

**Integral University, Lucknow**

**Evaluation Scheme and Syllabus**

**for**

**M.Sc. (Microbiology)**

**(Revised w.e.f. session 2015-2016)**

**2015-2016**

**Department of Biosciences**

**Department of Biosciences**  
**Evaluation Scheme**  
**M. Sc. Microbiology Semester – I**  
**Choice Based Credit System (CBCS)**

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Maximum Marks	Credits	Total Credit
			L	T	P	CT	TA	Total	ESE			
BS 441	General Microbiology	Core	3	1	0	15	10	25	75	100	3:1:0	4
BS 442	Biophysical Methods	Core	3	1	0	15	10	25	75	100	3:1:0	4
BS 443	Biomolecules	Core	3	1	0	15	10	25	75	100	3:1:0	4
BS 444	Microbial Cytology & Genetics	Core	3	1	0	15	10	25	75	100	3:1:0	4
BS 445	Soil and Agricultural Microbiology	Core	3	1	0	15	10	25	75	100	3:1:0	4
BS 446	General Microbiology & Biochemistry Lab	Practical	0	0	12	15	10	25	75	100	0:0:6	6
	<b>Total</b>									<b>600</b>		<b>26</b>

### M.Sc. Microbiology Semester II

Course Code	Course Title	Type of Paper	Periods			Evaluation Scheme				Maximum Marks	Credits	Total Credit
			L	T	P	CT	TA	Total	ESE			
BS 451	Microbial Metabolism	Core	3	1	0	15	10	25	75	100	3:1:0	4
MT 412	Bioinformatics and Biostatistics	Core	3	1	0	15	10	25	75	100	3:1:0	4
BS 452	Molecular Biology	Core	3	1	0	15	10	25	75	100	3:1:0	4
BS 453	Industrial Microbiology & Fermentation Technology	Core	3	1	0	15	10	25	75	100	3:1:0	4
Elective courses (Any one of the following)		Elective									3:1:0	4
BS 454	Microbial Diversity		3	1	0							
BS 455	Mycology and Plant Microbe Interactions		3	1	0	15	10	25	75	100		
BS412	Enzymology & Enzyme Kinetics		3	1	0							
BS 456	Applied Microbiology and Bioinformatics Lab	Practical	0	0	9+3=12	15	10	25	75	100	0:0:6	6
BS 419	Educational/ Industrial tour									Satisfactory/Unsatisfactory		
		Total								600		26

Course	Course Code	Associated labs	ESE	Credits
Biochemistry/Bioinformatics	BS 456	Applied Microbiology lab.	50	4

<b>lab. &amp; Bioinformatics Project</b>		<b>Bioinformatics lab &amp; Bioinformatics Project</b>	<b>25</b>	<b>2</b>
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# **Note:** The students of M.Sc. Microbiology have to undergo an educational/ industrial tour in microbiology based industry/ Research Institution for practical awareness at the end of second semester.

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**1<sup>st</sup> sem**

**Subject: General Microbiology**

**Subject Code: BS441**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

History and development of Microbiology - Theory of abiogenesis & biogenesis, Koch's postulates, River's postulate. Classification and Nomenclature of Microorganisms - concept of kingdom-protista, prokaryote and eukaryotes, Microbial taxonomy, recent criteria used in microbial taxonomy including numerical taxonomy and methods based on genetic relatedness, rRNA based phylogenetic relationship.

**UNIT II**

8

Introduction to Microbial Diversity: General characteristics and importance of Viruses, *Chlamydia*, *Rickettsia*, *Mycoplasma*, Bacteria and *Actinomycetes*. Main outline of bacterial classification

**UNIT III**

8

Distinguished characteristics, general account on morphology, classification and economic importance of Algae, Protozoa and Fungi. Fungi as Plant Pathogens.

**UNIT IV**

8

Study of microbes - Preparation and use of culture media, Pure culture and cultural characteristics & preservation methods of microbes. Bacterial Nutrition: Major nutritional types of bacteria, Microbial requirements of C, N, S, P, and microelements, growth factors, etc.

**UNIT V**

8

Growth and control of microbes – Growth phases – kinetics, asynchronous, synchronous, batch and continuous culture. Factors affecting growth; Measurement of growth. Control of microorganisms- Physical and Chemical methods.

