mLAC
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Excellence in Education
Since 1972

Maharani Lakshmi Ammanni College for Women **Autonomous**

Affiliated to Bengaluru City University
Re-accredited by NAAC with "A" grade, Recognised by UGC
under Section 2(f) and 12(b) of the UGC Act 1956
Conferred the Status of 'College with Potential for Excellence' by UGC

DEPARTMENT OF MICROBIOLOGY

NEP SYLLABUS

2021 ONWARDS

DEPARTMENT OF MICROBIOLOGY

PROGRAMME SPECIFIC OUTCOMES

PSO.1 - learning scientific reasoning skills and explore the basic concepts and application of Microbiology and its applied branches.

PSO.2 – Sequestering & Classification of various microbial forms and their significance, illustrating the acquired hands-on skills in Environmental, Food, Dairy and Medical Microbiology.

PSO.3 – Practicing strong oral, Writing and Entrepreneurship skills through seminars, Group discussions, projects, and field visits.

PSO.4 – Motivating students towards Research, critical thinking, and practice a wide range of careers in Global and Public health.

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DEPARTMENT OF MICROBIOLOGY

COURSE OUTCOMES

Name of the Program: B.Sc Microbiology **Semester:** I

Course Title: General Microbiology

Course code: MIC 101 -T

Academic year: 2023 – 24

Number of Credits: 04

I SEMESTER - THEORY

CO1: Students will acquire basic knowledge about microorganisms, technical terminologies of microscopy, staining, culture media and sterilization with a fundamental understanding of prokaryotic and eukaryotic cell organization

CO2: Understand the concepts related to branches of microbiology, gain insight into microbial origin of life through their fossilization process, microscopy types, media design and preparation, types of staining; sterilization and culture preservation and to differentiate prokaryotic and eukaryotic systems through distinguishable staining properties.

CO3: Capable of analyzing the historical contributions, scope of microbiology, significance, and application of microscopy, staining and sterilization and understand to differentiate prokaryotic and eukaryotic cells

CO4: Inculcate the perceptions on major discoveries in microbiology, advanced microscopy, and microbe control methods; they shall also be able to categorize microbes on structural, cellular, and morphological differences, compare and categorize organisms with prokaryotic and eukaryotic features

CO5: Students can evaluate the differences in microscopy, staining and sterilization methods with a thorough understanding of prokaryotic and eukaryotic cell characteristics

Name of the Program: B.Sc Microbiology **Semester:** I
Course Title: General Microbiology

Course code: MIC 101 -P

Academic year: 2023 – 24

Number of Credits: 02

I SEMESTER - PRACTICAL

CO 1: Students are trained for handling of microscope; use of oil immersion and to recognize and identify various laboratory instruments

CO 2: Practical skills such as aseptic methods and sterilization procedures are taught as preliminary procedures in microbiology

CO3: Students gain hands-on experience to enumerate and categorize microbes based on staining

: Students are trained for handling of microscope; use of oil immersion and to recognize and identify various laboratory instruments

I SEMESTER – OPEN ELECTIVE

Name of the Program: B.Sc Microbiology Semester: I

Course Title: Microorganisms in Human welfare

Course code: MIC- OEC -101

Academic year: 2023 – 24

Number of Credits: 03

CO1: Students shall be able to define and enlist the microbes in human welfare

CO2: Students are taught to illustrate the role of microorganisms in food, Agriculture and Pharmaceutical industry

CO3: Students accomplish to explain the significance of beneficial microbes in fermented foods, plant growth and disease therapy

I SEMESTER B.SC MICROBIOLOGY

SYLLABUS

NEP BATCH

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

MIC-101T: General Microbiology **56 hrs**

Course Title: General Microbiology	
Course Code: **MIC-101T**	L-T-P per week: 4-0-0
Total Contact Hours: **56**	Course Credits: 04
Formative Assessment Marks: **40**	Duration of ESA/Exam: **2 ½ hrs**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **60**

Unit – 1: Historical development and origin of microorganisms **14 hrs**

- Introduction to Microbiology, Habitat. Fossil evidence of microorganisms. Origin of life, primitive cells and evolution of microorganisms.
- Historical development of Microbiology – Theory of spontaneous generation, Biogenesis andAbiogenesis.
- Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, EdwardJenner, Alexander Fleming, Martinus Beijernick, Sergei Winogradsky and Elie Metchnikoff.
- Contribution of Indian scientists in the field of Microbiology.
- Microscopy- working principle, construction and operation of simple and compound microscopes. Different types of microscopes - Phase contrast, Bright Field, Dark Field, Fluorescent, Confocal, Scanning and Transmission Electron Microscopes

Unit – 2: Staining, sterilization and preservation techniques **14 hrs**

- Staining: Nature of stains, principles, mechanism, methods and types of staining-simple, Differential-Gram staining, acid fast staining, capsule staining, endospore, and inclusion bodies.
- Sterilization: Principles, types and techniques - physical and chemical.
- 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.
- Preservation of microorganisms: Methods of preservation, slant culture, stab culture, soil culture, mineral oil overlaying, glycerol preservation, Lyophilization.

Unit – 3: Prokaryotic microorganisms **14 hrs**

- Overview of prokaryotic cell structure: Size, shape, arrangement.
- Ultra structure of prokaryotic cell: bacterial and archaeal - cell wall and cell membrane. Components external to cell wall - capsule, slime, s-layer, pili, fimbriae, flagella; structure, motility, chemotaxis. Cytoplasmic matrix - Cytoskeleton, ribosome, inclusion granules:

Composition and function.

- Nuclear Materials – bacterial structure (its differences with the Eukaryotic chromosome); ExtraChromosomal material.
- Bacterial Endospore - Examples of spore forming organisms, habitats, function, formation andgermination. Reproduction in bacteria.

