



Syllabus for B.Sc. Microbiology (UG)

CHOICE BASED CREDIT SYSTEM (CBCS)

I & II Semester Microbiology Papers

Under-Graduate (UG) Program
Framed According to the National Education Policy (NEP 2020)

From the academic year 2021-22

MODEL CURRICULUM

Name of the Degree Program: BSc (Basic/Hons.)

Discipline Core: Microbiology

Total Credits for the Program: B.Sc. Basic - 136 and B.Sc. Hons. - 176

Starting year of implementation: 2021-22

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

Introduction:

The NEP-2020 offers an opportunity to effect paradigm shift from a teacher-centric to student-centric higher education system in India. It caters skill based education where the graduate attributes are first kept in mind to reverse-design the programs, courses and supplementary activities to attain the graduate attributes and learning attributes. The learning outcomes-based curriculum framework for a degree in **B.Sc. (Honours) Microbiology** is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. Effort has been made to integrate use of recent technology and use of MOOCs to assist teaching-learning process among students. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of knowledge and skills in **Microbiology** and allied courses, as well develop scientific orientation, spirit of enquiry, problem solving skills, human and professional values which foster rational and critical thinking in the students. This course serves a plethora of opportunities in different fields right from classical to applied aspects in **Microbiology**.

GRADUATE ATTRIBUTES IN B.Sc. (Hons.) Microbiology

Some of the characteristic attributes a graduate in **Microbiology** should possess are:

- Disciplinary knowledge and skills
- Skilled communication
- Critical thinking and problem solving capacity
- Logical thinking and reasoning
- Team Spirit & Leadership Quality
- Digital efficiency
- Ethical awareness / reasoning
- National and international perspective
- Lifelong learning

Flexibility:

- The programmes are flexible enough to allow liberty to students in designing them according to their requirements. Students may choose a single Major, one Major with a Minor, and one Major with two Minors. Teacher Education or Vocational courses

may be chosen in place of Minor/s below listed are the various options students may choose from.

- One Major subject/discipline, Two Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities.
- One Major and one Minor subject/discipline along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities
- Two Major subject/disciplines along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses, including Extracurricular Activities.
- One Major subject/discipline and one Vocational course along with Languages, Generic Electives, Ability Enhancement and Skill Development and courses including Extracurricular Activities.
- One Major Discipline and One Education Discipline along with Languages, Generic Electives, Ability Enhancement and Skill Development Courses including Extracurricular Activities.

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

- Acquire knowledge and gain understanding of concepts in microbiology and its applications in **pharma, food, agriculture, beverages, and nutraceutical industries.**
- Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance.
- Competent to apply the knowledge gained for conserving the environment and resolving the environment related issues.
- Learning, practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
- Exploring the microbial world and analyzing the specific benefits and challenges.
- Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.

- Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
- Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.
- Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
- Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.
- Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.
- Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

Assessment: Weightage for assessments

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

*In lieu of the research Project, two additional elective papers/ Internship may be offered in 8th semester.

Progressive Certificate, Diploma, Bachelor's Degree or Bachelor's Degree with Honours provided at the end of each year of exit of the Four-years Undergraduate Programme.

	EXIT OPTIONS	Credits Required
1.	Certificate upon the successful completion of the First Year (Two Semesters) of the multidisciplinary Four-years Undergraduate Programme/Five-years Integrated Master's Degree Programme.	44-48
2.	Diploma upon the successful completion of the Second Year (Four Semesters) of the multidisciplinary Four-years Undergraduate Programme/Five-years Integrated Master's	88-96

	Degree Programme.	
3.	Basic Bachelor's Degree at the Successful Completion of the Third Year (Six Semesters) of the multidisciplinary Four-years Undergraduate Programme/Five-years Integrated Master's Degree Programme.	132-144
4.	Bachelor's Degree with Honours in a Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-years Undergraduate Programme/Five-years Integrated Master's Degree Programme	176-192

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

1. Acquire and understand the concepts of microbiology and its application in **pharma, food, agriculture, beverages, and 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. Gain knowledge for conserving the environment and resolve the environmental related issues.
4. Apply the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture and food sectors.
5. Understand and apply good laboratory and good manufacturing practices in microbial quality control.
6. Understand biochemical and physiological aspects of microbes and develop broader perspectives to identify innovative solutions for present and future challenges posed by microbes.
7. Understand the application of microbes in forensic and working knowledge about clinical microbiology.
8. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.
9. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.
10. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of Microbiology.

