ಸರಕಾರಿ ಮಹಾವಿದ್ಯಾಲಯ (ಸ್ವಾಯತ್ತ), ಕಲಬುರಗಿ

(ನ್ಯಾಕನಿಂದ "A" ಶ್ರೇಣಿಯ ಮಾನ್ಯತೆ ಪಡೆದಿದೆ)

ಸೇಡಂ ರಸ್ತೆ, ಕಲಬುರಗಿ – 585 105

DEPARTMENT OF HIGHER EDUCATION

NATIONAL EDUCATION POLICY -2020(NEP-2020)

CURRICULUM STRUCTURES FOR

BACHELOR OF SCIENCE (BASIC AND HONORS) PROGRAMMES WITH MICROBIOLOGY AS MAJOR AND MINOR COURSES,

SYLLABUS FOR IST AND IIND

SEMESTERS AND

OPEN ELECTIVE COURSES IN MICROBIOLOGY

EFFECT FROM THE

ACADEMIC YEAR 2021-22

Submitted to

GOVERNMENT COLLEGE (AUTONOMOUS)

KALABURAGI

Approved by the BOS vide Resolution No.24 Dated 30-10-2021

B.Sc Microbiology (Basic / Hons.)

Semester 1

Title of the Courses:

Course 1 : DSC-1T, MBL 101, General Microbiology

Course 2 : OE 1T, MBL 301, Microbial Technology for Human Welfare

Course 3 : SEC 1T, MBL 701, Microbiological Methods and Analytical Techniques

Course 1 : DSC-1T, MBL 101, General Microbiology		Course 2 : OE 1T, MBL 301, Microbial Technology for Human Welfare		Course 3 : SEC 1T, MBL 701, Microbiological Methods and Analytical Techniques	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	56	3	42	1	14

General Microbiology

Content of Course 1: Theory: DSC-1T, MBL 101,

Unit – 1: Historical development, major contributions, origin of microorganisms and microscopy **14Hrs**

Historical development of microbiology -Theory of spontaneous generation, Biogenesis and Abiogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Edward Jenner, Alexander Fleming, Martinus Beijirinic, Segei Winogrodsky, Elei Metechnikoff. **Contributions of Indian scientists in the field of Microbiology**: **Khem Shahani, M.J.Thirumalachar, Ananda Mohan Chakrabarty, Natteri Veeraraghavan, Jyothi Prakash Tamang**. Fossil evidences of microorganisms. Primitive cells and evolution of microorganisms. Microcopy- working principle, construction and operation of simple and compound microscopes.

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Unit – 2: Staining, sterilization and preservation of microorganisms. **14 Hrs**

Staining: Nature of **stains**, principles, mechanism, methods and types of staining- Simple, Differential-Gram staining, Acid fast staining, staining of capsule, cell wall, endospore, inclusion bodies.

Sterilization: Principles, types and techniques, Physical, chemical, radiation and mechanical Preservation of microorganisms: Methods of preservation of microorganism, slant culture, stab culture, soil culture mineral oil overlaying, glycerol preservation.

Unit – 3: Types, structure, organisation and reproduction of prokaryotic Microorganisms **14 hrs**

Overview of Prokaryotic Cell Structure: Size, shape, arrangement. Diagram of Prokaryotic cell organisation, cell wall structure and Gram staining, cell membrane; Bacterial and Archaeal, Cytoplasmic matrix- Cytoskeleton, ribosome, inclusion granules: Composition and function. Nuclear Materials – Bacterial chromosomes structure (its differences with the Eukaryotic chromosome); Extra Chromosomal materials. Components external to cell wall- capsule, slime, s-layer, pilli, fimbriae, flagella; structure, motility, chemotaxis. Bacterial Endospore - Examples of spore forming organisms, habitats, function, formation and germination.

Reproduction in bacteria and bacterial cell cycle.