**Reference Books:**

- Gerherdt P, Murray RG, Wood WH. Kreig, NR (1994) Methods for General and Molecular Bacteriology, ASM, Washington DC.
- Madigan MT, Martinko JM, Parker J. (1997) Biology of Microorganisms, Prentice Hall International Inc.
- Mathews CK, Holde KEV. (1996) Biochemistry. The Benjamin/Cummings Publishing Company Inc. NY
- Pelczar Jr. MJ, Chan ECS, Krieg NR (1993). Microbiology – Mc Graw Hill. Inc, New York.
- Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1992). General Microbiology, Mac Millan Education Ltd. London.
- Stryer L. (1995) Biochemistry WH Freeman & Company, New York.

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**1<sup>st</sup> sem**

**Subject: Biophysical Methods**

**Subject Code: BS442**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Microscopy: Principles and application of light phase contrast, fluorescence, scanning and transmission electron microscopy

**UNIT II**

8

Isolation of cellular fractions-separation, purification of proteins and amino acids, assay techniques for enzymes, Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins.

**UNIT III**

8

Centrifugation: Ultracentrifugation - velocity and buoyant density determination. Density gradient centrifugation, molecular weight determination.

Chromatography: Basic principles and applications of ion-exchange, gel filtration, partition, affinity, HPLC and reverse phase chromatography, gas chromatography, TLC, Paper chromatography. Chromatofocussing.

**UNIT IV**

8

Principles and applications of molecular techniques in microbiology: Electrophoresis: Agarose Gel electrophoresis, PAGE, Isoelectric focusing, capillary electrophoresis. Pulse field gel electrophoresis. RFLP, RAPD, ARDRA, RISA, Western, Northern and southern blotting, FISH, Fluorescent activated cell sorting (FACS).

**UNIT V**

8

Determination of biopolymer structure (Principles and applications): X-ray diffraction, fluorescence, UV, visible, CD/ORD, ESR, NMR and Mass spectroscopy, Atomic Absorption Spectrophotometer, Plasma emission spectroscopy.

**Reference Books:**

Protein Purification by Robert Scopes, Springer Verlag Publication,  
1982 Tools in Biochemistry David Cooper

Methods of Protein and Nucleic acid Research, Osterman Vol I – III  
Centrifugation D. Rickwood

Practical Biochemistry, V<sup>th</sup> edition, Keth, Wilson and Walker.

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**1<sup>st</sup> sem**

**Subject: Biomolecules**

**Subject Code: BS443**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Carbohydrates: Definition, classification, structure and functions of carbohydrates; Stereoisomerism, aldoses and ketoses; Important classes of monosaccharides, disaccharides, Structural and storage polysaccharides and mucopolysaccharides.

**UNIT II**

8

Lipids: Definition and classification of lipids. Nature of fatty acids. Role of triglycerides in energy storage and phospholipids in membrane formation, sterols, pigments.

**UNIT III**

8

Proteins: Nature of naturally occurring amino acids, Structure and functions of proteins (primary, secondary, tertiary and quaternary structure), Forces responsible for maintenance of protein structure.

**UNIT IV**

8

Nucleic acids: Composition of nucleic acids (ribo and deoxyribonucleic acids); Nucleosides, nucleotides and polynucleotides. Structure and function of DNA and RNA. Types of DNA: A, B and Z DNA, their structure and significance; Physical & biochemical properties of RNA: tRNA, rRNA, mRNA and hnRNA; Primary, secondary, and tertiary structures of RNA.

**UNIT V**

8

Vitamins: Fat soluble and water soluble vitamins; elementary ideas about the physiological functions and deficiency diseases; Role of water soluble vitamins as co-enzyme precursor.

**Reference Books:**

- Eckstein F, Lilley DM (1996). Catalytic RNA. Springer Verlag.  
Freidberg EC, Walker GC, Siede W. (1995). DNA Repair and Mutagenesis, ASM Press.  
Freifelder D. (1991). Molecular Biology. Narosa Publishing House.  
Gardener EJ, Simmons MJ, Snustad DP. (1991). Principles of Genetics, John Wiley & Sons.  
Lewin, B. (1997) Genes VI. Oxford University Press.  
Lodish H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J. (1995) Molecular Cell Biology. Scientific American Books.  
Stryer L (1995). Biochemistry. W.H. Freeman and Company.  
Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1987) Molecular Biology of the Gene. The Benjamin/Cummings Publishing company  
Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000 Biochemistry by David Rawn

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**1<sup>st</sup> sem**

**Subject: Microbial Cytology and Genetics**

**Subject Code: BS444**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Prokaryotic Cell Organization – Bacterial cell wall, Biosynthesis of peptidoglycan, basis of antibiotics, Mode of action of antibiotics, development of resistance, cytoplasmic membrane, ultrastructures of bacterial cell, Endospore, flagella, cell membrane, pili, capsule, prokaryotic genome.