Unit – 4: Eukaryotic microorganisms **14 hrs**

- 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

General Microbiology Practical

Course 01: Practicals MIC-101P Course Title: **General Microbiology**	Course Credits: 02
Course Code: **MIC-101P**	L-T-P per week: 0-0-4
Total Contact Hours: 56	Duration of ESA/Exam: 4h
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 equipment's of microbiological laboratory (Autoclave, oven,incubator, LAF, spectrophotometer, colorimeter, vortex, magnetic stirrer etc.).
4. Bacterial motility by hanging drop method
5. Simple staining – Negative staining
6. Differential staining – Gram staining
7. Acid fast staining
8. Structural staining – Flagella and capsule
9. Bacterial endospore staining
10. Staining of reserved food materials (granular)
11. Staining of fungi by lactophenol cotton blue
12. Type study fungi – *Aspergillus, Cladosporium, Rhizopus*

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar Formative Assessment	
Assessment Occasion	Weightage in
House Examination/Test	20
Written Assignment/Presentation/Project / Term	15
Class performance/Participation	05
Total	40

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., NewJersey. 846pp.

1. Dubey, R.C. and Maheshwari, D.K. 1999. A Textbook of Microbiology, 1st edition, S. Chand & CompanyLtd.

2. 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.

3. Michael Pelczar, Jr., Chan E.C.S., Noel Krieg 1993. Microbiology - Concepts and Applications, International ed, McGraw Hill.

4. Pommerville, J.C. 2013. Alcamo's Fundamentals of Microbiology. Jones and Bartlett.

5. Schlegel, H.G. 1995. General Microbiology. Cambridge University Press, Cambridge, 655 pp.

6. Stanier, Ingraham et al. 1987. General Microbiology, 4th and 5th edition Macmillan education limited.International, edition 2008, McGraw Hill.

7. Talaro, K.P. 2009. Foundations in Microbiology, 7th International edition, McGraw Hill.

8. Tortora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pvt. Ltd., SanFrancisco.958 pp.

9. Tortora, G.J., Funke, B.R., Case C.L. 2008. Microbiology an Introduction, 10th ed. Pearson Education.

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

Course 02: Theory MIC-OEC-101: Microorganisms for Human Welfare Content **42 hrs**

Unit – 1: Food and Fermentation 14 hrs

- Fermented Foods – Types, nutritional values, and health benefits
- Probiotics, prebiotics, synbiotic and nutraceuticals
- Fermented Products – Alcoholic and non-alcoholic beverages, dairy products

Unit – 2: Agriculture 14 hrs

- Bio-fertilizers and bio-pesticides - types and applications
- Beneficial microorganisms in agriculture, VAM fungi
- Mushroom cultivation
- Biogas production

Unit – 3: Pharmaceutical Industry 14 hrs

- Drugs – types, development and applications
- Antibiotics – types, functions and antibiotic therapy
- Vaccines – types, properties, functions and schedules

Textbooks/References

1. Ananthnarayan, R and JayaramPanicker, 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 (EktaPakashan, Nadiad).
6. Prescott, M.J., Harly, J.P. and Klein 2002. Microbiology 5ft Edition, WCB McGraw Hill, New York.
7. Sateesh, M.K. 2010. Bioethics and Biosafety.IK International Pvt Ltd. 2.Dubey, RC A Textbook ofBiotechnology.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.

II SEMESTER B.SC MICROBIOLOGY

SYLLABUS

NEP BATCH

DEPARTMENT OF MICROBIOLOGY
COURSE OUTCOMES---- II SEM THEORY (NEP)

Name of the Program: B.Sc Microbiology Semester: II

Course Title: Microbial Biochemistry and Physiology

Course code: MIC 201 -T

Academic year: 2023 – 24

Number of Credits: 04

CO1: Students will attain basic knowledge about major elements of life, necessity of biomolecules, requirements of microbial nutrition with an necessary understanding of microbial respiration and photosynthesis

CO2: Able to understand the atomic and chemical bonds, classification levels of biomolecules, growth parameters of microbes and fundamentals of microbial metabolic processes

CO3: Capable of analysing the properties and significance of water and other biomolecules, growth enumeration patterns and mechanisms of microbial respiration and photosynthesis

CO4: Incorporate in-depth knowledge to differentiate biomolecules; help to apply the different metabolic situations and pathways in microbes

CO5: Students can evaluate the differences solution preparation, biomolecular differences, diverse nutrition levels and understand the physiology of microbes

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COURSE OUTCOMES--- II SEM PRACTICAL (NEP)

Name of the Program: B.Sc Microbiology **Semester**: II

Course Title: Microbial Biochemistry and Physiology

Course code: MIC 201 -P

Academic year: 2023 – 24

Number of Credits: 02

CO 1: Students are trained for preparation of solutions with basic calculations

CO 2: Practical skills to qualitatively estimate biomolecules are taught which shall enable basics of quality control skills

CO3: Students gain hands-on experience to enumerate and categorize microbes based on growth parameters

DEPARTMENT OF MICROBIOLOGY

COURSE OUTCOMES--- II SEM OPEN ELECTIVE (NEP)

Name of the Program: B.Sc Microbiology **Semester**: II

Course Title: Environmental Microbiology and Human Health

Course code: MIC- OEC -201

Academic year: 2023 – 24

Number of Credits: 03

CO1: Students shall able to define and recollect the microbes in soil, air, water and human health

CO2: Students are taught to illustrate the role of microorganisms in environment and human disease

CO3: Students accomplish to explain the significance of water standards and the role of microbes in human diseases with an insight into epidemiology and disease surveillance mechanisms

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

Course Title: MIC-201T **Microbial Biochemistry and Physiology**	
Course Code: **MIC-201T**	L-T-P per week: 4-0-0
Total Contact Hours: **56**	Course Credits: 04
Formative Assessment Marks: **40**	Duration of ESA/Exam: **2.5 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **60**

Course 1: Theory MIC-201T : Microbial Biochemistry and Physiology 56 hrs

Unit – 1: Biochemical concepts 14 hrs

- **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
- **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

Unit – 2: Macromolecules 14 hrs

- **Carbohydrates:** Definition, classification, structure and properties.
- **Amino acids and proteins:** Definition, structure, classification and properties of amino acids, structure and classification of proteins
- **Lipids and Fats:** Definition, classification, structure, properties and importance of lipids; fatty acids: types and classification
- **Porphyrins and Vitamins:** Definition, structure, properties and importance of chlorophyll, cytochromes and hemoglobin

