Syllabus for B.Sc., Microbiology

(For the students admitted from the Academic Year 2019-20 onwards)

PG & Research Department of Biotechnology & Microbiology

National College (Autonomous)

Tiruchirappalli – 620 001

PG & RESEARCH DEPARTMENT OF BIOTECHNOLOGY & MICROBIOLOGY

VISION

Transforming individuals into globally competent professionals with moral and ethical values.

MISSION

As a Department, we are committed to

- ✓ Achieve Academic Excellence in Microbiology through innovative teaching and learningprocesses
- ✓ Preparethestudentstobeaprofessionallycompetenttofacethechallengesintheirworkenvironment
- ✓ Establish world class infrastructure facilities inmicrobiology
- ✓ Encourage the students for active participation in co-curricular and extracurricularactivities
- ✓ Promote inter-disciplinary research among the faculty and thestudents
- ✓ Motivate the students to acquire entrepreneurial skills to become globalleaders
- ✓ Practice ethical standards by the faculty andstudents
- ✓ Enabling the faculty to improve theirknowledge through continuous improvement programmes.

PROGRAM EDUCATIONAL OBJECTIVES

B.Sc., Microbiology program will enable the graduates to

PEO1	Have a successful career in Microbiology and related disciplines.
PEO2	Excel in research career in microbiology and inter-disciplinary fields and actively contribute to science and society.
PEO3	Possess technical and professional competency to address growing demands of society and industrial needs ethically.
PEO4	Demonstrate life long independent and reflective skills in their career.
PEO5	Apply research and entrepreneurial skills augmented with a rich set of communication, teamwork and leadership skills to excel in their profession.
PEO6	Show continuous improvement in their professional career and appreciate human values and ethics

PROGRAM OUTCOMES

On completion of B.Sc., Microbiology Program, the students are expected to

No.	Description
PO1	Acquire both theoretical and practical knowledge of basic concepts in Microbiology
PO2	Understand and appreciate importance of microbes in different fields.
PO3	Explore microorganisms for novel day-to-day applications.
PO4	Satisfy educational entrance requirements of relevant professional bodies or to launch a career in microbiology or related disciplines.
PO5	Communicate effectively on complex microbial activities with the microbiology community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
PO6	Apply ethical principles, commit to professional ethics, responsibilities and norms of the life through value oriented life training.
PO7	Function effectively as an individual and as a member of diverse teams and in multidisciplinary settings.
PO8	Demonstrate knowledge and understanding of microbes and their products for betterment of environment and human life.
PO9	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technologicalchange.
PO10	Create confidence to become entrepreneur by providing entrepreneur skills and technical skills

B.Sc. MICROBIOLOGY
COURSE STRUCTURE UNDER C.B.C.S.

(Applicable to Candidates admitted from the Academic Year 2019-20 onwards)

Sem	Part	Course	Course Title	Inst. Hrs./ Wk	Credit	Exam Hrs.	Marks			Total
							CIA	External		
								W	O	
I	I	U19T1/U19H1/ U19S1	Tamil – I/ Hindi – I/ Sanskrit – I	6	3	3	25	75	-	100
	II	U19E1	English – I	6	3	3	25	75	-	100
	III	Core Theory I U19MB1	General Microbiology	5	5	3	25	75	-	100
		U19MB2P	Lab in General Microbiology & Microbial Physiology	3	-	-	-	-	-	-
		U19AMB1	Biochemistry - I	5	3	3	25	75	-	100
		U19AMB2P	Lab in Biochemistry - I & II	3	-	-	-	-	-	-
	IV	U19ES	Environmental Studies	2	2	3	25	75	-	100
Total				**30**	**16**					**500**
II	I	U19T2/ U19H2/ U19S2	Tamil – II/Hindi – II/ Sanskrit – II	6	3	3	25	75	-	100
	II	U19E2	English – II	4	2	3	25	75	-	100
		U19CE1	Communicative English – 1	2	1	3	25	70	05	100
	III	U19MB2P	Lab in General Microbiology & Microbial Physiology	3	6	3	25	70	05	100
		Core Theory III U19MB3	Microbial Physiology	5	5	3	25	75	-	100
		U19AMB2P	Lab in Biochemistry - I & II	3	3	3	25	70	05	100
		U19AMB3	Biochemistry - II	5	3	3	25	75	-	100
	IV	U19SBE 1	Computer Applications	2	2	3	25	75	-	100
Total				**30**	**25**					**800**

III	I	U19T3/U19H3/ U19S3	Tamil – III/Hindi – III/ Sanskrit – III	6	3	3	25	75	-	100
	II	U19E3	English – III	6	3	3	25	75	-	100
	III	Core Theory IV U19MB4	Bacteriology	4	4	3	25	75	-	100
		U19AMB4	Bioinstrumentation	4	3	3	25	75	-	100
		U19MB5P	Lab in Bacteriology & Microbial Genetics and Molecular Biology	3	-	-	-	-	-	-
		U19AMB5P	Lab in Bioinstrumentation & Biostatistics	3	-	-	-	-	-	-
	IV	U19SBE4	Medical Lab Technology	2	2	3	25	75	-	100
		U19SBE5P	Medical Lab Technology – Practical	2	2	3	25	70	05	100
Total				**30**	**17**					**600**
IV	I	U19T3/U19H4/ U19S4	Tamil – IV/Hindi – IV/ Sanskrit – IV	6	3	3	25	75	-	100
	II	U19E4	English – IV	4	2	3	25	75	-	100
		U19CE2	Communicative English – II	2	1	3	25	70	05	100
	III	Core Theory VI U19MB6	Microbial Genetics and Molecular Biology	4	4	3	25	75	-	100
		U19AMB6	Biostatistics	4	3	3	25	75	-	100
		U19MB5P	Lab in Bacteriology & Microbial Genetics and Molecular Biology	3	5	3	25	70	05	100
		U19AMB5P	Lab in Bioinstrumentation & Biostatistics	3	3	3	25	70	05	100
	IV	U19NMBT1	Non- Major Elective#	2	2	3	25	75	-	100
		U19VE	Value Education	2	2	3	25	75	-	100
Total				**30**	**25**					**900**

V	III	Core Theory VII U19MB7	Mycology and Parasitology	5	5	3	25	75	-	100
		Core Theory VIII U19MB8	Immunology	5	5	3	25	75	-	100
		Elective – Theory I U19MB9E	Virology	5	4	3	25	75	-	100
		Elective - Theory II U19MB10E	Genetic Engineering	5	4	3	25	75	-	100
		Core Course Lab IX U19MB11P	Lab for courses in Semester V	6	5	3	25	70	05	100
	IV	Non-Major Elective U19NMBT2	Non-Major Elective#	2	2	3	25	75	-	100
		U19SS	Soft Skills	2	2	3	25	75	-	100
Total				**30**	**27**					**700**
VI	III	Core Theory XI U19MB13	Food, Dairy and Industrial Microbiology	6	6	3	25	75	-	100
		Core Theory XII U19MB14	Bioinformatics	6	6	3	25	75	-	100
		Core Theory XIII U19MB15	Agricultural and Environmental Microbiology	6	6	3	25	75	-	100
		Elective - Theory III U19MB16E	Diagnostic Microbiology	5	4	3	25	75	-	100
		Core Course Lab X U19MB12P	Lab for Courses in Semester VI	6	6	3	25	70	05	100
	IV	U19GS	Gender Studies	1	1	3	25	75	-	100
		-	Extension Activities	-	1	-	-	-	-	-
Total				**30**	**30**					**600**
Grand Total				**180**	**140**					**4100**

- offered to students of other departments

SEMESTER - I		CODE - U19MB1
Core Course I: GENERAL MICROBIOLOGY		
CREDITS - 5		HOURS - 5

Preamble

This course is offered for the I year students to provide basic understanding of concepts and theories in Microbiology. It also helps students to understand different groups ofmicrobes.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	Define basic concepts and definitions of microbiology	K1
CO2	Familiarize basic concepts in microscopy and sterilization procedures	K1
CO3	Explain general characters of different groups of microbes andculturing media.	K2
CO4	Discuss the ultrastructure of bacterial cell. Differentiate prokaryotic and eukaryotic microbes	K2
CO5	Explain classification of microbes and Examine different methods for bacterial identification	K2

K1–Remember K2-Understand K3 -Apply

UNIT I

Introduction – Definition, scope and history of microbiology. Classification of microorganisms – general principles and nomenclature – Haeckel's three kingdom concept, Whittaker's five kingdom concept. Classification and characterization of bacteria according to Bergey's Manual of Systematic Bacteriology (9th edition). Basic understanding of classification of viruses, algae, fungi andprotozoa.

UNIT II

Microscopy: Principles and applications of simple, compound, bright field, dark field, phase contrast, fluorescent and electron microscopy. Principles of staining : Nature of dyes, types of staining – simple, differential, negative and spore staining, Sterilization : Principles and methods – physical (moist heat, dry heat, filtration, pasteurization, tyndallization, radiations) and chemical (alcohols, aldehydes, phenols, halogens andhypochlorites.