**UNIT II**

8

Eukaryotic Cell Organization and protein targeting: Membrane biology: Structure, function, membrane protein transport in eukaryotes. Structure and functions of cell organelles, Cytoskeleton (structural proteins- microfilaments, actins, etc), genetic organization (euchromatin, heterochromatin, Nucleosome model), concept of protein targeting.

**UNIT III**

8

Cell division and cell cycle: Eukaryotic Cell division cycle: Mitosis, Meiosis, Check points, role of cyclins and cyclin dependent kinases in its regulation. Cell proliferation and cell death, apoptosis.

**UNIT IV**

8

Cell Communication: Basics of signal transduction: Role of calcium, cAMP, G-proteins, inositol phosphates, phospholipases and protein kinases in signal transduction, Quorum sensing, Biofilms and their application.

**UNIT V**

8

Microbial Genetics: Gene transfer mechanisms in bacteria: Transduction: Generalized, restricted; Transformation: Discovery, competence development, molecular mechanism of DNA uptake; Conjugation: mechanism; mapping; Transposons in prokaryotes: Simple, Composite and complex transposons, Mechanism of transposition; Retrotransposons.

**References:**

- Alberts Bruce (1985) *Molecular Biology of Cell*. Garland Pub.
- Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (1987) *Outlines of Biochemistry Edition*, John Wiley and Sons, New Delhi.
- De Robertis E. D. P. and De Robertis E. M. F. (1987), *Cellular and Molecular Biology* Lea and Febiger, Philadelphia.
- Schlegel Hans G. (1995) *General Microbiology*, Edition 7, CUP, Cambridge.
- Stanier R. Y., Adelberg E. A., Ingraham J. L., (1976) *General Microbiology*, 4<sup>th</sup> edition, Mac Millan Press, London.



**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**1<sup>st</sup> sem**

**Subject: Soil and Agricultural Microbiology**

**Subject Code: BS445**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

**8**

Soil Microbiology: Structural and textural classes; Physico-chemical and biological properties of soil, soil enzymes, microorganisms and soil fertility. Methods used in soil chemistry and microbiological studies.

**UNIT II**

**8**

Rhizosphere and Phyllosphere – Rhizosphere and Phyllosphere microorganisms, Rhizosphere effect, root exudates, influence of rhizosphere on crop productivity, plant growth promoting bacteria, biological control within microbial communities of rhizosphere, role of antibiotics and siderophore in biocontrol of plant pathogens, Induced resistance: Phytoalexins.

**UNIT III**

**8**

**Biogeochemical cycles:** Carbon cycle: aerobic and anaerobic decomposition of native and added organic matter, lignolytic and cellulolytic microorganisms. Nitrogen cycle: symbiotic and asymbiotic nitrogen fixation, Ammonification, nitrification, denitrification.

**UNIT IV**

**8**

**Microbial transformation of Phosphorus, sulphur and micronutrients**– Phosphorus cycle, mineralization of inorganic phosphates. Microbial transformation of Iron and Manganese. Microbial transformation of sulphur- Sulphur cycle, sulphur oxidizing and reducing microorganisms (*Thiobacillus* and *Desulfovibrio*).

**UNIT V**

**8**

**Biofertilizers:** Definition and status of biofertilizer, types of biofertilizers. Nitrogenous and phosphatic biofertilizers - *Rhizobium*, *Azotobacter*, *Azospirillum*, *Frankia*, Vesicular Arbuscular Mycorrhiza and PSB/PSF Technologies for the production of biofertilizers. Methods of inoculation on seed and in soil. Quality control of biofertilizers.