Unit – 3: Microbial growth and nutrition 14 hrs

- **Microbial Nutrition:** Microbial nutrients, macro and micronutrients, classification of organisms based on nutritional requirements
- **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
- **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

Unit – 4: Bioenergetics, Respiration and Photosynthesis **14 hrs**

- **Bioenergetics:** Free energy, enthalpy, entropy, laws of thermodynamics. High energy compounds: classification, structure and significance, oxidation reduction reactions, equilibrium constant, redox potential
- **Microbial Respiration:** EMP pathway, 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)
- **Microbial Photosynthesis:** Light reaction: Light harvesting pigments, Photophosphorylation, CO_2 fixation pathways: Calvin cycle, CODH pathway, Reductive TCA pathway

Microbial Biochemistry and Physiology Practical

Course 01: Practicals: MIC-201P 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: 56	Duration of ESA/Exam: 4 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 turbidimetric 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: Written Assignment/Presentation/Project / Term Papers/Seminar

Formative Assessment	
Assessment Occasion	Weightage in
House Examination/Test	15
Class performance/Participation	10
Total	25

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, NewYork

9. Lodish, H.T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J. Darnell. 2004. Molecular Cell Biology, Scientific American Books, Inc. Newyork

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. Toratora, 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.

Theory: MIC-OEC-201 : Environmental Microbiology and Human Health **42 hrs**

Unit – 1: Soil and Air Microbiology **14 hrs**

- 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 hrs**

- 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 hrs**

- 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. 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., and Prescott, L. M. (2008). Prescott, Harley, and Klein's microbiology. New York: McGraw-Hill Higher Education.

Pedagogy: Written assignment/ Presentation Project/ Term papers/ Seminar

Formative Assessment: 40	
Assessment Occasion/type	**Weightage in marks**
IA (2)	20
Assignment/ Visits	10
Seminars/Group Discussions	10
Total	**40**

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III SEMESTER B.SC MICROBIOLOGY

SYLLABUS

NEP BATCH

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; Understanding biochemical and physiological aspects of microbes

PO3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.

PO4. Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.

Exploring the microbial world and analyzing the specific benefits and challenges.

Percentage of changes

Sl. no	Title of paper	Paper code	Percentage of changes
1.	Microbial Diversity (Theory)	MIC-301T	5 %
2.	Microbial Diversity (Practical)	MIC-301P	10 %
3.	Microbial Enzymology and Metabolism (Theory)	MIC-401T	-
4.	Microbial Enzymology and Metabolism (Practical)	MIC-401P	-

Program Name	**B.Sc Microbiology**		Semester	**Third Sem**
Course Title	**Microbial Diversity**			
Course No.	**MIC-301T**	**DSC -3T**	No. of Theory Credits	**4**
Contact hours	**56hrs**		Duration of ESA/Exam	**2.5 Hours**
Formative Assessment Marks	40		Summative Assessment Marks	60

Course Outcomes(COs):

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. Various parameters for Numerical and Chemotaxonomy. Study and measures of microbial diversity; Conservation and Economic values of microbial diversity. An overview of Bergey's Manual of Systematic Bacteriology.	
Unit-II	
Diversity of Prokaryotic Microorganisms Distribution, factors regulating distribution. General characteristics; Classification; habitat, structure, Cultural characteristics, Reproduction and Economic importance of: **Archaea:** *Thermus aquaticus,* Methanogens **Bacteria:** *Escherichia coli, Bacillus subtilis,* **Cyanobacteria***: Spirulina, Anabaena, Nostoc* **Actinomycetes:** *Streptomyces, Nocardia, Frankia* **Rickettsiae**: *Rickettsia rickettsi* **Chlamydiae**: *Chlamydia trachomatis* **Spirochaetes:** *Treponema pallidum* **Mycoplasma:** *Ureaplasma, Acholeplasma*	**16 Hrs**

Unit-III	
Diversity of Eukaryotic Microorganisms General characters; Classification- Economic importance **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, Spirulina* **Protozoa:** Classification up to the level of classes. Type study: *Amoeba, Euglena, Paramoecium, Plasmodium, Trypanosoma*	**16 Hrs**
Unit-IV	**16 Hrs**
Diversity of Viruses General structure, Isolation, purification, assay 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, Cauliflower mosaic virus **Microbial:** T4, lambda, cyano and mycophages. Sub viral particles; Viroids and Prions.	

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.	**MIC-301P**	**DSC-4P**	Contact hours	**26 Hrs**

Content

1. Isolation and identification of bacteria from soil, air and water
2. Isolation, and identification of fungi from soil, air and water
3. Isolation, and identification of Cyanobacteria
4. Isolation, and identification of Actinomycetes
5. Study of morphology of bacteria- cocci, bacilli, vibrio and spiral (slides)
6. Isolation of bacteriophages from sewage water and plaque analysis
7. Demonstration of viral inoculation in chick embryo
8. Type study: Cyanobacteria, *Nostoc, Spirulina* and isolated forms
9. Type study: Algae: *Chlorella, Diatoms, Gracilaria* and isolated forms
10. Type study: Fungi: *Rhizopus, Saccharomyces, Agaricus* and isolated forms
11. Type study: Protozoa: Amoeba, *Euglena, Plasmodium, Paramoecium, Trypanosoma* (slides)

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.,andLeppard,K.N.2001.Introduction to Modern Virology. 5th edition. Blackwell Publishing, USA
4. Prescott, Harley, Klein's Microbiology, J.M.Willey, L.M.Sherwood, C.J.Woolverton, 2008. 7th International edition ,Mc GrawHill
5. Vashishta,B.R, SinhaA.K and Singh V.P.2005. Botany–Fungi, S.Chand and Company Limited, New Delhi
6. Kotpal, R.L Protozoa 5th Edition2008. Rastogi Publications, Meerut, New Delhi

7. Madigan, M.T.Martinko, J.M,Dunlap, P.V.Clark,D.P.2009. Brock Biology of Microorganisms,12th edition, Pearson Benjamin Cummings
8. G.J.Tortora, B.R.Funke,C.L. 2008. Microbiology–AnIntroduction,Case,10thedition.,Pearson Education
9. Pelczar Jr. Chan, Krieg, Microbiology Concepts and Applications, International edition, McGrawHill
10. Alexopoulos,C.J.,Mims,C.W.andBlackwell,M.2002.IntroductoryMycology.JohnWileyandSons (Asia)Pvt.Ltd. Singapore. 869 pp, 4th edition.
11. Dubey R.C.,and Maheshwari,D.K. 1999. A Textbook of Microbiology, 1stedition, S.Chand &Company Ltd, New Delhi

MICROBIOLOGY OPEN ELECTIVE III SEMESTER

Program Name	**B.Sc Microbiology**		Semester	**Third Sem**
Course Title	**Microbial Entrepreneurship**			
Course Code	**MIC-OEC-301**	**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 Outcomes(COs):

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.	

