MODELCURRICULUM

Name of the Degree Program	**:**	**BSc**
(Basic/Hons.) Discipline Core	**:**	**Microbiology**
Total Credits for the Program	**:**	**B.Sc. Basic - 136andB.Sc. Hons. –176**
Starting year of implementation	**:**	**2021-22**

Program Outcomes:
Competencies need to be acquired by the candidate securing B.Sc.(Basic) or B.Sc.(Hons)

By the end of the program the students will be able to:

1. Knowledge and understanding of concepts of microbiology and its application in **pharma, food, agriculture, beverages, nutraceutical industries**.
2. Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance.
3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.
4. Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
5. Exploring the microbial world and analyzing the specific benefits and challenges.
6. Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
7. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
8. Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.
9. Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
10. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectuall property rights,biosafety and biohazards.
11. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, there by improving the employability.
12. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

Assessment:
Weightage for assessments (in percentage)

Type of Course	Formative Assessment /IA	Summative Assessment
Theory	**40%**	**60%**
Practical	**40%**	**60%**
Projects	**40%**	**60%**
Experiential Learning (Internships/MOO/ Swayametc.)	**40%**	**60%**

Curriculum Structure for the Undergraduate Degree Program
BSc (Basic /Hons.)

Total Credits for the Program : 176
Starting year of implementation : 2021-22
Name of the Degree Program : B.Sc. (Basic/Hons.)
Microbiology Program Articulation Matrix:

Semester	Title /Name Of the course	Program outcomes that the course addresses (not more than 3per course)	Pre-requisite course (s)	Pedagogy##	Assessment$
1	DSC-1T MBL101 General Microbiology 4Credits 100Marks	1.Knowledge and Understanding of Concepts of microbiology. 2.Learningand practicing Professionals kills In handling microbes. 3.Thorough Knowledge and Application of Good laboratory And good manufacturing Practices in	PUC or +2 (Life Sciences as One of the core disciplines)	The general pedagogy to Be followed for theory And practicals are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial visits, Hands on training, Case observations, Models/charts preparations, Problem Solving mechanism, Demonstrations, Project	LSSSDC (NSDC) assessment and certification For lab Technician or Lab assistant Job role

		Microbial quality control.		presentations, Experiential Documentation and Innovative methods.	
	DSC-1P MBL101 General Microbiology 2Credits 50Marks				
2	DSC-2TMBL102 Microbial Biochemistry and Physiology 4Credits 100Marks	Thorough knowledge and understanding of concepts of microbiology and its application in different microbiological industries.		The general pedagogy to be followed for theory and practicals are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial	LSSSDC(NSDC) Assessment and certification for lab technician or Lab assistant job role
				visits, Hands on training, Case observations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.	
	DSC-2PMBL 102 Microbial Biochemistry and Physiology 2Credits 50Marks				
3	DSC-3T MBL103 Microbial diversity 4Credits 100Marks				
	DSC-3P				

	MBL103 Microbial diversity 2Credits 50Marks				
4	DSC-4T MBL104 Microbial Enzymology and Metabolism 4Credits 100Marks				
	DSC-4P MBL104 Microbial Enzymology and Metabolism 2Credits 50Marks				
5	DSC-5T MBL105 Microbial Genetics and Molecular biology 3Credits 100Marks				
	DSC-5P MBL105 Microbial Genetics and Molecular biology 2Credits 50Marks				
	DSC-6T MBL106 Immunology and Medical microbiology 3Credits 100Marks				
	DSC-6P MBL106 Immunology				

	and Medical microbiology 2Credits 50Marks				
6	DSC - 7TM BL107 Food and Dairy Microbiology 3Credits 100Marks				
	DSC-7PMBL107 Food and Dairy Microbiology 2Credits 50Marks				
	DSC-8TMBL108 Industrial Microbiology and Bioprocess Technology 3Credits 100Marks				
	DSC-8PMBL108 Industrial Microbiology and Bioprocess Technology 2Credits 50Marks				
	DSC-9TMBL109 Microbial Genetic Engineering 3Credits 100Marks				

	DSC-9PMBL109 Microbial Genetic Engineering 2Credits 50Marks				
7	DSC-10TMBL110 Environmental and Agricultural Microbiology 3Credits 100Marks				
	DSC-10PMBL110 Environmental and Agricultural Microbiology 2Credits 50Marks				
	DSC-11TMBL111 Pharmaceuticaland ForensicMicrobiology 4Credits 100Marks				
	DSC-12TMBL 112 Biosafety, Bioetics&IRP 4Credits 100Marks				
8	DSC-13TMBL 113 Genomics, Proteomics and Metabolomics 4Credits 100Marks				

	DSC-14T MBL 114 Aquatic Microbiology 3Credits 100Marks				
9	DSC-15T MBL 115 Microbial Genetic Engineering 3Credits 100Marks				
	DSC-15P MBL 115 Microbial Genetic Engineering 2Credits 50Marks				
	DSC-16T MBL 116 Environmental and Agricultural Microbiology 3 Credits 100Marks				
	DSC-16PMBL116 EnvironmentalandAgriculturalMicrobiology2 Credits 50Marks				

	DSC-17TMBL117 Pharmaceutical and ForensicMicrobiology 4Credits 100Marks				
10	DSC-18TMBL118 Emerging MicrobialTechnologies 4 Credits 100Marks				
	DSC-19TMBL119 Extremophylic Microbes andExtremolytes 4 Credits 100Marks				
	DSC-20TMBL120 Molecular Diagnosis, Drug Designing and Advanced Vaccines 3 Credits 100Marks				

 # Note:

##Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self-study like seminar, term paper or MOOC.

$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/Evaluating/Creating).However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

B. Sc., Microbiology (Basic / Hons.)Semester 1

CourseTitle:DSC-1T,MBL101,GeneralMicrobiology	
Total Contact Hours:**56**	Course Credits:**4+2**
Formative Assessment Marks:**40%**	Duration of ESA/Exam:**3Hrs**
Model Syllabus Authors:**Curriculum Committee**	Summative Assessment Marks:**60%**

CoursePre-requisite(s):*Mention only course titles from the curriculum that are needed to be taken by the students before registering for this course.*

CourseOutcomes(COs):
At the end of the course the student should be able to:
(Write 3-7 course outcomes. Course outcomes are statements of observable student actions that serve as evidence of knowledge,skills and value sacquired in this course)

1. **Thorough knowledge and understanding of concepts of microbiology.**
2. **Learning and practicing professional skills in handling microbes.**
3. **Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.**

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs1-12)

Course Outcomes (COs) /Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Thorough knowledge and understanding of concepts of microbiology	□	□		□								
2.Learning and practicing professional skills in handling microbes		□		□			□					
3. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.		□		□			□					

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course.Mark ‘X’ in the intersection cell if a course outcome addresses a particular program outcome.

B.Sc., Microbiology (Basic/ Hons.)Semester 1

Title of the Courses:
Course1:DSC-1T,MBL101,General Microbiology
Course2:OE1T,MBL301, Microorganisms for Human Welfare
Course3:SEC1T,MBL701,Microbiological Methods and Analytical Techniques

Course1:DSC-1T, MBL101, **General Microbiology**		Course 2: OE1T,MBL301, **Microorganisms for Human Welfare**		Course 3: SEC1T,MBL701, **Microbiological Methods and Analytical Techniques**	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**	**1**	**14**

ContentofCourse1:Theory:DSC-1T,MBL101,General Microbiology	**56Hrs**
Unit – 1:Historical development of microbiology	14Hrs
Historical development of microbiology-Theory of spontaneous generation, Biogenesis and Abiogenesis. Contributions of AntonVon Leeuwenhoek, Louis Pasteur, Robert Koch,Joseph Lister and Edward Jenner, Alexander Fleming, Martinus Beijirinck, Segei Winogrodsky, Elei Metechnikoff. Contributions of Indian scientists in the field of Microbiology. Scope of Microbiology. Fossil evidences of microorganisms. Origin of life, primitive cells and evolution of microorganisms. Microcopy- working principle, construction and operation of simple and compound microscopes.	
Unit –2:Staining,sterilization and preservation of microorganisms	14Hrs
Staining: Nature of strains, principles, mechanism, methods and types of staining-Simple, Differential-Gram staining, Acid fast staining, staining of capsule, cell wall,endospore. Sterilization: Principles, types and techniques, Physical, chemical, radiation and mechanical. Preservation of microorganisms: Definition, importance, methods of preservation of microorganism –slant culture, stab culture, soil culture, mineral oil overlaying, glycerol preservation, lyophilization, cryopreservation.	