**References:**

Agricultural Microbiology – Rangaswami.  
Soil Microbiology – Alexander Martin.  
Soil and soil microorganisms – Subbarao

## **General Microbiology Lab BS 446**

1. General instructions, Microbiology laboratory and its discipline
2. Handling of microscopes, Calibration and measurement of microscopic objects
3. Cleaning of glassware and sterilization. Preparation and use of glassware cleaning solutions, sterilization.
4. Pure culture techniques: serial dilution, pour plate, spread plate, streak plate methods.
5. Enumeration of bacteria from soil samples.
6. Enumeration of fungi from soil samples.
7. Enumeration of actinomycetes from soil samples.
8. Culture and microscopic examination of bacteria by staining methods - Gram's, capsule and spore staining.
9. Culture and microscopic examination of fungi by Lacto-phenol cotton blue staining.
10. Identification techniques: morphological and biochemical identification of bacteria using Bergey's Manual of Determinative Biology.
11. Motility of bacteria.
12. Isolation of *Rhizobium* from nodules.
13. Estimation of carbohydrates
14. Estimation of protein
15. Estimation of DNA
16. Estimation of RNA
17. Estimation of chlorophyll

### **Reference Books:**

Cappuccino, J. C. and Sherman, N. (1992). *Microbiology: A laboratory manual*, Addison Wesley Pub. Co

Benson HJ (1994). *Microbiological Applications*, WmC Brown Publishers, Oxford.

Collins C.H, Lyne P.M, (1985). *Microbiological methods*. Butterworths, London.

Rhodes P.M, Stanbury P.F. *Applied Microbial Physiology - A practical approach*. IRL Press, Oxford University Press, Oxford.

Wilson K, Walker J. (1995) *Practical Biochemistry Principles and Techniques*, Cambridge University Press

K.R. Aneja

Bergey's Manual of Determinative Bacteriology

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**2<sup>nd</sup> sem**

**Subject: Microbial Metabolism**

**Subject Code: BS451**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Enzymes: Classification, properties and factors influencing enzyme activity, co-enzymes, prosthetic group and co-factors, Lock & key hypothesis, induced fit hypothesis, Enzyme kinetics: Michelis Menten equation, Lineweaver-Burk plot, Enzyme inhibition, Allosteric enzymes.

**UNIT II**

8

Aerobic and anaerobic metabolism in bacteria - role of ATP, reducing powers and Biochemistry of catabolic reactions in aerobic heterotrophs: Glycolysis, hexose monophosphate shunt and Entner doudoroff pathways, TCA cycle, Role of glyoxylate cycle in acetic acid oxidation. Electron transport chain and oxidative phosphorylation, Gluconeogenesis.

**UNIT III**

8

Metabolism of lipids, amino acids and Nucleic acids: Oxidation of fatty acid ( $\beta$ -oxidation) and its biosynthesis. Metabolism of amino acids. Biosynthesis and degradation of nucleotides.

**UNIT IV**

8

Microbial degradation of Xenobiotics and Fermentation: Special pathways for primary attack on organic compounds by microorganisms, Catabolic reactions of anaerobic chemoheterotrophs, Anaerobic respiration and fermentation. Autotrophic nutrition of microorganisms. Bacterial photosynthesis,

**UNIT V**

8

Nitrogen metabolism: Biological nitrogen fixation: nitrogenase enzymes, structure and properties, nif gene: regulation and functions. Physiology and biochemistry of nitrogen fixation, denitrification, nitrate and nitrite reduction, sulphate and sulphur reduction, H<sub>2</sub>S formation, deamination and transamination. Utilization of various nitrogen sources (ammonia, urea, nitrate, amino acids) by bacteria.

**References Books:**

Brock —Biology of Microorganisms||  
Brown, T.A. —Gene cloning: An introduction||  
Freifelder, DM —Molecular Biology||  
Lehninger —Biochemistry||  
Lewin —Genes||  
Old & Primrose —Principles of Gene Manipulation||  
Pelczar —Introduction of Microbiology||  
Stryer —Biochemistry||

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**2<sup>nd</sup> sem**

**Subject: Bioinformatics and Biostatistics**

**Subject Code: MT412**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Basics of computers – block diagram of computer, input and output devices, storage devices, operating systems – DOS, Windows, Linux. Basics of networking and their types, topologies, INTERNET: TCP/IP, World Wide Web, e-mail etc.