IIA. Model Program Structures for the Under-Graduate Programs in Bangalore University and its affiliated Colleges.

Subject: Microbiology

Semester	Discipline Core (DSC)(Credits) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits) (L+T+P)		Skill Enhancement Courses (SEC)		Total Credits
					Skill based (Credits) (L+T+P)	Value based (Credits) (L+T+P)	
I	DSC-T1 MBL 101 A1- General Microbiology (04) DSC-P1 MBL 101 General Microbiology (02)	OE-T1, MBL-301 Microorganisms for Human Welfare (03)	L1-1(3), L2- 1(3) (4 hrs. each)	-----	SEC-T1, MBL-701, Microbiological Techniques (1+0+2)	Physical Education for Health & Wellness fitness(1)(0+0+2)(1)(0+0+2)	25
II	DSC-T2 MBL 102 A2-Microbial Biochemistry and Physiology (04) DSC-P2 MBL 102 Microbial Biochemistry and Physiology (02)	OE-T2, MBL 302, Environmental Microbiology and Human Health (3)	L1-2(3), L2- 2(3) (4 hrs. each)	Environmental Studies (2)	-----	Physical Education - NCC/NSS/R&R(S&	25
Exit option with Certificate in Microbiology (50 Credits)							

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

Course Title: DSC-T1MBL101, General Microbiology (A1)	
Course Code: DSC-T1 MBL101	L-T-P per week: 4-0-0
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 40	Duration of ESA/Exam: 3 h
Model Syllabus Authors: Curriculum Committee	Summative Assessment Marks: 60

Course Prerequisite (s): PUC or +2 (Life Sciences as one of the core disciplines)

Course Outcomes (COs): At the end of the course the students will be able to:

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 (Pos 1-12)

Sl. No	Course Outcomes (COs) / Program Outcomes (POs)	T1	1	2	3	4	5	6	7	8	9	10	11
I	Core competency	X											
II	Critical thinking	X											
III	Analytical reasoning	X											
IV	Research skills	X											
V	Team work	X											

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

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

Content of Course 01: Theory: DSC-T1 MBL101: General Microbiology	56 h
Unit – 1: Historical development and origin of microorganisms	14 h
Historical development of Microbiology – Theory of spontaneous generation, Biogenesis and Abiogenesis. Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, Alexander Fleming, Martinus Beijerinck, Sergei Winogradsky and Elie Metchnikoff. Contribution of Indian scientists in the field of Microbiology. Fossil evidences of microorganisms. Origin of life, primitive cells and evolution of microorganisms. Microscopy- working principle, construction and operation of simple and compound microscopes.	
Unit – 2: Staining, sterilization and preservation techniques	14 h
Staining: Nature of stains, principles, mechanism, methods and types of staining-simple, Differential-Gram staining, acid fast staining, capsule staining, endospore, inclusion bodies. Sterilization: Principles, types and techniques - physical and chemical. Preservation of microorganisms: Methods of preservation, slant culture, stab culture, soil culture, mineral oil overlaying, glycerol preservation, Lyophilization.	
Unit – 3: Prokaryotic microorganisms	14 h
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 Material – 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	14 h
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 fungi-Vegetative, asexual and sexual	

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in marks
Assignment/ Field Report/ Project	15 Marks
Test	20 Marks
Participation in class	05 marks
Total	40 Marks

General Microbiology Laboratory Content:

Course 01: Practicals: DSC-P1MBL101: General Microbiology

Course Title: General Microbiology	Course Credits: 02
Course Code: DSC-P1MBL101	L-T-P per week: 0-0-4
Total Contact Hours: 28	Duration of ESA/Exam: 4 h
Formative Assessment Marks: 25	Summative Assessment Marks: 25

1. Microbiological laboratory standards and safety protocols.
2. Operation and working principles of light and compound microscope.
3. Working principle and operations of basic equipments of microbiological laboratory (Autoclave, oven, incubator, LAF, pH meter, spectrophotometer, colorimeter, vortex, magnetic stirrer etc.).
4. Isolation and identification of microorganisms from natural sources (Algae, Yeast, filamentous fungi and protozoa).
5. Bacterial motility by hanging drop method.
6. Simple staining – Negative staining.
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.