Unit – 4: Types, structure, organisation and reproduction of eukaryotic Microorganisms **14 hrs**

Over view of eukaryotic cell structure: General structure and types of cells; External cell coverings and cell membrane. Structure and function of Cytoplasmic matrix- cytoskeleton: Structure and function; single Membrane organelles- Endoplasmic reticulum, Golgi complex, Lysosome, Vesicles and Ribosomes; Double Membrane organelles- Nucleus, Mitochondrion and Chloroplast: Structure and Functions; Peroxisomes; Organelles of motility- Structure and movement of flagella and cilia. Reproduction in Eukaryotic microorganisms

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Course 1: Practical: DSC-1P, MBL 101, General Microbiology

1. Microbiological laboratory standards and safety protocols.
2. Standard aseptic conditions of Microbiological laboratory.
3. Operation and working principles of Light/ Compound microscope.
4. Applications of basic microbiological tools (Pipettes, Micropipette, Bunsen burner, Inoculation loop, Spreader).
5. Demonstration and observations of microorganisms from natural sources under light microscope (**Bacteria**, Yeast, Protozoa and Algae).
6. Demonstration of bacterial motility by hanging drop method.
7. Simple staining.
8. Differential staining - Gram staining.
9. Acid fast staining.
10. Structural staining - Flagella and Capsule.
11. Bacterial endospore staining.
12. Staining of reserved food materials.
13. Staining of fungi by Lactophenol cotton blue.
14. Negative staining.

Text Books / References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.
6. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.

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Microbial Technology for Human Welfare
Course 2 : Theory: OE 1T, MBL 301,

Microbial Technology for Human Welfare

Unit – 1: Food and Fermentation Microbial Technology 14 hrs

Fermented Foods – Types, Nutritional Values, Advantages and Health Benefits

Prebiotics, Probiotics, Synbiotics and Nutraceutical Foods

Fermented Products – Alcoholic and nonalcoholic beverages, fermented dairy products.

Unit – 2: Agriculture Microbial Technology **14hrs**

Microbial Fertilizers, Microbial Pesticides, Mushroom Cultivation, Biogas Production

Unit – 3: Pharmaceutical Microbial Technology **14hrs**

Microbial Drugs – Types and Development of Drug Resistance ,Antibiotics – Types, **Production and** Antibiotic Therapy Vaccines – Types, Properties, Functions and Schedules.

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Microbiological Methods and Analytical Techniques

Course 3 : Therory: SEC 1T, MBL 701,

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, Level 3.
- 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.

1. Principles which underlies sterilization of culture media, glassware and plastic ware to be used for microbiological work.
2. 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.
3. 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 a variety of modifications in the microscopes for specialized viewing.
4. Several separation techniques which may be required to be handled later as microbiologists.

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Course 3 :Theory: SEC 1T, MBL 701,

Microbiological Methods and Analytical Techniques **14hrs**

DIGITAL SKILLS:
The components of digital skills provided by KSHEC, will be followed accordingly.

Microbiological Skills

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, technique, inoculation of samples, incubation and observations of microbial colonies. Morphological characterization of microorganisms - Colony characteristics, Microscopic characters, biochemical/physiological tests or properties and identification. Subculturing of microorganisms and pure culture techniques.

Advanced Microscopic Skills: Different types of microscopes - Phase contrast, Bright Field, Dark Field, Fluorescent, Confocal, Scanning and Transmission Electron Microscopy, Scanning Probe Microscopy

Analytical Skills

Centrifugation, Chromatography and Spectroscopy: Principles, Types, Instrumentation, Operation and applications.

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Microbiological Methods and Analytical Techniques.
Course 3 : Practicals: SEC 1P, MBL 701,

1. Preparation of different microbiological culture media
2. Isolation and cultivation of bacteria, fungi
3. Characterization and identification of bacteria, fungi–
   colony characters and microscopic characters
4. Biochemical and physiological tests for identification of bacteria
5. Methods and practices in microbiology lab: MSDS (Material Safety Data Sheet), Good clinical Practices (GCP), Standard Operating Procedure (SOP), Good Laboratory Practices (GLP), Good Manufacturing Practices**(GMP).**
6. Usage and maintenance of basic equipment of microbiology lab: Principles, calibrations, and SOPs of balances (Types), pH meter (Types), Autoclaves (Types), Laminar flows and biosafety cabinets, basic Microscopes, homogenizers, stirrers, and **spectrophotometer**.
7. Procedures for documentation, lab maintenance, repair reporting
8. Separation of mixtures of biomolecules by paper / thin layer and column chromatography.
9. Demonstration of column packing in column chromatography.

Pedagogy :

The general pedagogy to be followed for theory and practicals are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial visits, Hands on training, Case observations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.

