVE OFFERED FOR THE STUDENTS OTHER THAN B.Sc., MICROBIOLOGY

Semester	Elective	Subject code	Subject title	H/W	Credit	CIA	ESE	Total
III	Non Major Elective I	GBNM3MB	LAB COURSE IN MUSHROOM CULTIVATION	4	2	-	50	50
IV	Non Major Elective II	GBNM4MB	LAB COURSE IN VERMICULTURE	4	2	-	50	50

NON MAJOR ELECTIVE I: LAB COURSE IN MUSHROOM CULTIVATION

(For those who joined since 2018-19)

Semester: III **Hours per Week: 4**
Sub.Code: GBNM3MB **Credit: 2**

Course Outcomes:

Mushroom cultivation lab facets the hands-on training for students to
CO 1: Describe the basic types of mushroom and its economic importance
CO 2: Expertise in various mushroom cultivation techniques
CO 3: Setup an own unit of mushroom cultivation firm
CO 4: Intend the candidates to go for self–employment.

List of Experiments:

1. Introduction & types of mushroom
2. Key to differentiate edible and poisonous mushrooms
3. Nutritional values & global status of mushroom
4. Preparation of culture, Mother spawn production and multiplication of spawn
5. Cultivation techniques of selected mushroom species (oyster / milky)
6. Harvesting and post-harvest handling techniques
7. Constraints in production – adverse environmental factors, pests and pathogens
8. Industrial cum study tour to mushroom cultivation farms
9. Preparation of food products of mushroom – Mushroom soup, pickle
10. Principles of marketing and marketing potentials

REFERENCE BOOKS:

1. Suman B.C. and Sharma V.P., **Mushroom Cultivation, Processing and Uses**, Agrobios. 2007.

2. Suman,B.C. and Sharma V.P., **Mushroom cultivation in India**, Eastern Book Corporation, 2007.
3. Shu–ting, Chang and Philip.G Miles, **Mushrooms: Cultivation, Nutritional value, Medicinal Effect and Environmental Impact**, CRC press, Washington, 2004.
4. Pathak Yadav Gour, **Mushroom Production and Processing Technology**, Agrobios (India), 2010.
5. EIRI, **Handbook of Mushroom Cultivation, Processing and Packaging,** Engineers India research institute.

NON MAJOR ELECTIVE II – LAB COURSE IN VERMICULTURE

(For students who joined since 2018-19)

Semester: IV **Hours per Week: 4**
Sub.Code: GBNM4MB **Credit: 2**

Course Outcomes:
Upon completion of the course, students will be able to,
CO 1: Demonstrate the core concepts about ecology.
CO 2: Classify the types of earthworms.
CO 3: Identify the local earthworms and their collection.
CO 4: Reflect critically about endemic & exotic earthworm composting.
CO 5: Utilize the wastes and paper as substrates for vermicomposting in a limited space.
CO 6: Reveal about aerobic & anaerobic composting.
CO 7: Exhibit the methods involved in the preparation of vermiwash.
CO 8: Emphasize knowledge about the issues in the life cycle of earthworms.
CO 9: Apply the vermiwash and vermicompost in fields
CO 10: Explore the knowledge on Vermicomposting and gain entrepreneur ideas through field trip.

List of Experiments:
1. Introduction to Ecology and Environment
2. Earthworms and types (ecological strategies)
3. Collection of local Earthworm sample
4. Compost using endemic & exotic varieties of earthworms
5. Compost using Paper, Cardboard and Vegetable wastes
6. Aerobic & Anaerobic composting
7. Preparations of Vermiwash
8. Life cycle of earthworms and related issues
9. Effect of Vermicompost and vermiwash in the growth of *Trigonella foenum -graecum* (Fenugreek) seeds
10. Field trip to Vermicomposting site

Reference Books:

1. Sultan Ahmed Ismail, **The Earthworm Book,** Edition 2, reprint, Other India Press, 2005
2. Katheem K.S, Mahamad H.I, Shlrene Quaik, Sultan Ahmed Ismail., **Prospects of Organic Waste Management and the Significance of Earthworms,** Springer international publishing Switzerland, 2016.
3. Bhatt J.V. and Khambata S.R., **Role of Earthworms in Agriculture,** Indian Council of Agricultural Research, New Delhi, 1959.
4. Dash M.C., Senapati B.K. and Mishra P.C., **Verms and Vermicomposting,** Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5–8, 1984, (Part B), School of Life Sciences, Sambalpur University, Jyoti Vihar, Orissa, 1980.
5. Edwards C.A. and Lofty J.R., **Biology of Earthworms,** Chapman and Hall Ltd., London, 1977.
6. Lee K.E., **Earthworms: Their ecology and Relationship with Soils and Land Use** Academic Press, Sydney, 1985.

GENERAL INTEREST COURSE I – ENVIRONMENTAL STUDIES
(For those who joined since 2018-19)

Semester: II **Hours per week: 2**
Sub.Code: GBES2 **Credits: 2**

Course Outcomes:

Upon the completion of the course, the students will be able to

CO1: Understand key concepts about the renewable and non-renewable resources of the environment.
CO2: Appreciate the concept, Structure and ecological pyramids of ecosystem.
CO3: Reflect critically about the different Protection Act of Biodiversity and its conservation.
CO4: Creates awareness about the environmental pollutions and its management.
CO5: Understand the natural resource exhaustion, related health issues in humans

Unit I **(6 hours)**

The concept of Environmental studies – Introduction, Definition, Scope and importance
Natural Resources **–** Forest, Mineral, Water and Land Resources, Food resources **–** changes caused by agriculture and overgrazing, effects of fertilizer and pesticide
Energy resources **–** use of alternate energy resources, Role of individual in conservation of natural resources.

Unit II **(6 hours)**

Ecosystems – Concept **–** Structure and function of an ecosystem, producers, consumers and decomposers, Energy flow **–** food chains **–** food webs and ecological pyramids

Unit III **(6 hours)**

Biodiversity and its conservation

Introduction – Definition – biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, endangered and endemic species of India, In- situ and Ex- situ conservation of biodiversity, Wildlife Protection Act, Forest Conservation Act, Public awareness,

Unit IV (6 hours)

Environmental Pollution and its prevention – Definition – causes, effects and control measures of air, water, soil. Climate change, global warming, acid rain, ozone layer depletion
Environment protection act – Air and Water (Prevention and Control of Pollution) Act, Solid waste management

Unit V (6 hours)

Human Population and the Environment – population growth – variation among nations – population explosion – Family welfare programme – Environment and human health – HIV/AIDS – Women and child welfare – Role of information technology in environment and human health

Text Books:

1. Kumaraswamy K., **Environmental Studies**, Jazym Publications, 2013.

References Books:

1. Dr. Biswarup Mukherjee., **Fundamentals of Environmental Biology**, Silver line Publications, 2008
2. Erach Bharucha, **Environmental studies for undergraduate courses**, University Grant commission, New Delhi, 2004
3. Arumugam N. and Kumaresan B., **Environmental Studies**, Saras publications, 2012.

DEPARTMENT OF MICROBIOLOGY AND BIOTECHNOLOGY

NOMINATION FOR THE NEXT BOARD OF STUDIES [2018-19]

SUBJECT EXPERTS LIST

S.No	Name & Designation
1	**Dr. A. Arun** Associate Professor and Head (i/c) Department of Microbiology Alagappa University Karaikudi – 630 003
2	**Dr. P. Rameshthangam** Assistant Professor Department of Biotechnology Alagappa University Karaikudi – 630 003
3	**Dr. RM. Vidhyavathi** Assistant Professor Department of Bioinformatics Alagappa University Karaikudi - 630 003
4	**Dr. V. Sugumar** Department of Oceanography and Coastal Area Studies School of Marine Sciences Alagappa University Thondi Campus Thondi – 623 409
5	**Dr M Anand** Assistant Professor Department of Marine & Camp; Coastal Studies, School of Energy Science Madurai Kamaraj University Madurai.