Text Books/References

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore.869 pp.
2. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA.987pp.
3. Black, J.G. 2008. Microbiology principles and explorations. 7th edition. John Wiley and Sons Inc., New Jersey. 846pp.
4. Dubey, R.C. and Maheshwari, D.K. 1999. A Textbook of Microbiology, 1st edition, S. Chand & Company Ltd.
5. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. 2009. Brock Biology of Microorganisms, - 12th edition, Pearson International edition, Pearson Benjamin Cummings.
6. Michael Pelczar, Jr., Chan E.C.S., Noel Krieg 1993. Microbiology - Concepts and Applications, International ed, McGraw Hill.
7. Pommerville, J.C. 2013. Alcamo's Fundamentals of Microbiology. Jones and Bartlett.
8. Schlegel, H.G. 1995. General Microbiology. Cambridge University Press, Cambridge, 655 pp.

9. Stanier, Ingraham et al. 1987. General Microbiology, 4th and 5th edition Macmillan education limited. International, edition 2008, McGraw Hill.
10. Talaro, K.P. 2009. Foundations in Microbiology, 7th International edition, McGraw Hill.
11. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pvt. Ltd., San Francisco.958 pp.
12. Tortora, G.J., Funke, B.R., Case C.L. 2008. Microbiology an Introduction, 10th ed. Pearson Education.
13. Willey, J. M., Sherwood, L., Woolverton, C. J., & Prescott, L. M. (2008). Prescott, Harley, and Klein's microbiology. New York: McGraw-Hill Higher Education.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in Marks
Assignment/Monograph	10
Test	10
Participation in class	05
Total	25

Course 02: Theory: OE-T1MBL301: Microorganisms for Human Welfare

Course Title: Microorganisms for Human Welfare	Course Credits: 03
Course Code: OE-T1MBL301	L-T-P per week: 0-0-3
Total Contact Hours: 42h	Duration of ESA/Exam: 4h
Formative Assessment Marks: 30	Summative Assessment Marks: 45
Unit – 1: Food and Fermentation	14 h
Fermented Foods – Types, nutritional values and health benefits. Probiotics, prebiotics, synbiotics and nutraceuticals. Fermented Products – Alcoholic and non-alcoholic beverages, dairy products.	
Unit – 2: Agriculture	14 h
Bio-fertilizers and bio-pesticides - types and applications, beneficial microorganisms in agriculture, AM fungi, Mushroom cultivation, Biogas production.	
Unit – 3: Pharmaceutical Industry	14 h
Drugs – types, development and applications. Antibiotics – types, functions and antibiotic therapy. Vaccines – types, properties, functions and schedules.	

Textbooks/References

1. Ananthnarayanan, R and Jeyaram Panicker, C. K. 2010. Textbooks of Microbiology, Orient Longman.
2. Dubey, R.C. and Maheshwari, D.K. 2013. A Textbook of Microbiology –2nd edition (S Chand & Co. N. Delhi).
3. Michael, J. Pelczar, Jr. E.C.S., Chan, Noel R. 1998. Krieg Microbiology Tata McGraw- Hill Publisher.
4. Pelczar, M.J., Chan E.C.S. and Kreig, N.R. 1993. Microbiology 5th edition (Tata McGraw-Hill, New Delhi)
5. Prescott, L.M., Harley, J.P. and Klein, D.A., 2007. Microbiology –7th edition (Wm. C. Brown Publishers, USA) Elementary Microbiology – Modi, HA (vol. I), 1st edition (Ekta Pakashan, Nadiad).
6. Prescott, M.J., Harly, J.P. and Klein 2002. Microbiology 5th Edition, WCB McGraw Hill, New York.
7. Sateesh, M.K. 2010. Bioethics and Biosafety. IK International Pvt Ltd. 2. Dubey, RC A Textbook of Biotechnology. S Chand Publications.
8. Singh, B.D. 2013. Expanding Horizons in Biotechnology. Kalyani Publication.
9. Sree Krishna, V. 2007. Bioethics and Biosafety in Biotechnology, New age international publishers
10. Willey, J.M., Sherwood L.M and Woolverton C.J., Prescott, Harley and Klein's. 2013. Microbiology. McGraw Hill Higher education. 9th Edition.

