



Government of Karnataka

Curriculum Framework for Four-Year Undergraduate Multidisciplinary Programme (Honours)& Master Programme in Colleges and Universities of Karnataka State Under NEP 2020.



**3rd and 4th Semester Model Syllabus
For UG Program in
Microbiology**

**Submitted to
Vice Chairman**

Karnataka State Higher Education Council

Submitted by

**Prof. DAYANAND AGSAR
Vice Chancellor, Gulbarga University
CHAIRMAN and MEMBERS
SUBJECTWISE EXPERT COMMITTEE
In Microbiology and Biotechnology**

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 introduction of 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.



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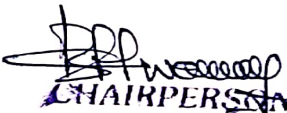
Model Curriculum

Program Name	B.Sc. Discipline	Total Credits for the Program	176
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)

- 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 demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance
- PO3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.
- PO4. Learning and practicing professional skills in handling microbes and contaminants in laboratories 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 for the 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.


CHAIRPERSON
Board of Studies in Microbiology
Kuvempu University, Jnana Sangam
Shankarghatta-577 451.

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
3.	MBL-103	DSC- 7	Theory	4	Microbial Diversity	60	40
			Practical	2	Microbial Diversity	25	25
		OE- 3	Theory	3	Microbial Entrepreneurship	60	40
4.	MBL-104	DSC- 8	Theory	3	Microbial Enzymology and Metabolism	<u>60</u>	<u>40</u>
			Practical	2	Microbial Enzymology and Metabolism	<u>25</u>	<u>25</u>
		OE- 4	Theory	3	Human Microbiome	<u>60</u>	<u>40</u>



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Model Curriculum

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

Course Pre-requisite (s):

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

1. Knowledge about microbes and their diversity
2. Study, characters, classification and economic importance of Pro-eukaryotic and Eukaryotic microbes.
3. Knowledge about viruses and their diversity

Content	Hrs
Unit-I	06 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 General characters; Classification; Economic importance; Distribution and factors regulating distribution. Bacteria and Archaea- An overview of Bergey's Manual of Systematic Bacteriology. Bacteria- <i>Escherichia coli</i> , <i>Bacillus subtilis</i> , <i>Staphylococcus aureus</i> Cyanobacteria- <i>Nostoc</i> , <i>Microcystis</i> , <i>Spirulina</i> Archea- <i>Thermusaquaticus</i> , <i>Methanogens</i> Actinomycetes: <i>Streptomyces</i> , <i>Nocordia</i> , <i>Frankia</i> Rickettsiae- <i>Rickettsia rickettsi</i> Chlamydiae- <i>Chlamydia trachomatis</i> Spirochaetes- <i>Trepanema pallidum</i>	
Unit-III	
Diversity of Eukaryotic Microorganism Diversity of Eukaryotic Microorganism: General characters; Classification- Economic importance Fungi: Ainsworth classification- detailed study up to the level of classes, Salient features and reproduction. Type study: <i>Rhizopus</i> , <i>Saccharomyces</i> , <i>Aspergillus</i> , <i>Agaricus</i> , <i>Fusarium</i>	

<p>Algae: Occurrence, distribution, and symbiotic association- Lichen; thallus organization and types. Type study: <i>Chlorella</i>, <i>Cosmarium</i>, Diatoms, <i>Gracilaria</i>,</p> <p>Protozoa: Classification up to the level of classes. Type study: <i>Amoeba</i>, <i>Euglena</i>, <i>Trichomonas</i>, <i>Paramecium</i>, <i>Trypanosoma</i></p>	
Unit –IV	
<p>Diversity of Virus</p> <p>General properties and structure, Isolation and purification and assay of virus. Principles of Viral Taxonomy- Baltimore and ICTV and the recent trends.</p> <p>Capsid symmetry- Icosahedral, helical, complex</p> <p>Structure, Replication and Significance of the following:</p> <p>Human & Animal viruses: HIV, Corona, Ortho and paramyxovirus, Oncogenic virus, H1N1</p> <p>Plant viruses: TMV, Ring spot virus</p> <p>Microbial viruses: T4/T7/lambda/cyano/mycophages.</p> <p>Subviral particles, Viroids, Virusoids, satellite and Prions.</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
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 = 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

