



College of Arts,
Science &
Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: B.Sc.

Subject: MICROBIOLOGY

Academic Year: 2018 – 2019

F.Y.B.Sc

**Credit Based Semester and Grading Syllabi approved
by Ad-hoc Board of Studies in Microbiology to be
brought into effect from June 2018.**

PREAMBLE

With the introduction of Autonomy by the S.I.E.S. College of Arts, Science and Commerce under the University of Mumbai; from the academic year 2018-19; the syllabus for the F.Y.B.Sc Microbiology has been drafted to cover the many aspects of the subject.

The syllabus has been planned to cover basic techniques of Microbiology and an introduction to newer advanced techniques which will be dealt in detail in the second and third year of the course. The syllabus is also designed as per the norms of the CBGS pattern which consists of two semesters per academic year.

The students will be introduced to validation and calibration in order to prepare them for industry work. Study of living forms needs a basic understanding of Biochemistry and Genetics. These two fundamental topics will be taught in the First year at a basic level and will cover advanced aspects in the next two years of the course. Hence the module of Macromolecules and Genetics has been introduced in the syllabus.

The aim of the course is to prepare the students over three years so that they are competent to think independently and be trained for a career in research or industry.

	SEMESTER I	
Course Code	Title	Credits
Course code SIUSMIC11	FUNDAMENTALS OF MICROBIOLOGY	2 Credits (45 lectures)
Unit-I	History, Introduction and Scope Of Microbiology Prokaryotic Cell Structure,	15 lectures.
Unit-II	Genetics and Biotechnology	15 lectures.
Unit-III	Nutrition and Cultivation	15 lectures.
Course code SIUSMIC12	BASICSOF MICROBIOLOGY I	2 Credits (45 lectures)
Unit-I	Microscopy and Staining	15 lectures.
Unit-II	Eukaryotic Cell Structure	15 lectures.
Unit-III	Control of Microorganisms	15 lectures.
SIUSMICPI	PRACTICALS	2 Credits
	SECTION-1 FUNDAMENTALS OF MICROBIOLOGY. (Practicals Based On Unit-I,II and III Of SIUSMIC11)	1 Credit (45 lectures)
	SECTION-2 BASICS OF MICROBIOLOGY I (Practicals Based On Unit-I,II and III Of SIUSMIC12)	1 Credit (45 Lectures)

SEMESTER II		
Course code SIUSMIC21	BASICS OF MICROBIOLOGY II	2 Credits (45 Lectures)
Unit-I	Study Of Different Groups Of Microbes-I	15 lectures.
Unit-II	Study Of Different Groups Of Microbes-II	15 lectures.
Unit-III	Microbial Interactions	15 lectures.
Course code SIUSMIC22	EXPLORING MICROBIOLOGY.	2 Credits (45 Lectures)
Unit-I	Microbial growth	15 lectures.
Unit-II	Biomolecules	15 lectures.
Unit-III	Microbes and human health	15 lectures.
SIUSMICPII	PRACTICALS	2 Credits
	SECTION-1 BASICS OF MICROBIOLOGY II (Practicals Based On Unit-I,II and III of SIUSMIC21)	1 Credit (45Lectures)
	SECTION-2 EXPLORING MICROBIOLOGY. (Practicals Based On Unit-I,II and III of SIUSMIC22)	1 Credit (45Lectures)

Learning objectives

The syllabus is drafted with the following objectives –

- To introduce the subject of Microbiology which is not taught at the junior college
- To teach them Microbial techniques, biosafety methods and analytical methods
- To train the students for projects and assignments so that they can do independent study
- To prepare the student for advance studies in the subject of Microbiology

Expected outcome

The students after three years of the course in Microbiology will be well trained for careers in

- Pharmaceutical industry
- Research Institutes
- Clinical Research work
- Environmental monitoring
- Quality assurance

F.Y.B.Sc. MICROBIOLOGY SYLLABUS

SEMESTER I

Course code SIUSMIC11	PAPER I	
	FUNDAMENTALS OF MICROBIOLOGY	45 LECTURES 2 CREDITS
UNIT	TOPIC	LECTURES
Unit I	<p>1. Historical aspects of Microbiology and Prokaryotic Cell structure</p> <p>1.1 History and scope of Microbiology (3L)</p> <p>a. Golden Age of Microbiology-Koch's Postulates, Medical Microbiology, Immunology, industrial microbiology and microbial ecology</p> <p>b. Future of microbiology</p> <p>1.2 Prokaryotic Cell structure and Function (12L)</p> <p>a. Cell wall</p> <p>b. Cell membrane</p> <p>c. Components external to cell wall-Capsule, Slime layer</p> <p>d. Flagella, Pili, Fimbriae</p> <p>e. Cytoplasmic matrix-Inclusion bodies, magnetosomes, ribosomes, gas vesicles</p> <p>f. Bacterial endospores and their formation</p>	15
Unit II	<p>2. Genetics and Biotechnology</p> <p>2.1. Genetics (7L)</p> <p>DNA as genetic material; Forms of DNA; Types of RNA; Griffith, Avery and McCleod, Hershey and Chase experiment Watson and Crick Model</p> <p>2.2 Nucleic acids: (3L)</p> <p>Nitrogenous bases- Purines, Pyrimidines</p> <p>Pentoses-Ribose, Deoxyribose</p> <p>Nomenclature of Nucleosides and nucleotides, polynucleotide chain to show bonding between nucleotides (Phosphodiester bonds)</p> <p>Basic structure of RNA and DNA</p> <p>2.3. Biotechnology (5L)</p> <p>a. Introduction Biotechnology as an interdisciplinary science</p> <p>b. Energy and Biotechnology –Biofuels</p> <p>c. Biotechnology and Health care –Diagnosis and treatment</p> <p>d. Bio fertilizer, Bio pesticide and Vermicomposting</p> <p>e. Bioleaching, Biosensors</p> <p>f. Biosafety – introduction</p>	15
Unit III	<p>3.1: Nutrition and Cultivation (10L)</p> <p>a. Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors.</p>	15

	b. Nutritional types of microorganisms c. Ingredients and Types of Culture media with examples d. Physical conditions required for growth. 3.2. Isolation and Preservation of Cultures (5L) a. Isolation of microorganisms and pure culture techniques b. Study of cultural characteristics c. Preservation of microorganisms d. Culture Collection Centers	
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Course code SIUSMIC12	PAPER II	
	BASICS OF MICROBIOLOGY I	45 LECTURES 2 CREDITS
UNIT	TOPIC	LECTURES/SEM
Unit I	1.1 Microscopy (8L) a. History of microscopy b. Optical spectrum, Lenses and mirrors c. Simple and compound light microscope d. Dark field Microscopy e. Phase contrast Microscopy f. Electron microscopy-TEM, SEM 1.2 Staining and Contrast enhancement techniques (7L) a. Dyes and stains: Types, Physicochemical basis, Fixatives, Mordants, Decolorizers b. Simple and differential staining c. Special staining (Cell wall, Capsule, Lipid granules, Spores, Metachromatic granules and Flagella)	15
Unit II	Eukaryotic Cell Structure: a. Overview of Eukaryotic cell structure b. plasma membrane Structure c. Cytoplasmic matrix, microfilaments, intermediate filaments, and microtubules d. Organelles of the Biosynthetic-secretory and endocytic Pathways –Endoplasmic reticulum and Golgi apparatus Definitions of Lysosome, Endocytosis, Phagocytosis, Autophagy, Proteasome e. Eukaryotic ribosomes f. Mitochondria g. Chloroplasts h. Nucleus –Nuclear Structure i. External Cell Coverings: Cilia And Flagella j. Comparison of Prokaryotic And Eukaryotic Cells	15

<p>Unit III</p>	<p>3.1. Control of Microorganisms (3L) a. Definitions of frequently used terms b. Rate of microbial death. c. Factors affecting the effectiveness of antimicrobial agents d. Properties of an ideal disinfectant 3.2. Physical methods of microbial control (5L) a. Dry and moist heat – mechanisms, instruments used and their operations b. Electromagnetic radiations – Ionizing radiations, mechanisms – advantages and disadvantages c. Bacteria proof filters d. Low temperature e. Osmotic pressure f. Desiccation 3.3. Chemical methods of microbial control (5L) - mechanism advantages and disadvantages (if any) applications. a. Phenolics b. Alcohols c. Heavy metals and their compounds d. Halogens e. Quaternary ammonium compounds f. Halogens g. Dyes h. Surfactant active agents/Detergents i. Aldehydes j. Peroxygens k. Sterilizing gases l. Chemotherapeutic agents - List types of agents active against various groups and mention the site of action (Detailed mode of action not to be done) 3.4. Evaluation of disinfectant (2L)–Tube dilution and Agar plate techniques, Phenol coefficient, Tissue toxicity index</p>	<p>15</p>
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SEMESTER II