Unit–3:Prokaryotic microorganisms:	14Hrs
Overview of prokaryotic cell structure: Size, shape, arrangement. Ultra structure of prokaryotic cell: Bacterial and Archaeal-cell wall and cell membrane. Components external to cell wall- capsule, slime, s-layer, pili, fimbriae, flagella; structure, motility, chemotaxis. Cytoplasmic matrix- Cytoskeleton, ribosome, inclusion granules: Composition and function. Nuclear Materials – Bacterial structure (its differences with the Eukaryotic chromosome); Extra Chromosomal material. Bacterial Endospore - Examples of spore forming organisms, habitats, function, formation and germination. Reproduction in bacteria.	
Unit–4:Eukaryotic microorganisms	14Hrs
Overview of eukaryotic cell: Types of cells; Structure and function of organelles- Cell wall, cell membrane, cytoplasmic matrix, cytoskeleton, endoplasmic reticulum, golgi complex, peroxisomes, lysosomes, vesicles, ribosomes, mitochondria chloroplast and nucleus. Structure and functions of flagella. Reproduction in eukaryotes: A brief account of vegetative, asexual and sexual methods of reproduction	

Course1:Practical: DSC-1P,MBL101,General Microbiology

1. Microbiological laboratory standards and safety protocols.
2. Operation and working principles of Light/Compound microscope.
3. Working principles and operations of basic equipments of microbiological laboratory (Laminar Air Flow Chamber, Autoclave, Hot air Oven, Incubator, pH meter, Spectrophotometer, Colorimeter, vortex, magnetic stirrer etc).
4. Demonstration and observations of microorganisms from natural sources under light microscope (Algae,Yeast and Protozoa).
5. Study of bacterial motility by hanging drop method.
6. Simple staining and negative staining technique
7. Differential staining- Gram staining.
8. Acid fast staining.
9. Structural staining - Flagella and capsule.
10. Bacterial endospore staining.
11. Staining of reserved food materials (granular).
12. Staining of fungi by lactophenol cotton blue.

Suggested Readings:

1. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
2. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
3. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
4. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
5. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark-12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
6. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
7. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
8. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008, Pearson Education.
9. Microbiology- Concepts and Applications, PelczarJr,Chan, Krieg, International ed, McGraw Hill.
10. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett
11. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Pub.Sudburry, 835 pp.
12. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.
13. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.Woolverton, 7th International, edition 2008, McGraw Hill.

Course2:Theory: OE1T, MBL301, Microorganisms for Human Welfare

Course2:OE1T,MBL 301,Microorganisms for Human Welfare	42Hrs
Unit–1:Food and Fermentation Technology	14Hrs
Fermented Foods–Types, Nutritional Values, Advantages and Health Benefits Prebiotics, Probiotics, Synbiotics and Nutraceuticals Fermented Products: Alcoholic-Beer and whisky; nonalcoholic beverages-coffee and tea; fermented dairy products-yoghurt and cheese; fermented fruit drinks-wine	
Unit–2:Agriculture	14Hrs
Bio-fertilizers and bio-pesticides - types and applications, beneficial microorganisms in agriculture, AM fungi, Mushroom cultivation, Biogas production.	
Unit –3:Biopharmaceuticals	14Hrs
Microbial Drugs–Introduction, Discovery, Antibiotics –Definition, characteristics, Types, Functions. Antibiotic Therapy and Development of Drug Resistance Vaccines–Types, Properties, Functions and Schedules	

Course 3: Theory: SEC 1T, MBL 701, Microbiological Methods and Analytical Techniques

LEARNING OUTCOMES

- Demonstrate skills as per National Occupational Standards(NOS) of "Lab Technician/Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council-LFS/Q0509,Level3.
- Perform microbiology and analytical techniques. Knowledge about environment ,health, and safety (EHS), good laboratory practices (GLP), good manufacturing practices (GMP) and standard operating procedures(SOP)
- Demonstrate professional skills at work, such as decision making, planning, and organizing, Problem solving, analytical thinking ,critical thinking, and documentation.

1. Principles which underlies sterilization of culture media, glassware and plastic ware to be used for microbiological work.
2. Principles of a number of analytical instruments which the students have to useduringthestudyandalsolaterasmicrobiologistsforperformingvariouslaboratorymanipulations.
3. Handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. They also get introduced to a variety of modifications in the microscopes for specialized viewing.
4. Several separation techniques which may be required to be handled later as microbiologists.

Course 3:Theory: SEC 1T,MBL701,

Microbiological Methods and Analytical Techniques

SEC1T,MBL701,Microbiological Methods and Analytical Techniques	14Hrs
DIGITALSKILLS: **The components of digital skills provided by KSHEC, will be followed accordingly.** **Microbiological Skills** Microbiological culture media: Composition, Preparation, Application and storage**;** Ingredients of media. Types- natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Isolation and cultivation of microorganisms: Collection of samples, processing of samples, serial dilution, technique, Inoculation of samples, incubation and observations of microbial colonies. Morphological characterization of microorganisms-Colony characteristics, Microscopic characters, biochemical / physiological tests or properties and identification. Sub-culturing of microorganisms and pure culture techniques. Preservation of microorganisms. Advanced Microscopic Skills: Different types of microscopes - Phase contrast,BrightField,DarkField,Fluorescent,ScanningandTransmissionElectron Microscopy **Analytical Skills** Centrifugation, Chromatography and Spectroscopy, Electrophoresis: Principles, Types, Instrumentation, Operation and applications.	

Course 3: Practicals: SEC 1P, MBL 701, Microbiological Methods and Analytical Techniques

1. Methods and practices in Microbiology lab: MSDS (Material Safety and Data Sheet),Good Clinical Practices (GCP),Standard Operating Procedure(SOP),Good Laboratory Practices(GLP),Good Manufacturing Practices (GMP)**.**
2. Usage and maintenance of basic equipments of microbiology lab: Principles, calibrations, and SOPs of balances, pH meter, autoclave, incubators, laminar air flow (LAF) and biosafety cabinets, microscopes, homogenizers,s tirrers.
3. Preparation of bacterial culture media
4. Preparation of fungal culture media
5. Preparation of algal culture media
6. Isolation and cultivation of bacteria, actinobacteria, fungi and algae
7. Identification and characterization of bacteria, actinobacteria,fungi and algae.
8. Biochemical and physiological tests for identification of bacteria
9. Separation of biomolecules by paper / thin layer chromatography.
10. Demonstration of column chromatography.
11. Preparation of permanent slides (bacteria, fungi and algae).
12. Procedures for documentation, lab maintenance, repair reporting.

Pedagogy:

The general pedagogy to be followed for theory and practicals are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling,RemedialCoaching.Field/Institution/Industrialvisits,Handsontraining,Caseobservations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.

Active learning as per LSSSDC (NSDC)LFS/Q0509guidelines,at skill training Level 3. Case studies about application of microbial biomolecules in various industries. Seminar on topics of microbial biochemistry.

FormativeAssessment:40%	
Assessment Occasion/type	**Weightage in Marks**
IA(2Tests)	20%:20Marks
Assignments/Visits	10%:10Marks
Seminars/Group Discussion	10%:10Marks
Total	40%:40Marks

Date	**CourseCo-ordinator**	**SubjectCommitteeChairperson**
14.09.2021	**SpecialOfficer,KSHEC**	**ViceChancellor,GulbargaUniversity**
	(Dr.Prasannakumar)	**(Prof.DayanandAgsar)**

B. Sc., Microbiology (Basic / Hons.)Semester 2

Title of the Courses:
Course 1: DSC-2T, MBL 102, Microbial Biochemistry and Physiology
Course2: OE-2T,MBL302, Environmental Microbiology and Human Health

Course1: DSC-2T,MBL102, Microbial Biochemistry and Physiology		**Course 2: OE-2T,MBL 302, Environmental Microbiology and Human Health**	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**

Content of Course:DSC-2T,MBL102, Microbial Biochemistry and Physiology	**56Hrs**
Unit-1Biochemical Concepts	14Hrs
Basic Biochemical Concepts: Major elements of life and their primary characteristics, atomic bonds and molecules – bonding properties of carbon, chemical bonds- covalent and non covalent, Hydrogen bonds and Vander Waal Forces. Biological Solvents: Structure and properties of water molecule, Water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water, Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer system, Handerson–Hasselbatch equation.	
Unit- 2 Macromolecules	14Hrs
Carbohydrates: Definition, classification, structure and properties. Amino acids and proteins: Definition, structure, classification and properties Lipids and Fats: Definition, classification, structure, properties and importance of lipids; fatty acids: types and classification, Vitamins, Definition, structure, properties and importance of chlorophyll, cytochromes and hemoglobin.	
Unit–3Microbial growth and nutrition	14Hrs
Microbial Growth: Definition of growth, Growth curve, phases of growth, Influence of environmental factors on growth, generation time and specific growth rate. Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth.	