Active learning as per LSSSDC (NSDC) LFS/Q0509 guidelines, at skill training Level 3. Case studies about application of microbial biomolecules in various industries. Seminar on topics of microbial biochemistry

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B.Sc Microbiology (Basic / Hons.)

Semester 2

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Title of the Courses:

Course 1 : DSC-2T, MBL 102, Microbial Biochemistry and Physiology
Course 2 : OE- 2T, MBL 302, Environmental and Sanitary Microbiology

Course 1: DSC-2T, MBL 102, Microbial Biochemistry and Physiology		Course 2: OE- 2T, MBL 302, Environmental and Sanitary Microbiology	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	56	3	42

Microbial Biochemistry and Physiology

Content of Course: DSC-2T, MBL 102, **56 hrs**

Unit - 1 Biochemical Concepts **14hrs**

Basic Biochemical Concepts: Major elements of life and their primary characteristics, atomic bonds and molecules – bonding properties of carbon, chemical bonds- covalent and non covalent, Hydrogen bonds and Vander Waal Forces.
Biological Solvents: Structure and properties of water molecule, Water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water, Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer system, Handerson – Hasselbatch equation.

Unit - 2 Macromolecules – Types, Structure and Properties **14 hrs**

Carbohydrates: Definition, classification, structure and properties.
Amino acids **and** proteins: Definition, structure, classification and properties of amino acids, and proteins.
Lipids and Fats: Definition, classification, structure, properties and importance of lipids.

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Porphyrins and Vitamins: Definition, structure, properties and importance of chlorophyll, cytochrome and hemoglobin, **types and functions of vitamins**.

Unit – 3 Microbial Physiology **14 hrs**

Microbial Growth: Definition of growth, Growth curve, phases of growth, calculation of generation time and specific growth rate. Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth. Measurement of Growth: Direct Microscopic count - Haemocytometer; Viable count, Membrane filtration; Electronic Counting; Measurement of cell mass; Turbidity measurements- spectrophotometer techniques. Influence of environmental factors on growth. Viable non-culturable organisms. Quorum sensing.

Microbial Nutrition: Microbial nutrients, Classification of organisms based on carbon source, energy source and electron source, Macro and micronutrients.

Unit – 4: Microbial Physiology- Bioenergetics, Microbial Respiration, Microbial Photosynthesis **14 hrs**

Bioenergetics: Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant, Redox potential, Law of thermodynamics.

Microbial Respiration:Respiratory electron transport chain in bacteria, oxidation – reduction reactions, protein translocation, oxidative and substrate level phosphorylation – inhibitors and mechanism, chemiosmotic coupling. Fermentation reactions (homo and hetero)

Microbial Photosynthesis: pigments, Photophosphorylation, TCA pathway.

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Microbial Biochemistry and Physiology

Course 1: Practicals: DSC-2P, MBL 102,

1. Preparation of Solution: Normal and Molar solutions
2. Calibration of pH meter and determination of pH of natural samples
3. Preparation of Buffer Solutions
4. Qualitative determination and identification of Carbohydrates
5. Qualitative determination and identification of Amino Acids
6. Qualitative determination and identification of Fatty Acids
7. Quantitative estimation of Reducing Sugur by DNS method
8. Quantitative estimation of Proteins by Biuret and Lowry's method
9. Determination of lipid saponification values of fats and iodine number of fatty acids
10. Determination of bacterial growth by spectrophotometric 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

Text Books / References

1. Felix Franks, 1993; Protein Biotechnology, Humana Press, New Jersey.
2. Stryer L, 1995; Biochemistry, Freeman and Company, New York.
3. Voet & Voet, 1995; Biochemistry, John Wiley and Sons, New York.
4. Nelson and Cox, 2000; Lehninger Principles of Biochemistry, Elsevier Publ.
5. Harper, 1999; Biochemistry, McGraw Hill, New York.
6. Palmer T. (2001), Biochemistry, Biotechnology and Clinical Chemistry, Harwood Publication, Chichester.
7. Boyer R. (2002), Concepts in Biochemistry 2nd Edition, Brook/ Cole, Australia.
8. Moat A. G., Foster J.W. Spector. (2004), Microbial Physiology 4th Edition Panama Book Distributors.
9. Caldwell, D. R. (1995) – Microbial Physiology and Metabolism. Brown Publishers.
10. Lodish H, T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J. Darnell. (2004) – Molecular Cell Biology, Scientific American Books, Inc. Newyork.