UNIT III

General characteristics and nature of Archaebacteria, Eubacteria, Cyanobacteria, Mycoplasmas, Rickettsiae, Chlamydias, Spirochaetes, Actinomycetes, Protozoa, Algae, Fungi andViruses.

UNIT IV

Microbial cell : Difference between the prokaryotic and eukaryotic microorganisms. Ultrastructure of bacteria, subcellular structures and cell envelope – slime, capsule, cell wall, pili, flagella, cell inclusions. Methods of bacterial identification – morphological, physiological, biochemical and serological properties.

UNIT V

Types of media: simple, defined, differential, selective, enriched, enrichment and transport media with specific examples for each type. Isolation of cultures from different samples: Spread plate, pour plate methods - Culture techniques – Pure culture techniques, streak plate and anaerobic culture - Methods of maintenance and preservation ofmicrobes.

TEXTBOOKS

1. Bernard D. Davis. Renato Dulbecco. Herman N. Eisen.and Harold, S. Ginsberg. (1990).Microbiology (4th edition). J.B .Lippincott company, NewYork.
2. Holt, J.S., Kreig, N.R., Sneath, P.H.A and Williams,S.T. Bergey's Manualof Determinative Bacteriology (9th Edition), Williams and Wilkins,Baltimore.
3. Prescott L.M. Harley J.P. and Klein D.A. (2003). Microbiology (5th edition) McGraw Hill, New York.
4. Madigan, M.T. Martinko.J.M and Parker J Brock T.D.(2017)Biology of Microorganisms.(15th edition).Prentice Hall International Inc,London.
5. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (2006). Microbiology, Mc. Graw Hill. Inc, NewYork.
6. Salle, A.J. (1996). Fundamental principles of Bacteriology.(7thedition).Tata McGraw-Hill publishing company Ltd, NewDelhi.
7. James G. Cappucina, Natalie Sherman. (1996). Microbiology – A laboratory manual, The Benjamin (Cummings Publishing C ompany,Inc.)
8. Mackie and McCartney. (1989). Practical Medical Microbiology, ChurchillLivingston.
9. Stainer, Ingharam, Wheelis and Painter. 1987. General Microbiology. 5th Edition. Macmillan Education,London.
10. PowarandDaginawala.2010.GeneralMicrobiology.VolumeI&II.HimalayaPublishingHouse
11. A Text book of Microbiology. Dubey, RC and Maheswari DK (2005). S. Chand & Company Ltd., NewDelhi.
12. Tortora, G.J., Funke, B.R. and Case, C.L. 2012. Microbiology - An Introduction. 11th Edition.PearsonEducation.

SEMESTER - I & II		CODE - U19MB2P
Core Course II: LAB IN GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY		
CREDITS - 3		**HOURS - 6**

Preamble

This course is offered for the I year students to provide practical understanding of basic techniques in microbiology laboratory. It also helps to learn methods in bacterial and fungal identification process.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	Familiarize general practices in microbiology laboratory	K1
CO2	Acquaint with parts of microscope and their handling for visualizing microbes	K2
CO3	Develop the skills in media preparation, sterilization and Inoculation techniques	K3
CO4	Apply and practice culturing, staining and biochemical techniques for microbial identification	K3
CO5	Acquire knowledge on Antibiotic Sensitivity Test, Haemocytometer, Micrometry and bacterial growth curve	K2 & K3

K1–Remember K2-Understand K3 -Apply

GENERAL MICROBIOLOGY

1. Microbiology laboratory: general practices and maintenances.
2. Microscopes – Basic Parts and Handling
3. Sterilization Principles and Techniques
4. Hanging Drop Experiment
5. Staining Techniques: Simple, Gram, Acid Fast, Spore
6. Media preparation: liquid, solid and agar slants, basal, enriched, enrichment, differential and selective
7. Inoculation techniques – pour plate – spread plate –dilution techniques
8. Micrometry

MICROBIAL PHYSIOLOGY

9. Growth of bacteria on liquid and solid media and their cultural characters.
10. Pure culture and subculture techniques.
11. Biochemical tests for bacterial identification – catalase test –oxidase test – IMVIC test – TSI test – Gelatin liquefaction – starch degradation – carbohydrate fermentation.
12. Viable bacteria –haemocytometer
13. Antibiotic Sensitivity Test (Kirby-Bauer Method)
14. Bacterial Growth Curve
15. Morphological Identification of Fungi.
16. Maintenance of Fungal cultures

SEMESTER - I		CODE - U19AMB1
Allied Course I: BIOCHEMISTRY - I		
CREDITS - 3		HOURS - 5

Preamble

This course is offered for the first year students as an allied course to enable them understand basic concepts and theories in Biochemistry.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	Define basic concepts and definitions employed in biochemistry	K1
CO2	List out factors affecting enzyme activity	K1
CO3	Explain basic characteristics of biomolecules namely carbohydrates, fats, nucleic acids and proteins.	K2
CO4	Discuss double helical model of DNA, Differentiate DNA and RNA.	K2
CO5	Describe enzymes and their role in living systems	K2

K1–Remember K2-Understand K3 -Apply

UNIT I

Chemistry of Carbohydrates: Definition and Classification of carbohydrates, linear and ring forms (Haworth formula) for monosaccharides for glucose and fructose. Disaccharides - sucrose and lactose. Physical properties - mutarotation. Chemical properties - Oxidation, reduction, osazone formation. Disaccharide - sucrose and lactose - occurrence, structure; Physical and chemical properties. Polysaccharides: starch and cellulose - occurrence, structure, physical and chemicalproperties.

UNIT II

Chemistry of aminoacids and proteins: Definition and classification of aminoacids, common properties of aminoacids, amphoteric nature, isoelectric point, isoelectric pH and Zwitter ion - Reaction with ninhydrin, 1-fluoro-2, 4-dinitronitrobenzene (FDNB) and SiegFried-s reaction – Proteins: Classification and Properties - Physical properties: salting in and salting out, denaturation, peptide bond - Structure of protein: primary, secondary, tertiary and quaternary - N-terminal determination – Edmans method and C- terminal determination - Van-Slykereaction.

UNIT III

Chemistry of Lipids: Definition, classification and functions. Occurrence, chemistry and biological functions-simple lipids: tertiary compound lipids (e.g. phospholipids), derived lipids: steroids (e.g. cholesterol). Saturated fatty acids: Butyric, arachidic and stearic acid. Unsaturated fatty acids: Oleic, linoleic and linolenic acid. Physical property emulsification. Chemical properties-saponification, rancidity, definition of acid number, saponification number, iodine number and Reichert-Meissl number. Bile acid and bile saltfunctions.

UNIT IV

Chemistry of Nucleic acids Definition, purines and pyrimidine bases, nucleoside, nucleotide and polynucleotide. Double helical model of DNA and its biological functions – Absorbance and effect of temperature – DNA types - Structure of RNA: tRNA, mRNA and rRNA-occurrence, chemistry and its biological functions. Differences between DNA and RNA.

UNIT V

Enzymes: Definition, units, various classification, nomenclature, specificity, isoenzymes, factors affecting enzyme activity – substrate, pH, temperature – conceptual view of MM equation – Enzyme Inhibition: Competitive, Noncompetitive and Uncompetitive – Vitamins: Definition, classification, water soluble (vitamin B1, B2, B3, B6, B12 and C) and fat soluble vitamins (A, D, E and K) – occurence, deficiency diseases, biochemical roles, daily requirements - Coenzyme forms and functions –Co-factors.

TEXTBOOKS

1. Fundamentals of Biochemistry - J.L. Jain, Sunjay Jain, Nitin Jain, S. Chand &Company.
2. Harper's Biochemistry- Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange Medical Books. 25thedition.
3. Biochemistry – Voet and Voet, 4th Edition, WileyPublication
4. Biochemistry- Dr. Amit Krishna De, S. Chand & Co.,Ltd.
5. Biochemistry – J. M. Berg, J. L. Tymochzo, L. Stryer (7th Edition) W. H. FreemanPublisher.
6. Lehninger Principles of Biochemistry- David L. Nelson, Michael M. Cox, Macmillan Worth Publishers.