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 textbook on food and Nutrition. Volume I. Bappco
4. Gopalan,.C. RamaSastry,B.V. and Balasubramanian, S.C (2009).Nutritive value of Indian Indian Foods. NIN. ICMR. Hyderabad
5. MudambiSRandRajagopalMV.2008.FundamentalsofFoods, Nutrition & diet therapy by New Age International Publishers, New Delhi. 5th edition

IV SEMESTER B.SC MICROBIOLOGY

SYLLABUS

Program Name	**B.Sc Microbiology**		Semester	**Fourth Sem**
Course Title	**Microbial Enzymology and Metabolism**			
Course No.	**MIC-401T**	**DSC -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2 Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Outcomes(COs):

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 Metabolism of Carbohydrates	**14 Hrs**
Concept of aerobic respiration, anaerobic respiration and fermentation. **Carbohydrate metabolism pathways** i.e. 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 Metabolism of amino acids, nucleotides and lipids	**14 Hrs**
Nitrogen Metabolism: Introduction to biological Nitrogen fixation, Ammonia assimilation. Assimilatory nitrate reduction, Dissimilatory nitrate reduction, denitrification **Biosynthesis of ribonucleotides and deoxyribonucleotides:** The denovo pathway of purines and pyrimidines, recycling by salvage pathway **Amino acid degradation and biosynthesis:** Deamination and decarboxylation- An overview of amino acids biosynthesis **Lipid degradation and biosynthesis**: β-oxidation of palmitic acid; Biosynthesis of palmitic acid. **Metabolism of one carbon compounds:** Acetogens: Autotrophic pathway of acetate synthesis **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 Basics of Enzymes	**14 Hrs**
Introduction to enzymes–Definition, enzyme unit, specific activity and turnover number, exo / endo-enzymes, constitutive/ induced enzymes, isozymes. Monomeric, Oligomeric and Multimeric enzymes. **Multi-enzyme complex:** pyruvate dehydrogenase; isozyme: lactate dehydrogenase. Ribozymes, abzymes **Structure of enzyme:** Apoenzyme and cofactors, prosthetic group-TPP, coenzyme, NAD, metal cofactors. **Classification of enzymes, Mechanism of action of enzymes**: active site, transition state complex and activation energy. Lock and key hypothesis and Induced Fit hypothesis. **Multi-substrate reactions**-Ordered, Random and Ping-Pong.	
Unit-IV Enzyme Kinetics and Regulation	**14 Hrs**
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.	

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.	**MIC-401P**	**DSC-4P**	Contact hours	**26 hours**
Content				
1. Estimation of RNA (Orcinol method) 2. Estimation of DNA-DPA method 3. Estimation of lactose and lactic acid from milk 4. Production and estimation of amylase enzyme and its activity 5. Estimation of total sugars by the phenol-sulphuric acid method 6. Identification of fatty acids and other lipids by TLC 7. Enzyme Immobilization by Sodium alginate method 8. Effect of variables on enzyme activity (amylase): a. Temperature b. pH c. substrate concentration d. Enzyme concentration 9. Determination of Km and Vmax of amylase (Line-weaver- Burke plot; Michaelis-Menton equation) 10. Demonstration of alcoholic fermentation				

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

MICROBIOLOGY OPEN ELCTIVE IV SEMESTER

Program Name	**B.Sc Microbiology**		Semester	**Fourth Sem**	
Course Title	**Human Microbiome**				
Course Code	**MIC-OEC-401**	**OE-4T**	No. of Theory Credits	**3**	
Contact hours	**Lecture**		Duration of ESA/Exam	**2.5 Hours**	
	Practical				
Formative Assessment Marks		**40**	Summative Assessment Marks		**60**

Course Outcomes(COs):

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, 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 microbiomefor metabolic health-role of gut microbiomes inhuman obesity, human type2 diabetes. Influence of microbiomes in aging. Probiotics-Criteria for probiotics, Development of Probiotics for animal and human use; Pre and synbiotic. 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	

Summative assessment = 40 marks theory paper, End semester Exam duration of exam 2.5 hours

Formative Assessment Occasion/type	**Weightage in Marks**
Assignment	10
Seminar	10
Case studies	10
Test	10
Total	**40marks**

DEPARTMENT OF MICROBIOLOGY

V SEM SYLLABUS (NEP BATCH)

2023-24

V SEMESTER MICROBIOLOGY PAPER-501T

Program Name	**BSc in MICROBIOLOGY**	Semester	**V**
Course Title	**MICROBIAL GENETICS AND MOLECULAR BIOLOGY (Theory)**		
Course Code:	**MIC-501T**	No. of Credits	**04**
Contact hours	**60 Hours(4 Hours per week)**	Duration of SEA/Exam	**$2^{1/2}$ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s) :

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

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

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

CO3. Compare and contrast housekeeping, constitutive, inducible and repressible genes