Course code SIUSMIC21	PAPER I	
	BASICS OF MICROBIOLOGY II	45 LECTURES 2 CREDITS
UNIT	TOPIC	LECTURES
Unit I	<p>1. Study of Different Groups of Microbes (I) :</p> <p>1.1 Viruses: (7L) a. Historical highlights, General properties of viruses b. Structure of viruses-capsids, envelopes, genomes c. Cultivation of viruses- overview d. Bacteriophages: Lytic cycle. Lysogeny e. prions, viroids</p> <p>1.2. Rickettsia, Chlamydia, Mycoplasma (3L) General features and medical significance</p> <p>1.3. Actinomycetes (3L) General features of <i>Nocardia</i> and <i>Streptomyces</i> Importance: ecological, commercial and medical</p> <p>1.4. Archaeobacteria (2L) Characteristics of major Archaeal groups</p>	15
Unit II	<p>2. Study Of Different Groups Of Microbes (II) :</p> <p>2.1 Protozoa (4L) Major Categories of Protozoa Based on motility, reproduction. Medically important Protozoa. Life cycle of <i>Entamoeba</i></p> <p>2.2 Algae (5L) Characteristics of algae: morphology, Pigments, reproduction, Cultivation of algae. Major groups of Algae – an overview. Biological, Medical and economic importance of Algae. Differences between Algae and Cyanobacteria</p> <p>2.3 Yeasts and Molds (5L) Characteristics: structure, Reproduction. Cultivation of Yeasts and Molds. Major fungal divisions- overview. Life cycle of yeast, Biological and economic importance</p> <p>2.4 Slime molds and Myxomycetes (1L)</p>	15

Unit III	3. Microbial interactions (15L) 3.1 Types of Microbial Interactions (4L) Mutualism, Cooperation, Commensalism, Predation Parasitism, Amensalism, Competition 3.2 Microbial associations with vascular plants (4L) a) Phyllosphere and Rhizosphere c) Mycorrhizae d) Nitrogen fixation : Rhizobia, Actinorrhizae, Stem Nodulating Rhizobia e) Fungal and Bacterial endophytes 3.3 Human Microbe Interactions. (7L) a) Normal flora of the human body : Skin, Nose and Nasopharynx, Oropharynx, Respiratory tract, Eye, External ear, Mouth, Stomach, Small intestine, Large intestine, Genitourinary tract b) Relationship between microbiota and the host c) Gnotobiotic animals	15
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Course code SIUSMIC22	PAPER II	
	EXPLORING MICROBIOLOGY	45 LECTURES 2 CREDITS
UNIT	TOPIC	LECTURES
Unit I	1. Microbial growth (15L) 1.1. Definition of growth, Mathematical Expression, Growth curve (2L) 1.2. Measurement of growth (7L) a. Direct microscopic count – Breed’s count, Petroff – Hausser counting chamber- Haemocytometer b. Viable count – Spread plate and Pour plate technique c. Measurements of cell constituents d. Turbidity measurements – Nephelometer and spectrophotometer techniques 1.3 Types of growth(3L) Synchronous growth, Continuous growth (Chemostat and Turbidostat) 1.4. Influence of environmental factors on growth.(3L) a. Microbial growth in natural environment b. Diauxic growth- concept and example	15

<p>Unit II</p>	<p>2. Biomolecules 2.1 Water- Structure, properties in brief (3L) 2.2. Chemical foundation: (2L) a. Biomolecules as compounds of carbon with a variety of functional groups b. Macromolecules as the major constituents of cells d. Configuration and Conformation with definitions and suitable examples only e. Types of Stereoisomers and importance of stereoisomerism in biology f. Types of bonds and their importance: Electrovalence, covalent, ester, phosphodiester, thioester, peptide, glycosidic</p> <p>2.3 Carbohydrates: (3L) Definition, Classification, Biological role, Monosaccharides, oligosaccharides (maltose, cellobiose, sucrose, lactose) and polysaccharide (starch, glycogen, peptidoglycan, cellulose)</p> <p>2.4 Lipids: (3L) Fatty acids as basic component of lipids and their classification, nomenclature, storage lipids and structural lipids Types of lipids with general structure of each and mention examples</p> <p>2.5 Amino acids, proteins and enzymes: (4L) General structure and features of amino acids (emphasis on amphoteric nature) Classification by R-group(<i>no structures</i>), Uncommon amino acids and their functions Peptides and proteins- Definition and general features and examples with biological role Primary, secondary, tertiary, quaternary structures of proteins- Brief outline</p>	<p>15</p>
<p>Unit III</p>	<p>3. Microbes and human health 3.1 Difference between infection and disease. (2L) Important terminology: Primary infection, secondary infection. Contagious infection, occupational disorder, clinical infection, subclinical infection, Zoonosis, genetic disorder, vector borne infection 3.2 Factors affecting infection: (3L) Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization and its effects. Host factors: natural resistance, species resistance, racial resistance</p>	<p>15</p>

	<p>3.3 Individual resistance: (3L) Factors influencing individual resistance: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. Interaction between Microbes and host is dynamic. Types of immunity- active, passive, racial, species</p> <p>3.4 Host defense against infection: Overview (7L)</p> <p>i) First line of Defense: skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes</p> <p>ii) Second line of defense: Biological barriers: Phagocytosis, Inflammation</p> <p>iii) Third line of defense: Brief introduction to antibody mediated and cell mediated immunity</p>	
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REFERENCES FOR PAPER I AND II

1. Advances in Biotechnology S. N. Jogdand ,6th Edition revised, Himalaya Publishing House, 2007
2. Brock Biology of Microorganisms 11th Michael T.MadiganandJ.M.Martin , Ed. International edition ,2006, Pearson Prentice Hall.
3. Foundations in Microbiology International 2002 edition, Kathleen Park Talaroand Arthur Talaro McGraw Hill
4. Fundamental Principles of Bacteriology, A.J. Salle, McGraw Hill Book Company Inc.1984
5. Fundamentals of microbiology, Martin Frobisher 9th edition ,W. B. Saunders Co., 1974
6. General Microbiology, Stanier, Ingraham et al , 4thand 5th ed. 1987, Macmillan Education Ltd
7. Microbiology TMH 5th Edition by Michael J. Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
8. Outlines of Biochemistry 5th edition, Conn P. Stumpf, G. Bruening and R. Doi. John Wiley and Sons. New York 1995
9. Prescott, Harley, Klein-Microbiology, 5th and 6th edition, International edition 2002 and 2006, McGraw Hill Biology of Microorganisms by Brock 11th edition
10. Principles of Biochemistry. 4th Edition. Lehninger D. Nelson and M. Cox. W.H. Freeman and Company. New York 2005
11. Textbook Of Microbiology , R. Ananthanarayan 7th Edition, Universities Press, 2009

	PRACTICALS SEMESTER I	2 Credits
	SECTION-1 FUNDAMENTALS OF MICROBIOLOGY.	1 Credit (45 lectures)
Unit-I	<ol style="list-style-type: none"> 1. Assignment : Contribution of Scientists in the field of Microbiology 2. Special staining: Cell wall, capsule, endospore, Flagella, lipid, metachromatic granules. 	
Unit-II	<ol style="list-style-type: none"> 3. Preparation of biofertilizer 4. Preparation of yoghurt 5. Production of fungal SCP or Production of Mushrooms 6. Leavening of bread or wine making 7. Immobilization of amylase producing fungi and demonstration of activity 8. Nucleic acid detection by DPA and Orcinol. 	
Unit-III	<ol style="list-style-type: none"> 9. Preparation of Culture Media: <ol style="list-style-type: none"> a. Liquid medium(Nutrient Broth) b. Solid Media(Nutrient agar, Sabourauds agar) 10. Preparation of slant ,butts and plates 11. Inoculation techniques and Study of Growth: <ol style="list-style-type: none"> a. Inoculation of Liquid Medium b. Inoculation of Solid Media(Slants, Butts and Plates) 12. Study of Colony Characteristics of pigmented and nonpigmented bacteria. 13. Study of Motility (Hanging Drop Preparation) 14. Use of Differential and Selective Media: (MacConkey and Salt Mannitol Agar) 	
	SECTION-2 BASIC TECHNIQUES INMICROBIOLOGY.	1 Credit (45 lectures)
Unit-I	<ol style="list-style-type: none"> 1. Parts of a microscope 2. Micrometry 3. Dark field and Phase contrast : Demonstration 	
Unit-II	<ol style="list-style-type: none"> 4. Monochrome staining 5. Gram Staining 6. Negative Staining. 	
Unit III	<ol style="list-style-type: none"> 7. Introduction to Laboratory equipments, disinfection and discarding techniques in laboratory <ol style="list-style-type: none"> a. Methods of preparation of glassware for Sterilization b. Control of microorganisms using moist heat 	

	c. Control of microorganisms using dry heat (e.g. Sterilization of Dry powders, Rubber gloves, Bandages, Screw capped tubes) 8. Effect of UV Light, Desiccation, surface tension 9. Osmotic Pressure, heavy metals (Oligodynamic action) 10. Effect of dyes, phenolic compounds and chemotherapeutic agents (disc inhibition method) 11. Evaluation of Disinfectant	
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	PRACTICALS SEMESTER 2	2 Credits
	SECTION-1	1 Credit
	BASICS OF MICROBIOLOGY.	(45 lectures)
Unit-I	1. Spot assay and plaque assay of Bacteriophage (Demonstration) 2. Slide Culture technique (Actinomycetes and Fungal Culture)	
Unit-II	3. Isolation of yeast, cultivation of other fungi 4. Cultivation on Sabouraud's agar 5. Static and Shaker Cultures 6. Fungal Wet mounts and Study of Morphological Characteristics: <i>Mucor</i> , <i>Rhizopus</i> , <i>Aspergillus</i> , <i>Penicillium</i> 7. Permanent slides of Algae, Protozoa 8. Isolation of anaerobes 9. Study of protozoa using wet mount from hay infusion broth	
	10. Normal flora of skin and saliva 11. Cough plate technique on SIBA 12. Wet Mount of Lichen 13. Isolation of <i>Rhizobium</i> 14. Isolation of <i>Azotobacter</i>	
	SECTION-2	1 Credit
	EXPLORING MICROBIOLOGY.	(45 lectures)
Unit-I	1. Growth curve (Demonstration) only in complex media. 2. Breed's Count 3. Haemocytometer 4. Viable count: Spread plate and pour plate. 5. Brown's opacity 6. Effect of pH and temperature on growth 7. Optimum Growth Conditions pH and temperature 8. Methods of culture preservation	