Measurement of Growth: Direct Microscopic count - Haemocytometer; Viable count, Membrane filtration; Electronic Coulter Counting method; Measurement of cell mass; Turbidity measurements- Nephelometer and spectrophotometer techniques. Growth Yield (definition of terms). Microbial Nutrition: Microbial nutrients, macro and micronutrients, classification of organisms based on nutritional requirements. MembraneTransport:Structureandorganizationofbiologicalmembranes,Typesofcellular transport - passive, facilitated, active, group translocation, membrane bound protein transport system, carrier models, liposomes, ion channels, Na^+K^+-ATPase.	
Unit–4: Bioenergetics, Respiration and Photosynthesis	14Hrs
Bioenergetics: Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant, Redox potential, Laws of thermodynamics, Energy coupling reactions, Exothermic and Endothermic reactions. Respiration: Glycolysis, TCA cycle and electron transport chain, oxidative and substrate level phosphorylation. Anaerobic respiration, Fermentation(homo and heterolactic fermentation) Microbial Photosynthesis: Photosynthetic pigments in prokaryotes. Types of Bacterial photosynthesis– Oxygenic and Anoxygenic: Photophosphorylation- Cyclic and Non- cyclic Light reaction, Dark Reaction (CO_2 fixationpathways)-Calvincycle.	

Course 1: Practicals: DSC-2P, MBL 102, Microbial Biochemistry and Physiology

1. Preparation of normal and molar solutions
2. Calibration of pH meter and determination of pH of natural samples
3. Preparation of buffer solutions (any 4)
4. Qualitative analysis of carbohydrates
5. Qualitative analysis of amino acids and proteins
6. Qualitative analysis of lipids
7. Estimation of reducing sugars by DNS method
8. Estimation of protein by Lowry's/Biuret method
9. Determination of saponification values and iodine number of lipids/fattyacids
10. Determination of bacterial growth by turbidometric method
11. Effect of pH, temperature and salt concentration on bacterial growth
12. Demonstration of aerobic and anaerobic respiration in microbes

Text Books/References

1. BoyerR.(2002),Conceptsin Biochemistry2nd Edition,Brook/Cole,Australia.
2. Caldwell,D.R.(1995) –MicrobialPhysiologyandMetabolism.BrownPublishers.
3. FelixFranks,1993;ProteinBiotechnology,HumanaPress,New Jersey.
4. Harper,1999;Biochemistry,McGrawHill,NewYork.
5. LodishH,T.Baltimore,A.BerckB.L.Zipursky,P.Mastsydaire andJ.Darnell.(2004)–
6. Moat A. G., Foster J.W. Spector. (2004), Microbial Physiology 4th Edition Panama BookDistributors.
   MolecularCellBiology,ScientificAmericanBooks, Inc.Newyork.
7. NelsonandCox,2000;LehningerPrinciplesofBiochemistry, ElsevierPubl.
8. Palmer T. (2001), Biochemistry, Biotechnology and Clinical Chemistry, HarwoodPublication,Chichester.
9. StryerL,1995;Biochemistry,FreemanandCompany,NewYork.
10. Voet&Voet,1995;Biochemistry,JohnWileyandSons,NewYork.

Course 2:Theory: OE- 2T, MBL 302, Environmental Microbiology and Human Health

Course 2 :Theory: OE- 2T, MBL 302,Environmental Microbiology and Human Health	**42Hrs**
Unit–1:Soil and Air Microbiology	14 Hrs
Soil and Air as a major component of environment. Types and properties of soil. Distribution of microorganisms in soil and air. Major types of beneficial and harmful microorganisms in soil and air.	
Unit –2:WaterMicrobiology	14 Hrs
Water as a major component of environment. Types and uses of water. Microorganisms in different water bodies. Standard qualities and analysis of drinking water	
Unit –3:Microbial Diseases and Control	14 Hrs
Public health hygiene and communicable diseases. General Account of Microbial infections - Airborne, water borne and Food borne- Source, Mode of Transmission, Symptoms, Prevention and control. Surveillance of microbial infections.	

Text Books/References

1. ATextbookofMicrobiology,R.C.DubeyandD.K.Maheshwari,1stedition,1999,S.Chand&Company Ltd.
2. Alexopoulos,C.J.,Mims,C.W.,andBlackwell,M.2002.IntroductoryMycology.John WileyandSons(Asia)Pvt. Ltd.Singapore. 869 pp.
3. Atlas,R.M.1984.Basicandpracticalmicrobiology.MacMillanPublishers,USA.987pp.
4. Black,J.G.2008.Microbiologyprinciplesandexplorations.7edn.JohnWileyandSonsInc.,New Jersey846pp.
5. BrockBiologyofMicroorganisms,M.T.Madigan,J.M.Martinko,P.V.Dunlap,D.P.Clark-12thedition, PearsonInternational edition2009,PearsonBenjaminCummings.
6. FoundationsinMicrobiology,K.P.Talaro,7thInternationaledition2009,McGrawHill.
7. GeneralMicrobiology,Stanier,Ingrahametal,4thand5thedition1987,Macmillaneducationlimited.International,edition2008,McGrawHill.
8. Microbiology– AnIntroduction,G.J.Tortora,B.R.Funke,C.L.Case,10thed.2008,PearsonEducation.
9. Microbiology-ConceptsandApplications,PelczarJr,Chan,Krieg,International ed,McGrawHill.
10. Pommerville,J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett
11. Prescott,Harley,Klein'sMicrobiology,J.M.Willey,L.M.Sherwood,C.J.Woolverton,7thPub..Sudburry,835pp.
12. Schlegel,H.G.1995.GeneralMicrobiology.CambridgeUniversityPress Cambridge,655pp.
13. Toratora,G.J.,Funke,B.R.andCase,C.L.2007.Microbiology9thed.PearsonEducationPte.Ltd., SanFrancisco.958pp.

Pedagogy:

The general pedagogy to be followed for theory and practicals are as under.

Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling,RemedialCoaching.Field/Institution/Industrialvisits,Handsontraining,Caseobservations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experimental documentation and Innovative methods.

Formative Assessment:40%	
Assessment Occasion/type	**Weightage in Marks**
IA (2 Tests)	20%:20Marks
Assignments/Visits	10%:10Marks
Seminars / Group Discussion	10%:10Marks
Total	40%:40Marks

Date	**Course Co-ordinator**	**Subject Committee Chairperson**
14.09.2021	**Special Officer, KSHEC (Dr.Prasanna kumar)**	**Vice Chancellor, Gulbarga University (Prof. Dayanand Agsar)**

MANGALOREUNIVERSITY

B. Sc. MICROBIOLOGY

National Education Policy (NEP) - 2020

SYLLABUS AND EXAMINATION SCHEME

FOR

III AND IV SEMESTER

2022-23

PREAMBLE

The role of education is paramount in nation building. One of the major objectives of UGC is maintenance of standards of higher education. Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introductionof Choice Based Credit System (CBCS) which further expects Learning Outcome-Based curriculum to maximize the benefits of the newly designed curriculum. The Learning Outcome- Based Curriculum in Microbiology will help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. The commission strives to promote the link of students with the society/industry such that majority of the students engage in socially productive activities during their period of study in the institutions and at least half of the graduate students will secure access to employment/self-employment or engage themselves in pursuit of higher education. The model curriculum envisages to cater to the developmental trends in higher education, incorporating multi- disciplinary skills, professional and soft skills such as teamwork, communication skills, leadership skills, time management skills and inculcate human values, professional ethics, and the spirit of Innovation / entrepreneurship and critical thinking among students and promote avenues for display of these talents, linking general studies with professional courses. Besides imparting disciplinary knowledge to the learners, curriculum should aim to equip the students with competencies like problem solving, analytical reasoning and moral and ethical awareness. Introduction of internship and appropriate fieldwork/case studies are embedded in the curriculum for providing wider exposure to the students and enhancing their employability.

Learning outcomes specify what exactly the graduates are expected to know after completing a Programme of study. The expected learning outcomes are used as reference points to help formulate graduate attributes, qualification descriptors, Programme learning outcomes and course learning outcomes. Keeping the above objectives of higher education in mind the Learning Outcome-Based Curriculum Framework (LOCF) for the discipline of Microbiology has been prepared and presented here.

