



BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

**(Semester Scheme with Multiple Entry and Exit Options for
Under Graduate Course- as per NEP 2020)**

**Syllabus for B.Sc.Microbiology
III & IV Semester**

2022-23 onwards



Program Name	B.Sc.Discipline	Total Credits for the Program	Credits
Core	Microbiology	Starting 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)

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

Weightage for assessments (in percentage)

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

Contents of Courses for B.Sc. Microbiology as Major**Mode III A**

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

ProgramName	BSc Microbiology		Semester	III Sem
CourseTitle	Microbial Diversity			
CourseNo.	MBL-103	DSC -3T	No. of Theory Credits	4
Contact hours	56hrs		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:	
<ol style="list-style-type: none"> 1. Acquire knowledge about microbes and their diversity 2. Study the characteristics, classification and economic importance of Prokaryotic and Eukaryotic microorganisms. 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 regulating distribution. An overview of Bergey's Manual of Systematic Bacteriology. General characteristics; Classification; Economic importance of: Archaea: <i>Thermus aquaticus</i> , Methanogens Bacteria: <i>Escherichia coli</i> , <i>Bacillus subtilis</i> , Cyanobacteria: <i>Microcystis</i> , <i>Spirulina</i> Actinomycetes: <i>Streptomyces</i> , <i>Nocardia</i> , <i>Frankia</i> Rickettsiae: <i>Rickettsia rickettsi</i> Chlamydiae: <i>Chlamydia trachomatis</i> Spirochaetes: <i>Trepanemapallidum</i> , Mycoplasma	16 Hrs

Unit-III	
Diversity of Eukaryotic Microorganism General characters; Classification- Economic importance Fungi: Ains worth classification-detailed study upto the level of classes, Salient features and reproduction. Type study: <i>Rhizopus, Saccharomyces, Aspergillus, Agaricus, Fusarium</i> Algae: Occurrence, distribution, and symbiotic association- Lichen; thallus organization and types. Type study: <i>Chlorella, Diatom, Gracilaria,</i> Protozoa: Classification up to the level of classes. Type study: <i>Euglena, Trichomonas, Plasmodium, Trypanosoma</i>	16 Hrs
Unit-IV	16 Hrs
Diversity of Viruses General structure, Isolation, purification and culturing of viruses. Principles of Viral Taxonomy- Baltimore and ICTV and the recent trends. Capsidsymmetry - Icosahedral, helical,complex Animal: HIV,Corona,OrthoandParamyxovirus, Oncogenic virus Plants: TMV, Papaya virus Microbial: T4, lambda, Cyanophages and mycophages. Subviralparticles: Viroidsand Prions.	

CourseArticulationMatrix:Mappingof CourseOutcomes(COs)withProgramOutcomes(POs1-12)

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

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

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

CourseTitle	MicrobialDiversity(Practical)		PracticalCredits	2
CourseNo.	MBL-103	DSC-4P	Contacthours	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 Cyano bacteria
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, Coronavirus

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, 5th Edition. Prentice Hall. New Jersey
- 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. 7th International, 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, 12th edition, Pearson Benjamin Cummings
- 9 G.J. Tortora, B.R. Funke, C.L. 2008. Microbiology-An Introduction, Case, 10th edition., Pearson Education, UK.

1 Stanier, 1987, Ingraham *et al.*, General Microbiology, 4th and 5th edition Macmillan education limited

- 1 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 and Sons (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	III Sem
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:	
<ol style="list-style-type: none"> 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, Government organization/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=60Marks	
Formative Assessment Occasion/type	Weightage in Marks
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	60marks + 40marks= 100 marks

References

- 1 Srilakshmi,B.(2007).Dietetics.New Age Internationalpublishers.NewDelhi
- 2 Srilakshmi,B.(2002).NutritionScience.NewAgeInternationalpublishers. New Delhi
- 3 Swaminathan,M.(2002).AdvancedtextbookonfoodandNutrition.VolumeI.Bappco
- 4 Gopalan,.C.RamaSastry,B.V. and Balasubramanian, S.C (2009).Nutritive value of IndianFoods. NIN. ICMR. Hyderabad.
- 5 MudambiSRandRajagopalMV.2008.FundamentalsofFoods,Nutrition&diettherapybyNewAgeInternational Publishers, NewDelhi. 5th edition.