Course Title	Microbial Diversity		Practical Credits	2
Course No.	MBL-103	DSC-4P	Contact hours	
Content				
1.	Study of morphology of bacteria			
2.	Isolation of bacteria from soil			
3.	Isolation of bacteria from air and water			
4.	Isolation of fungi from soil			
5.	Isolation of fungi from air and water			
6.	Cultivation of Cyanobacteria			
7.	Cultivation of actinomycetes			
8.	Measurement of microbial cell size by Micrometry			
9.	Cyanobacteria - <i>Nostoc</i> , <i>Microcystis</i> , <i>Spirulina</i>			
10.	Study of Algae – <i>Chlorella</i> , <i>Diatoms</i> , <i>Gracilaria</i>			
11.	Study of Fungi – <i>Rhizopus</i> , <i>Aspergillus</i> , <i>Saccharomyces</i> , <i>Agaricus</i>			
12.	Study of Protozoa – <i>Amoeba</i> , <i>Paramoecium</i> , <i>Euglena</i>			
13.	Study of HIV, TMV, Corona virus T4 Phage			
14.	Study of Paramyxovirus, Oncogenic viruses			

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. New Jersey
3	Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5 th edn. 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, 7 th International, edition 2008, McGraw Hill
6	Vashishta B.R., Sinha A.K and Singh V. P. Botany – Fungi 2005, S. Chand and Company Limited, New Delhi
7	Kotpal R.L Protozoa 5 th Edition 2008, Rastogi Publications, Meerut, New Delhi.
8	Brock Biology of Microorganisms, M.T. Madigan, J.M. Martinko, P. V. Dunlap, D. P. Clark- 12 th edition, Pearson International edition 2009, Pearson Benjamin Cummings

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

Date:

Subject Committee Chairperson



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Model Curriculum

Program Name	BSc Microbiology	Semester	Third Sem
Course Title	Microbial Entrepreneurship		
Course Code	OE-3	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. Demonstrate Entrepreneurial skills
2. Acquire knowledge industrial Entrepreneurship
3. Acquire knowledge about Healthcare Entrepreneurship

CONTENT	42 HRS
Unit-I	14 Hrs
General Entrepreneurship Entrepreneurship and microbial entrepreneurship - Introduction and scope, Business development, product marketing, HRD, Bio-safety 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 (Mushroom and Spirulina) etc.	
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 S.C.Balasubramanian (2009), Nutritive value of Indian Foods. NIN.ICMR. Hyderabad.
5	Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi

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Model Curriculum

Program Name	BSc Microbiology	Semester	Fourth Sem
Course Title	Microbial Enzymology and Metabolism		
Course No.	MBL:104	DCS -4T	No. of Theory Credits 4
Contact hours	56 hrs	Duration of ESA/Exam	2 ½ 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

Basics of Enzymes

Definitions of terms – 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, Ping-pong.

Enzyme catalysis: Catalytic mechanisms with Types & examples, catalytic mechanisms and testing – Serine proteases and Lysozyme

Unit –II	14 Hrs
<p>Enzyme Kinetics and Regulation</p> <p>Enzyme Kinetics: Kinetics of one substrate reactions. i. Equilibrium assumptions ii. Steady state assumptions iii. Lineweaver-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 catalysed reaction. Kinetics of two substrate reactions. Pre steady state kinetics-Kinetics of immobilized enzymes</p> <p>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. HIV enzyme inhibitors and drug design.</p> <p>Microbial Enzymes: sources- Bacterial, Fungal, Yeast and their applications.</p>	
Unit –III	14 Hrs
<p>Metabolism of Carbohydrates</p> <p>Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation</p> <p>Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, Phosphoketolase pathway. TCA cycle.</p> <p>Utilization of Lactose, Maltose, Galactose, Cellulose and Pectin.</p> <p>Fermentation – Fermentation balance, concept of linear and branched fermentation pathways.</p> <p>Fermentation pathways: Alcohol fermentation and Pasteur effect; Butyric acid and Butanol-Acetone Fermentation, Mixed acid and 2,3-butanediol fermentation, Propionic acid Fermentation (Succinate pathway and Acrylate pathway), acetate Fermentation</p> <p>Chemolithotrophic Metabolism: Chemolithotrophy – Hydrogen oxidation, Sulphur oxidation, Iron oxidation, Nitrogen oxidation.</p> <p>Anaerobic respiration with special reference to assimilatory nitrate reduction and sulphate reduction.</p>	