Unit-II	9. Carbohydrates- Benedicts, Molisch's test. 10. Proteins, amino acids- Biuret, Ninhydrin.	
Unit-III	11. Study of virulence factors – Enzyme Coagulase 12. Study of virulence factors – Enzyme Hemolysin 13. Study of virulence factors – Enzyme Lecithinase	

Guidelines for Examination Pattern:-

There are two theory papers of 60 marks each (External assessment) at the end of each term.

There are 40 marks given for internal assessment of both the theory papers at the end of each term.

Practicals (External Assessment) of 50 marks at the end of each term for each paper

PAPER	TYPE OF EXAM	MARKS	
		Paper I	Paper II
A. <u>THEORY</u>			
Paper I and Paper II (INTERNAL) for semester I and II	CLASS TEST (MCQ)	20	20
	PARTICIPATION IN THE CLASS	5	5
	ASSIGNMENT	15	15
	TERM END EXAM	60	60
	TOTAL	100	100
B. <u>PRACTICAL</u>			
Semester I	Term end exam	50	50
Semester II	Term end exam	50	50
	TOTAL	100	100

PRACTICAL EXAMINATION PATTERN

(Semester end practical examination):- 50 Marks Per Section

Section-I based on course-1, Section-II based on course-2

Sr.No.	Particulars	Marks	Total
1.	Laboratory work (Section-I, II)	40 + 40 = 80	
2.	Journal (Section-I, II)	05 + 05 = 10	
3.	Viva (Section-I, II)	05 + 05 = 10	
Grand Total		50 + 50 = 100	

PRACTICAL BOOK / JOURNAL
Semester I and II

For each semester end practical Examination, students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In-charge of the department, failing which the student will not be allowed to appear for the practical examination.

PATTERN OF THEORY EXAM FOR PAPER I and II

Total marks:- 60

Q1:- Unit I – 15

Q2:- Unit II – 15

Q3:- Unit III – 15

Q4:- Unit I, II and III – 15

All the above questions will have internal choice.



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Program: B.Sc.

Course: Microbiology

Syllabus for S.Y.B.Sc.

To be implemented from 2018-2019

PREAMBLE

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The students will be introduced to Industrial Microbiology, validation and calibration in order to prepare them for industry work. Hence the module of Industrial, Food and Dairy microbiology has been introduced in the syllabus.

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S.Y.B.Sc Microbiology Syllabus (General Outline)
For autonomy
Semester III

SEMESTER III			
Course Code	Title	Credits	Lectures / week
SIUSMIC-31 Theory	Biomolecules and Analytical Microbiology	2 Credits (45 lectures)	3
Unit-I	Estimation of Biomolecules and Biostatistics	15 lectures.	1
Unit-II	Nucleic acid chemistry and Genetic elements	15 lectures.	1
Unit-III	Analytical techniques 1	15 lectures.	1
SIUSMIC-32 Theory	Environmental Microbiology	2 Credits (45 lectures)	3
Unit-I	Air Microbiology	15 lectures.	1
Unit-II	Fresh Water and Sewage Microbiology	15 lectures.	1
Unit-III	Soil and Geo Microbiology	15 lectures.	1
SIUSMIC-33 Theory	Advances in Microbiology and Medical Microbiology	2 Credits (45 lectures)	3
Unit-I	Nanobiotechnology, Biofilms and biosensors with applications	15 lectures.	1
Unit-II	Epidemiology and Diagnostic Microbiology	15 lectures.	1
Unit-III	Introduction to Immunology	15 lectures.	1
SIUSMICP-3	PRACTICALS	3 Credits	9
SECTION-1	Biomolecules and Analytical Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-31)	1 Credit (45 lectures)	3
SECTION-2	Environmental Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-32)	1 Credit (45 lectures)	3
SECTION-3	Advances in microbiology and Medical Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-33)	1 Credit (45 lectures)	3

S.Y.B.Sc Microbiology Syllabus (General Outline)
For autonomy
Semester IV

	SEMESTER IV		
Course Code	Title	Credits	Lectures / week
SIUSMIC-41 Theory	Metabolism and Basic Analytical Techniques	2 Credits (45 Lectures)	3
Unit-I	Introduction To Metabolism and Bioenergetics	15 lectures.	1
Unit-II	Enzyme Kinetics	15 lectures.	1
Unit-III	Analytical techniques 2	15 lectures.	1
SIUSMIC-42 Theory	Industrial, Food and Dairy Microbiology	2 Credits (45 Lectures)	3
Unit-I	Industrial Microbiology	15 lectures.	1
Unit-II	Food Microbiology	15 lectures.	1
Unit-III	Dairy Microbiology	15 lectures.	1
SIUSMIC-43 Theory	Microbial diversity, taxonomy and Applications Of Microbiology	2 Credits (45 lectures)	3
Unit-I	Microbial Taxonomy	15 lectures.	1
Unit-II	Microbial diversity in extreme environments and Metagenomics	15 lectures.	1
Unit-III	Biofertiliser, Biopesticide , Bioremediation	15 lectures.	1
SIUSMICP-4	PRACTICALS	3 Credits	9
SECTION-1	Metabolism and Basic Analytical Techniques (Practicals Based On Unit-I,II and III Of SIUSMIC-41)	1 Credit (45 lectures)	3
SECTION-2	Industrial, Food and Dairy Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-42)	1 Credit (45 Lectures)	3
SECTION-3	Microbial diversity and taxonomy and Applications Of Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-43)	1 Credit (45 Lectures)	3

S.Y.B.Sc Semester III (Detailed Syllabus)			
Course Code	Title	Credits	Notional Periods
SIUSMIC-31 Theory	Biomolecules and Analytical Microbiology	2 Credits (45 lectures)	Self Study (45)
Unit-I	Unit I: Estimation Of Biomolecules and Biostatistics	15 Lectures	15
	1.1 Macromolecular composition of a microbial cell	1	
	1.2 Methods of elemental analysis: Carbon ,Nitrogen and Phosphorus	2	
	1.3 Estimation of Proteins and amino acids Proteins by Biuret method (Direct and indirect) Amino acids by Ninhydrin method	2	
	1.4 Estimation of Carbohydrates Total carbohydrates by Anthrone method Reducing Sugars (maltose) by DNSA method Reducing sugar Felhing's method	2	
	1.5 Extraction of Lipids by Soxhlet method	1	
	1.6 Estimation of Nucleic acids General principles and extraction of nucleic acids DNA by DPA method, RNA by Orcinol method	2	
	1.7 Basics of Biostatistics: Introduction to Biostatistics Sample and Population Data presentation: Dot diagram, Bar diagram, Histogram, Frequency curve. Central Tendency: Mean, Median, Mode Summation, notations.	5	
Unit II	Unit II: Nucleic acid chemistry and Genetic elements	15 Lectures	15
	2.1 Nucleic acid chemistry Denaturation of double helical DNA and RNA Nucleic acid from different species can form Hybrids, Nucleotides and nucleic acids undergo non enzymatic transformations, DNA methylation	6	
	2.3 Other Functions of nucleotides		
	2.4 Central dogma of life, Genetic code	4	
	2.5 Plasmids and types of Plasmids	2	
	2.6 Transposons (Structure and Types)	3	
Unit III	Unit III: Analytical Techniques 1	15 Lectures	
	1.1 Spectroscopic Techniques <ul style="list-style-type: none"> • Visible, UV and IR spectrophotometry • Principles, instrumentation and applications 	8	