Composition of Curriculum - Committee for Microbiology

Sl. No.	Name and Organization	Designation
1	Prof. Dayanand Agsar Vice-Chancellor Gulbarga University, Kalaburagi	Chairman
2	Prof. S.R. Niranjan Professor, University of Mysore, Mysore	Member
3	Dr. Vedamurthy.A.B Professor, Karnataka University, Dharwad	Member
4	Dr.V.Krishna Professor, Kuvempu University, Shivamogga	Member
5	Dr.C.Srinivas Professor, Bangalore University, Bengaluru	Member
6	Dr.M.Jayashankar Professor, Mangalore University, Konaje	Member
7	Dr.Arun Jyothi MathiasAssociate Professor Maharani Cluster University, Bengaluru	Member
8	Smt. K.M.Sharuraj Associate Professor Govt. Science College, Hassan	Member
9	Dr. Anuradha.M Principal, Padmashree Institute of Management and Sciences, Bengaluru.	Member
10	Dr.Gayatri Devaraj Professor, Davangare University, Davangere	Member
11	Dr.Syeda Kausar Fathima Associate Professor, Govt. College for Women, Mandya	Member
12	Dr. M. Jayappa Special Officer, KSHEC, Bengaluru	Member Convener

Contents

Curriculum as per KSHEC

Program Name	**B.Sc. Discipline**	Total Credits for the Program	**Credits**
Core	**Microbiology**	Year of implementation	**2021-22**

Program Outcomes: At the end of the program the student should be able to:

(Refer to literature on outcome-based education (OBE) for details on Program Outcomes)

PO1. Knowledge and understanding of concepts of microbiology and its application in pharma,food, agriculture, beverages, nutraceutical industries.
PO2. Understand the distribution, morphology and physiology of microorganisms and demonstratethe skills in aseptic handling of microbes including isolation, identification and maintenance
PO3. Competent to apply the knowledge gained for conserving the environment and resolvingthe environmental related issues.
PO4. Learning and practicing professional skills in handling microbes and contaminants inlaboratories and production sectors.
PO5. Exploring the microbial world and analysing the specific benefits and challenges.
PO6. Applying the knowledge acquired to undertake studies and identify specific remedial measures forthe challenges in health, agriculture, and food sectors.
PO7. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
PO8. Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.
PO9. Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
PO10. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.
PO11. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyse outcomes by adopting scientific methods, thereby improving the employability.
PO12. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

Assessment:Weightage for assessments (in percentage)

Type of Course	**Formative Assessment / IA**	**Summative Assessment**
Theory	40	60
Practical	25	25
Projects	-	-
Experiential Learning (Internships etc.)	-	-

Contents of Courses for B.Sc. Microbiology as Major

Model II A

Semester	Course code	Course Category	Theory / Practical	Credits	Paper Title	Marks	
						S.A	I.A/ F.A
3.		DSC- 7	Theory	3	Microbial Diversity	60	40
			Practical	2	Microbial Diversity	25	25
		OE- 3	Theory	3	Microbial Entrepreneurship	60	40
4.		DSC- 8	Theory	3	Microbial Enzymology and Metabolism	60	40
			Practical	2	Microbial Enzymology and Metabolism	25	25
		OE- 4	Theory	3	Human Microbiome	60	40
	Exit Option with Diploma in Microbiology (100 Credits)						

Program Name	**BSc Microbiology**		Semester	**Third Semester**
Course Title	**Microbial Diversity**			
Course No.	**MBL-103**	**DSC -3T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2 Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):.

Course Outcomes (COs): At the end of the course the student should be able to:

1. Acquire knowledge about microbes and their diversity
2. Study the characteristics, classification and economic importance of Prokaryotic and Eukaryoticmicroorganisms.
3. Gain knowledge about viruses and their diversity

Content	**Hrs**
Unit–I	**08 Hrs**
Biodiversity and Microbial Diversity Concept, definition and levels of biodiversity; Biosystematics – Major classification systems-Numerical and Chemotaxonomy. Study and measures of microbial diversity; Conservation and Economic values of microbial diversity.	
Unit -II	
Diversity of Prokaryotic Microorganisms Distribution, factors regulatingdistribution of Prokaryotic Microorganisms. An overview of Bergey's Manual of Systematic Bacteriology. General characteristics; Classification; Economic importance of: **Archaea:** *Thermus aquaticus,* Methanogens **Bacteria:** *Escherichia coli, Bacillus subtilis,* **Cyanobacteria***: Microcystis, Spirulina* **Actinomycetes**: *Streptomyces, Frankia* **Rickettsiae:** *Rickettsia rickettsi* **Chlamydiae:** *Chlamydia trachomatis* **Spirochaetes:** *Trepanema pallidum,* **Mycoplasma:** A general account.	**16 Hrs**
Unit -III	
Diversity of Eukaryotic Microorganism General characters, distribution, Classification of eukaryotic Microorganisms: **Fungi:** Ainsworth classification- detailed study up to the level of classes. Salient features, reproduction and economic importance of fungi. Type study: *Rhizopus, Saccharomyces, Aspergillus, Agaricus, Fusarium* **Algae:** Occurrence, distribution,; thallus organization and economic importance. Type study: *Chlorella, Diatom, Gracilaria.* Symbiotic association- **Lichen** **Protozoa:** Occurrence, distribution, reproduction and economic importance. Classification up to the level of classes. Type study: *Euglena, Trichomonas,Plasmodium, Trypanosoma*	**16 Hrs**

Unit -IV	16 Hrs
Diversity of Viruses General structure, Isolation, purification and culturing of viruses. Principles of ViralTaxonomy- Baltimore and ICTV and the recent trends. Capsid symmetry- Icosahedral, helical, complex **Animal viruses:** HIV, Corona, Ortho and Paramyxovirus, Oncogenic virus **Plant viruses:** TMV, Papaya virus **Microbial viruses:** T4, lambda, cyano and myco phages. Sub viral particles. Viroids and Prions.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Knowledge about microbes and their diversity		✓			✓			✓				
Study, characters, classification and economicimportance of Pro-eukaryotic and Eukaryotic microbes		✓	✓		✓							
Knowledge about viruses and their diversity		✓				✓				✓		

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	**Weightage in Marks**
Attendance	10
Seminar and Assignment	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Microbial Diversity (Practical)**		Practical Credits	**2**
Course No.	**MBL-103**	**DSC-3P**	Contact hours	**26 Hrs**

Content

1. Isolation and identification of bacteria from soil, air and water
2. Isolation, and identification of fungi from soil, air and water
3. Isolation, and identification of Cyanobacteria
4. Isolation, and identification of Actinomycetes
5. Study of morphology of bacteria - cocci, bacilli, vibrio and spiral
6. Measurement of microbial cell size by Micrometry,
7. Spore count by haemocytometer
8. Type study: Cyanobacteria *Nostoc, Microcystis Spirulina*
9. Type study: Algae; *Chlorella, Diatoms, Gracilaria*
10. Type study: Fungi; *Rhizopus, Saccharomyces, Agaricus*
11. Type study: Protozoa: *Euglena,Plasmodium, Trypanosoma*
12. Study of micrographs /models - HIV, TMV, Corona virus

Practical assessment

Assessment

Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References:

1. Black, J.G. 2002. Microbiology-Principles and Explorations. John Wiley and Sons, Inc. New York
2. Brock, T.D. and Madigan, M.T. 1988. Biology of Microorganisms, V Edition. Prentice Hall. NewJersey
3. Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5th edition.Blackwell Publishing, USA
4. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington, D.C
5. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 2008. 7thInternational, edition ,McGraw Hill
6. Vashishta, B.R, Sinha A.K and Singh V. P. 2005. Botany – Fungi, S. Chand and Company Limited,New Delhi

7. Kotpal, R.L Protozoa 5th Edition 2008. Rastogi Publications, Meerut, New Delhi.
8. Madigan, M.T. Martinko, J.M, Dunlap, P. V. Clark, D. P. 2009. Brock Biology of Microorganisms, 12thedition, Pearson Benjamin Cummings
9. G. J. Tortora, B. R. Funke, C. L. 2008. Microbiology – An Introduction, Case, 10th edition., Pearson Education, UK.
10. Stanier, 1987,Ingraham *et al*, General Microbiology, 4th and 5th edition Macmillan education limited
11. Pelczar Jr. Chan, Krieg, Microbiology- Concepts and Applications, International edition, McGraw Hill
12. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 2002. Introductory Mycology. John Wiley andSons (Asia) Pvt. Ltd. Singapore. 869 pp, 4th edition.
13. Vashishta, B.R Sinha A.K and Singh V. P. 2005. Botany - Algae S. Chand and Company Limited,New Delhi
14. Dubey R. C., and Maheshwari, D. K. 1999. A Textbook of Microbiology, 1st edition, S. Chand &Company Ltd, New Delhi
15. K. P. Talaro, 2009. Foundations in Microbiology, 7th International edition, McGraw Hill

Date: Subject Committee Chairperson

Program Name	**BSc Microbiology**		Semester	**Third Semester**
Course Title	**Microbial Entrepreneurship**			
Course Code	**MBL:303**	**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**2 Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):	
Course Outcomes (COs): At the end of the course the student should be able to: 1. Demonstrate entrepreneurial skills 2. Acquire knowledge on Industrial entrepreneurship 3. Acquire knowledge on Healthcare Entrepreneurship	
Content	**42 Hrs**
Unit–I	**14 Hrs**
General Entrepreneurship Entrepreneurship and microbial entrepreneurship - Introduction and scope, Business development, product marketing, HRD, Biosafety and Bioethics, IPR and patenting, Governmentorganization/ Institutions/ schemes, Opportunities and challenges.	
Unit -II	**14 Hrs**
Industrial Entrepreneurship Microbiological Industries – Types, processes and products, Dairy products, Fermented foods, Bakery and Confectionery, Alcoholic products and Beverages, Enzymes – Industrial production and applications. Biofertilizers and Biopesticides, SCP and SCO. Neutraceutical products.	
Unit -III	**14 Hrs**
Healthcare Entrepreneurship Production and applications: Sanitizers, Antiseptic solutions, Polyphenols (Flavonoids), Alkaloids,Cosmetics, Biopigments and Bioplastics, Vaccines, Diagnostic tools and kits.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

References

1 Srilakshmi, B. (2007). Dietetics. New Age International publishers. New Delhi

2 Srilakshmi, B. (2002). Nutrition Science. New Age International publishers. New Delhi

3 Swaminathan, M. (2002). Advanced text book on food and Nutrition. Volume I. Bappco

4 Gopalan,.C. RamaSastry, B.V. and Balasubramanian, S.C (2009). Nutritive value of IndianFoods. NIN.ICMR.Hyderabad.

5 Mudambi S R and Rajagopal M V.2008. Fundamentals of Foods, Nutrition & diet therapy by NewAge International Publishers, New Delhi. 5th edition.