Unit-IV												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. Regulation by feedback mechanisms. Recycling via the salvage pathway 3. Amino acid degradation and biosynthesis 4. Lipid degradation and biosynthesis 5. Metabolism of one carbon compounds: Methylotrophs: i. Oxidation of methane, methanol, methylamines; ii. Carbon assimilation in methylotrophic bacteria and yeasts Methanogens: i. Methanogenesis from H ₂ , CO ₂ , CHOH, HCOOH, methylamines; ii. Energy coupling and biosynthesis in methanogenic bacteria, Acetogens - Autotrophic pathway of acetate synthesis. 6. Metabolism of two-carbon compounds: Acetate - Glyoxylate cycle. Acetic acid bacteria: Ethanol oxidation, sugar alcohol oxidation. Glyoxylate and glycolate metabolism –i. Dicarboxylic acid cycle, ii. Glycerate pathway iii. Beta hydroxyaspartate pathway Oxalate as carbon and energy source.												
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		✓						✓			✓	
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											

Course Title	Microbial Enzymology and Metabolism		Practical Credits	2
Course No.	MBL:104	DSC-4P	Contact hours	
Content				
<ol style="list-style-type: none"> 1. Handling of micropipettes and checking their accuracy 2. Isolation of cholesterol and lecithin from egg yolk 3. Identification of fatty acids and other lipids by TLC/GC 4. Determination of degree of unsaturation of fats and oils 5. Isolation of lactose from bovine milk 6. Estimation of total sugars by the phenol-sulphuric acid method 7. Estimation of DNA - DPA method & UV absorbance method 8. Estimation of RNA (Orcinol method) 9. Isolation of glutamic acid from gluten 10. Determination of molar absorption coefficient (ϵ) of L-tyrosine 11. Determination of the isoelectric point of the given protein 12. Estimation of polyphenols/ tannins by Folin-Denis method 13. Chemotaxis of <i>Pseudomonas</i> 14. Demonstration of alcoholic fermentation 15. Effect of variables on enzyme activity (amylase): a. Temperature b. pH c. substrate concentration d. Enzyme concentration e. Determination of K_m of amylase (Lineweaver-Burke plot; Michaelis-Menten graph) 				
<div style="border: 1px solid black; padding: 5px; text-align: center;"> Newly Added Experiments </div> <ol style="list-style-type: none"> 1. Separation of amino acids by paper chromatography 2. Screening of fungi for cellulose and pectin degradation 3. Screening of fungi for invertase 4. Enzyme immobilization by Alginate method 5. Gelatin hydrolysis 6. Microscopic examination of Root nodules 7. Demonstration of Ammonification 8. Demonstration of Nitrification – Nitrite and Nitrate 9. Demonstration of Denitrification 10. Demonstration of lipolytic activity 11. Demonstration of citric acid production 12. Study of photographs/models: Chemolithotrophy-hydrogen oxidation, sulphur oxidation, iron oxidation, nitrogen oxidation, biological nitrogen fixation, ammonia assimilation, ribozymes, abzymes, lock and key hypothesis, enzyme inhibition – competitive, non competitive and un competitive. Enzyme regulation – allosteric enzymes. Feed back inhibition. 				