	1.2 pH meter: principle, instrumentation and application	2	15
	1.3 Electrophoresis General principles, Factors affecting electrophoresis, apparatus, support media – agarose gels, polyacrylamide gels and applications	5	
SIUSMIC-32 Theory	Environmental Microbiology	2 Credits (45 lectures)	Self Study (45)
Unit-I	Unit I: Air Microbiology	15 Lectures	
	1.1 Aeromicrobiology: Important airborne pathogens and toxins, Aerosols, nature of bioaerosols, aeromicrobiological pathway, microbial survival in the air, extramural aeromicrobiology, intramural aeromicrobiology	7	15
	1.2 Sampling Devices for the Collection of Air Samples, Detection of microorganisms on fomites	5	
	1.3 Air Sanitation	2	
	1.4 Air Quality Standards	1	
Unit-II	Unit II : Fresh Water and Sewage Microbiology	15 lectures.	
	Unit II (A) Fresh Water Microbiology:		
	2.1 Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes, marshes and bogs	3	
	2.2 Potable water: Definition, water purification, water quality standards and pathogens transmitted through water	2	
	2.3 Microbiological analysis of water: Indicator organisms and their detection in water- Total Coliforms, Faecal Coliforms and <i>E. coli</i> , Faecal <i>Streptococci</i> , <i>Clostridium perfringens</i>	2	15
	Unit II (B) Sewage Microbiology:		
	2.4 Modern Waste Water treatment: Primary, Secondary and Tertiary Treatment	1	
	2.5 The nature of wastewater and Monitoring of waste water treatment process (BOD,COD)	2	
	2.6 Removal of Pathogens by Sewage treatment Processes	1	
	2.7 Oxidation Ponds and Septic tanks	1	
	2.8 Sludge Processing	1	
	2.9 Disposal of treated waste water and biosolids.	2	
Unit III	Unit III: Soil and Geo Microbiology:	15 lectures.	15
	3.1 Terrestrial Environment Soil- Definition, Composition, function , Textural triangle Types of soil microorganisms and their activities	2	
	3.2 Methods of studying soil microorganisms: Sampling, Cultural methods, Physiological	5	

	methods, Immunological methods, Nucleic acid based methods, Radioisotope techniques		
	3.3 Biogeochemical Cycles: Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus Cycle, Iron cycle	6	
	3.4 Soil Bioremediation	2	
SIUSMIC-33 Theory	Advances in microbiology and Medical Microbiology	2 Credits (45 lectures)	Self Study (45)
Unit I	Unit I: Nanobiotechnology, Biofilms and biosensors with applications	15 lectures	
	1.1 Nanobiotechnology: Introduction of Nanobiotechnology and application in drug and gene delivery, Types of nanomaterials, nanoparticles, nanocapsules, nanotubes, liposomes, nanogels, Dendrimers, Gold nanoparticles (Definition and applications)	8	15
	1.2 Biofilms and biosensors with applications: Biofilms: Introduction of biofilms, Types of biofilms, Mechanism of formation of biofilms and applications of biofilms. Biosensors: Introduction, design, working and applications of biosensors	7	
Unit II	Epidemiology and diagnostic Microbiology	15 lectures.	
	2.1 Epidemiological terminology: Epidemiology, sporadic diseases, endemic diseases, Hyperendemic Diseases, Epidemic Diseases, Index Case, Pandemic Disease, Outbreak	1	15
	2.2 The Spread of Infection: a) Reservoirs of infection-Human reservoir, Animal reservoir, non-living reservoir. b) Transmission of Disease- Contact transmission, Vehicle Transmission and vectors	2	
	2.3 Nosocomial infection: (1L) Microorganisms in hospitals, compromised host, Transmission and control of Nosocomial infection	1	
	2.4 Isolation of Pathogens from clinical specimens: a) Growth media and Culture b) Collection of specimens, handling and transport c) Types of specimens and their culture ---Blood, Urine, Faeces, sputum, Cerebrospinal fluid, pus, genital and culture of Anaerobes.	4	
	2.5 Identification of microorganisms from specimens: a) Microscopy b) Growth-Dependent Identification Methods	2	
	2.6 Rapid Methods of Identification: Molecular Methods and Analysis of	5	

	Metabolic Products: a) Nucleic Acid –Based Detection Methods b) Gas liquid Chromatography c) Plasmid Fingerprinting		
Unit III	Introduction to Immunology	15 lectures.	
	3.1 Basic concepts in immunology Haematopoiesis, Blood cell types, Components of immune system – Cells and organs of the immune system	6	15
	3.2 Types of Immunity: Innate and Acquired	3	
	3.2 Humoral and Cell mediated immune response	4	
	3.3 Phagocytosis and Acute and chronic inflammation	2	
SIUSMICP-3	PRACTICALS	2 Credits	Notional Periods
Section-1	Biomolecules and Analytical Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-31)		
	1. Estimation of total sugar by Anthrone method 2. Estimation of reducing sugar by DNSA method 3. Estimation of reducing method by Fehling's method 4. Estimation of protein Biuret method (indirect and direct) 5. Extraction of lipid by Soxhlet method (Demonstration) 6. Isolation and detection of DNA from onion /E.coli 7. Estimation of DNA by DPA method 8. Estimation of RNA by Orcinol Method 9. Data presentation and interpretation 10 Use of pH meter 11 U.V. spectrophotometer (Demo) 12 Electrophoresis(Demo)	1 Credit (45 lectures)	Self Study (45)
Section-2	Environmental Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-32)		
	1. Enumeration of microorganisms in air and study of its load after fumigation 2. Study of air microflora and determination of sedimentation rate 3. Routine analysis of water: a. Standard Plate Count b. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test c. Rapid Detection of <i>E.coli</i> by MUG Technique (Demonstration) 4. Waste water analysis: a. Study of microbial flora in raw and treated sewage	1 credit (45 lectures)	Self Study (45)

	b. Determination of total solids in wastewater c. Determination of BOD and COD of wastewater 5. Total viable count of soil microflora 6. Isolation of bacteria, Actinomycetes and fungi from soil 7. Enrichment and isolation of Nitrosifiers, Nitrifiers, Cellulose degraders, Sulphate reducers and Phosphate solubilisers from soil 8. Winogradskys column 9. Visit to a sewage treatment plant or water purification plant		
Section-3	Advances in microbiology and Medical Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-33)		
	1. Study of biofilm: slide immersion tech and staining. 2. Preparation of nano particles and study their antibacterial activity. 3. Blood staining by the Field's method 4. Use of Selective and Differential Solid Media: Mac Conkeys agar, SS agar, XLD agar, TCBS agar, SIBA, Salt Mannitol agar, CLED agar, Cetrimide agar. 5. Use of Biochemical Media/Tests for Identification of Pathogens: Carbohydrate fermentation, Indole test, Methy Red test, Vogues Proskauer test, Citrate Utilization, Lysine Decarboxylase, Gelatin Liquefaction, Nitrate Reduction, Phenylalanine deaminase test, Urease test, TSI agar, Oxidase test, Catalase test, Bile solubility test, Coagulase test, Optochin test and Bacitracintest. 6. Preparation of serum and plasma 7. Single Radial Immuno Diffusion assay 8. Blood grouping (Direct) 9. Phagocytosis (Demo)	1 Credit (45 lectures)	Self Study (45)

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7. Methods in biostatistics for medical and research workers. 6th edition. B. K. Mahajan. Jaypee brothers, Medical Publishers (P)ltd
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4. Fundamentals of Microbiology, 9th Edition , Frobisher, Hinsdill, Crabtree, Goodheart, 1974, Saunders College Publishing
5. Introduction to Environmental Microbiology – Barbara Kolwzan, Waldemar Adamiak.
6. Prescott's Microbiology, 8th Edition; Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, 2011, Mc Graw Hill International Edition
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1. Bionanotechnology - Andrew and Waqar, One Central Press Ltd, UK., November, 2014.
2. Brock biology of microorganism by Michael T Madigan. and John M Martinco. Pearson education.
3. Diagnostic Microbiology, Bailey and Scott, 11th edition Publ: Mosby
4. Immunology Essential and Fundamental, Third Edition, Pathak and Palan.
5. Immunology; Kuby 6th edition.
6. Microbiology By Prescott, Harley, Klein's 7th Edn
7. Microbiology, An Introduction by Tortora, Funke and Case 9th and 11th edition, Pearson education.
8. Practical medical microbiology by Mackie and McCartney 14th edition. Publ: Churchill Livingstone
9. Textbook of Microbiology by Anantnarayan and Paniker's, 8th Ed.
10. The Elements of Immunology by Fahim Khan. Pearson Education.