Date:

Subject Committee Chairperson

Program Name	**BSc Microbiology**		Semester	**Fourth Semester**
Course Title	**Microbial Enzymology and Metabolism**			
Course No.	**MBL:104**	**DSC -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2 Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):

Course Outcomes (COs): At the end of the course the student should be able to:

1. Differentiating concepts of chemoheterotrophic metabolism and chemolithotrophic metabolism.
2. Describing the enzyme kinetics, enzyme activity and regulation.
3. Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms

Content	**56 Hrs**
Unit–I	**14 Hrs**
Metabolism of Carbohydrates Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, Phosphoketolase pathway. TCA cycle. Fermentation - Concept of linear and branched fermentation pathways. Fermentation pathways: Alcohol fermentation and Pasteur effect; Butyric acid Fermentation, Mixed acid fermentation, Propionic acid Fermentation, acetate fermentation. Chemolithotrophic metabolism: Chemolithotrophy -Oxidation of Hydrogen, Sulphur, Iron and Nitrogen. Anaerobic respiration with special reference to dissimilatory nitrate reduction and sulphate reduction.	
Unit -II	**14 Hrs**
Metabolism of aminoacids, nucleotides and lipids 1. Nitrogen Metabolism: Introduction to biological Nitrogen fixation, Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification 2. Biosynthesis of ribonucleotides and deoxyribonucleotides: The de novo pathway of purines and pyrimidines, recycling by salvage pathway 3. Amino acid degradation and biosynthesis: Deamination and decarboxylation. An overview of aminoacid biosynthesis 4. Lipid degradation and biosynthesis: β-oxidation of palmitic acid; Biosynthesis of palmitic acid. 5. Metabolism of one carbon compounds: Acetogens: Autotrophic pathway of acetate synthesis 6. Metabolism of two-carbon compounds: Acetate: Acetic acid bacteria: Ethanol oxidation, sugar alcohol oxidation. Glyoxylate and glycolate metabolism: i. Dicarboxylic acid cycle, ii. Glycerate pathway iii. Beta hydroxyl aspartate pathway. Oxalate as carbon and energy source.	

Unit -III	14 Hrs
Basics of Enzymes Introduction to enzymes–Definition, enzyme unit, specific activity and turnover number, exo/ endoenzymes, constitutive/ induced enzymes, isozymes. Monomeric, Oligomeric and Multimeric enzymes. Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase. Ribozymes, abzymes **Structure of enzyme**: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme, NAD, metal cofactors. Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis and Induced Fit hypothesis. Multi-substrate reactions -Ordered, Random and Ping-pong.	
Unit -IV	**14 Hrs**
Enzyme Kinetics and Regulation Enzyme Kinetics: Kinetics of one substrate reactions. i. Equilibrium assumptions ii. Steady state assumptions iii. Line weaver-Burk, Hanes-Woolf, Eadie-Hofstee equations and plots. Kinetics of enzyme inhibition. Competitive, non-competitive and uncompetitive inhibition. Effect of changes in pH and temperature on enzyme catalyzed reaction. Kinetics of two substrate reactions. Pre steady state kinetics. Kinetics of immobilized enzymes Enzyme regulation: Allosteric enzyme - general properties, Hill equation, Koshland Nemethy and Filmer model, Monod Wyman and Changeux model. Covalent modification by various mechanisms. Regulation by proteolytic cleavage - blood coagulation cascade. Regulation of multi-enzyme complex- Pyruvate dehydrogenase. Feedback inhibition.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Differentiating concepts of chemoheterotrophic metabolism and chemolithotrophic metabolism		✓						✓			✓	
Describing the enzyme kinetics, enzyme activity and regulation.		✓						✓			✓	
Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms		✓						✓			✓	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	**Weightage in Marks**
Attendance	10
Seminar and Assignment	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Microbial Enzymology and Metabolism(Practical)**		Practical Credits	**2**
Course No.	**MBL:104**	**DSC-4P**	Contact hours	

Content

1. Estimation of total lipid
2. Identification of fatty acids and other lipids by TLC
3. Isolation of lactose from bovine milk
4. Estimation of total sugars by the phenol-sulphuric acid method
5. Estimation of DNA - DPA method & UV absorbance method
6. Estimation of RNA (Orcinol method)
7. Determination of molar absorption coefficient (ε) of l-tyrosine
8. Estimation of polyphenols/ tannins by Folin- Denis method
9. Demonstration of alcoholic fermentation
10. Effect of variables on enzyme activity (amylase): a. Temperature b. pH c. substrate concentration
    d. Enzyme concentration
11. Determination of Km and Vmax of amylase (Lineweaver-Burke plot; Michaelis-Mentonequation)
12. Identification of metabolic pathways through charts (Any 3)

Practical assessment

Assessment

Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References

1. Philipp. G. Manual of Methods for General Bacteriology.
2. David T. Plummer. An Introduction to Practical Biochemistry
3. Wood W. B. Wilson J.H., Benbow R.M. and Hood L.E. 1981. Biochemistry- A Problem Approach,2nd edition. The Benjamin/ Cummings Pub.co
4. Segel I.R., 2nd edition., 2004, Biochemical calculations, John Wiley and Sons
5. Irwin H. Segel, 2nd Edition, Biochemical Calculations, John Wiley & Sons

Date:

Subject Committee Chairperson

Program Name	**BSc Microbiology**		Semester	**Fourth Semester**
Course Title	**Human Microbiome**			
Course Code	**MBL:304**	**OE-4T**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): At the end of the course the student should be able to:

1. Articulate a deeper understanding on biological complexities of human micro biome.
2. Understand broader goals of biological anthropology.
3. Compare and contrast the micro biome of different human body sites and impact human healthpromotion

Content	**42 Hrs**
Unit–I	**14 Hrs**
INTRODUCTION TO MICROBIOME Normal human microbiota and their role in health-gut microflora, skin microflora, microflora ofreproductive and excretory system. Symbiotic and parasitic association.	
Unit -II	**14 Hrs**
MICROBIOMES AND HUMAN HEALTH Pre and post-natal Microbiome, Nutritional modulation of the gut microbiome for metabolichealth -role of gut microbiomes in human obesity, human type 2 diabetes. Influence of microbiome in aging. Probiotics-Criteria for probiotics, Development of Probiotics for animal and human use; Preand synbiotics. Functional foods-health claims and benefits, Development of functional foods.	
Unit -III	**14 Hrs**
CULTURING OF MICROBES FROM MICROBIOMES Culturing of organisms of interest from the microbiome: bacterial, fungal, and yeast.Study of the microbiome genome **Microbiomes and diseases:** Microbiome and disease risks: The gut microbiome and host immunity, bacteriocins and other antibacterials. Human microbiome research in nutrition	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative assessment = 40 marks theory paper, End semester Exam duration of exam 2 hours	
Formative Assessment Occasion / type	**Weightage in Marks**
Assignment	10
Seminar	10
Case studies	10
Test	10
Total	**40 marks**

References

1. Jason A. Tetro, 2016. The Human Microbiome, Handbook DE Stech Publications inc,
2. Rebecca E. Hirsch, 2016. The Human Microbiome, Twenty First Century Books.
3. Julian R Marchesi, 2019. The Human Microbiota And Microbiome, CABI
4. Alanna Collen, 2016. 10% Human: How Your Body's Microbes Hold the Key to Health and happiness

Date: Subject Committee Chairperson

National Education Policy (NEP) - 2020
Question paper pattern for B.Sc. Microbiology- Practical Paper
University Examination
(III and IV Semester)