SEMESTER - I & II		CODE - U19AMB2P
Allied Course II: LAB IN BIOCHEMISTRY - I & II		
CREDITS - 3		**HOURS - 6**

Preamble

This course is offered for the first year students as a lab course to enable them learn various practical approach for understanding biomolecules.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	General Guidelines employed in Lab Safety, working principle, basic handling and maintenance of common laboratory equipments.	K1
CO2	Understand and Apply basic calculations needed during preparationof solutions employed in biochemistry laboratory	K2 & K3
CO3	Develop the skills needed in estimation of various biomolecules	K2
CO4	Understand the importance of colorimetric analysis in biomolecules studies	K2

K1–Remember K2-Understand K3 -Apply

BIOCHEMISTRY – I

1. Lab Safety and Calculations in Biochemistry
2. Equipment Handling (Demo and Practice)
3. Preparation of Buffers
4. Measurement of ionic strength of buffers using pH meter
5. Estimation of glucose by Benedict's method
6. Identification of reducing sugars by DNS method
7. Estimation of Protein by Lowry's method
8. Estimation of Cholesterol

BIOCHEMISTRY – II

9. Isolation and estimation of biomolecules from natural sources Qualitative analysis
10. Carbohydrates: Glucose, fructose, galactose, mannose, maltose, lactose and arabinose and xylulose.
11. Amino acids: Arginine, cysteine, tryptophan and tyrosine.
12. Lipids: oils
13. Estimation of protein by Biuret method.
14. Estimation of DNA using diphenylamine.
15. Estimation of glucose by O-Toluidine.
16. Paper Chromatography(Demonstration)
17. Gel Electrophoresis(Demonstration)

SEMESTER - I		CODE - U19ES
Part IV: ENVIRONMENTAL STUDIES		
CREDITS - 2		HOURS - 2

UNIT I

Environment and Natural Resources: Definition, scope, importance of Environmental Studies - Need for public awareness. Natural resources — classification - Associated problems a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification • Role of an individual in conservation of natural resources • Equitable use of resources for sustainable lifestyles.

UNIT II

Ecosystems • Concept of an ecosystem • Structure and function of an ecosystem • Producers, consumers and decomposers • Energy flow in the ecosystem • Ecological succession • Food chains, food webs and ecological pyramids • Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans,estuaries).

UNIT III

Biodiversity and its conservation • Introduction — Definition: genetic, species and ecosystem diversity • Biogeographical classification of India • Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values • Biodiversity at global, National and local levels • India as a mega- diversity nation • Hot-spots of biodiversity • Threats to biodiversity: habitat loss, poaching of wildlife, man- wildlife conflicts • Endangered and endemic species of India • Conservation of biodiversity In-situ and Ex- situ conservation ofbiodiversity.

UNIT IV

Environmental Pollution Definition • Cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards • Solid waste Management : Causes, effects arid control measures of urban and industrial wastes • Role of an individual in prevention of pollution • Pollution case studies • Disaster management floods, earthquake, cyclone andlandslides.

UNIT V

Social Issues and the Environment • From Unsustainable to Sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Resettlement and rehabilitation of people; its problems and concerns. Case Studies • Environmental ethics: Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion,

nuclear accidents and holocaust. Case Studies • Wasteland reclamation • Consumerism and waste products • Environment Protection Act • Air (Prevention and Control of Pollution) Act • Water (Prevention and control of Pollution) Act • Wildlife Protection Act • Forest Conservation Act • Issues involved in enforcement of environmental legislation • Publicawareness.

TEXTBOOKS

1. Ekambaranatha Ayyar.M. and T.N. Ananthakrishnan, 1992. Manual of Zoology Vol. 1 [Invertebrata], parts I and II.S. Viswanathan (Printers and Publishers) Pvt. Ltd;Madras.
2. Agarwal, K.C. 2001 Environmental Biology, Nidi Pubi. Ltd.Bikaner.
3. Sharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.,Ahmedabad.
4. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw HillInc.
5. Clark R.S., Marine Pollution, Clanderson Press Oxford(TB)
6. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico PubI. House,Mumbai,
7. De A.K., Environmental Chemistry, Wiley EasternLtd.
8. Down to Earth, Centre for Science and Environment(R)
9. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ.Press.
10. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
11. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment.Cambridge Univ. Press
12. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House,Delhi.
13. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition.
14. Mhaskar A.K., Matter Hazardous, Techno-Science Publication(TB)
15. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co.(TB)
16. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co.USA.
17. RaoMN.&Datta,A.K.1987.WasteWatertreatment.Oxford&IBHPubi.Co.Pvt.Ltd.
18. Sharma B.K., 2001. Environmental Chemistry. Geol Pubi. House,Meerut
19. Survey of the Environment, The Hindu(M)
20. Townsend C., Harper J, and Michael Begon,Essentials of Ecology, Blackwell Science (TB)
21. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media(R)
22. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co.Philadelphia, USA (M) Magazine (R) Reference (TB)Textbook

SEMESTER - II		CODE - U19MB3
Core Course III: MICROBIAL PHYSIOLOGY		
CREDITS - 5		HOURS - 5

Preamble

This course is offered in the second semester for the students of Microbiology UG students. It provides strong foundation on different aspects related to microbialphysiology.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	Define definitions in microbial growth, transport and stress responses	K1
CO2	List out different terminologies associated with microbial growth and transport	K1
CO3	Explain bacterial growth curve and factors affecting it, Bacterial bioluminescence and transport of nutrients	K2
CO4	Discuss aerobic, anaerobic respiration process and various biogeochemical cycles in microbes	K2
CO5	Compare and Contrast aerobic and anaerobic respiration pathway stages	K2 and K3

K1–Remember K2-Understand K3 -Apply

UNIT I

Microbial growth: Definition of growth, balanced and unbalanced growth, growth curve, generation time, specific growth rate, batch and continuous culture, factors affecting microbial growth - Synchronous growth, diauxic growth curve. Measurement of cell numbers, cell mass and metabolic activity - classification based on temperature and pH ranges, solutes and water activity, oxygen concentration.

UNIT II

Microbial Transport: Diffusion – Passive and facilitated, Primary active and secondary active transport, Group translocation, symport, antiport and uniport, transport of Iron – sporulation - Modes of nutritional uptake - passive diffusion, facilitated diffusion and active transport.

UNIT III

Aerobic and Anaerobic respiration: Glycolysis, Kreb's cycle, EMP pathway, ED, pathway, Pentose-Phosphate pathway, Electron transport chain – Phosphorylation: Oxidative and Substrate level phosphorylation. Homo and Hetero Fermentation.

UNIT IV

Microbial stress responses- Osmotic stress and osmoregulation, oxidative stress, pH stress and acid tolerance, thermal stress and heat shock response, nutrient stress and starvation stress, extremophiles. Bacterial bioluminescence: Definition, mechanisms, significance & applications. Photosynthetic microbes and their photosynthetic pigments- oxygenic phototrophic bacteria (Cyanobacteria)-Anoxygenicphototrophicbacteria(GreenandPurplebacteria)-CO_2fixation,Calvincycle.

UNIT V

Biogeochemical cycles- Carbon cycle, nitrogen cycle, sulphur cycle. Introduction to biological nitrogen fixation. Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

TEXTBOOKS

1. Bernard D. Davis. Renato Dulbecco. Herman N. Eisen.and Harold, S. Ginsberg. (1990). Microbiology (4th edition). J.B .Lippincott company, NewYork.
2. Holt, J.S., Kreig, N.R., Sneath P.H.A andWilliams,S.T. Bergey's Manual of Determinative Bacteriology (9th Edition), Williams and Wilkins, Baltimore.
3. Prescott L.M. Harley J.P. and Klein D.A. (2003). Microbiology (5th edition) McGraw Hill, New York.
4. Madigan, M.T. Martinko.J.M andParker J Brock T.D. (2017)Biology of Microorganisms.(15th edition).Prentice Hall International Inc,London.
5. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (2006). Microbiology, Mc. Graw Hill. Inc, NewYork.
6. Salle, A.J. (1996). Fundamental principles of Bacteriology.(7th edition).Tata McGraw-Hill publishing company Ltd, NewDelhi.
7. James G. Cappucina, Natalie Sherman. (1996). Microbiology – A laboratory manual, The Benjamin (Cummings Publishing C ompany,Inc.)
8. Mackie and McCartney. (1989). Practical Medical Microbiology, ChurchillLivingston.
9. Stainer, Ingharam, Wheelis and Painter. 1987. General Microbiology. 5thEdition. Macmillan Education,London.
10. PowarandDaginawala.2010.GeneralMicrobiology.VolumeI&II.HimalayaPublishingHouse
11. A Text book of Microbiology. Dubey, RC and Maheswari DK (2005). S. Chand & Company Ltd., NewDelhi.
12. Tortora, G.J., Funke, B.R. and Case, C.L. 2012. Microbiology - An Introduction. 11th Edition. PearsonEducation.

SEMESTER - II		CODE - U19AMB3
Allied Course III: BIOCHEMISTRY - II		
CREDITS - 3		HOURS - 5

Preamble

This course is offered in second semester for microbiology UG students. It enables students to learn and understand different metabolic pathways observed in living cells. This course also helps students to know linking between differentpathways.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	Define basic concepts and definitions of metabolism and metabolic pathways	K1
CO2	List out different stages in metabolism of various biomolecules	K1
CO3	Explain important metabolic pathways associated with various biomolecules	K2
CO4	Compare and contrast various metabolic pathways and understand important links among each pathway.	K2 & K3

K1–Remember K2-Understand K3 -Apply

UNIT I

Introduction to Metabolism: Definition, Anabolism, catabolism, Metabolic Pathways, Importance Carbohydrate Metabolic Pathways: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogenesis and Glycogenolysis, Entner-Doudoroffpathway.