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Environmental and Sanitary Microbiology

Course 2 :Theory: OE- 2T, MBL 302, **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: Sanitary Microbiology **14 hrs**

Public health hygiene and communicable diseases. Survey and surveillance of microbial infections. Airborne microbial infections, waterborne microbial infections, Food borne microbial infections. Epidemiology of microbial infections, their detection and control.

Text Books / References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.
6. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
7. Microbiology- Concepts and Applications, Pelczar Jr,Chan, Krieg, International ed, McGraw Hill.
8. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
9. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.

Head
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Government of Karnataka

Model Curriculum

Program Name	**BSc Microbiology**		Semester	**Third Sem**
Course Title	**Microbial Diversity**			
Course No.	**MBL-103**	**DCS -3T**	No. of Theory Credits	**4**
Contact hours	**56hrs**		Duration of ESA/Exam	**2:30Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):.

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

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

Content	56 Hrs
Unit–I	**14 Hrs**
Biodiversity and Microbial Diversity Concept, definition, and levels of biodiversity; Biosystematics – Major classification systems- Numerical and Chemotaxonomy. Study and measures of microbial diversity; Conservation and Economic values of microbial diversity.	
Unit -II	**14hrs**
Diversity of Prokaryotic Microorganisms General characters; Classification; Economic importance; Distribution and factors regulating distribution. **Bacteria and Archaea-** An overview of Bergey's Manual of Systematic Bacteriology.**Bacteria-** *Escherichia coli, Bacillus subtilis, Staphylococcus aureus* **Cyanobacteria-** *Nostoc, Microcystis, Spirulina* **Archea***Thermusaquaticus,* Methanogens **Actinomycetes:** *Streptomyces, Nocordia, Frankia* **Rickettsiae-** *Rickettsia rickettsi* **Chlamydiae** – *Chlamydia trachomatis* **Spirochaetes-** *Trepanemapallidum*	
Unit -III	**14 hrs**
Diversity of Eukaryotic Microorganism **Diversity of Eukaryotic Microorganism**: General characters; Classification- Economic importance **Fungi:** Ainsworth classification- detailed study up to the level of classes, Salient features and reproduction. Type study: *Rhizopus, Saccharomyces, Aspergillus, Agaricus, Fusarium*	

Algae: Occurrence, distribution, and symbiotic association- Lichen; thallus organization and types. Type study: *Chlorella, Cosmarium,* Diatoms,*Gracilaraia,* **Protozoa:** Classification up to the level of classes. Type study: *Amoeba, Euglena, Trichomonas, Paramoecium, Trypanosoma*	
Unit -IV	**14 hrs**
Diversity of Virus General properties and structure, Isolation and purification and assay of virus. 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, Ring spot virus **Microbial:** T4/T7/lambda/cyano/mycophages. Sub viral particles. Virans and Prions. Ortho and Paramyxo Virus. Oncogenic Virus.	

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

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

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

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

Government of Karnataka

Model Curriculum

Program Name	**BSc Microbiology**		Semester	**Third Sem**
Course Title	**Microbial Entrepreneurship**			
Course Code		**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**	**42 hrs**	Duration of ESA/Exam	**2 :30 Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):	
Course Outcomes (COs): At the end of the course the student should be able to: 1. Demonstrate entrepreneurial skills 2. Acquire knowledge industrial entrepreneurship 3. Acquire knowledge about Healthcare Entrepreneurship	
CONTENT	**42 HRS**
Unit–I	**14 Hrs**
General Entrepreneurship Entrepreneurship and microbial entrepreneurship - Introduction and scope, Business development, product marketing, HRD, 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 (Mushroom and Spirulina) etc.	
Unit -III -	**14 Hrs**
Healthcare Entrepreneurship Production and applications: Sanitizers, Antiseptic solutions, Polyhenols (Flavonoids), Alkaloids, Cosmetics, Biopigments and Bioplastics, vaccines, Diagnostic tools and kits.	

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

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

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Model Curriculum

Program Name	**BSc Microbiology**		Semester	**Fourth Sem**
Course Title	**Microbial Enzymology and Metabolism**			
Course No.	**MBL:104**	**DCS -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2 ½ Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):.