**UNIT II**

8

Biological data file formats: \*.FASTA, \*.PIR, \*.GDE, \*.PDB, Alignment files (\*.ALN) etc. Search engines: ENTREZ, DBGET, SRS etc. Primary nucleotide sequence atabases: Genbank, EMBL, DDBJ; Primary Protein sequence databases: SwissProt, Protein information resources, TR-EMBL. Etc. Secondary databases: PROSITE, PRINTS, BLOCKS, PFAM.; Microbiology DATABASES: ICTV, AnimalVirusInformation System (AVIS).

**UNIT III**

8

Sequence analysis –Pair wise Sequence Alignment: Needleman Wunsch, Smith Watermann algorithms, Sequence similarity search programs – BLAST and FASTA. Substitution matrices: PAM, BLOSSUM. Multiple sequence alignments: Center Star method, Clustal, PRAS. Phylogenetic analysis: Character based (Parsimony) and distance based methods (UPGMA, neighbor joining), Protein structure prediction: Homology modeling, Primer Designing, Multi dimensional protein identification technology – identification using database.

**UNIT IV**

8

Biostatistics: Measures of central tendency – mean (arithmetic, harmonic & geometric) median and mode; Measures of dispersion- range, quartile deviation, mean deviation and standard deviation. Coefficient of variation.

**UNIT V**

8

Correlation analysis: positive and negative correlation, Karl Pearson's coefficient of correlation, Spearman's rank correlation. Regression analysis: regression line Y on X and X on Y, angle between two regression lines. Test of significance: null and alternative hypothesis, level of significance, Z-test, Student's t-test, Chi-square test for goodness of fit and independence of attributes.

**Reference Books**

Developing Bioinformatics Computer Skills: Cynthia Gibas & Per Jambeck – 2001 –Shroff  
Bioinformatics Basics: Applications in Biological Science and Medicine – 2002 - HH Rashidi & LK Buehler, CRC Press, London

Bioinformatics: Sequence, structure and databanks – 2000 - Des Higgins & Willie Taylor –  
Bioinformatics: A practical guide to the analysis of genes and proteins – 2001 - AD Baxevanis &  
BFF Ouellette – Wiley Interscience – New York  
Biostatistics (1996) Arora PN & Malhon PK – Imalaya Publishing House, Mumbai.  
Primer of Biostatistics – Stanton A & Clantz – The McGraw Hill Inc., New York.

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**2<sup>nd</sup> sem**

**Subject: Molecular Biology**

**Subject Code: BS452**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Nucleic acid as information carriers and Replication: Griffith, Avery, McLeod and McCarty, Hershey and Chase experiment; Possible modes of replication: Meselson and Stahl experiment; Prokaryotic DNA replication; Origin of replication; Roles, properties and mechanism of action of DnaA, Helicase, HD protein, Primase, DNA gyrase, Topoisomerase, DNA Polymerase, DNA ligase; Fidelity and regulation of replication;  $\sigma$  or Rolling circle replication in  $\phi$ X174.

**UNIT II**

8

Transcription in prokaryotes: Prokaryotic promoter; RNA polymerase: X-Ray crystallographic structure, Subunits, Types of  $\sigma$  subunit; Recognition of promoter; Binding and initiation sites; Melting of DNA; Abortive initiations; Promoter clearance; Rho dependent and Rho independent termination of transcription; Sigma cycle; Reverse transcription.

**UNIT III**

8

Translation in prokaryotes: Adapter role of tRNA, Evidences for a triplet code; Properties of Genetic code; Codon family and Codon pairs; Significance of Isoacceptor tRNAs and Wobble hypothesis; A, P and E sites of ribosome; Ribosome binding site; Formation of initiation complex; Transpeptidation and Translocation; Ribosome cycle; Roles of Initiation factors, Elongation factors, Release factors, Aminoacyl tRNA synthetase, tRNA, rRNA, GTP, Peptidyl transferase site and Factor binding site of ribosomes in translation.

**UNIT IV**

8

Post - transcriptional / Cotranscriptional processing of rRNA, mRNA, tRNA: Addition of 5' cap and 3' Poly A tail in mRNA, RNA splicing - Self splicing and Spliceosome mediated splicing, Cutting events or action of ribonucleases, Covalent modifications, RNA editing. Post - translational processing: Basics of Protein folding, Intein splicing, Chemical modification, Proteolytic cleavage, Zymogen activation; Polycistronic and monocistronic.