UNIT II

Amino Acid Metabolism: General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids - Special metabolism of methionine, histidine, phenylalanine - Urea cycle and its regulation.

UNIT III

Lipid Metabolism: Introduction - Hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids - Fatty acid biosynthesis, Lipid biosynthetic pathway - Metabolism of cholesterol and production of bilepigments.

UNIT IV

Nucleic acid Metabolism: Nucleic Acid Biosynthesis - Degradation of purine and pyrimidine nucleotides - Purine salvage pathway - Biosynthesis of deoxyribonucleotides and polynucleotides - Inhibitors of nucleic acidbiosynthesis.

UNIT V

Coenzymes. Cofactors & Vitamin Metabolism: Role and mechanism of action of NAD+/NADP+, FAD, thiamine pyrophosphate, biotin, pyridoxal phosphate - Biosynthesis of Vitamins – Ascorbic acid and Folic acid.

TEXT BOOKS

1. Donald Voet, Judith G. Voet and Charlotte W. Pratt, “Fundamentals of Biochemistry – Life at the molecular level”. John Wiley and Sons, Inc., Asia,2006.

2. Robert K. Murray, Daryl K. Granner and Victor W. Rodwell, “Harper’s Illustrated Biochemistry”. McGraw Hill Education (Asia),2006.

3. Jeremy M. Berg, John L. Tymozko and Lubert Stryer, “Biochemistry”, Fifth edition, W.H. Freeman

and Company, New York,2002.
4. David L. Nelson and Michael M. Cox, “Lehninger Principles of Biochemistry” Fourth Edition, W H Freeman and Company, New York,2005.

SEMESTER – III		COURSE CODE: U19MB4
Core Course IV – BACTERIOLOGY		
HOURS: 4		CREDITS: 4

Objectives:

- To understand the classification of bacteria.
- To understand the pathogenicity of bacteria.

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Understand the characteristics of pathogenic bacteria	C2
➢ Explain the pathogenicity of bacteria	C3
➢ Understand host-pathogen interaction	C2
➢ Employ the learnt basics for specimen collection	C3

C1 – Remember C2 – Understand C3 – Apply

UNIT I

Normal microbial flora of human body; General attributes and virulence factors of bacteria causing infections. Host Parasite relationships. Mechanism of bacterial pathogens-virulence factors-routes of infection.

UNIT II

Morphology, classification, cultural characteristics, pathogenicity, laboratory diagnosis and prevention of infections caused by the following organisms: *Staphylococcus aureus, Streptococcus pneumoniae, Neisseria meningitidis, Neisseria gonorrhoeae, Corynebacterium diphtheriae*, *Clostridium tetani, Clostridium botulinum.*

UNIT III

Morphology, cultural characteristics, pathogenicity, laboratory diagnosis and prevention of infections caused by the following organisms: *Escherichia coli, Shigella, Salmonella, Vibrio cholerae, Pseudomonas, Mycobacterium tuberculosis, Mycobacteriumleprae.*

UNIT IV

Morphology, cultural characteristics, pathogenicity, laboratory diagnosis and prevention of infections caused by the following Zoonotic disease causing organisms and its control: *Bacillus anthracis, Brucella, Leptospira, Francisella tularensis, Coxiellaburnetii*

UNIT V

Collection and transport of clinical specimens, Hospital borne infections and its control measures, Disposal methods of hospital wastes. Antibacterial agents-drug resistance and sensitivity.

TEXT BOOKS

1.Salle, A.J. (1992). Fundamental Principles of Bacteriology. 7th Edition, Mc. Graw Hill Publishing Co. Ltd., NewYork.

2. AnanthanarayananR.andJayaramPanickerC.K.(1994).TextbookofMicrobiology.OrientLongman

3.Baron, E.J. and Finegold S.M. (1995). Scientific Company. Diagnostic Microbiology. Blackwell ScientificCompany.

4. Brooks G., Carrol K.C., Butel J. and Morse S. (2012) Jawetz Melnick and Adelberg Medical Microbiology, 26th Edn. Lange MedicalPublications.
5. Greenwood D., Slack R.C.B., Barer M.R. and Irving W.L. (2012) Medical Microbiology, 18th Edn. Elsevier ChurchillLivingstone.

SEMESTER–III & IV		COURSE CODE: U19MB5P
Core Course V: LAB IN BACTERIOLOGY & MICROBIAL GENETICS AND MOLECULAR BIOLOGY		
HOURS: 6		**CREDITS: 5**

Preamble

This course is offered for 2nd year (3rd Semester) students to provide an outline idea on various practical aspects in identifying bacterial organisms.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	Get practical knowledge in specimen collection and processing	K1
CO2	Become technically expert which will helpful to work in clinical laboratory	K1
CO3	Able to identify clinical pathogens and its mechanisms behind bacterial development of resistance to antibiotics	K2
CO4	Acquire knowledge of genetic material analysis and to independently work , handle on lab protocols involving molecular techniques	K3

K1–Remember K2-Understand K3 -Apply

BACTERIOLOGY

1. General requirements of collection, transport of clinical specimens, direct examination.
2. Simple, differential and special staining of clinical material.
3. Isolation and identification of bacterial pathogens from clinical specimens.
4. Isolation of microflora from human microbiome.
5. Antimicrobial sensitivity testing and determination of MIC and quality control.

MICROBIAL GENETICS & MOLECULAR BIOLOGY

1. Isolation of Plasmid DNA.
2. Estimation of nucleic acids
   a) UV - VIS spectrophotometer analysis.
   b) Analysis of nucleic acids by agarose gel electrophoresis.
3. Detection of proteins by SDS-PAGE
4. Isolation of spontaneous mutant: antibiotic resistant mutants
5. Isolation of auxotrophic mutant by chemical and UV mutagenesis
6. AMES test.
7. Uninterrupted bacterial conjugation.(Demonstration)
8. Isolation of phage.

References

1. Baily and Scott's Diagnostic Microbiology, 2006. MosbyLondon.
2. Collins and Lyne's Microbiological methods, 2001. Arnold publishers, Newyork.
3. Palanivelu P. Analytical Biochemistry & Separation Techniques 4/e, 21st Century Publication, Palkalai Nagar, Madurai - 625 021(2004).
4. Maniatis T., Fritsch E.F. & Sambrook J. Cold Spring, Molecular Cloning, A laboratory manual, Cold Spring Harbor laboratory (2002).
5. David R.W, Botstein D & Roth J.R., Advanced bacterial genetics, Cold Spring Harbor laboratory(1980).

SEMESTER - III		CODE – U19AMB4
Allied Course IV: BIOINSTRUMENTATION		
CREDITS - 3		HOURS - 4

Objectives:

- To understand the principle and working of spectroscopic techniques.
- To understand the practical applications of separation techniques.

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Understand the basics of instruments	C2
➢ Explain the separation technique and Structural elucidation	C3
➢ Separation and purification of biomolecules by Chromatography	C3
➢ Employ separation techniques for Proteins and Nucleic acid	C3

C1 – Remember C2 – Understand C3 – Apply

UNIT I

Basics of Instrumental analysis: Selection of analytical methods, Accuracy, Precision, Detection Limit, Sensitivity and Analytical Range – Types of errors: Random and Systematic – Calibration methods: Standard curve and internal standard addition.

UNIT II

Spectroscopic and Imaging Analysis: Principles, Instrumentations and Applications of UV-Visible and IR spectrophotometry, Fluorescence, **Electron Microscopy** (Scanning Electron Microscopy and Transmission Electron Microscopy) and Flow Cytometry.

UNIT III

Structure Elucidation Techniques: NMR, MS–Ionization (MALDI, ESI), Analyzer (TOF and Quadrupole) and Detector. **Separation Techniques:** Centrifugation – Principle and applications; Types (Differential, Ultra and industrial centrifugation).

UNIT IV

Chromatographic Techniques: Theories on chromatography: Rate and Plate theory and Van Deemter equation – Resolution of chromatography – Principle, Instrumentation and Applications of Thin Layer, Adsorption, Gel Exclusion, Ion exchange, Affinity, Gas and Liquid chromatography (HPLC).

UNIT V

Electrophoretic Techniques: Concepts of influential factors and troubleshooting – Principle, Instrumentation and Applications of Gel (Agarose, PAGE and SDS-PAGE), Capillary, Pulse field and Native. Isoelectric focusing: Theory, Instrumentation and Applications.