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

1. Differentiating concepts of chemoheterotrophic metabolim and chemolithotrophic metabolism.
2. Describing the enzyme kinetics, enzyme activity and regulation.
3. Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms

Content	**56 Hrs**
Unit–I	**14 Hrs**
Metabolism of Carbohydrates Chemo heterotrophic Metabolism- Anaerobic respiration and fermentation Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, Phosphoketolase pathway. TCA cycle. Fermentation - Concept of linear and branched fermentation pathways. Fermentation pathways: Alcohol fermentation and Pasteur effect, Crabtree effect Butyric acid and Butanol- Acetone Fermentation. Chemolithotrophic Metabolism:Chemolithotrophy - Hydrogen oxidation, Sulphur oxidation, Iron oxidation, Nitrogen oxidation.	

Unit –II	14 Hrs
. **Metabolism of amino acids, nucleotides and lipids** **1.Nitrogen Metabolism** Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification **2. Nucleic acid metabolism: Biosynthesis of ribonucleotides and deoxyribonucleotides** The de novo pathway. Recycling via the salvage pathway. **3. Amino acid degradation and biosynthesis** **4. Lipid degradation and biosynthesis** **5.Metabolism of one carbon compounds:** Methylotrophs : i. Oxidation of methane, methanol, methylamines; ii. Carbon assimilation in methylotrophic bacteria and yeasts Methanogens: biosynthesis in methanogenic bacteria **6. Metabolism of two-carbon compounds:Acetate**: i. Glyoxylate cycle. **Acetic acid bacteria**: Ethanol oxidation, sugar alcohol oxidation. **Glyoxylate and glycolate metabolism**: Dicarboxylic acid cycle, **Oxalate** as carbon and energy source	
Unit –III	**14 Hrs**
Basics of Enzymes **Definitions of terms** – enzyme unit, specific activity and turnover number, exo/ endoenzymes, constitutive/ induced enzymes, isozymes. Monomeric, Oligomeric and Multimeric enzymes. Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase. Ribozymes, abzymes **Structure of enzyme**: Apo enzyme and cofactors, prosthetic group-TPP, coenzyme, NAD, metalcofactors. Classification of enzymes, Mechanism of action of enzymes: active site, and activation energy. Lock and key hypothesis and Induced Fit hypothesis. Multi substrate reactions -Ordered, Random, Ping-pong. **Enzyme catalysis:** Catalytic mechanisms with type examples, catalytic mechanisms and testing -Serine proteases and Lysozyme	

Unit –IV	14 Hrs
Enzyme Kinetics and Regulation Enzyme Kinetics: Kinetics of one substrate reactions. enzyme inhibition. Competitive, non-competitive and uncompetitive inhibition. Effect of changes in pH and temperature on enzyme catalysed reaction.Kinetics of two substrate reactions. immobilized enzymes. Enzyme regulation:Allosteric enzyme - general properties, Hill equation, Koshland Nemethy and Filmer model, Regulation by proteolytic cleavage - blood coagulation cascade. Regulation of multi-enzyme complex- Pyruvate dehydrogenase,HIV enzyme inhibitors and drug design.	

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

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Differentiating concepts of chemoheterotrophic metabolim and chemolithotrophic metabolism		✓						✓			✓	
Describing the enzyme kinetics, enzyme activity and regulation.		✓						✓			✓	
Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms		✓						✓			✓	

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

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

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Model Curriculum

Program Name	**B.Sc Microbiology**		Semester	**Fourth Sem**
Course Title	**Human Microbiome**			
Course Code		**OE-4T**	No. of Theory Credits	**3**
Contact hours	**Lecture**	**42 hrs**	Duration of ESA/Exam	**2:30 Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):

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

1. Articulate a deeper understanding on biological complexities of human micro biome.
2. Understand broader goals of biological anthropology.
3. Compare and contrast the microbiome of different human body sites and impact human health promotion

Content	**45 Hrs**
Unit–I	**14 Hrs**
INTRODUCTION TO MICROBIOME Evolution of microbial life on Earth, Symbiosis host-bacteria . Microbial association with plants and animals, Symbiotic and parasitic, Normal human microbiota and their role in heatlh. Microbiomes other than digestive system.	
Unit –II	**14 Hrs**
MICROBIOMES AND HUMAN HEALTH Microbiome in early life, Nutritonal modulation of the gut microbiome for metabolic health- role of gut mocrobiomes in human obesity, human type 2 diabetes and longevity. Probiotics-Criteria for probiotics, Development of Probiotics for animal and human use; Pre and synbiotics. Functional foods-health claims and benefits, Development of functional foods.	