Time: 2 Hours	**Max.Marks: 25**
Q.No.1.Conduct the experiment A and report the result	08 Marks
Q.No.2.Conduct the experiment B and report the result	05 Marks
Q.No.3.Identifyand comment on C and D	4 X 2 =08 Marks
Q.No.4.Class record	04 Marks

National Education Policy (NEP) - 2020
Question paper pattern for B.Sc. Microbiology- Practical Paper
Internal assessment Examination
(III and IV Semester)

Time: 2 Hours	**Max. Marks: 25**
Q.No.1.Conduct the experiment A and report the result	08Marks
Q.No.2.Conduct the experiment B and report the result	05 Marks
Q.No.3.Identify and comment on C and D	4 X2 =08Marks
Q.No.4.Viva Voce	04 Marks

National Education Policy (NEP) - 2020
Question paper pattern for B.Sc. Microbiology-DSC
University Theory examination
(III and IV Semester)

Time: 3 hrs **Max Marks: 60**

NOTE:*Answer one complete set of questions from each unit
*Draw diagrams wherever necessary

UNIT-I

2+5+8=15

1. a)
   b)
   c)

OR

2. a)
   b)
   c)

UNIT-II

2+5+8=15

3. a)
   b)
   c)

OR

4. a)
   b)
   c)

UNIT-III

2+5+8=15

5. a)
   b)
   c)

OR

6. a)
   b)
   c)

UNIT-IV

2+5+8=15

7. a)
   b)
   c)

OR

8. a)
   b)
   c)

National Education Policy (NEP) - 2020
Question paper pattern for B.Sc. Microbiology-DSC
Internal Assessment Theory examination
(III and IV Semester)

Time: 1.30hrs **Max Marks: 30**

NOTE:*Draw diagrams wherever necessary

Part A

I. Discuss any 5 of the following: **2X 5= 10 Marks**

a. e.
b. f.
c. g.
d. h.

Part B

II. Answer any 2 questions **5X2=10 Marks**

1.
2
3.
4.

Part C

III. Answer any 1question **10X1=10Marks**

1.
2

National Education Policy (NEP) - 2020
Question paper pattern for B.Sc. Microbiology-Open Elective Paper
University Theory examination
(III and IV Semester)

Time: 3 hrs **Max Marks: 60**

NOTE:*Draw diagrams wherever necessary

Part A

I. Discuss any 5 of the following: **2X 5= 10 Marks**

a. e.
b. f.
c. g.
d. h.

Part B

II. Answer any 4 questions from the following: **5X4=20 Marks**

1.
2
3.
4.
5.
6.

Part C

III. Answer any 3questions from the following: **10X3=30 Marks**

1. (6+4 or 5+5)
2. (6+4 or 5+5)
3. (6+4 or 5+5)
4. (6+4 or 5+5)

National Education Policy (NEP) - 2020
Question paper pattern for B.Sc. Microbiology-Open Elective Paper
Internal Assessment Theory examination
(III and IV Semester)

Time: 1.30hrs **Max Marks: 30**

NOTE:*Draw diagrams wherever necessary

Part A

I. Discuss any 5 of the following: **2X 5= 10 Marks**

a. e.
b. f.
c. g.
d. h.

Part B

II. Answer any 2 questions from the following **5X2=10 Marks**

1.
2
3.
4.

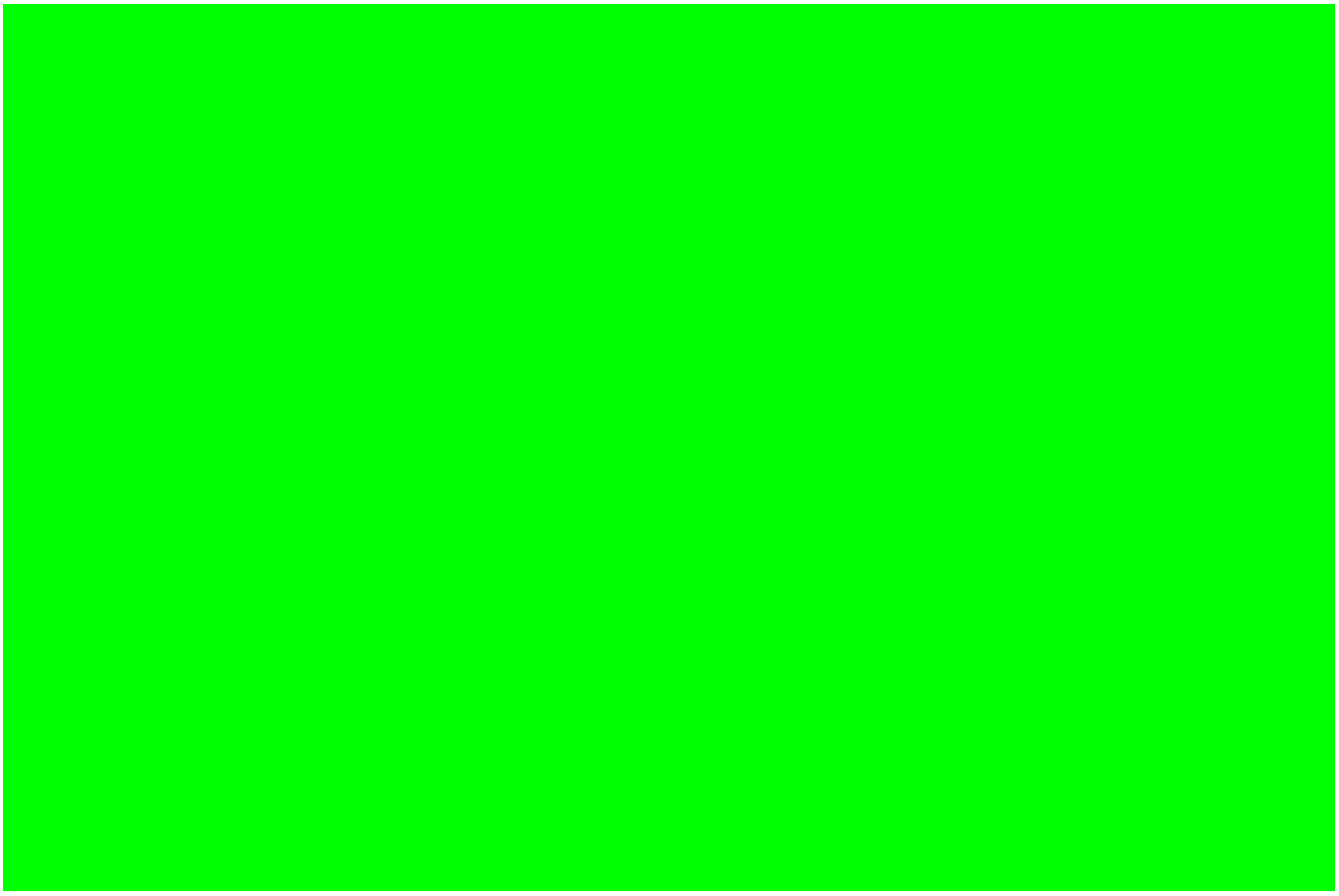
Part C

III. Answer any 1question from the following **10X1=10 Marks**

1.
2

Government of Karnataka

Curriculum Framework for Undergraduate Programme in Colleges and Universities of Karnataka State



5th and 6th Semester Model Syllabus
for
B.Sc. in
MICROBIOLOGY

Submitted to

VICE CHAIRMAN
KARNATAKA STATE HIGHER EDUCATION COUNCIL
30, PRASANNA KUMAR BLOCK, BENGALURU CITY UNIVERSITY CAMPUS
BENGALURU, KARNATAKA – 560009

Government of Karnataka

Model Curriculum

Program Name	**BSc in MICROBIOLOGY**	Semester	**V**
Course Title	**MOLECULAR BIOLOGY (Theory)**		
Course Code:	**MIC C9-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s) :

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Understand concepts involved in replication, transcription, translation, regulation of gene expression in bacteria and Eukaryotes.

CO2. Differentiate the process of replication, transcription, translation, regulation of gene expression in bacteria and Eukaryotes.

CO3. Understand the genetic switch in bacteriophages.

CO4. Compare and contrast housekeeping, constitutive, inducible and repressible genes

CO5. Outline regulatory mechanisms in bacteria to control cellular processes

Contents	
UNIT 1: DNA Replication and Prokaryotic transcription.	**15 Hrs**
DNA Replication : Central dogma of molecular biology, Genetic code, Structure and types of DNA and RNA, Bacterial Cell cycle. Replicon. *OriC*. Bidirectional replication. Steps in Initiation of replication. DNA polymerases, Replication fork, replisome. Mechanism of DNA polymerase III in detail. Ligase. Eukaryotic DNA polymerases. Termination of replication. Extrachromosomal replicons. Replication of DNA strand with 5' end,linear end, replication of adenovirus and ϕ29 DNAs, rolling circle in replication of phage genomes, F plasmid,. Replication of ColE1 DNA. Replication of mtDNA, D loop. Replication of telomeres **Prokaryotic transcription:** Transcription bubble, Stages of transcription, Bacterial RNA polymerase - structure and mechanism, recognition of promoters and DNA melting, abortive initiation. Elongation, Termination, antitermination. Phage T7 RNA polymerase, alternative sigma factors - transcription of heat shock genes, phage SPO1 genes, sporulation in *Bacillus*. Stringent response in *E.coli*.	