Contents	
Unit 1 DNA and replication Types of genes and their organization in viruses, prokaryotes and eukaryotes **Historical developments of DNA** as a genetic material; Griffith experiment of Transformation, Proof that genetic information stored in DNA, Enzymatic approach to prove DNA mediates transformation by Avery, MacLeod and McCarty, Hershey and Chase experiment to prove DNA carries the genetic information in T2 bacteriophage. RNA stores the genetic information in some viruses, viroids and prions. Structure of Watson Crick model of DNA, types of DNA; Plasmid DNA **DNA replication in Prokaryotes**: Semi, Conservative methods, Rolling circle model, Origin of replication, Primers and Templates, Replication fork, Unidirectional and Bidirectional (Theta model)-DNA repair mechanisms	**15 Hrs**
Unit 2 Genetics of major microbial groups **Genetics of Bacteria**: Structure and life cycle of bacteria *E. coli* Mutant genes in bacteria **Genetics of Viruses--**Structure and life cycle of Bacteriophage T4 and Lambda, lytic and lysogenic cycle of bacteriophage; episomes **Genetics of Fungi:** life cycle of Yeast and *Neurospora*, Tetrad analysis **Mechanism of genetic exchange in bacteria** Bacterial Conjugation: Properties of the F plasmid, F^+ x F^- conjugation, sexduction F′ x F^- conjugation, Hfr x F^- conjugation Bacterial Transformation: Types of transformation mechanisms found in prokaryotes, Natural and artificial methods of transformation.	**15 Hrs**

Transduction: U-Tube experiment; Generalized and specialized transduction Mutations: mutagens; Types of mutation (spontaneous and induced)	
UNIT 3 Transcription RNA structure; difference between DNA and RNA; Types of RNA, structure and their functions (mRNA, rRNA, tRNA) **Prokaryotic transcription:** Transcription unit; Transcription bubble, Stages of transcription, Bacterial RNA polymerase - structure and mechanism, recognition of promoters and DNA melting, abortive initiation. Elongation, Termination, anti-termination. mRNA formation and function **RNA types, RNA splicing and Processing**: capping, pre-mRNA splicing, spliceosome, autocatalytic splicing, alternative splicing, polyadenylation, primary transcript; tRNA splicing and maturation, production of rRNA, Catalytic RNAs - auto splicing, ribozymes, ribonuclease P, viroids and virusoids, RNA editing **Eukaryotic Transcription**: Eukaryotic RNA polymerases - RNA polymerase I, II, III. Mechanism of RNA polymerase in detail. Promoters, Transcription factors, basal apparatus,promoter clearance, elongation. Enhancers, silencers, termination.	**15 Hrs**
UNIT 4 Translation Genetic code, charging of tRNA, differences between initiator tRNA and elongator tRNA, ribosome structure. Accuracy of translation. Stages of translation. Role of IFs in initiation of bacterial translation, Formation of initiation complex. Initiation of Eukaryotic translation – Mechanism; Role of Translation factors (IFs, EFs, TFs). Elongation of polypeptide, peptide bond formation, peptidyl transferase activity, translocation, Termination. Regulation of translation. Post translational modifications of proteins.	**15hrs**

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

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

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

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

V SEMESTER MICROBIOLOGY PAPER-501P

Course Title	**MICROBIAL GENETICS AND MOLECULAR BIOLOGY (Practical)**	Practical Credits	**02**
Course Code	**MIC- 501P**	Contact Hours	**4 Hours/ week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Preparation of Buffers – TE, TAE, Lysis Buffer
2. Extraction and Isolation of Bacterial DNA
3. Extraction and Isolation of Fungal DNA
4. Quantification of DNA by DPA method
5. Determination of Melting Temperature (Tm) of DNA
6. Isolation and Characterization of petite mutant in yeast
7. Isolation of Antibiotic Resistant Mutant by Gradient Plate Method
8. Determination of phage concentration by Plaque Assay / Phage titration
9. Induction of Mutation in bacteria by Chemical /Radiation (UV) methods
10. Induction of Mutation in yeast by Chemical / Radiation (UV) methods
11. Selection of Auxotrophic mutants by Replica Plating Method
12. Bacterial Conjugation, Transformation Transduction and semi-conservative mode of DNA replication (charts)

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Test	15

Attendance and Performance	10
Total	**25 Marks**

References

1	*Karp's Cell and Molecular Biology* by Gerald Karp, Janet Iwasa, Wallace Marshall. Ninth Edition. 2020
2	Lewin's Genes XII. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick. Jones and Bartlett Learning.2017
3	James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Molecular Biology of the Gene, 7th edition. 2017
4	Freifelder's Essentials of MOLECULAR BIOLOGY. George M Malacinski, 4th ed. 2015
5	Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
6	Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York
7	Alberts Bruce , Johnson A , Lewis J , Raff M , Roberts K, Walter P (2014) Molecular Biology of the Cell. 5th Edition, Taylor and Francis. New York, USA.
8	Tropp BE (2012) Molecular Biology: Genes to Proteins. 4rd Edition, Jones & Bartlett, Learning, Burlington, MA
9	Allison A. Elizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey
10	Aranda PS, LaJoie DM, Jorcyk C L (2012). Bleach Gel: A Simple Agarose Gel for Analyzing RNA Quality. Electrophoresis. 33(2): 366–369. Doi: 10.1002/elps .201100335.
11	Bloch KD; Grossmann B (1995). Digestion of DNA with Restriction Endonucleases. https://doi.org/10.1002/0471142727.mb0301s31
12	Chomczynski P, Sacchi N (2006). "The single-step method of RNA isolation by acid guanidinium thiocyanate-phenol-chloroform extraction: twenty-something years on". Nat Protoc. 1 (2): 581–5.doi:10.1038/nprot.2006.83.
13	Elkins K M (2013). DNA Extraction Forensic DNA Biology.
14	Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith, Kevin Struhl (2003). Current Protocols in Molecular Biology. John Wiley & Sons, New York, United States.
15	Johnson M (2019). RNA extraction, Synatom Research, Princeton, New Jersey, United States. DOI//dx.doi.org/10.13070/mm.en.2.201.
16	Lewis M. Agarose gel electrophoresis (basic method). Department of Pathology, University of Liverpool. http://diyhpl.us/~bryan/irc/protocol-online/protocolcache/agarogel.html
17	Randall DR. (2009). Molecular Biology Laboratory manual.
18	Sambrook JF, Russell DW (2001). Molecular Cloning: a Laboratory Manual. 3rd edition. Cold Spring Harbor, N.Y. Cold Spring Harbor Laboratory Press
19	Struhl K, Seidman J G, Moore D D, Kingston RE, Brent R, Ausubel FM, Smith JA. (2002). hort Protocols in Molecular Biology: A Compendium of Methods from Current Protocols in Molecular Biology. John Wiley & Sons Inc., New York, United States
20	Surzycki S (2000). Basic techniques in molecular biology. Springer.
21	Yılmaz M, Ozic C, Gok İ (2012). Principles of Nucleic Acid Separation by Agarose Gel Electrophoresis. Gel Electrophoresis - Principles and Basics, Dr. Magdeldin S (Ed.), ISBN: 978-953-51-0458-2, InTech. http://www.intechopen. com/books/gel-electrophoresis-principles-And basics