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. Mannual of Methods for General Bacteriology.
2	David T. Plummer An Introduction to Practical Biochemistry
3	Biochemistry- A Problem Approach, Wood W.B. Wilson JH, Benbow RM and Hood LE.2nd ed , 1981, The Benjamin/ Cummings Pub.co .
4	Biochemical calculation, Segel I.R., 2nd ed., 2004, John Wiley and Sons
5	Biochemical Calculations, Irwin H. Segel, 2nd Edition John Wiley & Sons

Date:

Subject Committee Chairperson

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Model Curriculum

Program Name	BSc Microbiology		Semester	Fourth Sem
Course Title	Human Microbiome			
Course Code		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: <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 microbiome of different human body sites and impact human health promotion 	
Content	45 Hrs
Unit-I	14 Hrs
INTRODUCTION TO MICROBIOME Evolution of microbial life on Earth, Symbiosis host-bacteria . Microbial association with plants and animals, Symbiotic and parasitic, Normal human microbiota and their role in health. Microbiomes other than digestive system.	
Unit -II	14 Hrs
MICROBIOMES AND HUMAN HEALTH Microbiome in early life, Nutritional modulation of the gut microbiome for metabolic health- role of gut microbiomes in human obesity, human type 2 diabetes and longevity. 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 organisms of interest from the microbiome : bacterial, archaeal, fungal, and yeast, viral. Extracting whole genomes from the microbiome to study microbiome diversity 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 = 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	Fundamentals of Microbiome science - how microbes shape animal biology, Princeton University Press, New Jersey, United States Rob DeSalle and Susan L Perkins (2015).
2	Welcome to the microbiome getting to know the trillions of bacteria and other microbes in, on, and around you Yale University Press Suggested Readings Rodney Dietert (2016).
3	The Human Superorganism: how the microbiome is revolutionizing the pursuit of a health life Dutton Books Justin Sonnenburg and Erica Sonnenburg (2014).
4.	The good gut: taking control of your weight, your mood, and your long-term health. Penguin Press. Emeran Mayer (2016).
5.	The Mind-Gut Connection: How the Astonishing Dialogue Taking Place in Our Bodies Impacts Health, Weight, and Mood. eBook, Harper Wave Books Martin J. Blaser (2014).
6	Cox, LM., et al., Altering the intestinal microbiota during a critical developmental window has lasting metabolic consequences Cell, 2014. 158(4): p 705-21.
7	Douglas, A, Fundamentals of Microbiome Science: How Microbes Shape Animal Biology 2018, 41 William Street, Princeton, New Jersey 08540: Princeton University Press.
8	HMP, C, Structure, function and diversity of the healthy human microbiome. Nature, 2012 486(7402):p. 207-14
9	Diaz Heijtz, R., et al., Normal gut microbiota modulates brain development and behavior Proc Natl Acad Sci U S A, 2011 108(7): p. 3047-52.
10.	Sonnenburg, ED., et al., Diet-induced extinctions in the gut microbiota compound over generations Nature, 2016 529(7585): p. 212-5.
11.	Zou, J. et al, Fiber-Mediated Nourishment of Gut Microbiota Protects against Diet-Induced Obesity by Restoring IL-22-Mediated Colonic Health Cell Host Microbe, 2018 23(1): p. 41-53 e4.
12	Yassour, M., et al, Strain-level analysis of mother-to-child bacterial transmission during the first few months of life. Cell Host Microbe, 2018 24(1): p 146-154 e4 Microbiomes and Health- 11:680:475
13	Dominguez-Bello, MG., et al., Partial restoration of the microbiota of cesarean-born infants via Vaginal microbial transfer Nat Med, 2016 22(3): p. 250-3.
14	Moeller, AH., et al., Rapid changes in the gut microbiome during human evolution Proc Natl Acad Sci U S A, 2014 111(46): P- 16431-5.
15	Prescott's Microbiology, 11 th Edition By Joanne Willey and Kathleen Sandman and Dorothy Wood
16	Henderson Gemma et al (2015), Rumen microbial community composition varies with diet and host, but a core microbiome is found across a wide geographical range, Scientific Reports,
17	Salle, A.J (1992) Fundamental Principles of Bacteriology. 7th Edition, Mc. Graw Hill Publishing Co. Ltd., New York.

Date:


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Board of Studies in Microbiology
Kuvempu University, Jnana Sanyadri
Shankarghatta-577 451:

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