S.Y.B.Sc Semester IV (Detailed Syllabus)			
Course Code	Title	Credits	Notional Periods
SIUSMIC-41 Theory	Metabolism and Basic Analytical Techniques	2 Credits (45 lectures)	Self Study (45)
Unit-I	Introduction To Metabolism and Bioenergetics	15 Lectures	
	1.1 Bioenergetics and thermodynamics: Energy transformations, thermodynamic quantities, standard –free energy, difference between ΔG and $\Delta G_o'$	6	15
	1.2 Structure of ATP, phosphoryl group transfer and ATP, Types of energy –rich compounds, multi-roles of ATP, inorganic phosphoryl group donor	5	
	1.3 Biochemical and chemical reactions, Biological oxidation-reduction reaction	4	
Unit-II	Enzyme Kinetics	15 Lectures	
	2.1 Introduction of Enzymes: General properties of enzymes Concept of activation energy Rate law for a simple catalysed reaction, Michaelis-Menten equation and it's derivation Lineweaver Burk plot Classification of enzymes	6	15
	2.2.Overview of Coenzyme: Coenzymes: Different types and reactions catalyzed by coenzymes NAD ⁺ : structure, occurrence and biochemical function	2	
	2.3 Enzyme Kinetics: Saturation kinetics Effect of temperature and pH Effect of Inhibitors- Reversible and irreversible, competitive, Non competitive and uncompetitive inhibitors, Multisubstrate reactions- Ordered, Random and pingpong reactions. Allosteric effects in enzyme catalysed reactions- Koshland-Nemethy and Filmer model and Monod, Wyman and Changeux model	7	

Unit-III	Analytical techniques 2	15 Lectures	
	3.1 Paper and thin layer Chromatography Introduction to chromatography, types of chromatography Paper chromatography: Principle, circular, ascending and descending Paper Chromatography, Thin layer chromatography : principle, preparation of TLC plates, procedure for TLC, preparative TLC, 2D TLC, HPTLC	4	
	3.2 Column chromatography : Introduction and principle Size Exclusion chromatography , Ion Exchange chromatography, Affinity chromatography, High Performance Liquid chromatography Gas chromatography	8	
	3.3 Centrifugation Introduction : basic principles of sedimentation, Types, Preparative centrifugation and its applications, Analytical centrifugation and its application	3	15
SIUSMIC-42 Theory	Industrial, Food and Dairy Microbiology	2 Credits (45 lectures)	Self Study (45)
Unit-I	Industrial Microbiology	15 lectures	
	1.1 Strains of industrially important microorganisms: a. Desirable characteristics of industrial strain b. Principles and methods of primary and secondary Screening.	3	
	1.2 Types of fermentations: a. Surface and Submerged, b. Batch, continuous fermentation c. Solid state fermentation 1.3 Design of an ideal fermenter: conventional stirred tank reactor	5	15
	1.3 Concept of upstream and Downstream processing Industrial inoculum build up	3	
	1.4 Media for industrial fermentations: a. Production and Inoculum media, b. Media components :- Carbon source, nitrogen source, amino acids and vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers	4	
Unit-II	Food Microbiology	15 lectures	
	2.1 Introduction: Significance, food as a substrate and sources 2.2 Intrinsic and extrinsic factors	3	15

	2.3 General Principles of spoilage: Spoilage of fresh foods: fruits and vegetables, eggs, meat, poultry and seafood	2	
	2.4 General principles of food preservation (principle of each method and example of foods only): High temperature (Including TDT, TDP, D, F and Z value), Low temperature (Freezing), Asepsis, Drying, Radiations, Chemical preservatives.	5	
	2.5 Food control agencies:- HACCP, FDA, FSSAI	2	
	2.6 Methods of detection of microorganisms in food: overview of cultural, microscopic, physical, chemical and bioassay methods	3	
Unit-III	Dairy Microbiology	15 lectures	
	3.1 Milk- Definition , composition,	1	
	3.2 Spoilage of milk: Sources of contamination of milk Color defects Flavour defects Ropiness of milk Stormy fermentation of milk	3	
	3.3 Pasteurization of milk-LTLT, HTST, UHT Method Efficiency testing of Pasteurization (Phosphatase Test)	3	
	3.4. Milk products:- production of a Yoghurt	1	
	b Butter	1	
	c Cheese-Cheddar and Cottage cheese	2	
	d Dried milk	1	
	3.5. Quality control of milk:- a. Rapid platform test:- MBRT, Resazurin b. Microbiological analysis of milk:- SPC, Coliform count, Psychrophiles, Thermophilic count.	3	
			15
SIUSMIC-43 Theory	Microbial diversity, taxonomy and Applications Of Microbiology	2 Credits (45 lectures)	Self Study (45)
Unit-I	Microbial Taxonomy		
	3.1 Introduction to microbial taxonomy Systems of classification (Cavalier Smith 6 kingdom) Bergey's manual The three domain concept based on phylogeny Nomenclature Taxonomic ranks Numerical Taxonomy	4	
	3.2 Methods of analysis used in classification : Phenotypic analysis (Morphological characteristics, Physiological and metabolic characteristics, Biochemical characteristics, Ecological characteristics, Fatty acid analysis)	2	
			15

	3.3 Genetic analysis 3.4 Amino acid sequencing	5	
	3.5 Phylogenetic analysis Nucleic acid sequencing Analysis of individual genes Multilocus gene sequence analysis Whole genome sequence analysis 3.6 Phylogenetic tree: Types	4	
Unit-II	Biodiversity in extreme environments and Metagenomics	15 lectures	
	Biodiversity In Extreme Environments 2.1 Extreme Environments and their types with respect to the physical conditions which lead to microbial stress a) Temperature based environments- Low and high temperature environments b) pH based environments- Acidic and alkaline environments, Acid mine drainage c) Environments with high salt concentration	7	15
	2.2 Applications of extremophiles: a) Applications of Acidophiles and Alkalophiles b) Applications of halophiles- in biotechnology and medicine c) Applications of psychrophiles in pharmaceuticals and environment. d) Applications of thermophiles and hyperthermophiles in enzymology	7	
	2.3 Metagenomics	1	
Unit-III	Biofertiliser, Biopesticide , Bioremediation	15 lectures	
	3.1 Biofertiliser: Introduction of Biofertilizers Different types of biofertilizers Mass production of Biofertilizers Application of Biofertilizers Azolla as cattle feed List of Biofertilizer production units Constraints in Biofertilizer Technology, Biofertilizer strains developed	8	15
	3.2 Biopesticides Introduction of biopesticides Types of Biopesticides Basic requirements for establishment of Biopesticide units, Technical Aspects of Biopesticides Major biopesticides produced and used in India Biopesticide formulations	3	
	3.3 Bioremediation: Introduction of Bioremediation Principle of Bioremediation Factors affecting Bioremediation	4	

	Microbial Populations used for Bioremediation processes, Bioremediation strategies, Advantages and Disadvantages of Bioremediation		
SIUSMICP-4	PRACTICALS	2 Credits	
Section-1	Metabolism and Basic Analytical Techniques (Practicals Based On Unit-I,II and III Of SIUSMIC-41)	1 Credit (45 lectures)	
	<ol style="list-style-type: none"> 1. Problems on bioenergetics to calculate the K_{eq}; Gibbs energy, enthalpy, etc 2. Isolation of amylase, protease, lipase producers 3. Extracellular production of invertase from yeast 4. Effect of pH, Temp, substrate and enzyme concentration on activity of invertase. 5. Determination of K_m and V_{max} of an enzyme 6. Separation and identification of amino acids and sugars by ascending paper chromatography 7. Density gradient centrifugation 	1 Credit (45 lectures)	Self Study (45)
Section-2	Industrial, Food and Dairy microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-42)		
	<ol style="list-style-type: none"> 1. Crowded plate technique 2. Antibiotic producer screening by Wilkins overlay method 3. Antibiotic spectrum determination (streak/strip) 4. Isolation of food spoilage agent: <ol style="list-style-type: none"> a) Fruit/Vegetable- Physical and Microscopic and Pectinolytic agent b) Meat - Proteolytic, lipolytic, sacchrolytic 5. Determination of TDT and TDP 6. Determination of Salt and sugar tolerance 7. Determination of MIC of a Chemical preservative 8. Visit to Food/Dairy industry 9. RPT of Milk- RRT, MBRT, DMC 10. Microbiological Quality Control of Milk as per BIS/FSSSAI 11. Analysis of Cheese, Paneer, Butter, Yogurt/curd as per BIS/FSSAI (Group experiment) 12. Solid state fermentations (group experiment) 	1 Credit (45 lectures)	Self Study (45)
Section- 3	Microbial diversity, taxonomy and Applications of Microbiology (Practicals Based On Unit-I,II and III Of SIUSMIC-43)		
	<ol style="list-style-type: none"> 1. Estimation of heavy metals (Titration method) 2. Preparation of biofertilizer 3. Efficacy of biofertilizer 4. Study of thermophiles, acidophiles and psychrophiles 5. Identification of bacteria 	1 Credit (45 lectures)	Self Study (45)

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2. Instrumental Methods of chemical analysis, V.K. Ahluwalia, Ane Books Pvt.Ltd;2015.
3. Laboratory manual in Biochemistry- J.Jayaraman.
4. Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. 4th edition W.H. Freeman and Company[Low price edition- for sale in India, Pakistan, Sri Lanka, Bangladesh, Nepal and Bhutan]
5. Outlines of Biochemistry. E.E. Conn and P. K. Stumpf , G. Bruening, R.N.Do. 5th Edition, John Wiley and sons.
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8. Principles of Biochemistry- G. Zubay, W.W. Parson, D.E.Vance. Wm. C. Brown Publishers
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2. Food Microbiology, Frazier and Westhoff , Tata McGraw Hill, 4th Edition
3. Industrial Microbiology by Casida L. E., 2009 Reprint, New Age International (P) Ltd, Publishers, New Delhi
4. Industrial Microbiology. A. H. Patel. MacMillan. New Delhi. 1984.
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7. Current Research, Technology and Education Topics in Applied Microbiology and Microbial Biotechnology. A Mendez Vilas Edition
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11. Molecular Biotechnology : Principles And Applications Of Recombinant DNA; Glick, Bernard; Pasternak, Jack 2003.
12. Text book of Biotechnology by R C Dubey. 4th edition
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Guidelines for Examination Pattern:-