Pedagogy: Chalk and Talk, PPT, Group discussion, Seminars, Field visit

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	15
Written Assignment/Presentation/Project / Term Papers/Seminar	10
Class performance/Participation	05
Total	30

Skill Enhancement Course in Microbiology
Course 03: Theory: SEC-T1MBL701, Microbiological 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.
- Principles which underlies sterilization of culture media, glassware and plastic ware to be used for microbiological work.
- Principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.
- 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.

Course content:03		14 h
Course Title: SEC-T1MBL701: Microbiological Techniques		
Total Contact Hours: 14 Hours	Duration of ESA:01Hrs.	
Formative Assessment Marks:	Summative Assessment Marks: 25	
Unit-1: <ul style="list-style-type: none"> • Microbiological culture media: Types, Composition, Preparation, Application and storage; Ingredients of media, 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, 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, Bright Field, Dark Field, Fluorescent, Confocal, Scanning and Transmission Electron Microscopes, Scanning Probe Microscopy 		

<ul style="list-style-type: none"> • Centrifugation, Chromatography and spectroscopy: principles, types, instrumentation, operation and applications. 	
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Lab content of Skill Enhancement Course in Microbiology

Course - 03: Practicals: SEC-P1MBL701, Microbiological Techniques

Course content:03	
Course Title: SEC-P1MBL701: Microbiological Techniques	
Total Contact Hours: 28 Hours	Duration of ESA:02Hrs.
Formative Assessment Marks: 25	Summative Assessment Marks: 25

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, stirrers.
3. Preparation of different types of bacterial culture media.
4. Preparation of different types of fungal culture media.
5. Preparation of different types 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: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in Marks
Assignment/Monograph	10
Test	10
Participation in class	05
Total	25

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

Course Title: DSC-T2 MBL102, Microbial Biochemistry and Physiology (A2)	
Course Code: DSC-T2 MBL102	L-T-P per week: 4-0-0
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 40	Duration of ESA/Exam: 3 h
Model Syllabus Authors: Curriculum Committee	Summative Assessment Marks: 60

Course Outcomes (COs): At the end of the course the students will be able to:

1. Acquire thorough knowledge and understanding of concepts of Microbiology.
2. Learn and practice professional skills in handling microbes.
3. Gain thorough knowledge and apply good laboratory and good manufacturing practices in microbial quality control.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos 1-12)

Sl. No	Course Outcomes (COs) / Program Outcomes (POs)	T1	1	2	3	4	5	6	7	8	9	10	11
I	Core competency	X											
II	Critical thinking	X											
III	Analytical reasoning	X											
IV	Research skills	X											
V	Team work	X											

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.), Second Semester

Content of Course 1: Theory: DSC-T2MBL102: Microbial Biochemistry and Physiology	56h
Unit – 1: Biochemical concepts	14h
<p>Basic Biochemical Concepts: Major elements of life and their primary characteristics, atomic and chemical bonds – covalent, non-covalent, ionic, hydrogen and Vander Waal's Forces.</p> <p>Biological Solvents: Structure and properties of water molecule, water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, acids, bases, electrolytes, pH and buffers, Henderson–Hasselbalch equation.</p>	
Unit – 2: Macromolecules	14h
<p>Carbohydrates: Definition, classification, structure and properties.</p> <p>Amino acids and proteins: Definition, structure, classification and properties of amino acids, structure and classification of proteins.</p> <p>Lipids and Fats: Definition, classification, structure, properties and importance of lipids; fatty acids: types and classification.</p>	