Unit –III	14 Hrs
CULTURING OF MICROBES FROM MICROBIOMES Culturing organisms of interest from the microbiome : bacterial, archaeal, fungal, and yeast, viral. Extracting whole genomes from the microbiome to study microbiome diversity **Microbiomes and diseases:** Microbiome and disease risks: The gut microbiome and host immunity, bacteriocins and other antibacterials. Human microbiome research in nutrition	

Pedagogy

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

References	
1	
2	
3	
4	
5	

Date:

Subject Committee Chairperson

5th SEMESTER MODEL SYLLABUS FOR B.Sc. IN MICROBIOLOGY

Program Name	B.Sc. in MICROBIOLOGY	Semester	V
Course Title	MICROBIAL GENETICS (Theory)		
Course Code:	DSC-5T	No. of Credits	04
Contact hours	60 Hours (4 Hours per week)	Duration of SEA/Exam	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 the fundamental molecular principles of genetics

CO2. Understand structure of DNA, replication, transcription, translation, regulation of gene expression.

CO3 Knowledge on the basis of genetic mapping in bacteria, linkage analysis in fungi.

Contents	
UNIT 1: Mendel's principles of inheritance Mendel's experimental approach to prove genetic principles. Principles of dominance and Segregation; phenotype, genotype, traitscontrolled by genes, existence of alleles (dominant and recessive), monohybrid (single character) cross, F1 and F2 generation, heterozygous, homozygous, test cross to test genotype of F1 plants. Principle of independent assortment; Dihybrid (two characters) cross, pattern of assortment of alleles. Chromosomal basis of inheritance; chromosome number, haploid (n), diploid (2n). **DNA as genetic material;** Griffith experiment of Transformation, Experimental evidence to show DNA as the genetic material, Involvement of DNA in bacterial transformation by Avery, MacLeod and McCarty, Hershey and Chase experiment to prove DNA carries the genetic information inbacteriophage. RNA as genetic material in viruses.	15 Hrs
UNIT 2: Molecular Biology-1 **DNA structure:** Chemistry and structure of DNA, nucleoside, nucleotide, organization of DNA in cells, Watson and Crick model of DNA, DNA denaturation and renaturation. **DNA Replication:** Bacterial Cell cycle. Experimental proof for semi-conservative replication, Replicon. *OriC*. Direction of replication. Stages of replication, Role of DNA polymerases and other enzymes in replication. Theta-replication, rolling-circle model, linear DNA replication. **Transcription:** Gene structure, Stages of transcription – initiation, elongation, termination, prokaryotic and eukaryotic RNA polymerases, -. Promoters, Transcription factors, basal apparatus, RNA splicing and Processing, 5'-capping, mRNA splicing, spliceosome, alternative splicing, polyadenylation, RNA editing.	15 Hrs

Unit 3: Molecular Biology-2: **Translation:** Genetic code, rules governing the genetic code. tRNA structure, ribosome structure. Stages of translation –initiation, elongation and termination. Regulation of translation. Post translational modifications of proteins. **Regulation of gene Expression:** Gene regulation in bacteria. Operon concept, *lac* operon, *trp* operon, Control of gene expression in eukaryotes - Regulation through modification of gene structure- histone modifications, chromatin remodeling, DNA methylation. transcriptional activators, RNA interference. **Mutations:** Mutations and their chemical basis, types of mutations – Spontaneous and induced mutations, physical and chemical agents of mutagenesis, the expression of mutations, mutant detection and selection. **DNA repair:** DNA repair mechanisms, excision repair, SOS repair, post-replication repair, recombination repair.	15 Hrs
UNIT 4: Genetics of Viruses Structure and life cycle of Bacteriophage T4 and Lambda, lytic and lysogenic cycle of bacteriophage. Recombination and genome mapping in viruses. **Genetics of Bacteria;** Structure and life cycle of bacteria, General principles of bacterial recombination, bacterial plasmids, fertility factors, resistance factors, col plasmids, other types of plasmids, transposable elements. **Transformation:** Competence, compatibility, transformants. **Conjugation:** F^+ x F^- conjugation. Hfr conjugation, F^- conjugation, Genemapping in bacteria byconjugation. **Transduction:** Generalized and specialized transduction, mapping the genome. **Genetics of Fungi:** life cycle of Yeast and *Neurospora*, heterothallism, parasexuality, Terad analysis, two point and three point test cross, detecting linkage and mapping genes in yeast and *Neurospora*, recombination in fungi.	15 Hrs