UNIT 2 Transcription **Eukaryotic Transcription**: Eukaryotic RNA polymerases - RNA polymerase I, II, III. Mechanism of RNA polymerase in detail. Promoters, Transcription factors, basal apparatus, promoter clearance, elongation. Enhancers, silencers, termination. **RNA splicing and Processing**: mRNA capping, pre-mRNA splicing, lariat, snRNPs, spliceosome, autocatalytic splicing, alternative splicing, polyadenylation, tRNA splicing and maturation, production of rRNA, Catalytic RNAs - auto splicing, ribozymes, rinonuclease P,viroids and virusoids, RNA editing	**15 Hrs**
UNIT 3 Translation Genetic code, tRNA structure, charging of tRNA, differences between initiator tRNA and elongator tRNA, ribosome structure. Accuracy of translation. Stages of translation. Role of IFs in initiation of bacterial translation, Formation of initiation complex. Initiation of eukaryotic translation - Scanning model of mRNA, IRES, Role of eIFs. Elongation of polypeptide - EF-Tu, EF-G, peptide bond formation, peptidyl transferase activity, translocation, eEFs. Termination. Regulation of translation. Post translational modifications of proteins. Protein maturation and secretion - protein splicing,molecular chaperones. Protein translocation and secretion in bacteria	**15 Hrs**
UNIT 4 Regulation of gene Expression **Control of gene expression in prokaryotes** Regulatory mechanisms in bacteria. Positive and negative transcriptional control in bacteria. Operon concept, polycistronic mRNA. *lac* operon - negative inducible, allolactose,mutants of *lac* operon structure of *lac* repressor, mechanism of binding of repressor to operator. Catabolite repression of *lac* operon.Regulation by lac repressor and CAP. *trp* operon regulation - repressor control & attenuator control. Arabinose operon - positive and negative transcriptional control by AraC. Riboswitch control of *rib* operon of *Bacillus subtilis*. Control of translation by riboswitches and small RNAs. Global regulatory mechanisms - *mal* regulon, two-component signal transduction systems.Regulation of lytic & lysogenic life cycle in bacteriophage λ. Control of lytic cycle by regulatory proteins - *cro* gene, *N* gene, lambda repressor - structure, DNA binding mechanism. Events in switch from lytic to lysogenic cycle. Maintenance of lysogeny. **Control of gene expression in eukaryotes** Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation. Regulation through transcriptional activators, Co-activators and repressors, enhancers and insulators. Regulation through RNA processing and degradation. Regulation through RNA interference	**15 Hrs**

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
Understand concepts involved in replication, transcription, translation, regulation of gene expression in bacteria and eukaryotes		√	√		√							√
Differentiate the process of replication, transcription, translation, regulation of gene expression in bacteria and eukaryotes		√	√		√							√
Understand the genetic switch in bacteriophages		√	√		√							√
Compare and contrast housekeeping, constitutive, inducible and repressible genes		√	√		√							√
Outline regulatorymechanisms in bacteria to control cellular processes		√	√		√							√

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40 Marks**
Formative Assessment as per guidelines are compulsory	

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Model Curriculum

Course Title	**MOLECULAR BIOLOGY (Practical)**	Practical Credits	**02**
Course Code	**MIC C10P**	Contact Hours	**4 Hours/ week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Micropipeting: Moving Very Small Volumes Very Accurately
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Extraction of crude DNA from bacteria and yeast by phenol/chloroform method.
4. Determination of purity and quantity of DNA
5. Determination of DNA melting point and GC content
6. Extraction and visualization of plasmids from bacterial cultures
7. Extraction and visualization of genomic DNA from bacterial cultures
8. Measurement of β-galactosidase activity in stimulated and control cells of *E.coli*
9. β-galactosidase Activity Assay in Yeast
10. DNA extraction from agarose gel
11. RNA extraction and visualization from yeast.
12. Analysis of RNA quality and integrity
13. Determining nucleotide composition of RNA
14. Restriction enzyme digestion of DNA molecule - DNA fingerprinting
15. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE)

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

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Model Curriculum

Program Name	**BSc in Microbiology**	Semester	**V**
Course Title	**FOOD MICROBIOLOGY (Theory)**		
Course Code:	**MIC C13-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. To understand the association of microbes in food and the quality testing of food
CO2. To understand the preservation and food safety protocols
CO3. To understand the methods of spoilage of food and the diseases associated with it
CO4. To learn the properties of milk and the types of preservation of milk.
CO5. To learn the types of fermented food and dairy products and its significance

CONTENTS	**45 Hrs**
Unit 1-Microbes and food : Food as a substrate for micoorganisms- Intrinsic and extrinsic parameters affecting the growth of microbes. Microorganismsin food and their sources(molds, yeats and bacteria) **Food borne infections** and intoxication *Staphylococcus, Clostridium. Salmonella, Bacillus, Brucella, Listeria.* Mycotoxin, Phycotoxins **Fermented Food :** Fermented vegetable-sauerkraut, pickles. Meat- sausage. Beverages kombucha. Sourdough.Microbes as food- SCP, SCO. Neutrceuticals and Synbiotics	15 hrs
Unit 2-Spoilage of Food, Preservationand Food safety- **Spoilage:** Principles of food spoilage. Sources of food contamination, Types of spoilage. Spoilage of meat and poultry, Fish and sea foods. Spoilage cereals, fruits and vegetables. Spoilage of canned food. **Preservation:** Principles of food Preservation. Methods of preservation-Physical(temperature, Drying, irradiation), chemical (Class I and Class II). Bio preservation.Canning.Food Packaging-Types of packaging materials, properties and benefits. **Quality testing of food-** Rapid microbiological methods, Examination of faecal streptococci	15hrs

Unit 3-Dairy Microbiology: History. Properties of milk. Types of milk- dried, liquid, Condensed. **Microorganisms in milk.** Starter culture and its types-(single, mixed) Sources of contamination of milk. Microbiological analysis of milk- Rapid platform tests(organoleptic, alcohol, COB, Alcohol test, Phosphatase test, DMC, sedimentation test.). Reductase tests. SPC. Preservation of milk- Pasteurization. Dehydration, sterilization. . Packing of milk and dairy products. **Fermentation in milk**: Lactic acid, gassy fermentation, souring **Dairy products:** Cheese- Types and production (Cheddar), Tofu, Yoghurt, Acidophilus milk. Prebiotics, Probiotics.	15 hrs
Unit 4: Food Standards, sanitation and quality control: Bacterial indicator organisms in food contamination. Food Safety –risk and hazards, Food safety standards in Poultry Egg, meat and food Industries. Food Safety Laws and Regulations- BIS FSSAI, Codex Alimentarius. Food quality and control.Good Hygiene practices, GLP, GMP(Waste treatment disposal methods), HACCP, Food control agencies and their regulation	15 hrs

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-15)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)														
	1	2	3	4	5	6	7	8	9	1	1	1	1	1	1
To understand the association of microbes in food and the quality testing of food															
To understand the preservation and food safety Protocols															
To understand the methods of spoilage of food and the diseases associated with it															
To learn the properties of milk and the types of preservation of milk.															
To learn the types of fermented food and dairy products and its significance															

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40 Marks**
Formative Assessment as per guidelines are compulsory	

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Model Curriculum

Course Title	**FOOD MICROBIOLOGY (Practical)**	Practical Credits	**02**
Course Code	**MIC C14-P**	Contact Hours	**4HRS/WEEK**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1.Isolation of bacteria and fungi from infected fruits and vegetables
2. Isolation of bacteria and fungi from fermented food and stored/ preserved food.
3.Reductase tests-MBRT/Resazurin
4.Estimation of Titrable acidity in milk.
5.Fat estimation – Gerber's method
6.Bacterial examination by SPC, DMC
7.Estimation of lactose in milk
8. Production of yoghurt
9.Study of food borne pathogens- *Staphylococcus, Salmonella, Aspergillus, Clostridium*
10.Significant microbes in Food and Dairy *Lactobacillus, Streptococcus, Penicillium, Rhizopus*
11**.** Standard analysis of water
12.Study of leavening properties of yeast
13. To study the normal flora of egg and fish
14.Wine preparation
15.Entrepreneurship –To study the necessary measures to be an entrepreneur in food industry

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

References	
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Model Curriculum

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Theory)**		
Course Code:	**MIC C15-T**	No. of Credits	**4**
Contact hours	**60**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Common to the Course Programme at Entry Level

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1: To gain a preliminary understanding about various immune mechanisms.