**UNIT V**

8

Regulation of gene expression: Concept of operon: Lac and Trp operons, Eukaryotic gene expression, Significance of repressor, Attenuation; histone modifications, Mutation: Types of mutations, DNA repair mechanisms: Photoreactivation, Base excision repair, Nucleotide excision repair, Transcription coupled repair, Mismatch repair, Recombination repair, Translesion DNA synthesis; Y-family DNA Polymerases.

**Reference Books:**

Lewin B. (2000). Genes VII. Oxford University press

Lodish H, Baltimore D, Berk A, Zipursky SL, Darnell J. (1995). Molecular cell biology.

Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1987). Molecular biology of the gene.

Brown T A (1995) Essential molecular biology, vol. I, A practical approach, IRL press, Oxford.

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**2<sup>nd</sup> sem**

**Subject: Industrial Microbiology & Fermentation Technology**

**Subject Code: BS453**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Introduction to Industrial Microbiology: Basic principles of fermentation technology, Isolation, screening and maintenance of industrially important strains, Types of fermentations, Growth Kinetics of microbes during fermentation (Batch and continuous). Fermentation media-Types of fermentation media, sources of carbon, nitrogen, trace elements, growth factors, precursors, buffers, antifoam agents, sterilization of media.

**UNIT II**

8

General design of fermenter, concept and importance of gas exchange and mass transfer and scale-up in microbial fermentation. Processes of fermentation. Basic concept of cell and enzyme immobilization and reactors used for immobilized enzymes.

**UNIT III**

8

Growth and product formation: Definition of primary and secondary metabolites, and their control, screening of new metabolites and isolation approaches of unidentified microbial products. Overproduction of industrially important metabolites by strain improvement; Product recovery and techniques involved in downstream processing.

**UNIT IV**

8

Microbial production of industrially important products: A brief idea about the products obtained from microbes, commercial production of citric acid and glutamic acid, antibiotics (as penicillin), solvents (ethanol), vitamins (B12), enzymes (Protease). Production of single cell protein-Microorganisms and substrates used, techniques of production, merits and demerits of single cell protein.

**UNIT V**

8

Introduction to intellectual property rights; Intellectual property laws; significance of IPR. Forms of IPR like patent, design copyright and trademark. Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms. Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity. Trade related aspects of Intellectual Property Rights and Budapest treaty.

**Reference Books**

Industrial Microbiology by L.E Casida , John Wiley and sons INC.

Prescott and Dunn,s Industril microbiology, 4th edition (1982) by Gerald Reed.

Food processing:Biotechnological applications by S.S Marwaha and

Microbial technology vol.I & II by H.J.Peppler & D.Perlman.Academic press INC.

Principles of fermentation technology by P. Stanbury & Allan Whitekar, Pergamon

Press Industrial microbiology by Cruger and Cruger



**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**2<sup>nd</sup> sem**

**Subject: Microbial Diversity**

**Subject Code: BS454**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I**

8

Microbial ecology: Concept of habitat and ecological niches, Ecosystem, Energy flow, food chain, food web, biotic community concept, Microbial succession, adaptation and natural selection of microbial population.

**UNIT II**

8

Microbial interactions - Symbiosis, Synergism, Commensalism, Ammensalism, Predation and Parasitism, Mycorrhizal associations-structure, characteristics and their role in Agriculture and Forestry, Algal association with other microorganisms and plants

**UNIT III**

8

Anoxygenic photosynthetic microbes-General characteristic of purple and green sulphur bacteria. Oxygenic photosynthetic microbes- General characteristics of Cyanobacteria and Prochlorales; Role of blue green algae (BGA) in agriculture

**UNIT IV**

8

Methanogenic Archeobacteria—General characteristics. Bioluminescent and nitrogenfixing bacteria- A high energy spending bacteria. Magnetotactic bacteria Microorganisms in prospecting of oils Extremophiles- Acidophilic, alkalophilic, psychrophilic, thermophilic and halophilic microorganisms.

**UNIT V**

8

Microbes of toxic environments: acid mine drainage, coal desulphurisation, waste containing cyanides, xenobiotics, pesticides and chemicals, heavy metals, hydrocarbons & radio isotopic materials Concept of autotrophy – an example of extreme synthesis Biodeterioration-concept, biodeterioration of wood, stonework, pharmaceutical products, rubber, plastic, paints, lubricants, cosmetics, control of biodeterioration

**Reference Books:**

Extremophiles-(2000) By B.N.Johari Springer Verlag, New York.