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 the fundamental molecular principles of genetics		√		√			√					
Understand structure of DNA, replication, transcription, translation, regulation of gene expression.		√					√				√	
Knowledge on the basis of genetic mapping in bacteria, linkage analysis in fungi.		√					√					√

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

Model Curriculum

Program Name	BSc in Microbiology	Semester	V
Course Title	FOOD MICROBIOLOGY (Theory)		
Course Code:	DSC- 6T	No. of Credits	04
Contact hours	60 Hours (4 Hours per week)	Duration of SEA/Exam	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

CONTENTS	45 Hrs
UNIT 1-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,* Mycotoxins. **Fermented Food:** Fermented vegetable-sauerkraut, pickles. Meat- sausage. Beverage- kombucha. Sourdough. Microbes as food- SCP, SCO. Neutrceuticals and Symbiotic.	15 Hrs
UNIT 2-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 safety. Food Packaging-Types of packaging materials, properties and benefits. Quality testing of food-Rapid microbiological methods, Examination of faecal contaminants.	15 Hrs
UNIT 3: a) Food Biotechnology **Single cell protein – *Spirulina, Fusarium, Saccharomyces*;** fermented foods, mushroom technology; fungal foods; microbial production of flavours, natural food colourants from bacteria, fungi and algae, enzymes for food processing (protease, lipase, invertase) sweeteners, food waste management. b) Food and sanitation **Food sanitation and control-** Good Hygiene practices, GLP, GMP(Waste treatment disposal methods), HACCP, Food control agencies and their regulation –FSSAI, FDA, FAO	15 Hrs

UNIT 4-Dairy Microbiology	15 Hrs
History, Properties of milk, Types of milk- dried, liquid and 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.	

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
To understand the association of microbes in food and the quality testing of food		√						√			√	√			
To understand the preservation and food safety protocols		√					√			√					
To understand the methods of spoilage of food and the diseases associated with it		√		√											
To learn the properties of milk and the types of preservation of milk.	√	√													
To learn the types of fermented food and dairy products and its significance				√	√			√							

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	

6th SEMESTER MODEL SYLLABUS FOR B.Sc. IN MICROBIOLOGY

Program Name	B.Sc. in Microbiology	Semester	VI
Course Title	MEDICAL MICROBIOLOGY AND IMMUNOLOGY (Theory)		
Course Code:	DSC-7T	No. of Credits	4
Contact hours	60 Hours (4 hours per week)	Duration of SEA/Exam	2 hours
Formative Assessment Marks	40	Summative Assessment Marks	60

Course Pre-requisite(s): Common to the Course Programme at Entry Level

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 serodiagnosis of infectious diseases
CO3: To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process.
CO4: To understand pathogenic bacterial infections, symptoms, diagnosis and To understand pathogenic bacterialinfections, symptoms, diagnosis and treatment process treatment process

UNIT-I: Human microbiota and Medical Bacteriology Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: 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. **Medical Bacteriology** Details of Symptoms, mode of transmission, prophylaxis and control **Rrespiratory diseases:** *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis* **Gastrointestinal Diseases:** *Escherichia coli, Salmonella typhi, Vibrio cholerae,* **Others:** *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*.	15 hrs.
UNIT-II Medical Virology, parasitology and Mycology Details of Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Corona, Influenza, swine flu, Ebola, Chikungunya, Japanese Encephalitis Protozoan diseases: Malaria, Kala-azar, Entamoeba Fungal infections- Cutaneous mycoses: Tinea, pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis **Antimicrobial therapy** **Antimicrobial agents:** General characteristics and mode of action Antibacterial agents: Inhibitor ofnucleic 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