TEXT BOOKS

1. Skoog, D. A., Holler, F. J., and S. R. Crough. "Instrumental Analysis, 6th." (2007). Brooks Cole Publishing Company. USA.
2. Wilson, K., and J. Walker. "Principles and Techniques of Practical Biochemistry and Molecular Biology, 7th." (2010). Cambridge University Press, U.K.
3. R., and S.K. Anand. "Instrumental Methods of Chemical Analysis, 5th," 2012. Himalaya Publishing House, India.

REFERENCE BOOKS

1. Sharma, B.K. “Instrumental Methods of Chemical Analysis, 24th.” (2014). GOEL Publishing House, India.

SEMESTER - III & IV		CODE – U19AMB5P
Allied Course V: LAB IN BIOINSTRUMENTATION & BIOSTATISTICS		
CREDITS - 3		HOURS - 6

1. Spectrophotometric Evaluation of dyes by UV-Vis spectrophotometry
2. DNA quantification using UV-Vis spectrophotometry
3. DNA isolation from bacterial culture
4. DNA visualization by Gel electrophoresis
5. Paper chromatography
6. Lyophilization
7. SEM (Demonstration)
8. Flow Cytometer (Demonstration)
9. SPSS Software (Demonstration)

SEMESTER - III		CODE – U19SBE2
PART – IV: Skilled Based Elective II : MEDICAL LABORATORY TECHNOLOGY		
CREDITS - 2		HOURS - 2

Objectives:

- To gain basic knowledge on medical laboratory procedures
- To understand methods of measurable clinical parameters
- To understand basics of histopathology
- To understand the principles of biomedical equipment used in diagnosis

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Define diagnostic principles and methods	C1
➢ Understand the concepts of blood formation and status of maturation	C2
➢ Understand Collection, processing and preservation of blood and clinical samples	C2
➢ Describe methods of histopathological studies	C3

C1 – Remember C2 – Understand C3 – Apply

Unit I

Basic laboratory principles -Organization of clinical laboratory and Safety measures - personnel hygiene,code of conduct. Overview of Lymphatic system, Urinary system, respiratory system and circulatory system.

Unit II

Sample collection-Urine, sputum, Blood. Types of blood collection: capillary puncture-venipuncture, Anticoagulants. Composition of blood. Outline of Hematopoiesis. ABO blood grouping, Rh typing. Blood transfusion- Donor selection, Screening of donor (history, age, weight, Hb, pulse, BP, temperature, interval, registration), Post donation care, Preservation of samples.

Unit III

Blood cells count: Total count, differential cell count, platelet count, Hemoglobin Estimation, Packed cell volume (PCV) , Erythrocyte Sedimentation Rate [E.S.R.] – Westergren's Method, Bleeding time, clotting time, Latex agglutination test. Pregnancytest.

Unit IV

Introduction to Histopathology, Tissue preparation, labeling, Fixation – Simple fixative, compound fixative, histochemical fixative, Dehydration- Ethyl alcohol – Acetone, Clearing, impregnantion, embedding- Paraffin wax, sectioning. Microtome and its application.Staining of tissues - H&E Staining. Bio-Medical waste management- anoverview.

Unit V

Diagnostic Methods- Outline of Radio imaging, X-Ray, MRI, CT, Ultra sound scan, Mamography,ECG, EEG, Nephalometry, sphygmomanometer. Autoanalyser-Types of Auto Analysers-Semi and Fully automated Electrolyte Analyser (ISE). Need for Automation,Advantages of Automation.

References

1. GradWohl, Clinical Laboratory-methods and diagnosis, Vol-IKanai L. Mukherjee, Medical Laboratory Technology Vol. I.Tata McGraw Hill 1996, NewDelhi.
2. Gradwohls, 2000. Clinical Laboratory Methods and Diagnosis. (ed) AlesC.
3. Sonnenwirth and Leonard jarret, M.D. B.I. Publications, NewDelhi
4. Sood Ramnik,(2015), Text book of Medical Laboratory Technology,2nd edition, Jaypee Publications

SEMESTER - III		CODE – U19SBE3P
PART – IV: Skilled Based Elective II : MEDICAL LABORATORY TECHNOLOGY		
CREDITS - 2		HOURS - 2

1. Blood collection
2. Differential count of Leucocyte
3. Estimation of Haemoglobin
4. Packed Cell Volume [PCV]
5. Erythrocyte Sedimentation rate [ESR]
6. Bleeding Time, Clotting Time.
7. Latex Agglutination
8. Liver function tests (SGPT, SGOT)
9. Pregnancy test

References

1. Bernadette F. Rodak, George A. Fritsma, Kathryn Doig (2007) Hematology: Clinical Principles and Applications 3rd Ed, Elsevier HealthSciences.
2. RamanicSood,LaboratoryTechnology(Methodsandinterpretation)4thEd.J.P.Bros,NewDelhi
3. Mukharji, Medical LaboratoryTechniques, Vol - I, II & III, 5th Edn. Tata McGrawHill, Delhi.

SEMESTER - IV		CODE – U19MB6
Core Course VI : MICROBIAL GENETICS AND MOLECULAR BIOLOGY		
CREDITS - 4		HOURS - 4

Preamble

This course is offered for 2nd year (4th Semester) students to gain basic knowledge on genetic material and related process.

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO1	Understand the properties, structure and function of genes in living organisms at the molecular level	K1
CO2	Familiarize basic concepts in genetic material replication	K1
CO3	Gain knowledge about the genetic material transfer	K2 & K3
CO4	Gain knowledge on molecular mechanisms underlying mutations, detection of mutations and DNA damage and repair	K2
CO5	Understand the molecular mechanisms involved in transcription and translation	K2

K1–Remember K2-Understand K3 –Apply

UNIT I

History – experiments of Hershey Chase and Griffith, DNA as the genetic material – discovery of DNA structure – DNA, RNA as a genetic material – Genetic code, wobble hypothesis. Selection of bacterial variation: Direct - fluctuation test, indirect - replica plating. Mutagenesis and mutagenic agents. Detection of mutagen – ames test, in *vitro* mutagenesis.

UNIT II

DNA Replication: Basic rules- Semi conservative model- Meselson and Stahl experiment, replication of circular DNA molecule- conservative, rolling circle mechanism, θ mode of replication. Enzymes involved in DNA replication. Control of replication.

UNIT III

Genetic exchange in bacteria: Transformation. Conjugation. Transduction: DNA generalized and specialized transduction. Molecular biology of phages - T4 Phage and Lambda phage (Lytic and Lysogenic cycle).

UNIT IV

Mutations – spontaneous and induced, base pair changes, frame shifts, deletions, inversions, tandem duplications, insertions. Mutagens - Physical and Chemical mutagens, Outlines of DNA damage and repair mechanisms -excision repair, SOS.

UNIT V

Transcription – RNA polymerases in prokaryotes and eukaryotes – their function- process of transcription in prokaryotes- initiation, elongation and termination- factors involved. Regulation of gene expression in bacterial system- the operon model- detailed study of *lac* and *trp*operons.

REFERENCES

1. Benjamin Lewin. Gene VII: Oxford University Press:2000.
2. Watson, J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A., & Weiner, A. M. Molecular biology of the Gene 4/e, The Benjamin/Cumming Publishing Company Inc.1992.
3. Snyder L & Wendy W. Molecular Genetics of Bacteria, 2/e, ASM press, WashingtonDC, 2003.
4. DavidFreifelder.D.2008.MicrobialGenetics,EighteenthEdition,NarosaPublishingHouse,NewDelhi.
5. Freifelder,D.2000.MolecularBiology,SecondEdition,NarosaPublishinghouse.NewDelhi.
6. Turner, P.E., McLennan, A.G., Bates, A.D. and White, M.R.H. 1999. Instant Notes in Molecular Biology, Viva Books Ltd., NewDelhi.

SEMESTER - IV		CODE – U19AMB6
Allied Course VI : BIOSTATISTICS		
CREDITS - 4		**HOURS - 5**

Objectives:

- To understand the significance of statistical analysis in biology.
- To acquire knowledge on various statistical tools available for the analysis of biological data.

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Interpret the experimental data with statistical tools	C3
➢ Utilize the concepts of hypotheses and experimental designs for practical purposes	C3
➢ Understand the basics of statistical tools	C2
➢ Employ statistical methods for the analysis of biological data	C3

C1 – Remember C2 – Understand C3 – Apply

UNIT I:

Statistical Measures: Measures of Central tendency: Mean and its types, Median and Mode – Measures of Variation: Mean deviation and Standard deviation – Standard error – Correlation: Karl Pearson's Correlation Coefficient and Spearman's Rank Correlation Coefficient.

UNIT II:

Hypothesis Testing: Null and Alternative hypotheses–Type I and Type II errors – Level of significance – Small sample testing based on t and F distributions: single mean, difference of means, paired t-test and variance ratio test – Large sample testing: single mean, difference of means, single proportions and difference of proportions – Chi square test for Goodness of fit and Independent of attributes.