CO2: To familiarize with Immunological techniques and serodiagnosis of infectious diseases

CO3: To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process

CO4: To understand pathogenic bacterial infections, symptoms, diagnosis and To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process treatment process

Contents	**60 Hrs**

UNIT-I-Normal microflora of the human body and host pathogen interaction — 15 hrs.

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. Sample collection, transport and diagnosis**.**

Clinical Microbiology- Medical Bacteriology

The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control respiratory diseases: *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae,* Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani,*.

Unit-II Medical Virology, parasitology and Mycology	**15 Hrs**
The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Corona, Influenza, swine flu, Ebola, Chikungunya, Japanese Encephalitis **Protozoan diseases**: Malaria, Giardia, Entamoeba **Fungal infections-** Cutaneous mycoses: Tinea, pedis (Athlete's foot) Systemic mycoses: **Parasitology-** Histoplasmosis, Opportunistic mycoses: Candidiasis (10Hrs) **Antimicrobial agents**: **General characteristics and mode of action** Antibacterial agents: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, And Azidothymidine. **,** Antibiotic resistance, MDR, XDR, MRSA, NDM-1 5hrs	
Unit-III	**15 Hrs**
Historical perspective of immunology-Edward Jenner, Luis Pasteur, attenuation. **Immunity-** Natural (active and passive) and artificial (active and passive) with example, Innate and acquired, Humoral and cell mediated immunity. **Cells and organs of immune system:** Hematopoiesis, cytokines, properties and functions of B and T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils and Basophils), Monocytes and macrophages, Dendritic cells and Mast cells.Primary lymphoid organs; Bone marrow and Thymus. Secondary lymphoid organs; Spleen and Lymphnodes. **Antigen**: Immunogenicity and antigenicity, epitopes, haptens. Properties of antigencontribute to immunogenicity; Chemical nature (proteins, carbohydrates, lipids andnucleic acids), degree of foreignness, molecular weight, chemical composition and complexity, degradability. Adjuvants (alum, freunds incomplete and complete) and their importance. **Antibody**: Basic structure of antibody, light and heavy chain, variable and constant region, hinge region, Fab and Fc. Structure and functions of different types of antibodies (IgM, IgG, IgA, IgE, and IgD). Antibody mediated effector functions; opsonization, complement activation and antibody dependent cell mediated cytotoxicity (ADCC). Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype. Monoclonal antibody production by hybridoma technology	

Unit-IV	**15 Hrs**
Principles and applications of antigen-antibody interactions: Definition of affinity an avidity. Immunoprecipitation; Radial (Mancini) and double (Ouchterlony) immunodiffusion. **Agglutination reactions**: Hemagglutination, Bacterial agglutination, passive agglutination, and agglutination inhibition. Enzyme linked immune-sorbent assay (ELISA): Direct, indirect ELISA. Radioimmunoassay (RIA). Immunofluorescence. **Complement system**: Functions of complement components, Complement activation by classical, alternative pathway to develop membrane attack complex (MAC). Complement fixation test. **Hypersensitive reactions:** Classification, Humoral Immunity mediated hypersensitivity; Type I (IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity Type IV (DTH).	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-15)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**12**	**13**	**14**	**15**
To gain a preliminary understanding about various immune mechanisms.															
To familiarize with Immunological techniques and serodiagnosis of infectious diseases															
To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process															
To understand pathogenic bacterial infections, symptoms, diagnosis and To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process treatment process															

Pedagogy : Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10 Marks
Class Test	10 Marks
Debate/Quiz/Assignment	10 Marks
Seminar	10 Marks

Total	**40 Marks**
Formative Assessment as per guidelines are compulsory	

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Model Curriculum

Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Practical)**	Practical Credits	**2**
Course Code	**MIC C16-P**	Contact Hours	**4 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**
Practical Content			

1	**Biosafety levels and guidelines to protect from Biorisk and Biohazard in the laboratory.**
2	Identify pathogenic bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcu Bacillus*) on the basis of cultural, morphological and biochemical characteristics: IMViC,
3	Perform urease production and catalase tests
4	Perform TSI, nitratereduction Test
5	Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
6	Study of bacterial flora of skin by swab method
7	Perform antibacterial sensitivity by Kirby-Bauer method
8	Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox,HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
9	Study of various stages of Malarial parasite in RBCs using permanent mounts.
10	Identification of human blood groups.
11	Perform Total and Differential Leukocyte Count of the given blood sample.
12	Separate serum from the blood sample and perform germ tube test of *candida albicans*
13	Perform KOH mounting and staining of fungal cells from infected keratin or nail.
14	Perform immunodiffusion by Ouchterlony method.
15	Perform DOT ELISA.

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Attendance	05 Marks
Records	05 Marks
Performance	05 Marks
Test	10 Marks
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

REFERENCES	
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Model Curriculum

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**INDUSTRIAL MICROBIOLOGY**		
Course Code:	**MIC C19-T**	No. of Credits	**4**
Contact hours	**60**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Common to the Course Programme at Entry Level

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Learn the overview of scope and importance of industrially important microbes
CO2. Acquaint with different types of fermentation processes and equipments
CO3. Evaluate the factors influencing the enhancement of cell and product formation during fermentation
CO4. Acquire the knowledge of the production of value-added products
CO5. Acquire the knowledge of purification of value-added products

Contents	**45 Hrs**
Unit-I: Introduction to Industrial microbiology: Scope and concepts; Criteria for selection of industrially important microbes; Preservation of industrially important microbes.Types of fermentation process: Submerged fermentation, Solid state fermentation (Koji), batch fermentation, continuous fermentation, kinetics of fermentation process.	15 Hrs
Unit-II: Fermenter: Basic features; design and components of a bioreactor; Specialized bioreactors and their applications: tubular bio reactors, fluidized bed reactor, packed bed reactors, membrane bioreactors, Photo-bioreactors and anaerobic bioreactors; Sterilization of fermenter, Control of air, temperature, pH, foaming and feed; Aseptic inoculation and Sampling methods; Scale up of fermentation process-Merits and demerits. Fermentation media**:** Strategies for media formulation; Natural and synthetic media; Role of buffers, precursors, inhibitors, inducers and micronutrients.	15 Hrs
Unit-III: General production strategies of microbial products and Downstream processing: **Antibiotic, Enzymes, anti-cholesterol compound, anti-cancerous compound, hormones. Objectives and significance of downstream processing**: Overview of steps in extraction and Purification of product; Filtration and centrifugation; cell disruption- Physical, chemical and biological methods; Product extraction; product purification, recovery and product testing.	15 Hrs
Unit IV: Industrial production of secondary metabolites Brewing Science, microbes in brewery science, alcohol fermentation technology, Industrial production of Wine, Beer, Penicillin, Fungal amylase, Vit- B12, Bioenergy- Biofuel, Biodiesel, Biomethane, Bio hydrogen. Industrial safety measures. Industrial waste water management .IPR and patents.	15 hrs

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-15)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Learn the overview of scope and importance of industrially important microbes															
Acquaint with different types of fermentation processes and equipments															
Evaluate the factors influencing the enhancement of cell and product formation during fermentation															
Acquire the knowledge of the production of value-added products															
Acquire the knowledge of purification of value-added products															

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10 Marks
Class Test	10 Marks
Debate/Quiz/Assignment	10 Marks
Seminar	10 Marks
Total	**40 Marks**
Formative Assessment as per guidelines are compulsory	

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Model Curriculum

Course Title	**Industrial Microbiology (Practical)**	Practical Credits	**2**
Course Code	**MIC C20P**	Contact Hours	**Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

PRACTICAL CONTENT

1. Demonstration of a basic fermenter
2. Preparation of natural medium used in a industry
3. Preparation of synthetic medium used in a industry
4. Production of amylase/protease/cellulase/pectinase/invertase by solid substrate fermentation (with Atleast 2 substrates)
5. Production of enzyme (amylase/protease/cellulase/invertase by submerged fermentation
6. Preservation of microbes with glycerol/soil.
7. Preservation of microbes by Silica gel method/lyophilization
8. Study of growth and revival of Mammalian cell lines
9. Air filter challenge test
10. Production and estimation of any one secondary metabolite
11. Downstream technique- Solid-liquid separation by using a centrifugation
12. Downstream technique- Demonstration of Microfiltration technique
13. Downstream technique- cell disruption by sonicator/enzyme
14. Estimation of dissolved oxygen and free carbon di oxide.
15. Internship report

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Attendance	05 Marks
Records	05 Marks
Performance	05 Marks
Test	10 Marks
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

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1. Arindam Kuilaand Vinay Sharma (2018) Principles and Applications of Fermentation Technology, Wiley.
2. Casida L E.J.R. (2016) Industrial Microbiology, 2nd edition, New Age International Publisher.
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