There are three theory papers of 60 marks each (External assessment) at the end of each term. There are 40 marks given for internal assessment for each theory papers at the end of each term. Practicals (External Assessment) of 50 marks at the end of each term for each paper

PAPER	TYPE OF EXAM	MARKS		
		Paper I	Paper II	Paper III
<u>THEORY</u>				
Paper I, II and Paper III (INTERNAL) for semester III and IV	CLASS TEST (MCQ)	20	20	20
	PARTICIPATION IN THE CLASS	5	5	5
	ASSIGNMENT	15	15	15
Theory	TERM END EXAM	60	60	60
	TOTAL	100	100	100

PRACTICAL EXAMINATION PATTERN

Semester end practical examination):- 50 Marks Per Section

Section-I based on course-1, Section-II based on course-2 and Section-III based on course-3

Sr.No.	Particulars	Marks	Total
1.	Laboratory work (Section-I, II, III)	40 + 40 + 40 =120	
2.	Journal (Section-I, II,III)	05 + 05 + 05 =015	
3.	Viva (Section-I, II,III)	05 + 05 + 05 =015	
	Grand Total	50 + 50 + 50 =150	

PRACTICAL BOOK / JOURNAL

Semester III and IV

For each semester end practical Examination, students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

PATTERN OF THEORY EXAM FOR PAPER I and II

Total marks:- 60

Q1:- Unit I – 15

Q2:- Unit II – 15

Q3:- Unit III – 15

Q4:- Unit I, II and III – 15

All the above questions will have internal choice.



SIES

College of Arts,
Science &
Commerce

RISE WITH EDUCATION
Sion(W), Mumbai – 400022

Program: B.Sc.
Course: Microbiology
Syllabus for T.Y.B.Sc.
To be implemented from 2018-2019

(Credit Based Semester and Grading System with
effect from the academic year 2018–2019)

PREAMBLE

The existing university syllabus of T.Y.B.Sc. Microbiology was due for revision as per the CBSGS pattern which is done as follows and will be implemented from the academic year 2018- 2019 under autonomy.

Keeping in tune, with the revised autonomous syllabi of F.Y.B.Sc. and S.Y.B.Sc., the committee has taken utmost care to maintain the continuity in the flow of information of higher level at T.Y.B.Sc. Hence some of the modules of the existing university T.Y.B.Sc. syllabus have been upgraded with the new modules in order to make the learners aware about the recent developments in various branches of Microbiology (like Microbial Genetics, Molecular Biology, Virology, Medical Microbiology, Immunology, Microbial Biochemistry, Industrial Microbiology, Microbial Biotechnology) with an objective to raise the students awareness in interdisciplinary courses such as Biostatistics, Bioinformatics , Bioinstrumentation, Nanoscience

All the 8 courses of theory and practicals (Semester-V and Semester-VI together) are compulsory to the students offering microbiology as a single major subject (6 units pattern of the old course). These courses are:-

1. SIUSMIC51 and SIUSMIC61
2. SIUSMIC52 and SIUSMIC62
3. SIUSMIC53 and SIUSMIC63
4. SIUSMIC54 and SIUSMIC64

However, students opting for double major subject (3 units pattern of old course) shall have following 04 courses of theory and practicals (Semester-V and Semester-VI together) compulsory:-

1. SIUSMIC51 and SIUSMIC61
2. SIUSMIC52 and SIUSMIC62

**T. Y. B. Sc. MICROBIOLOGY THEORY
SEMESTER-V**

COURSE CODE	TITLE	CREDITS and Lectures/SEM
SIUSMIC51	MICROBIAL GENETICS	2.5 credits (60 L)
Unit I	DNA REPLICATION	15 L
Unit II	MUTATION AND REPAIR	15 L
Unit III	GENETIC EXCHANGE	15 L
Unit IV	TRANSCRIPTION, GENETIC CODE AND TRANSLATION	15 L
SIUSMIC52	MEDICAL MICROBIOLOGY AND IMMUNOLOGY PART I	2.5 credits (60 L)
Unit I	MEDICAL MICROBIOLOGY I	15 L
Unit II	MEDICAL MICROBIOLOGY II	15 L
Unit III	GENERAL IMMUNOLOGY-I	15 L
Unit IV	GENERAL IMMUNOLOGY-II	15 L
SIUSMIC53	MICROBIAL BIOCHEMISTRY : PART- I	2.5 credits (60 L)
Unit I	BIOLOGICAL MEMBRANES and TRANSPORT	15 L
Unit II	BIOENERGETICS and BIOLUMINESCENCE	15 L
Unit III	METHODS OF STUDYING METABOLISM AND CATABOLISM OF CARBOHYDRATES	15 L

Unit IV	FERMENTATIVE PATHWAY and ANABOLISM OF CARBOHYDRATES	15 L
SIUSMIC54	BIOPROCESS TECHNOLOGY	2.5 credits (60 L)
Unit I	STRAIN IMPROVEMENT AND STERILIZATION TECHNIQUES	15 L
Unit II	FERMENTER EQUIPMENT AND CONTROL	15 L
Unit III	DOWNSTREAM PROCESSING AND ENVIRONMENTAL ASPECTS	15 L
Unit IV	TRADITIONAL INDUSTRIAL FERMENTATIONS PART-I	15 L

N.B.- (I) Each theory period shall be of 48 minutes duration. Theory component shall have 240 instructional periods plus 240 notional periods per semester which is equal to 384 learning hours. For theory component the value of One Credit is equal to 38.40 learning hours.

(II) Each practical period shall be of 48 minutes duration. Practical component shall have 240 instructional periods plus 60 notional periods per semester which is equal to 240 learning hours. For practical component the value of One Credit is equal to 40 learning hours.

T. Y. B. Sc. Microbiology Theory: SIUSMIC-51(Microbial Genetics).

Learning Objectives:

Microbial Genetics is an undergraduate T.Y. B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing and understanding biological genetic information. It develops knowledge of the underlying theories of genetics which exhibits a broad understanding of genetic exchange among prokaryotes. It also gives students hands-on competence in fundamental molecular biology theories and laboratory techniques. It gives an overview of recombinant DNA technology and biotechnology applications utilising genetic manipulation. It also provides practical experience of the major analytical techniques used in bioinformatics. It also deals with basic structure and life cycle of different types of viruses and explains different terminologies like cancer, prions, viroids and their mechanism. This course will help students to build on the basic information regarding DNA structure transcription, translation and genetic code that they have gained in S. Y.B.Sc.

Learning Outcomes:

Students should be able to-

- a) Understand the molecular mechanism involved in DNA replication
- b) Understand how to identify and classify mutations in DNA followed by mechanism of DNA repair
- c) Understand basic concepts of homologous recombination and genetic exchange among prokaryotes
- d) Understand natural plasmids and transposons present in prokaryotes
- e) Understand an account of prokaryotic gene structure and the mechanisms controlling gene expression

SIUSMIC-51: MICROBIAL GENETICS

Course Code	Title	Lectures/ Semester	Notional Periods
SIUSMIC51	MICROBIAL GENETICS	2.5 Credits 60Lectures	Self Study (60)
	<u>UNIT I DNA REPLICATION</u>		
	1.1. Historical perspective — conservative, dispersive, semi-conservative, Bidirectional and semi- discontinuous	15L	15
	1.2. Prokaryotic DNA replication – Details of molecular mechanism involved in Initiation, Elongation nd Termination	4L	
	1.3. Enzymes and proteins associated with DNA replication - primase, helicase, topoisomerase, SSB, DNA polymerases, ligases, Ter and Tus proteins	4L	
	1.4. Eukaryotic DNA replication -- Molecular details of DNA synthesis, replicating the ends of the chromosomes	2L	
	1.5. Rolling circle mode of replication	1L	
	<u>UNIT II MUTATION AND REPAIR</u>		
	2.1. Mutation	15 L	15
	2.1.a. Terminology: alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes	2L	
	2.1. b. Fluctuation test.	1L	
	2.1. c. Types of mutations: Point mutation, reverse mutation, suppressor mutation, frameshift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutations.	2L	

	<p>2.1.d. Causes of mutation: Natural/spontaneous mutation--replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for –</p> <ul style="list-style-type: none"> i. Chemical mutagens- base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. ii. Physical mutagen iii. Biological mutagen(only examples) <p>2.1. e. Ames test</p> <p>2.2 DNA Repair</p> <ul style="list-style-type: none"> a. Mismatch repair b. Light repair c. Repair of alkylation damage d. Base excision repair e. Nucleotide excision repair f. SOS repair 	<p>5 L</p> <p>1L</p> <p>4L</p>	
	<p><u>UNIT III GENETIC EXCHANGE</u></p> <p>3.2.a. Transformation</p> <ul style="list-style-type: none"> i. Introduction and History ii. Types of transformation in prokaryotes- Natural transformation in <i>Streptococcus pneumoniae</i>, <i>Haemophilus influenzae</i>, and <i>Bacillus subtilis</i> iii. Mapping of bacterial genes using transformation. iv. Problems based on transformation <p>3.2.b. Conjugation</p> <ul style="list-style-type: none"> i. Discovery of conjugation in bacteria ii. Properties of F plasmid/Sexfactor iii. The conjugation machinery iv. Hfr strains, their formation and mechanism of conjugation v. F' factor, origin and behavior of F' strains, Sexduction. vi. Mapping of bacterial genes using conjugation (Wolman and Jacob experiment). vii. Problems based on conjugation 	<p>15L</p> <p>4L</p> <p>5L</p>	<p>15L</p>