UNIT III:

Non – Parametric tests: Kruskal-Wallis test – Mann-Whitney U test – Rank test. Analysis of Variance: One way ANOVA.

UNIT IV:

Curve fitting: Regression: Linear and simple linear regression, Curve of regression – Least square method for straight lines and curves.

UNIT V:

Design of Experiments: Single factor experiments – Completely Randomized Design – Randomized Block Design – Latin Square Design – Factorial Design- Plackett Burmann Design – Response Surface Methodology. Introduction to Software Packages: SPSS and MATLAB

TEXT BOOKS:

1. Veer Bala Rastogi, “Fundamentals of Biostatistics“, Ane books Pvt. Ltd, Second edition , 2009.
2. Gupta S. P, “Statistical Methods”, Sultan Chand & Sons Publishers, 2004.

REFERENCE BOOKS:

1. Walpole R. E., Myers S.L. & Keying Ye, “Probability and Statistics for Engineers and Scientists”, Pearson Education Inc, 2002.
2. Jerrold H. Zar, Biostatistical Analysis, 4/e, Prentice Hall, 1999.
3. Douglas C. Montgomery, Design and Analysis of Experiments,7/e, Wiley, 2008

SEMESTER - V		CODE - U19MB7
Core Course VII : MYCOLOGY AND PARASITOLOGY		
CREDITS - 5		HOURS - 5

Objectives:

- To acquire knowledge on different types fungi and parasites.
- To learn the symptoms of the diseases caused by them.

Course Outcomes:

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

Course Outcome	COGNITIVE LEVEL
➢ To understand the basic properties and classification of fungi.	C1
➢ To gain knowledge on plant diseases caused by fungi.	C1
➢ To understand the life cycle of protozoan.	C2
➢ To understand the host-parasite interaction.	C2

C1 – Remember C2- Understand C3 - Apply

Unit I

Fungi-general characters of Phycomycetes, Chytridiomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Mode of nutrition, life cycle pattern in Phycomycetes, Ascomycetes and Basidiomycetes. Economic importance of fungi with special reference to Antibiotics, Organic acids, Enzymes, Fungal SCP and Edible Mushroom.

Unit II

Plant Diseases caused by Fungi : General aspects, effects, symptoms, causal organisms, disease cycle and control measures of Wart disease of Potato, White rust of Crucifers, Leaf curl of Peaches, Smut disease of Onion and leaf spot disease of Ground nut.

Unit III

Animal Diseases caused by Fungi. Mycoses, Mycotoxicoses, Phycomycoses, Candidiases, Dermatophytosis, Aspergillosis, Otomycosis, Penicillinosis and their therapy. Mycotoxins related disorders.

Unit IV

Introduction to Protozoan Diseases: Toxoplasma gondit, Plasmodium vivax, Giardia lamlia, Trypanosoma gambiense, Entamoeba histolytica and Cryptosporidium sp.; their symptoms and life cycle.

Unit V

Diseases cause by Fasciola hepatica, Taenia solium, Ascaris lumbricoides and their life cycle pattern. Host-parasite interaction, Nature of pathogens – intra and extra cellular, host resistance and defense mechanisms.

REFERENCE BOOKS

1. Chakraborthy,P.(2006). A Text Book of Microbiology.New Central book agency,Kolkata

SEMESTER - V		CODE - U19MB8
Core Course VIII : IMMUNOLOGY		
CREDITS - 5		HOURS - 5

Objectives:

- To understand the basic functions of immune system and its components.
- To interpret the various types of antibodies and their relative functions.
- To understand the mechanism of hypersensitivity and its implications.
- To analyze the issues and challenges in transplants and grafts.

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Define basic concepts and components in immunology,	C1
➢ Understand Innate and Adaptive immunity and the components	C2
➢ Understand mechanisms of Immune response	C2
➢ Apply basic techniques of antigen-antibody interactions	C3

C1 – Remember C2 – Understand C3 – Apply

UNIT I

Basics of Immune System: Historical perspectives and overview of immune system – Immunity – Classification: Innate, Acquired (Natural, Artificial - Active and Passive) – Innate: Anatomic, Physiological, Phagocytic and Inflammatory barriers – Acquired: Two arms (Humoral and Cellular), Haematopoiesis – Cells, tissues and organs of the immune system – their structure and functions – Interrelationship between innate and adaptive immunity.

UNIT II

Antigens Definition and types – Antigenicity – immunogen and immunogenicity – properties - epitope – hapten – adjuvants – Immune response and its types – Antibodies - structure – types – function – Clonal selection theory – Monoclonal Antibodies and its applications - Hybridoma Technology for MAb production- Complement – structure -properties – functions of complement components and pathways.

UNIT III

Antigen-Antibody Interactions: Definition, different levels of interactions - types – *in vitro* methods – agglutination – precipitation – ABO Blood grouping and Rh typing - ELISA – RIA – IF – Flowcytometry – HA & HI – CFT – *in vivo* methods – Skin tests - immune complex tissue demonstrations.

UNIT IV

Cell Mediated Immunity: T-cells and types - Antigen processing and presentation – Major histocompatability complex – Class 1 & 2. Cytokines: Interleukins and interferons - Cytokine receptors – Hypersensitivity – Definition - Gell and Coombs classification – Antibody mediated: Anaphylaxis (IgE mediated), Cytotoxic (antibody-dependent), immune complex mediated - Delayed type hypersensitivity - Autoimmune diseases - Immune tolerance.

UNIT V

Transplantation immunology – Blood Transfusion reactions – Tissue and Organ transplantation - Graft

rejection – Graft vs Host reaction – Tumor immunology – tumor associated antigens. Immune response to tumor - Vaccines –Immunization types – Vaccine types – live attenuated vaccines, killed vaccines, purified polysaccharide vaccines – toxoid vaccines – recombinant vaccines and DNA vaccines.

TEXT BOOKS

1. Punt J, Sharon Stranford, Patricia Jones and Judith A Owen. J. Kuby Immunology (2018) 8th ed. WH Freeman.
2. Roitt, I.M., M.David Roth, Jonathan Brostoff and David Male (Editors). Immunology (2012) 8th Edn, Elsevier Saunders, London, UK.
3. Richard Coico and Geoffrey Sunshine. Immunology: A Short Course, (2015) 7th Edn,Wiley Blackwell, NY,
4. Gabrial Virella (Editor) Medical Immunology (2001) 5th Edition, Marcel Dekkar, NY.
5. Weir M. D. and J. Stewart, Immunology (1997), 8th Ed., Churchill Livingston, USA.
6. Roitt, I.M., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Roitt's Essential Immunology (2017) 13th Edition, Wiley-Blackwell Publishers, UK
7. Hyde R. M., Microbiology and Immunology (2012), 3rd Edition. Springer Science & Business Media.
8. Ananthanarayanan R and C.K.Jayaram Paniker, Textbook of Microbiology, (2005) 7th ed., Orient Longman Publishers.
9. Pelczar M.J., E.C.S. Chan and N. R. Krieg, Microbiology, (2001), 5th ed., McGraw Hill Publications

SEMESTER - V		CODE - U19MB9E
Elective Course I: VIROLOGY		
CREDITS - 4		HOURS - 5

Objectives:

- To acquire knowledge on different types of viruses causing diseases to humans and plants
- To learn their methods of cultivation and preventive aspects.

Course Outcomes:

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

COURSE OUTCOMES	COGNITIVE LEVEL
➢ To understand the basic properties and classification of viruses.	C1
➢ To gain knowledge on virus cultivation, viruses affecting plants.	C1
➢ To get expose to the clinical aspects of DNA viruses.	C2
➢ To get expose to the clinical aspects of RNA viruses.	C2
➢ Explain classification of microbes and Examine different methods for bacterial identification	C2

C1 – Remember C2- Understand C3 - Apply

Unit I

History, General characteristics of virus: size, host specificity, viral structure, resistance, envelope, proteins. Classification of Viruses: Baltimore, ICTV classification. Replication of viruses.

Unit II

Cultivation of viruses (Cell culture, Embryonated egg). Sub viral agents –Virions, Prions, Satellite virus. Bacteriophages- Life Cycle & its types. Plant viruses - Cauliflower mosaic virus, RNA containing virus - Tobacco mosaic virus - Poty virus, Tomato spotted wilt, Potato leaf roll virus, Rice tungro virus, Mosaic disease of sugarcane

Unit III

Morphology, general properties, clinical symptoms, epidemiology, lab diagnosis and treatment of DNA viruses - Pox viruses: Orthopox virus, Herpes Simplex Virus, Adenoviruses, Cytomegalo virus. Varicella Zoster virus.

Unit IV

Morphology, general properties, clinical symptoms, epidemiology, lab diagnosis and treatment of RNA viruses- Picorna virus, Polio virus, Coxsackie virus, Rhabdo viruses, Orthomyxo viruses, Hepatitis virus, Corona Virus, Retro virus (HIV).