Porphyrins and Vitamins: Definition, structure, properties and importance of chlorophyll, cytochromes and hemoglobin.	
Unit – 3: Microbial growth and nutrition	14h
<p>Microbial Growth: Definition, growth curve, phases of growth, growth kinetics, generation time. Synchronous culture, continuous culture (chemostat and turbidostat), coulter cultures, diauxic growth. Measurement of growth: Direct microscopic count - Haemocytometer; viable count, membrane filtration; electronic Counting; Measurement of cell mass; Turbidity measurements - Nephelometer and spectrophotometer based techniques; Measurement of cell constituents. Growth yield. Influence of environmental factors on growth.</p> <p>Microbial Nutrition: Microbial nutrients, macro and micronutrients, classification of organisms based on nutritional requirements.</p> <p>Membrane Transport: Structure and organization of biological membranes, Types of cellular transport - passive, facilitated, active, group translocation, membrane bound protein transport system, carrier models, liposomes, ion channels, Na⁺K⁺-ATPase.</p>	
Unit – 4: Bioenergetics, Respiration and Photosynthesis	14h
<p>Bioenergetics: Free energy, enthalpy, entropy, laws of thermodynamics. High energy compounds: classification, structure and significance, oxidation reduction reactions, equilibrium constant, redox potential.</p> <p>Microbial Respiration: Electron transport chain, protein translocation, and substrate level phosphorylation, oxidative phosphorylation, inhibitors of ETC and mechanism, structure and function of ATP synthase and ATP synthesis. Fermentation reactions (homo and hetero lactic fermentation)</p> <p>Microbial Photosynthesis: Light reaction: Light harvesting pigments, Photophosphorylation, CO₂ fixation pathways: Calvin cycle, CODH pathway, Reductive TCA pathway.</p>	

Text Books/References

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
2. Atlas, R.M. 1984. Basic and practical Microbiology. Mac Millan Publishers, USA. 987 pp.
3. Black, J.G. 2008. Microbiology principles and explorations. 7th edition. John Wiley and Sons Inc., New Jersey 846 pp.
4. Boyer, R. 2002, Concepts in Biochemistry 2nd Edition, Brook/Cole, Australia.
5. Caldwell, D.R. 1995 – Microbial Physiology and Metabolism. Brown Publishers
6. Dubey R.C. and Maheshwari D.K. 1999. A Textbook of Microbiology, 1st edition, S. Chand & Company Ltd.
7. Felix Franks, 1993. Protein Biotechnology, Humana Press, New Jersey.
8. Harper, 1999. Biochemistry, McGraw Hill, New York
9. Lodish, H.T. Baltimore, A. Berck B.L. Zipursky, P. Mastysdaire and J. Darnell. 2004. Molecular Cell Biology, Scientific American Books, Inc. New York
10. Madigan, M.T., Martinko J.M., Dunlap P.V., Clark D.P. 2009. Brock Biology of Microorganisms, 12th edition, Pearson International edition Pearson Benjamin

Cummings.

11. Michael Pelczar, Jr., Chan E.C.S., Noel Krieg 1993. Microbiology - Concepts and Applications, International ed, McGraw Hill.
12. Moat, A. G., Foster, J.W. Spector. 2004. Microbial Physiology 4th Edition Panama Book Distributors.
13. Nelson, and Cox, 2000. Lehninger Principles of Biochemistry, Elsevier Publ.
14. Palmer, T. 2001. Biochemistry, Biotechnology and Clinical Chemistry, Harwood Publication, Chichester.
15. Pommerville, J.C. 2013. Alcamo's Fundamentals of Microbiology. Jones and Bartlett.
16. Schlegel, H.G. 1995. General Microbiology. Cambridge University Press Cambridge, 655 pp.
17. Stanier, Ingraham et al. 1987. General Microbiology, 4th and 5th edition Macmillan education limited. International, edition 2008, McGraw Hill.
18. Stryer, L, 1995. Biochemistry, Freeman and Company, New York.
19. Talaro, K.P. 2009. Foundations in Microbiology, 7th International edition McGraw Hill.
20. Tortora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th edition. Pearson Education Pvt. Ltd., San Francisco. 958pp.
21. Tortora, G.J., Funke, B.R., Case, C.L. 2008. Microbiology-An Introduction, 10th ed. Pearson Education.
22. Voet and Voet, 1995; Biochemistry, John Wiley and Sons, New York.
23. Willey, J. M., Sherwood, L., Woolverton, C. J., and Prescott, L. M. (2008). Prescott, Harley, and Klein's microbiology. New York: McGraw-Hill Higher Education.