	3.2.c. Transduction i. Introduction and discovery ii. Generalised transduction iii. Use of Generalised transduction for mapping genes iv. Specialised transduction	3L	
	Unit IV: <u>TRANSCRIPTION, GENETIC CODE</u> <u>AND TRANSLATION</u>	15L	
	4.1 Transcription in Eukaryotes - Eukaryotic RNA polymerase, Transcription of protein- coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self Splicing of Introns, RNA editing	6L	
	4.2 Genetic code - Nature of genetic code and characteristics of genetic code, wobble hypothesis and problems based on genetic code.	3L	
	4.3 Translation process - Transfer RNA, structure of tRNA, tRNA genes, Recognition of the tRNA anticodon by the mRNA codon, Adding of amino acid to tRNA , Ribosomal RNA and Ribosomes, Ribosomal RNA Genes, Initiation of translation, Initiation in Bacteria, Initiation in eukaryotes, Elongation of the polypeptide chain, termination of translation, protein sorting in the cell.	6L	

SIUSMIC-52 (Medical Microbiology and Immunology: Part-I)

Learning objectives:

One of the most important areas of microbiology, medical microbiology encompasses the aetiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases that are enlisted in the syllabus. This course will help students to build on the basic information regarding host defence mechanisms that they have gained in S.Y.B.Sc. Immunology is an integral part of Medical Microbiology and this course is designed for T.Y.B.Sc. Microbiology students and it is assumed that the students have achieved a basic understanding of Innate Immunity and Host Defence mechanisms. The course has been designed to help understand the ability of our immune system to defend against invading pathogens in a logical fashion. This includes our innate ability to defend against microorganisms (innate immunity); should this first line of defence fail, how we can fight infections (acquired immunity); if we react excessively, what price we pay (hypersensitivity); and very importantly, how we can prevent pathogens from infecting us (vaccination).

Learning Outcomes: (Medical Microbiology)

Students should be able to-

- Give details of the virulence factors and other features of the pathogen
- Correlate these virulence factors with the pathogenesis and clinical features of the disease
- Comment on the mode of transmission, epidemiology and therefore modes of prophylaxis of these diseases
- Given a few key clinical features, identify the likely causative agent.
- Comment on the methods of diagnosis of the disease.

Learning Outcomes: (Immunology)

Students should be able to-

- Conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens
- Discuss the role of antigen in initiating the immune response
- Correlate the structure and functions of immunoglobulin

SIUSMIC-52: MEDICAL MICROBIOLOGY AND IMMUNOLOGY I

Course Code	Title	Lectures/ Semester	Notional Periods
SIUSMIC52	MEDICAL MICROBIOLOGY AND IMMUNOLOGY I	2.5Credits (60Lectures)	Self Study (60)
	<p style="text-align: center;">Unit I: MEDICAL MICROBIOLOGY- I</p> <p>Study of A Few Infectious Diseases (w.r.t. Cultural Characteristics of the etiological agent, pathogenesis and clinical features laboratory diagnosis, treatment and prevention only.</p> <p style="text-align: center;">1. Respiratory tract infections</p> <ul style="list-style-type: none"> i. <i>S. pyogenes</i> infections ii. Influenza iii. Tuberculosis iv. Pneumonia caused by <i>K.pneumoniae</i> and <i>S.pneumoniae</i> <p style="text-align: center;">2. Study of urinary tract infections</p> <p style="text-align: center;">3. CNS infections</p> <ul style="list-style-type: none"> i. Tetanus ii. Polio iii. Bacterial meningitis 	15L	15
	<p style="text-align: center;">UNIT II : MEDICAL MICROBIOLOGY- II</p> <p>Study of few diseases (w.r.t. Cultural characteristics of the etiological agent, pathogenesis and clinical features, laboratory diagnosis, treatment and prevention only)</p> <p>2.1 Study of skin infections</p> <ul style="list-style-type: none"> i. Pyogenic skin infections caused by <i>Pseudomonas</i> and <i>S.aureus</i> ii. Leprosy 	15	15
		7L	

- iii. Fungal infections-Candidiasis,
Ringworm Viral Infections-
Herpes simplex

2.2 Study of gastrointestinal tract infections

- i. Infections due to
Enteropathogenic *E.coli* strains
- ii. Enteric fever-*Salmonella*
- iii. Shigellosis
- iv. Rotavirus
- v. Dysentery due to *Entamoeba histolytica*, *Helicobacter*,
Campylobacter

8L

	<p style="text-align: center;">UNIT III : GENERAL IMMUNOLOGY-I</p> <p>3.1 Antigens Immunogenicity versus antigenicity: Concepts-Immunogenicity, Immunogen, Antigenicity, Antigen, Haptens- Haptens as valuable research and diagnostic tools. Factors that influence immunogenicity - Foreignness, Molecular size, Chemical composition, Heterogeneity, Susceptibility of antigen to be processed and presented, Contribution of the biological system to immunogenicity Genotype of the recipient, Immunogenic dosage, Route of administration. Adjuvants Epitopes / antigen determinants - General concept, Characteristic properties of B - cell epitopes, concepts of sequential and non-sequential epitopes (with only one example each). Properties of B - cell and T - cell epitopes. Comparison of antigen recognition by T cells and B cells Types of antigens – heterophile antigens, isophile antigens, sequestered antigens, super antigens, bacterial and viral antigens</p> <p>3.2 Immunoglobulins Basic structure, types of heavy and light chains, constant variable regions, Immunoglobulin domains-hinge region. Basic concepts - hypervariable region, complementarity determining regions (CDRs), framework regions (FRs) and their importance.</p> <p>Immunoglobulin classes and biological activities - Immunoglobulin G, Immunoglobulin M, Immunoglobulin A, Immunoglobulin E, Immunoglobulin D, (including diagrams)</p> <p>Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes.</p> <p>Immunoglobulin Superfamily</p> <p>3.3 Monoclonal antibodies Production and application</p>	<p style="text-align: center;">15L</p> <p style="text-align: center;">6L</p> <p style="text-align: center;">6L</p> <p style="text-align: center;">3L</p>	<p style="text-align: center;">15</p>
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	UNIT IV : GENERAL IMMUNOLOGY- II	15L	15
	<p>4.1 Antigen Antibody reactions Precipitation reaction -Immuno electrophoresis Agglutination reactions - haemeagglutination, bacterial agglutination, passive agglutination, agglutination inhibition. Radioimmunoassay (RIA), Enzyme Linked Immunosorbent Assay indirect, competitive and sandwich ELISA Immunofluorescence- Direct and indirect. Western blotting.</p>	8L	
	<p>4.2 Major histocompatibility complex Introduction Three major classes of MHC encoded molecules The basic structure and functions of Class I and Class II MHC Molecules Peptide binding by Class I and Class II MHC molecule</p>	3L	
	<p>4.3 Antigen presenting cells Types of APC's Endogenous antigens: The cytosolic pathway Exogenous antigens: The endocytic pathway</p>	4L	

SIUSMIC-53 (Microbial Biochemistry Part-I)

Learning objectives:

This course is designed for T.Y.B.Sc. Microbiology students to achieve a basic understanding of solute transport and metabolism. The course has been designed to expose students to methods of studying energy generation, fermentative metabolism as well as anabolism. There has been a lot of importance attached to biochemical reactions in living cells. The student must be exposed to the mechanism of solute transport and methods to study the same. The students are already exposed to laws of thermodynamics in the lower level; however, they should be made aware of the electron transport chain in Prokaryotes and Mitochondria. ATP synthesis and anabolic mechanisms need to be explained to the students to understand the breakdown of mono, di and oligosaccharides. The students will also be exposed to the fermentative pathways and anabolic reactions.

Learning Outcomes:

Students should be able to-

- Understand the architecture of the membrane and how solute is transported inside the cell.
- Describe and explain the electron transport chains in prokaryotes and mitochondria and understand the mechanism of ATP synthesis.
- Explain bioluminescence mechanism and its significance
- Discuss the experimental aspect of studying catabolism and anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.
- Describe various other pathways which produce different end products.
- Describe anabolic reactions in carbohydrate synthesis.
- Apply the concepts of energetics and catabolism in biodegradation of various substrates.