Unit V

Viral Vaccines. Prevention and treatment of viral diseases. Interferon & Antiviral agents. Identification of viruses: cytopathic effect. Sero diagnosis: antibody assay, haemaglutination, complement fixation test, immunofluorescence test, immunoassay, Western blot and molecular diagnosis of viral infections: nucleic acid probes, PCR.

REFERENCE BOOKS

1. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.

2. Singh V. (2010) Text book of Virology, 1st Edn. IBDC publishers.
3.Oarsman S.N.J., van Zyl G.U., Nutt L., Anderson M.I. and Preiser W. (2012) Virology Illustrated colour text, 1st Edn. Elsevier Health Sciences.
4. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing
5. Carter J and Saunders V(2007). Virology: Principles and Applications. John Wiley and Sons.
6. Chakraborthy,P.(2006). A Text Book of Microbiology.New Central book agency,Kolkata

SEMESTER - V		CODE - U19MB10E
Elective Course II: GENETIC ENGINEERING		
CREDITS - 4		HOURS - 5

Objectives:

- To understand the types of restriction enzymes.
- To describe the stages of gene cloning and cloning vectors in application.

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Interpret the restriction sites through restriction mapping.	C3
➢ Utilize the mechanisms of cloning vectors in genetic engineering.	C3
➢ Understand the basics of cloning and its techniques.	C2
➢ Employ sequencing methods for genetic experiments.	C3
➢ Differentiate the working of microarrays.	C2

C1 – Remember C2 – Understand C3 – Apply

UNIT I

Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, exonuclease & endonuclease, Concept of restriction and modification - Restriction endonucleases, DNA modifying enzymes, Ligases.

UNIT II

Different Kinds of Vectors - Plasmids, Phage vectors, Virus vectors, Shuttle vectors and expression vectors - YAC, BAC - S. cerevisiae system as a model. Methods of Transformation, Recombinant Selection and Screening, Molecular cloning.

UNIT III

Sequencing (chemical degradation; chain termination and automated sequence). Mutagenesis, altered expression and engineering genes. Site-directed mutagenesis.

DNA amplification using polymerase chain reaction (PCR): Key Concepts, Types (Reverse Transcriptase and cloning PCR), Analysis of Amplified Products. Applications of PCR: RFLP, RAPD, DNA Finger printing and Viral, bacterial detection. Blotting techniques.

UNIT IV

Strategies for the production of recombinant proteins - insulin- human growth hormone- industrially important proteins. Construction of genomic library and cDNA library. Concept of gene editing (CRISPR).

UNIT V

Application of rDNA Technology in plants: Transgenic plants with reference to virus and pest resistances, herbicide tolerance and stress tolerance (cold, heat and salt); Bio-pharmaceuticals and secondary metabolite production.

REFERENCE BOOKS

1. Bernard R, Glick and Jack J. Pasternak. (2002). Molecular Biotechnology, Panima Publishing House, New Delhi.
2. Brown T. A. (2001). Gene Cloning, Blackwell Science Publishers.
3. Ernst L and Winnacker. (2003). Genes to Clones, Panima Publishing House, New Delhi.
4. Glover D.M and Hames B.D. (1995). DNA cloning I & II, IRL Press.
5. Innis M. A, Gelfand D.H and Sninskey D. J. J. (1995). PCR strategies, Acadmic Press.
6. Primrose S. B. (2001). Molecular Biotechnolgy, Panima Publishing House, New Delhi.
7. Watson J.D, Gilman M, Witkowski and Zoller M. (1992). Recombinant DNA, Scientific American books.

SEMESTER -V		CODE – U19MB11P
Core Course Lab IX **LAB FOR COURSES IN SEMESTER V**		
CREDITS - 5		**HOURS - 6**

LAB FOR COURSES IN SEMESTER V
(Group & Individual practical)

1. Restriction digestion of DNA
2. Ligation of digested DNA
3. Transformation (Group)
4. Selection and Screening
5. Blood Grouping
6. Total WBC and RBC
7. Estimation of Haemoglobin
8. Preparation of Serum components
9. Radial Immunodiffusion test
10. Double Immunodiffusion test
11. Viruses – Classification
12. Viruses – Bacteriophage isolation
13. Plaque formation assay

SEMESTER - VI		CODE - U19MB13
Core Course XI : FOOD, DAIRY AND INDUSTRIAL MICROBIOLOGY		
CREDITS - 6		HOURS - 6

Objectives:

- To acquire knowledge on different types of industrially important organisms.
- To learn the methods of media formulation and preservation of these organisms and their applications.

Course Outcomes:

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

Course Outcome	COGNITIVE LEVEL
➢ To understand the basic properties and classification of industrially important microbes.	C1
➢ To gain knowledge on fermentor and its design.	C1
➢ To understand the methods of downstream processing and their application.	C2
➢ To understand the production of industrial products from microorganisms.	C2

C1 – Remember C2- Understand C3 - Apply

Unit I

Introduction-Importance of food and dairy Microbiology-Types of microorganisms in food spoilage-source of Contamination-Factors influencing microbial growth in Foods-Dairy and fermentative products (ice cream, yoghurt and kefir).

Unit II

Food borne diseases, intoxication and food poisoning- Staphylococcus, Clostridium, Escherichia coli and Salmonella infections. Elimination or control strategies of microbial load in foods: Removal of microorganisms, temperature control, water activity and moisture control, aerobic or anaerobic conditions (canning) – Concepts of Good manufacturing practices(GMP)-hazard analysis and critical control points and personal hygiene.

Unit III

Isolation and screening of industrially important microbes. Strain improvement, Media/substrates for industrial fermentation. Media formulation, Preservation of industrially important microorganisms. Fermentation and Fermentor/Bioreactor: Concepts of basic modes of fermentation – Batch, Fed batch and Continuous fermentation. Types of fermentation- surface, submerged and solid state. Fermentor and its types.

Unit IV

Bioprocessing – Downstream processing of industrial fermentation processes, product purification and recovery, Physico-chemical basis of bio-separation processes, techniques for purification of end products – chromatography, electrophoresis, distillation, filtration, crystallization.

Unit V

Antibiotics: Production and recovery of penicillin and streptomycin, production and recovery of Organic solvents- ethanol and wine, commercial production of vinegar. Enzyme kinetics- Production of enzymes-Amylases and protease. Amino acids: production of L-glutamic acid and L-lysine. Vitamins: Vitamin C, Organic acids-Lactic acid and Citric acid (fermentation and recovery).

TEXT BOOKS

2. Arnold L. Demain and Julian E. Davis. (2004). Industrial Microbiology and Biotechnology, ASM Press.
3. Casida L.E. (1968). Industrial Microbiology, John Wiley & Sons.
4. Emt.el-Mansi and Bryce C.F.A. (2004). Fermentation Microbiology and Biotechnology, Taylor and Francis Ltd.
5. Prescott L. M, Harley J. P and Klein D. A. (1999). Microbiology, 4th edition, Mc Graw Hill.
6. Stainer R.Y, Ingrtham J.L, Wheels M.L and Painter P.R. (1987). General Microbiology, MacMillan.
7. Stanbury P.F, Whitaker A and Hall S.J. (1997). Principles of fermentation technology, Oxford University Press.
8. William C. Frazier ,Dennis C. Westhoff , N.M. Vanitha . Food Microbiology, 2017.

SEMESTER - VI		CODE - U19MB14
Core Course XII: BIOINFORMATICS		
CREDITS - 6		HOURS - 6

Objectives:

- To understand the History and scope of Bioinformatics
- To learn the Features involved in bioinformatics
- To learn the Databases used in bioinformatics like NCBI, EMBL, DDBJ
- To learn the Techniques in bioinformatics.

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Understand the basic concepts of bioinformatics, biological databases for biomolecules.	C2
➢ Explore the knowledge about the computational tools and structural prediction analysis.	C3
➢ Types of structural prediction methods for proteins & DNA.	C3
➢ Interpret the 3D structure transmembrane proteins, membrane proteins and Lipids	C2
➢ Understanding and attempting to develop the new algorithms for structural & functional analysis of biomolecules.	C3

C1 – Remember C2 – Understand C3 – Apply

UNIT I

Introduction to Bioinformatics - Overview - Definition - History and Objectives of Bioinformatics - Scope of Bioinformatics - Bioinformatics in India.

UNIT II

Database Management System - Multiplicity of Data and Data Mining - Data Integration - Data Analysis. Online resources for Bioinformatics - Intranet and Internet Packages - Information Networks.

UNIT III

Genbank - Genome Sequence Database - NCBI, EMBL, DDBJ - Gene Disease Database - OMIM, KEGG disease database.

UNIT IV

Protein Sequence Databases - Swissprot, neXtprot, Interpro, PIR, Protein Data Bank, Prosite, Pfam, Prints, Blocks, Profiles.