Date:

Subject Committee Chairperson

Program Name	BSc Microbiology		Semester	IV Sem
Course Title	Microbial Enzymology and Metabolism			
Course No.	MBL:104	DSC -4T	No. of Theory Credits	4
Contact hours	56hrs		Duration of ESA/Exam	2Hours
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:	
<ol style="list-style-type: none"> 1. Differentiating concepts of chemoheterotrophic metabolism and chemolithotrophic metabolism. 2. Describing the enzyme kinetics, enzyme activity and regulation. 3. Differentiating concepts of aerobic and an aerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms 	
Content	56 Hrs
Unit-I	14 Hrs
<p>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 - Fermentation balance, concept of linear and branched fermentation pathways. Fermentation pathways: Alcohol fermentation and Pasteur effect; Butyric acid and Butanol-Acetone Fermentation, Mixed acid and 2,3-butanediol fermentation, Propionic acid Fermentation, acetate fermentation. Chemolithotrophic metabolism: Chemolithotrophy-Oxidation of Hydrogen, Sulphur, Iron and Nitrogen. An aerobic respiration with special reference to dissimilatory nitrate reduction and sulphate reduction.</p>	
Unit-II	14 Hrs
Metabolism of amino acids, nucleotides and lipids	
<p>1. Nitrogen Metabolism Introduction to biological Nitrogen fixation, Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification</p> <p>2. Biosynthesis of ribonucleotides and deoxyribonucleotides The de novo pathway of purines and pyrimidines, recycling by salvage pathway</p> <p>3. Amino acid degradation and biosynthesis: Deamination and decarboxylation- An overview of amino acids biosynthesis</p> <p>4. Lipid degradation and biosynthesis: β-oxidation of palmitic acid; Biosynthesis of palmitic acid.</p> <p>5. Metabolism of one carbon compounds: Acetogens: Autotrophic pathway of acetate synthesis</p> <p>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 hydroxylaspartate pathway</p> <p>Oxalate as carbon and energy source</p>	

Unit-III	14 Hrs
<p>Basics of Enzymes Introduction to enzymes– Definition, enzyme unit, specific activity and turnover number, exo/endoenzymes, constitutive/ inducedenzymes, isozymes. Monomeric, Oligomeric and Multimericenzymes. Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase. Ribozymes, abzymes Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme, NAD, metalcofactors. Classification of enzymes, Mechanism of action of enzymes: activesite, transition state complex and activation energy. Lock and key hypothesis and Induced Fithy pothesis. Multisubstrate reactions- Ordered, Random and Ping-pong.</p>	
Unit-IV	14 Hrs
<p>Enzyme Kinetics and Regulation Enzyme Kinetics: Kinetics of one substrate reactions. i.Equilibrium assumptionsi. Steadystate Assumptions iii. Lineweaver-Burk, Hanes-Woolf, Eadie-Hofstee equations and plots. Kinetics of enzymeinhibition. Competitive, non-competitive and uncompetitive inhibition. Effect of changes in pH and temperature on enzyme catalyzed reaction. Kinetics of two substrate reactions. Presteadystate 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 variousmechanisms. Regulation by proteolytic cleavage - blood coagulation cascade. Regulation of multi-enzyme complex- Pyruvate dehydrogenase. Feedback inhibition.</p>	

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	60marks + 40marks= 100 marks

CourseTitle	Microbial Enzymology and Metabolism(Practical)		Practical Credits	2
CourseNo.	MBL:104	DSC-4P	Contact hours	
Content				
<ol style="list-style-type: none"> 1. Estimation of total lipid 2. Identification of fatty acids and other lipids byTLC 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 absorptionco efficient(ϵ) ofl-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.pHc. substrate concentration d. Enzyme concentration 11. Determination of K_m and V_{max} of amylase (Line weaver-Burkeplot; 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:

SubjectCommitteeChairperson

ProgramName	BSc Microbiology		Semester	IV Sem
CourseTitle	Human Microbiome			
CourseCode	MBL:304	OE-4T	No. of Theory Credits	3
Contacthours	Lecture		DurationofESA/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: <ol style="list-style-type: none"> 1. Articulate a deeper understanding on biological complexities of human microbiome. 2. Understand broader goals of biological anthropology. 3. Compare and contrast the micro biome of different human body sites and impact human health promotion 	
Content	42Hrs
Unit-I	14 Hrs
INTRODUCTION TO MICROBIOME Normal human microbiota and their role in health-gut microflora, skinmicroflora, microflora of reproductive 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 metabolic health-role of gut microbiomes in human obesity, human type2 diabetes. Influence of microbiome in aging. Probiotics-Criteria for probiotics, Development of Probiotics for animal and human use; Pre and 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 microbiomegenome	
Microbiomes and diseases: Microbiome and disease risks: The gut microbiome and host immunity, bacteriocins and other antibacterials. Human microbiome research in nutrition	

Pedagogy

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

References	
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Date:

Subject Committee Chairperson