Bangalore University

Jnana Bharathi Campus, Bengaluru-560 056

3rd and 4th Semester Syllabus
For UG Program in
Microbiology framed under NEP- 2020

Department of Microbiology
Bangalore University
Bengaluru-560 056

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.

Contents

BANGALORE UNIVERSITY

Department of Microbiology

Jnana Bharathi Campus, Bengaluru -560 056. Phone.No.080-22961461

==========

Dr. J. Savitha
Professor and Chairman

Date: 20.08.2022

Proceedings of the Board of studies (BOS)(UG)

A BOS meeting was held on 20th August, 2022 regarding finalization of Under graduate (UG) 3rd and 4th Semester Microbiology and Biotechnology syllabus of Bangalore University as per the NEP regulation.

The Chairperson welcomed all the members of the BOS (UG) and then the members were invited to discuss the syllabus of the 3rd and 4th semester Microbiology received from the Karnataka Higher Education council.

The members have gone through the syllabus critically and approved the syllabus with minor correction. The suggestions made by the all members were incorporated. The meeting ended with vote of thanks by the Chairperson.

Chairman (BOS)

CHAIRMAN
Department of Microbiology
& Biotechnology
Bangalore University, JB Campus,
Bangalore - 560 056.

Sl No	Name	Signature
1	Dr. Kavya shree R	ABSENT
2	Smt. Nalina N	–
3	Dr. Sudiptha Kumar Mohanty	
4	Dr. Mohana D.C	
5	Dr. Geethanjali P.A	
6	Dr. Raja Naika H	ABSENT
7	Prof. C Srinivas	
8	Prof. J Savitha	

Curriculum as per KSHEC

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)

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.

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.		DSC- 3	Theory	4	Microbial Diversity	60	40
			Practical	2	Microbial Diversity	25	25
		OE- 3	Theory	3	Microbial Entrepreneurship	60	40
4.		DSC- 4	Theory	4	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**
Course Title	**Microbial Diversity**			
Course No.	**MBL-103**	**DSC -3T**	No. of Theory Credits	**4**
Contact hours	**56 hrs.**		Duration of ESA/Exam	**3 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 Eukaryotic microorganisms.
3. Gain knowledge about viruses and their diversity

Content	**56 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	**16 Hrs**
Diversity of Prokaryotic Microorganisms Distribution, factors regulating distribution. 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, Nocardia, Frankia* Rickettsiae: *Rickettsia rickettsi* Chlamydiae: *Chlamydia trachomatis* Spirochaetes**:** *Trepanema pallidum*, Mycoplasma	
Unit -III	**16 Hrs**
Diversity of Eukaryotic Microorganism General characters; Classification- Economicimportance **Fungi:** Ainsworth classification- detailed study up to the level of classes, Salient features and reproduction. Type study: *Rhizopus, Saccharomyces, Aspergillus, Agaricus, Fusarium* **Algae:** Occurrence, distribution, and symbiotic association- Lichen; thallus organization and types. Type study: *Chlorella, Diatom, Gracilaria,* **Protozoa:** Classification up to the level of classes. Type study: *Euglena, Trichomonas, Plasmodium, Trypanosoma*	

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. Capsid symmetry- Icosahedral, helical, complex **Animal:** HIV, Corona, Ortho and Paramyxovirus, Oncogenic virus **Plants:** TMV, Papaya virus **Microbial:** 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 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 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-4P**	Contact hours	**4 hrs/week**

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. 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, 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 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

Program Name	**BSc Microbiology**		Semester	**Third**
Course Title	**Microbial Entrepreneurship**			
Course Code	**MBL:303**	**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**	**42 Hrs**	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, 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 = 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 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. 5th edition.

Program Name	**BSc Microbiology**		Semester	**Fourth**
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	**3 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 - 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. 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 aminoacids 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 hydroxyaspartate 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. Multisubstrate 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	4hrs/week

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-Menton equation)
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

Program Name	**BSc Microbiology**		Semester	**Fourth**
Course Title	**Human Microbiome**			
Course Code	**MBL:304**	**OE-4T**	No. of Theory Credits	**3**
Contact hours	**Lecture**	**42 Hrs**	Duration of ESA/Exam	**2Hours**
	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 health promotion

Content	**42 Hrs**
Unit–I	**14 Hrs**
INTRODUCTION TO MICROBIOME Normal human microbiota and their role in health-gut microflora, skin microflora, 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 type 2 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 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

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,