V SEMESTER MICROBIOLOGY PAPER-MIC-502T

Program Name	**BSc in MICROBIOLOGY**	Semester	**V**
Course Title	**GENETIC ENGINEERING (Theory)**		
Course Code:	**MIC-502T**	No. of Credits	**04**
Contact hours	**60 Hours(4 Hours per week)**	Duration of SEA/Exam	**$2^{1/2}$ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s) :

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

CO1 Outline regulatory mechanisms in bacteria to control cellular processes

CO2 Understand the fundamental molecular principles of genetic engineering

CO3 Understand the applications of genetic engineering

CO4 Comprehend the principle and application of analytical techniques and understand the genetic switch in bacteriophages.

UNIT 1 Regulation and Control of gene expression in prokaryotes Regulatory mechanisms in bacteria. Positive and negative transcriptional control in bacteria. Operon concept, polycistronic mRNA. *lac* operon - negative inducible, allolactose, mechanism of binding of repressor to operator. Catabolite repression of *lac* operon. Regulation by lac repressor and CAP. *trp* operon-- regulation - repressor control & attenuator control. Regulation of lytic & lysogenic life cycle in λ bacteriophage Control of lytic cycle by regulatory proteins - *cro* gene, *N* gene, lambda repressor - structure, DNA binding mechanism. Events for switching from lytic to lysogenic cycle. Maintenance of lysogeny. **Control of gene expression in eukaryotes** Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation. Regulation through transcriptional activators, Co-activators and repressors, enhancers and insulators. Regulation through RNA processing and degradation. Regulation through RNA interference	**15Hrs**

Unit 2: Introduction to Microbial Genetic Engineering **Historical prospectives**: Definition of genetic engineering, milestones in genetic engineering. **Tools in Microbial Genetic Engineering**: Restriction modification systems- Types, Mode of action, nomenclature, applications of restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases, methylases, Terminal	**15 Hrs**

deoxynucleotidyl transferase, kinases and phosphatases and DNA ligases. **Gene Cloning Vectors**: Definition and Properties. Characteristics of cloning vectors. Plasmid vectors: PBR and pUC series. Bacteriophage lambda, cosmids, plant vectors (Ti plasmid of Agrobacterium) animal factors (SV40)	

Unit 3 Cloning host- Cloning in *Escherichia coli*, cloning in *Saccharomyces cerevisiae*, cloning in GRAS microorganism. GeneLibrary: Construction of cDNA library, genomic library. **Steps of genetic engineering:** Isolation and Detection of DNA: Isolation of DNA, restriction digestion and ligation of DNA; Use of linkers and adaptors. **DNA transfer methods:** Microinjection, Biolistic, Electroporation, Calcium chloride and Liposome mediated DNA transfer. Screening and selection of recombinants: DNA hybridization, blue-white selection, antibiotic selection, colony and plaque hybridization	**15 Hrs**
Unit 4: Techniques and applications in Microbial Genetic Engineering Agarose gel electrophoresis, Blotting techniques- Southern blotting, Northern blotting, dot blot, DNA microarray analysis, Western blotting. DNAsequencing- Sanger's method. PCR techniques and applications, Chromatography (PC, TLC), Spectroscopy (UV – vis spectroscopy) **Recombinant microorganisms**: Application of recombinant microorganisms in basic research, Medicine: Gene therapy. Agriculture: Disease resistant crops, Nitrogen Fixation. Industry: Vaccines. Environment: Genes for bioremediation Biological, ethical and social issues of genetic engineering and IPR. Prospects, safeguards ofgenetic engineering.	**15 Hrs**

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**
Outline regulatory mechanisms in bacteria to control cellular processes		√		√			√					
Understand the fundamental molecular principles of genetic engineering		√					√				√	
Understand the applications of genetic engineering and comprehend the principle and application of analytical techniques		√					√					√
Understand the genetic switch in bacteriophages.			√		√		√	√				

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

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

V SEMESTER MICROBIOLOGY PAPER-502P

Course Title	**GENETIC ENGINEERING (Practical)**	Practical Credits	**02**
Course Code	**MIC-502P**	Contact Hours	**4 Hours/ week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content	
1	Study and Working of Micropipettes
2	Extraction and visualization of Plasmid from bacterial culture
3	Extraction of RNA from yeast cells
4	Resolution and Visualization of Protein by SDS-PAGE method
5	Separation of enzymes by Paper chromatography
6	Measurement of β-galactosidase activity in Bacteria (E coli)
7	Restriction enzyme digestion of DNA
8	Ligation of DNA
9	Demonstration of amplification of DNA by PCR method
10	Demonstration of Southern blotting
11	Problems related to genetic engineering
12	Bacterial transformation by $CaCl_2$ method
13	Study of Vectors: pBR, pUC series, Bacteriophage, cosmids, phagemids, Gene cloning

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Test	15
Attendance and Performance	10
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

REFERENCES:

1.	Microbial Genetics by Maloy ET. Al. 1994. Jones and Bartlett Publishers.
2.	Molecular Genetics of Bacteria by J. W. Dale. 1994. John Wiley and Sons.
3.	Modern Microbial Genetics. 1991 by Streips and Yasbin. Niley Ltd.
4.	Molecular Biology of the Gene 4th Edition by J.D. Watson, N.H. Hoppkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. 1987, The Benjamin / Cummings Publications Co. Inc. California.

5.	Gene VII by Lewin Oxford University Press. 2000.
6.	Bacterial and Bacteriophage Genetics. 4th Editions by Birge
7.	Microbial Genetics by Frefielder. 4th Edition.
8.	Organization of Prokayotic Genome. 1999 by Robert L.Charlebois, ASM Publications.
9.	Molecular Genetics of Bacteria, 1997 by Larry, Snyder and Wendy, Champness, ASM
10.	Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
11.	Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
12.	Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
13.	Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
14.	Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
15.	Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
16.	Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings Wiley
17.	JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.