UNIT V

Pair wise Sequence alignment - BLAST and FASTA - Gap Penalty - Multiple Sequence alignment - Clustal W - Clustal Omega - Phylogenetic analysis - NJ, MP, ML methods - distance and similarity - clustering methods.

TEXT BOOKS

10. S.C.Rastogi, Namita Mendiratta, Parag Rastogi, Bioinformatics - Concepts, Skills and Applications, Second Edition, CBS Publishers, New Delhi (2006)
11. T.K. Attwood and D.J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Ltd., New Delhi (2004).
12. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi (2003).
13. D. Higgins and W. Taylor (Eds), Bioinformatics- Sequence, structure and databanks,
14. Oxford University Press, New Delhi (2000). A. Baxevanis and B.F. Ouellette. Bioinformatics: A practical Guide to the Analysis of Genes and Proteins, Wiley-Interscience, Hoboken, NJ (1998).
15. S. R. Swindell, R.R.Miller and G.S.A.Myers (Eds.), Internet for the Molecular Biologist, Horizon Scientific Press, Wymondham, UK, (1996).
16. Andrea Cabibbo, Richard Grant and Manuela Helmer-Citterich (Eds.), The Internet for Cell and Molecular Biologists (2nd Edn.), Horizon scientificPress, Norwich, UK (2004).

SEMESTER - VI		CODE - U19MB15
Core Course XIII: AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY		
CREDITS - 6		HOURS - 6

Objectives:

- To acquire knowledge about the concepts of Aeromicrobiology, plant diseases, and disposal of wastes.

Course Outcomes:

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

COURSE OUTCOMES	COGNITIVE LEVEL
➢ To gain basic knowledge of interactions of microbes in Agriculture and Environment.	C1
➢ To get familiarize with the microbial involvement in the cyclic process.	C2
➢ To understand the microbial disease in agriculture and use of microbial pesticides	C2 & C3
➢ To procure knowledge on the involvement of microbes in air and aquatic system.	C2
➢ To get awareness on the treatment process of solid and liquid wastes.	C3

C1 – Remember C2- Understand C3 - Apply

Unit I

Microbial interactions - Commensalism, Synergism, Mutualism, Amensalism, Competition, Parasitism and Predation. Interaction of microbes with plants: Rhizosphere, Phyllosphere, Mycorrhizae. Biofertilizer (Azolla, Azotobacter, Azospirillum, Rhizobium) and their advanatges. Organic matter decomposition - Composting & Vermicomposting.

Unit II

Biogeochemical cycles –Carbon cycle, Nitrogen cycle: nitrification, denitrification, nitrogen fixation, Phosphorus cycle, Sulphur cycle and Iron cycle.

Unit III

Plant Pathology: Bacterial diseases - Citrus canker, Blight of rice. Fungal diseases - Red rot of sugarcane, Tikka leaf spot of ground nut. Viral diseases - TMV, Vein clearing disease of Bhendi, cauliflower mosaic. Microbial Pesticides – types and applications – Pseudomonas fluorescens, Bacillus thuringiensis, Trichoderma viridae and Nuclear Polyhedrosis Virus (NPV).

Unit IV

Microbiology of air –Sources of microorganisms in air –Assessment of air quality –air sampling techniques –Enumeration of air borne organisms –air borne diseases –air sanitation. Aquatic Microbiology –Ecosystems –Fresh water (Ponds, Lakes, Streams, Marine, Esturies, Mangrooves, Deep sea).

Unit V

Waste: Types of wastes – characterization of solid and liquid wastes. Solid waste treatment – saccharification – composting, Liquid waste treatment - Treatment methods – primary and secondary (anaerobic – methanogenesis) aerobic: trickling, activated sludge, oxidation pond – tertiary treatment. Biological Oxygen Demand & Chemical Oxygen Demand. Bioremediation of Xenobiotic compounds

(chlorinated hydrocarbons, pesticides, surfactants, metals, nitrates).

REFERENCE BOOKS

1. Agrios AG. Plant Pathology, Elsevier Academic Press, New Delhi. 2006.
2. Burns RC and Slater JH. Experimental Microbial Ecology – Blackwell Scientific Publications, Oxford, London. 1982.
3. Christon J Hurst. Manual of Environmental Microbiology, 2nd edition. American Society for Microbiology, Washington. 2002.
4. Duncan Mara and Nigel Horen. The Handbook of water and waste water Microbiology. Academic press-An imprint of Elsevier. 2003.
5. Gareth M Evans and Judith C Furlong. Environmental Biotechnology-Theory and Application, John Wiley and sons Ltd. 2003.
6. Jogdand, S.N. Environmental Biotechnology, Himalaya Publishing House. New Delhi. 2010. Munn CB. Marine Microbiology- Ecology and Applications. Bios Scientific publishers, New York. 2004.
7. Sambamurty A. Textbook of Plant Pathology, I.K. International Publishing House, New Delhi. 2009.

SEMESTER - VI		CODE - U19MB16E
Elective Course III: DIAGNOSTIC MICROBIOLOGY		
CREDITS - 4		HOURS - 5

Objectives:

- To asses and select appropriate methods for isolation and identification of infectious agents
- To professionally interpret the scientific information from microbiological reports
- To understand concepts of anti-microbial agents and their mechanisms of action

Course Outcomes:

At the completion of the course, the student would be able to:

COURSE OUTCOMES	COGNITIVE LEVEL
➢ Identify infectious agents and isolate them.	C3
➢ Perform tests to investigate anti-microbial agents.	C3
➢ Adhere and follow the standard guidelines for biohazard safety.	C3
➢ Differentiate the clinical samples for diagnosis	C2

C1 – Remember C2 – Understand C3 – Apply

UNIT I

Factors influencing development of infectious diseases. Components of infectious disease process. Modes of transmission. Types of diseases – communicable and non-communicable infectious diseases. Infectious diseases caused by bacteria, fungi, algae, protozoa, helminths and viruses.

UNIT II

Organization of a clinical microbiological laboratory – responsibilities and organization. Organization of Bacteriology section, mycology section, parasitology and virology sections in a clinical laboratory.

UNIT III

Standard precautions, concepts and methods of antisepsis, disinfections and sterilizations. Biological safety measures- gloves, masks, PPE, Biosafety levels, biosafety cabinets. Shipping or transport of pathogens and clinical specimens.

UNIT IV

Types of clinical specimens processed by a clinical microbiology laboratory. Specimen quality. Proper selection, collection, and transport of clinical samples. Contamination of samples. Rejection of samples.

UNIT V

Types of examination of samples - macroscopic, microscopic, and isolation. Staining techniques. Culture media – types and importance of sterile techniques. Identification of microorganisms using biochemical tests, Gas or liquid chromatography. Immunodiagnostic procedures. Molecular diagnostic procedures. Introduction to automated methods- microbe identification and immunodiagnostics.

REFERENCE BOOKS

1. Engelkirk, P.G., Duben-Engelkirk J.L, Laboratory diagnosis of infectious diseases : essentials of diagnostic microbiology, Wolters Kluwer/Lippincott Williams & Wilkins, c2008, ISBN: 9780781797016.
2. Carey RB, Bhattacharyya S, Kehl SC, Matukas LM, Pentella MA, Salfinger M, Schuetz AN. 2018. Practical Guidance for Clinical Microbiology Laboratories: Implementing a Quality Management System in the Medical Microbiology Laboratory. Clin Microbiol Rev. 31(3):e00062-17.

SEMESTER -VI		CODE – U19MB12P
Core Course Lab X **LAB FOR COURSES IN SEMESTER VI**		
CREDITS - 5		**HOURS - 6**

LAB FOR COURSES IN SEMESTER VI
(Group & Individual practical)

1. Introduction to parts of the fermentor
2. Mode of fermentation (Batch, Fed-Batch & Continuous)
3. Bacterial Growth Curve (Culture flask and fermentor)
4. Production of Biomass
5. Amylase Production
6. Safety Guidelines to work in a clinical microbiology lab
7. Microscopic examination of clinical samples
8. Isolation of organisms from clinical samples
9. Identification of pathogenic bacteria using biochemical characteristics
10. Retrieval of DNA/Protein/Gene sequence from NCBI and similarity analysis
11. Biomolecule 3D structure prediction
12. Evolutionary analysis – DAMBE, MEGA
13. Molecular and structural visualization of biomolecules through PyMOL
14. Molecular Docking
15. Molecular Simulation
16. Enumeration of total microbial count of soils
17. Isolation and Identification of N fixing bacteria from soil
18. Isolation of Phosphate solubilizing bacteria from soils
19. Identification of AMF- plant root association
20. Biocontrol activity of biopesticides against fungal plant pathogens
21. Isolation and enumeration of air borne organisms- air sanitation (fumigation)
22. Isolation and enumeration of bacteria from marine environment