UNIT-III: Immunosystem Edward Jenner, Louis Pasteur, Immunity; Natural (active and passive) and artificial (active and passive) with example, Innate and acquired, Humoral and cell mediated. Early theories to explain the formation and specificity of antibody; Selective, instructional and clonal selection. 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.	15 Hrs
UNIT-IV: Antigen and Antibody **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. epitopes. **Antibody: Basic structure of antibody, light and heavy chain, variable and constant region, hinge region. Structure and functions of different types of antibodies.** **Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype. Polyclonal, Monoclonal antibody production.** **Complement system:** Functions of complement components, Complement activation type of complement activation pathways, membrane attack complex (MAC), complement fixation, **Hypersensitive reactions:** Classification, Type I, Type II, Type III and Type IV. **Antigen-antibody interactions:** Definition of affinity and avidity. Agglutination, Immunoprecipitation; Radial diffusion (Mancini) and double diffusion (Ouchterlony). Enzyme linked immune-sorbent assay (ELISA): Direct, indirect and sandwich ELISA. Radioimmunoassay (RIA). Immunofluorescence.	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	1	12	13	14	15
To gain a preliminary understanding about various immune mechanisms.	√														
To familiarize with Immunological techniques and serodiagnosis of infectious diseases		√	√							√					
To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process	√			√						√					
To understand pathogenic bacterial infections, symptoms, diagnosis and To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process treatment process	√				√	√				√					

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

Model Curriculum

Program Name	B.Sc. in Microbiology	Semester	VI
Course Title	INDUSTRIAL MICROBIOLOGY And Biotechnology		
Paper code	DSC-8T	No. of Credits	4
Contact hours	60 Hours (4 Hours per week)	Duration of SEA/Exam	2 hours
Formative Assessment Marks	40	Summative Assessment Marks	60

Course Pre-requisite(s): Common to the Course Programme at Entry Level

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

CO1. Learn the overview of scope and importance of industrially important microbes

CO2. Acquaint with different types of fermentation processes and equipments

CO3. Evaluate the factors influencing the enhancement of cell and product formation during fermentation

CO4. Acquire the knowledge of the production of value-added products

CO5. Acquire the knowledge of purification of value-added products

Contents	60 Hrs
UNIT-I: Introduction Scope and concepts; Criteria for selection of industrially important microbes; Preservation of industrially important microbes. Types of fermentation process: Submerged fermentation, Solid state fermentation, batch fermentation, continuous fermentation. **Fermenter:** Basic features; design and components of a bioreactor; 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.	15 Hrs
UNIT-II: General production strategies of microbial products and Downstream processing Antibiotic, Enzymes, anti-cholesterol compound, anti-cancerous compound, hormones. **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. Enzyme immobilization Methods of immobilization, advantages and applications of immobilization.	15 Hrs
UNIT-III: 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 deoxynucleotidyltransferase, kinases and phosphatases and DNA ligases.** **Cloning Vectors:** Definition and Properties. Characteristics of cloning vectors. Plasmid vectors: pBR and pUC series. Bacteriophage lambda, cosmids, BACs, YACs. Use of linkers and adaptors.	15 Hrs

Expression vectors: Baculovirus based vectors. **DNA transfer methods:** Microinjection, Biolistic, Electroporation, Calcium and Liposome mediated DNA transfer. Identification and selection of recombinants: DNA hybridization, DNA sequencing- Sanger's method. PCR techniques and applications. Genome library	
UNIT-4: Industrial Biotechnology Microbial synthesis of commercial products- protein pharmaceuticals Insulin and Interferons; antibiotics; bioplastics (PHB, PHA), microbial enzymes, microbial metabolites – organs acids, amino acids. Plant Biotechnology: Transgenic plants: principle, production method and development of pest and disease resistant plants; tolerance to abiotic stress; genetic manipulation of flower pigmentation; nutritional improvement; modification of plant products, edible vaccines, anti-sense RNA technology. **Animal Biotechnology:** Cloning strategies, somatic nuclear transfer; Methods and applications of transgenic animals; mammalian cell culture; brief account of gene therapy, ethical aspects of cloning and transplantations.	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 of industrially important microbes	√														
Acquaint with different types of fermentation processes and equipments												√			
Evaluate the factors influencing the enhancement of cell and product formation during fermentation								√							
Acquire the knowledge of the production of value-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 Marks
Class Test	10 Marks
Debate/Quiz/Assignment	10 Marks
Seminar	10 Marks