Formative Assessment	
Assessment Occasion	Weightage in marks
Assignment/ Field Report/ Project	15 Marks
Test	20 Marks
Participation in class	05 marks
Total	40 Marks

Microbial Biochemistry and Physiology Laboratory Content

Course 01: Practicals: DSC-P2, MBL102: Microbial Biochemistry and Physiology

Course Title: Microbial Biochemistry and Physiology	Course Credits: 02
Course Code: DSC-P1 MBL102	L-T-P per week: 0-0-4
Total Contact Hours: 28	Duration of ESA/Exam: 03 h
Formative Assessment Marks: 25	Summative Assessment Marks: 25

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 sugar by DNS method.
8. Estimation of protein by Lowry's method.
9. Determination of saponification values and iodine number of lipids/fatty acids.
10. Determination of bacterial growth by turbidometric method & calculation of generation time.
11. Effect of pH, temperature and salt concentration on bacterial growth.
12. Demonstration of aerobic and anaerobic respiration in microbes.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in Marks
Assignment/Monograph	10
Test	10
Participation in class	05
Total	25

Course 02: Theory: OE-T2, MBL302: Environmental Microbiology and Human Health

Course Title: Environmental Microbiology and Human Health	Course Credits: 03
Course Code: OE-T2MBL302	L-T-P per week: 0-0-3
Total Contact Hours: 42h	Duration of ESA/Exam: 3h
Formative Assessment Marks: 30	Summative Assessment Marks: 45
Unit – 1: Soil and Air Microbiology	14 h
Soil and air as a major component of environment. Types, properties and uses of soil and air. Distribution of microorganisms in soil and air. Major types of beneficial microorganisms in soil. Major types of harmful microorganisms in soil.	
Unit – 2: Water Microbiology	14 h
Water as a major component of environment. Types, properties and uses of water. Microorganisms of different water bodies. Standard qualities of drinking water	
Unit – 3: Microbial Diseases and Control	14 h
Public health hygiene and communicable diseases. Survey and surveillance of microbial infections. Air borne microbial diseases, water borne microbial diseases, Food borne microbial infections. Epidemiology of microbial infections, their detection and control.	

Text Books/References

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
2. Atlas, R.M. 1984. Basic and practical Microbiology. Mac Millan Publishers, USA. 987 pp.
3. Black, J.G. 2008. Microbiology principles and explorations. 7th edn. John Wiley and Sons Inc., New Jersey 846 pp.
4. Dubey R.C. and Maheshwari D.K. 1999. A Textbook of Microbiology, 1st edition, S. Chand & Company Ltd.
5. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. 2009. Brock Biology of Microorganisms, - 12th edition, Pearson International edition, Pearson Benjamin Cummings.
6. Michael Pelczar, Jr., Chan E.C.S., Noel Krieg 1993. Microbiology - Concepts and Applications, International ed, McGraw Hill.
7. Pommerville, J.C. 2013. Alcamo's Fundamentals of Microbiology. Jones and Bartlett.
8. Schlegel, H.G. 1995. General Microbiology. Cambridge University Press, Cambridge, 655 pp.
9. Stanier, Ingraham et al. 1987. General Microbiology, 4th and 5th edition Macmillan education limited. International, edition 2008, McGraw Hill.
10. Talaro, K.P. 2009. Foundations in Microbiology, 7th International edition, McGraw Hill.
11. Tortora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pvt. Ltd., San Francisco. 958 pp.
12. Tortora, G.J., Funke, B.R., Case C.L. 2008. Microbiology an Introduction, 10th ed. Pearson Education.

13. Willey, J. M., Sherwood, L., Woolverton, C. J., and Prescott, L. M. (2008). Prescott, Harley, and Klein's microbiology. New York: McGraw-Hill Higher Education.

Pedagogy: Chalk and Talk, PPT, Group discussion, Seminars, Field visit

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	15
Written Assignment/Presentation/Project / Term Papers/Seminar	10
Class performance/Participation	05
Total	30