DEPARTMENT OF MICROBIOLOGY

VI SEM SYLLABUS (NEP BATCH)

2023-24

VI SEMESTER MICROBIOLOGY PAPER-MIC-601T

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Theory)**		
Course Code:	**MIC 601T**	No. of Credits	**4**
Contact hours	**60 Hours(4 hours per week)**	Duration of SEA/Exam	**2 ½ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

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

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

CO2: To familiarize with Immunological techniques and sero diagnosis of infectious diseases

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

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

Contents	**60 Hrs**
UNIT-I Basics of Immunology Historical perspective of immunology; Immunity: Definition, Types (Innate and acquired) Mechanism of Innate immunity. Cells and organs of immune system: Hematopoiesis, cytokines, properties and functions of B and T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils and Basophils), Monocytes and macrophages, Dendritic cells and Mast cells. Primary lymphoid organs; Bone marrow and Thymus. Secondary lymphoid organs; Spleen and Lymph nodes. **Antigen**: Immunogenicity and antigenicity, epitopes, haptens. Properties of antigen contribute to immunogenicity; Chemical nature (proteins, carbohydrates, lipids and nucleic acids), degree of foreignness, molecular weight, chemical composition and complexity, degradability. Adjuvants (alum, Freund's incomplete and complete) and their importance. B and T cell epitopes. Antigen presentation (Endocytic and cytosolic pathway) **Antibody**: Basic structure of antibody, light and heavy chain, variable and constant region, hinge region, Fab and Fc. Structure and functions of different types of antibodies (IgM, IgG, IgA, IgE, and IgD). Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype. Monoclonal antibody production by hybridoma technology	**15 hrs**

UNIT-II Immune response: AMI, CMI, MHC, Immunological memory, Immunological tolerance **Principles and applications of antigen-antibody interactions:** Definition of affinity and avidity. Immunoprecipitation; Radial (Mancini) and double (Ouchterlony) immunodiffusion. Antibody mediated effector functions: opsonization, complement activation and antibody dependent cell mediated cytotoxicity (ADCC). Agglutination reactions: Hemagglutination, Bacterial agglutination, passive agglutination, and agglutination inhibition. Enzyme linked immune-sorbent assay (ELISA): Direct, indirect, sandwich and competitive ELISA. Radioimmunoassay (RIA). Immunofluorescence. Complement system: Functions of complement components, complement activation by classical, alternative and lectin pathway to develop membrane attack complex (MAC). Complement mediated opsonization, complement fixation test. Hypersensitive reactions: Classification, Humoral Immunity mediated hypersensitivity; Type I (IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity Type IV (DTH). Vaccines: Definition and types with suitable examples Brief introduction to Tumor Immunology, Transplant Immunology and autoimmune diseases	**15 Hrs**
UNIT-III Medical Microbiology Normal microflora of the human body and host pathogen interaction Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. Sample collection, transport and diagnosis. **Clinical Microbiology: Medical Bacteriology** The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control of respiratory diseases: Tuberculosis, Scarlet fever Gastrointestinal Diseases: Cholera, Typhoid Neurological diseases: Tetanus STD: Gonorrhoeae	**15 Hrs**
UNIT-IV: Medical Virology, parasitology and Mycology The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control- Viral diseases: Polio, Herpes, Hepatitis, Rabies, AIDS, Influenza Protozoan diseases: Malaria, Kala-Azar, Amoebiasis Fungal infections- Cutaneous mycoses: Tinea, Systemic mycoses: Histoplasmosis; Opportunistic mycoses: Candidiasis Antimicrobial agents: General characteristics and mode of action Antibacterial agents: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Antibiotic resistance, MDR, XDR, MRSA, NDM-1	**15 Hrs**

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	13	14	15
To gain a preliminary understanding about various immune mechanisms.	√					√									
To familiarize with Immunological techniques and sero diagnosis of infectious diseases	√		√						√						
To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process.									√	√					
To understand pathogenic viral infections, symptoms, diagnosis						√						√			
To understand pathogenic protozoan infections, symptoms, diagnosis and treatment process treatment process										√					

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

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

VI SEMESTER MICROBIOLOGY PAPER-601P

Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Practical)**	Practical Credits	**2**
Course Code	**MIC-601P**	Contact Hours	**4Hours/week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

	Practical content
1.	Identification of human blood groups.
2.	Perform Differential Leukocyte Count of the given blood sample.
3.	Separate serum from the blood sample (demonstration).
4.	Ouchterlony method(ODD)
5.	Radial Immunodiffusion (RID)
6.	Perform DOT ELISA.
7.	VDRL test
8.	Widal test
9.	Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, MacConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
10.	Study of bacterial flora of skin by swab method
11.	Perform antibacterial sensitivity by Kirby-Bauer method
12.	Study of pathogenic microbes: *Clostridium, Streptococcus, Entamoeba, Plasmodium, Candida, Salmonella*

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Test	15
Attendance and Performance	10
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

REFERENCES	
1	Ananthanarayan R and Paniker C.K.J (2009) Textbook of Microbiology, 8th Edition, University Press,Publication.
2	Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3	Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4	Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.9th edition. McGraw Hill Higher Education
5	Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14thedition. Pearson International Edition
6	Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
7	Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
8	Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman andCompany, New York.
9	Murphy K, Travers.P,Walport M. (2008).Janeway's Immunobiology.7th edition Garland Science ,Publishers, New York.
10	Peakman.M.and Vergani D. (2009).Basic and Clinical Immunology,2nd edition Churchill, Livingstone Publishers, Edinberg.
11	Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

VI SEMESTER MICROBIOLOGY PAPER-602T

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**FOOD, DAIRY AND INDUSTRIAL MICROBIOLOGY (Theory)**		
Course Code:	**MIC-602T**	No. of Credits	**04**
Contact hours	**60 Hours(4 Hours/ week)**	Duration of SEA/Exam	**$2^{1/2}$ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

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

CO1. To understand the association of microbes in food and the quality testing of food

CO2. To understand the preservation and food safety protocols

CO3. To understand the methods of spoilage of food and the diseases associated with it

CO4. To learn the properties of milk and the types of preservation of milk.