Microbial diversity (1999) by D.Colwd Academic press.

Bergy's Manual of Systematic Bacteriology (1984). Vols.I and III .Williams and Wilkins, Baltimore Academic press

Microbial life in extreme environments (1978) by D.S.Kushner Academic press Inc. NY.

Microbial ecology (1979) by J.M.Lynch and N.J.Poole. Blackwell Publications, Oxford.

Brock biology of microorganisms (2000). 9th eds.by Madigan, Martinko and Jack parker.

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**2<sup>nd</sup> sem**

**Subject: Mycology and Plant Microbe Interactions**

**Subject Code: BS455**

**(Revised w.e.f. session 2015-2016)**

**L T P**  
**3 1 0**

**UNIT I:**

8

**Fungi:** Historical account; General characters of fungi with special reference to thallus organization and reproduction in fungi. Nutritional types of fungi: biotrophs, hemibiotrophs, symbionts and necrotrophs and life cycle in fungi. Genetic variation in fungi- heterocaryosis and parasexual cycle and their significance. Sex hormones in fungi.

**UNIT II:**

8

**General classification of fungi.** Study of the following main groups of fungi: Myxomycota with special reference to *Stemonitis*; Plasmodiophormycetes with special reference to *Plasmodiophora*; Oomycetes with special reference to *Pythium*; Zygomycotina with special reference to *Zygorhynchus*; Ascomycotina with special reference to Yeasts, *Protomyces*, *Aspergillus*, *Taphrina*; Basidiomycotina with special reference to *Puccinia*, *Agaricus*; Deuteromycotina with special reference to *Alternaria*.

**UNIT III:**

8

**Economic importance of fungi:** Lichens: types, biology and physiology of lichen thallus, economic importance of lichens; Mycorrhiza. Beneficial uses of fungi, industrial production of enzymes and penicillin. Edible Mushrooms. Fungi as animal parasites, mycoses of vertebrates- types and symptoms. Insect fungus association. Role of saprotrophs in ecosystems.

**UNIT IV:**

8

**Plant Microbe interaction:** Interaction in Rhizosphere and phyllosphere. Plant growth promotion and its mechanisms, Biofertilizers and biopesticides. Plant pathogens: Koch's postulates. Classification of plant diseases. Dissemination of phytopathogens. Causal agents of plant diseases. General symptoms of plant diseases. Factors influencing infection, colonization and development of symptoms. Specialization of parasitism, pathogenesis: role of enzymes and toxins in pathogenesis. Genetics of host- pathogen interaction. Defense mechanism in host: effect of infection on host physiology. Control of plant pathogens (plant quarantine; Cultural, Physical, chemical & biological methods of control).

**UNIT V:**

8

**Plant Diseases:** Epidemiology, symptoms, etiology, perennation and control of following diseases: Damping off of seedling and fruit rot- *Pythium* ; Stem gall of coriander- *Protomyces macrospores*; Peach leaf curl- *Taphrina deformans* ; Rust of wheat- *Puccinia recondite* ; Covered smut of barley-*Ustilago hordei*; Leaf spot and shot holes- *Alternaria* spp. Citrus canker; Tobacco mosaic disease; Root knot of vegetables- *Meloidogyne* ; Abiotic/Non pathogenic diseases - Black tip of mango ; Mycotoxins and storage diseases.

**Reference Books:**

- Aneja, K.R. & Mehrotra, R.S. (2011). Fungal Diversity & Biotechnology. New Age International Publishers, New Delhi.
- Alexopoulos, C. J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology. 4<sup>th</sup> edition John Wiley & Sons, USA.
- Mehrotra, R.S. and Aneja, K.R. (2010). Introduction to Mycology. Wiley Eastern Ltd. New Delhi.
- Moore –Landcker, E. (1996). Fundamentals of the Fungi. Prentice Hall
- Agriose, G.N. 2005, Plant Pathology, 5<sup>TH</sup> edition Academic Press, Inc., Ainsworth, G.C. and Sussman, A.A. (Eds).
- J.W. Deacon (1997) Modern Mycology (Basic Microbiology) 3<sup>rd</sup> Ed. Wiley Blackwell

**Integral University, Lucknow**  
**Department of Biosciences**

**M. Sc. (MB) 1<sup>st</sup> year**

**2<sup>nd</sup> sem**

**Subject: Enzymology & Enzyme Kinetics**

**Subject Code: BS412**

**(Revised w.e.f. session 2015-2016)**

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**UNIT I**

8

Classification and nomenclature of enzymes. General properties of enzymes. Mechanism of enzyme action: Chymotrypsin, ribonuclease, activation of transition metal cation, activation by alkaline earth metal cation, nicotinamide nucleotide, flavin nucleotide and adenosine phosphate.

**UNIT II**

8

Michaelis-Menten initial rate equation based on equilibrium assumption, Briggs-Haldane steady state approach, integrated form of the Michaelis equation, methods for the determination of  $K_m$  and  $V_{max}$  normalized initial rate equation and normalized curves, Haldane relationship.

**UNIT III**

8

Effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions. Enzyme inhibition and activation: Types of reversible inhibitors, qualitative analysis of data, derivation of equations for different types of inhibitions, determination of inhibitor constant, determination of activator constant.

**UNIT IV**

8

Multisubstrate enzyme kinetics: random bi-bi, and ping pong reactions. Intracellular localization of enzymes, purification of enzymes and tests for homogeneity.

**UNIT V**

8

Immobilization; kinetics of immobilized systems. Isozymes. Allosteric enzymes. Industrial and clinical scope of enzymes.

**Reference Books:**

Lehninger, AL —Principles of Biochemistry||

Lubert Stryer —Biochemistry||

Voet & Voet —Biochemistry||

Shuler —Bioprocess Engineering||

Alan Fersht —Enzyme Structure and Mechanism||

David S. Sigman, Paul S. Sigman —The Enzymes: Mechanisms of Catalysis||

Palmer —Enzymes||

Dixon & Webb —Enzymes

## **Applied Microbiology and Bioinformatics Lab BS 456**

1. Measurement of bacterial growth/growth curve.
2. Effect of physical and chemical factors on the growth of bacteria: temperature, pH, and salts.
3. Enumeration of phyllosphere/rhizosphere microbial flora.
4. Enumeration/Isolation of PSB/PSF
5. Detection of extracellular microbial enzyme: Beta lactamases
6. Testing for antibiotic sensitivity and/or toxicity using bacterial system
7. Determination of MIC values (tube dilution and spot plate method)
8. Screening for antibiotic producing microbes
9. Microbiological examination of milk and milk products
10. Microbiological quality testing of milk (MBRT test)
11. Microbial examination of industrial waste water/sewage.
12. Basics of computers – basic commands – file creation, copying, moving & deleting in DOS & Windows. Internet - Using browsers – search engines.
13. Using biological databases – GENBANK, EMBL, Swissprot – Protein Data Bank.
14. Different types of sequence analysis queries in BLAST and FASTA. (Homology search)
15. Multiple sequence alignments (Clustal) and Phylogenetic Analysis. (Phylip or Clustal)
16. Gene Prediction.

### **Reference Books**

Gerhardt P. Murray RG, Wood WA, and Kreig NR (ed.) (1994) Methods for General and Molecular Bacteriology - American Society for Microbiology, Washington D.C.

Patrick R. Murray. (editor chief) (1999) Manual of clinical microbiology, 7<sup>th</sup> edition, ASM Press, Washington D.C.

Prakash M., Arora, C.K. (1998) Pathological techniques - Anmol Publications Pvt. Ltd. N.D.

Sambrook J, Fritsch EF, Maniatis T. (1989). Molecular cloning. Cold Spring Harbor Laboratory Press.

Sambrook J and Russell DW(2001) Molecular cloning - A laboratory manual (3<sup>rd</sup> edition, Vol 1,2,3), Cold Spring Laboratory Press, New York.

Ausubel FM (1994) Current protocols in molecular biology, Vol. 1 & 2. John Wiley & Sons Inc.

### **Educational/Industrial Tour BS 419**

The students of M.Sc. Microbiology will undergo educational/Industrial tour in Microbiology based industry/research institution for practical awareness at the end of 2<sup>nd</sup> semester. The students have to submit the report of the visit based on which Satisfactory or Unsatisfactory non-creditable grades will be given to the students.