CO5. To learn the types of fermented food and dairy products and its significance

CO6. Learn the overview of scope and importance of industrially important microbes

CO7.Acquaint with different types of fermentation processes and equipments

CO8. Evaluate the factors influencing the enhancement of cell and product formation during fermentation

CONTENTS	
Unit 1 Food microbiology **Microbes and food:** Food as a substrate for microorganisms- Intrinsic and extrinsic parameters affecting the growth of microbes. Microorganisms in food and their sources(molds,yeast and bacteria) **Food borne infections** and intoxication *Staphylococcus, Clostridium. Salmonella, Bacillus, Brucella, Listeria.* Mycotoxin, Phycotoxins **Fermented Food:** Fermented vegetable-sauerkraut, pickles. Meat- sausage. Beverages- kombucha. Sourdough. Microbes as food- SCP, SCO. Nutraceuticals and Synbiotics **Spoilage of Food, Preservation and Food safety-** **Spoilage:** Principles of food spoilage. Sources of food contamination, Types of spoilage. Spoilage of meat and poultry, Fish and sea foods. Spoilage cereals, fruits and vegetables. Spoilage of canned food. **Preservation:** Principles of food Preservation. Methods of preservation-Physical (temperature,drying, irradiation), chemical (Class I and Class II). Bio preservation. Canning. Food Packaging-Types of packaging materials, properties and benefits. **Quality testing of food**- Rapid microbiological methods, Examination of fecal Streptococci **Food sanitation and control**- Good Hygiene practices, GLP, GMP (Waste treatment disposalmethods), HACCP, Food control agencies and their regulation	**15 hrs**

Unit 2-Dairy Microbiology: History. Properties of milk. Types of milk- dried, liquid, condensed. **Microorganisms in milk.** Starter culture and its types-(single, mixed) Sources of contamination of milk. Microbiological analysis of milk- Rapid platform tests (organoleptic, alcohol, COB, alcohol test, Phosphatase test, DMC, sedimentation test.). Reductase tests. SPC. Preservation of milk- Pasteurization. Dehydration, sterilization. . Packing of milk and dairy products. **Fermentation in milk**: Lactic acid, gassy fermentation, souring **Dairy products:** Cheese- Types and production (Cheddar), Tofu, Yoghurt, Acidophilus milk. Prebiotics, Probiotics.	**15 hrs**
Unit-3: Introduction to Industrial microbiology Scope and concepts; Criteria for selection of industrially important microbes; Preservation of industrially important microbes. Types of fermentation process: Submerged fermentation, Solid state fermentation (Koji), batch fermentation, Continuous fermentation, kinetics of fermentation process. Fermentor: Basic features; design and components of a bioreactor; Specialized bioreactors and their applications: tubular bio reactors, fluidized bed reactor, packed bed reactors, membrane bioreactors, Photo-bioreactors and anaerobic bioreactors	**15 Hrs**
Unit-4 DSP and Microbial technology Sterilization of fermentor, Control of air, temperature, pH, foaming and feed; Aseptic inoculation and sampling methods; Scale up of fermentation process-Merits and Demerits. Fermentation media: Strategies for media formulation; Natural and synthetic media; Role of buffers, precursors, inhibitors, inducers and micronutrients. Objectives and significance of downstream processing: Overview of steps in extraction and purification of product; Filtration and centrifugation; cell disruption- Physical, chemical and biological methods; Product extraction; product purification, recovery and product testing. General production strategies of microbial products and Downstream processing: Alcohol: Industrial alcohol and alcoholic beverages- beer, wine and whisky Organic acids: citric acid Vitamins: B12 Amino acid: glutamic acid Antibiotics: Penicillin Enzymes: Amylase Bio fuels: methane and hydrogen gas production, types of substrate, process; Mechanism, by-products, plant construction Vaccines- Hepatitis b Hormones- Human Insulin	**15 Hrs**

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

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

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

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

VI SEMESTER MICROBIOLOGY PAPER-MIC-602 P

Course Title	**FOOD, DAIRY AND INDUSTRIAL MICROBIOLOGY (Practical)**	Practical Credits	**2**
Course Code	**MIC -602P**	Contact Hours	**4 Hours/Week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

PRACTICAL CONTENT
1. Isolation of bacteria and fungi from infected fruits and vegetables 2. Isolation of bacteria and fungi from fermented food and stored/ preserved food. 3. Reductase tests-MBRT/Resazurin 4. Fat estimation – Gerber's method 5. Role of yeast in bread making 6. Bacterial examination by SPC, DMC 7. Production of yoghurt 8. Study of food borne pathogens- *Staphylococcus, Salmonella, Aspergillus, Clostridium* 9. Significant microbes in Food and Dairy: *Lactobacillus, Streptococcus, Penicillium, Rhizopus* 10. Wine production from selected fruits/vegetables 11. Production of /protease/cellulase/pectinase/invertase by solid substrate fermentation(with at least 2 substrates) 12. Production of enzyme (/protease/cellulase/invertase by submerged fermentation 13. Preservation of microbes with glycerol/soil/Silica gel method/lyophilization 14. Downstream technique- Demonstration of Microfiltration technique 15. Field visit to industry/organization related to microbiology

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Test	15
Attendance and Performance	10
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

References	
1	Arindam Kuilaand Vinay Sharma (2018) Principles and Applications of Fermentation Technology,Wiley.
2	Casida L E.J.R. (2016) Industrial Microbiology, 2nd edition, New Age International Publisher.
3	Crueger W&A Crueger (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology.Edited by K.R. Aneja. Panima Publishing Corporation.
4	Michael, J.W., Neil L. Morgan (2013) Industrial microbiology: an Introduction. Blackwell science
5	Nduka Okafor,Benedict Okeke (2017). Modern Industrial Microbiology and Biotechnology. 2ndEdition :CRC Press Publishers
6	Stanbury P.F., W. Whitaker & S.J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevierpublication
7	Alexander N. Glazer, Hiroshi Nikaido (2014), Microbial Biotechnology: Fundamental of appliedMicrobiology, 2nd Edition, Cambridge University Press