SIUSMIC-53: DETAIL SYLLABUS

Course Code	Title	L/ Semester	Notional Periods
SIUSMIC 53	MICROBIAL BIOCHEMISTRY:(Part- I)	2.5 Credits (60L)	Self Study (60)
	UNIT I BIOLOGICAL MEMBRANES and TRANSPORT	15	15
	1.1 Composition and architecture of membrane	02	
	1.1.1 Lipids		
	1.1.2 Integral and peripheral proteins and interactions with lipids		
	1.1.3. Permeability and outer membrane- a barrier		
	1.1.4. Aquaporins		
	1.1.5. Mechanosensitive channels		
	1.2 Methods of studying solute transport	02	
	1.2.1 Using whole cells		
	1.2.2. Using Liposomes		
	1.2.3. Using Proteoliposome		
	1.3 Solute transport across membrane	08	
	1.3.1. Passive transport facilitated by membrane proteins.		
	1.3.2. Transporters grouped into Superfamilies		
	1.3.3. Co transport across plasma membrane (Uniport, Antiport, Symport)		
	1.3.4. Active transport and electrochemical gradient		
	1.3.5. Ion gradient provides energy for secondary Active transport e.g. Lactose transport		
	1.3.6. ATPases and transport		
	1.3.7. ABC transporters e.g. Histidine transport		
	1.3.8. Shock sensitive system – Role of binding proteins e.g. Maltose uptake		
	1.3.9. Phosphotransferase system		
	1.3.10. Schematic representation of various		

	<p>Membrane transport mechanisms in <i>E. coli</i></p> <p>1.4 Other examples of solute transport- Iron transport : A special problem Bacterial protein export 1.4.3. Bacterial membrane fusion central to many biological processes</p>	03	
	<p>UNIT II BIOENERGETICS AND BIOLUMINESCENCE.</p> <p>2.1. Biochemical mechanism of generating ATP- Substrate level, Oxidative, and Photo Phosphorylation</p> <p>2.2 Electron transport chain</p> <p>2.2.1 Universal electron acceptors that transfer electrons to ETC 2.2.2. Carriers in ETC i. Hydrogen carriers – Flavoproteins, Quinones ii. Electron carriers – Iron sulphur proteins, Cytochromes 2.2.3. Mitochondrial ETC i. Biochemical anatomy of mitochondria ii. Complexes in Mitochondrial ETC iii. Schematic representation of Mitochondrial ETC</p> <p>2.3 Prokaryotic ETC</p> <p>2.3.1. Organization of electron carriers in bacteria 2.3.2. Generalised electron transport pathway in bacteria 2.3.3. Different terminal oxidases 2.3.4. Branched bacterial ETC 2.3.5. Pattern of electron flow in <i>E. coli</i> - aerobic and anaerobic 2.3.6. Pattern of electron flow in <i>Azotobacter vinelandii</i></p> <p>2.4. ATP synthesis</p> <p>2.4.1 Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential 2.4.2. Free energy released during electron transfer from NADH to O₂. 2.4.3. Chemiosmotic theory 2.4.4. Structure and function of Mitochondrial ATP</p>	15	15
		03	
		03	
		03	
		03	
		03	

synthase (No Kinetics)			
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2.4.5. Mechanism by Rotational catalysis			
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2.4.6. Structure of bacterial ATP synthase			
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2.4.7. Inhibitors of ETC, Inhibitors of ATPase, Uncouplers, Ionophores			
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	<p>2.5 Other modes of generation of electrochemical energy 2.5.1 ATP hydrolysis 2.5.2 Oxalate formate exchange 2.5.3 End product efflux, Definition- Lactate efflux 2.5.4 Bacteriorhodopsin - Definition, Significance, 2.5.5 Function as proton pump,</p> <p>2.6 Bioluminescence 2.6.1 Brief survey of bioluminescent systems 2.6.2 Biochemistry of light emission 2.6.3 Schematic diagram 2.6.4 Significance / Application</p>	<p>02</p> <p>1L</p>	
	<p style="text-align: center;">UNIT III: METHODS OF STUDYING METABOLISM AND CATABOLISM OF CARBOHYDRATES</p> <p>3.1. Experimental Analysis of metabolism 3.1.1. Goals of the study 3.1.2. Levels of organization at which metabolism is studied. 3.1.3. Metabolic probes 3.1.4. Use of radioisotopes in biochemistry i. Pulse labeling ii. Assay and study of radiorespirometry –to differentiate EMP and ED 3.1.5. Use of biochemical mutants. 3.1.6. Sequential induction technique</p> <p>3.2 Catabolism of Carbohydrates 3.2.1 Breakdown of polysaccharides – glycogen, Starch, cellulose. 3.2.2. Breakdown of oligosaccharides– lactose, maltose, sucrose, cellobiose 3.2.3. Utilization of monosaccharides – fructose, Galactose. 3.2.4. Major pathways- i. Glycolysis (EMP) ii.HMP Pathway and Significance of the pathway iii. ED pathway, iv. TCA cycle and Significance of the cycle v. Anaplerotic reactions vi. Glyoxylate bypass, vii. Incomplete TCA in anaerobic bacteria</p>	<p>15</p> <p>03</p> <p>10</p>	<p>15</p>

	3.3 Amphibolic role of EMP and TCA cycle	01	
	3.4 Energetics of Glycolysis, ED and TCA pathway – Balance sheet only(No efficiency calculation)	01	
	UNIT IV FERMENTATIVE PATHWAY AND ANABOLISM OF CARBOHYDRATES	15	15
	4.1 Fermentative pathways (With structures and enzymes)	04	
	4.1.1. Lactic acid fermentation – i. Homofermentors ii. Heterofermentors iii. <i>Bifidobacterium</i> pathway (Schematic)		
	4.1.2. Alcohol fermentation i. by ED pathway in bacteria ii. by EMP in yeasts		
	4.2 Other modes of fermentations in microorganisms	05	
	4.2.1 Mixed acid, 4.2.2 Butanediol 4.2.3. Butyric acid 4.2.4. Butanol-acetone 4.2.5. Propionic acid (Acrylate pathway and succinate propionate pathway)		
	4.3 Anabolism of Carbohydrates	06	
	4.3.1. General pattern of metabolism leading to synthesis of a cell from Glucose 4.3.2. Gluconeogenesis (Mitochondrial aspect not included) 4.3.3. Biosynthesis of Glycogen 4.3.4. Biosynthesis of Peptidoglycan		

SIUSMIC-54 (BIOPROCESS TECHNOLOGY)

Learning Objectives

Bioprocess Technology and Environmental Microbiology course is designed to develop the learner's ability to study the techniques used in the different phases of industrial microbiology such as strain improvement, basic fermentation equipment and its sterilization aspects. It gives an in depth focus of the different types of fermenters used in industry for production of different products, and also emphasizes its process parameters. It includes the principles and describes the main steps and processes in the industrial production of beverages and enzymes. The downstream process and the environmental aspects of the final product are also included.

Industrial and Environmental Microbiology becomes an important application based paper covering microbial fermentations as well as applying the techniques of molecular biology to enzyme technology, animal tissue culture as well as plant tissue culture. Thus, it becomes a laboratory to market scenario where the entire products reach. The learner is provided with the details of productions of important products like antibiotics, vitamins, organic acid and enzymes along with the analysis techniques using various instruments and statistical tools.

The learner is expected to learn the need of Quality management and regulatory bodies as the products need to fulfill these requirements. Thus this paper readies the learner to understand and apply the knowledge of fermentation technology and related products.

This course aims to enable graduates to enter industry with an appropriate level of understanding of the need for both the science and business aspects to be achievable to make a viable product and enhance their enterpreunial skills.

Learning Outcomes:

Students should be able to-

- Describe the applications of microbes and its strain improvement in Industrial Microbiology.
- Apply kinetic formula to determine growth and productivity parameters of batch and continuous fermentations
- Describe the design of bioreactors for different applications and its process parameters
- Design media, growth conditions and techniques for producing and recovering different types of products of commercial value
- Design an industrial process by keeping in view the strict guidelines for its recovery and disposal
- Learner will be well –versed with the environmental aspects such as carbon credits and containment levels.
- Learn to develop the corrective measures for dealing with the environmental pollution and its consequences.

SIUSMIC-54: DETAIL SYLLABUS

Course Code	Title	L/ Semester	Notional Periods
SIUSMIC 54	BIOPROCESS TECHNOLOGY	2.5 CREDITS (60 L)	Self Study (60)
	<u>Unit I: Strain Improvement and sterilization Techniques</u>	15	
	<p>1.1 Strain improvement of industrial microorganisms</p> <ul style="list-style-type: none"> i. selection of mutants with altered permeability ii. isolation of mutants not producing feedback inhibitors/repressors (all methods- 1e.g. only) iii. Use of auxotrophs for production of primary metabolites- e.g. aspartate family iv. The selection of induced mutants synthesizing improved levels of primary metabolites. v. Isolation of induced mutants for secondary metabolites. vi. isolation of mutants that do not recognize the presence of inhibitors and repressors with e.g. (gradient plate – lysine) vii. isolation of auxotrophic mutants (e.g. – Penicillin Davies and miniature technique) viii. Isolation of resistant and revertant mutants <p>1.2 Sterilization and achievement of aseptic conditions</p> <ul style="list-style-type: none"> i. Introduction Medium sterilization (<i>concept of nabra factor</i>) ii. Methods of batch sterilization iii. The design of continuous sterilization process iv. Sterilization of air and gasses 	10L	
		5L	

	UNIT II FERMENTER EQUIPMENT AND CONTROL	15L	15
	<p>2.1 Design of fermenter</p> <p>a) Scale Up, Basic functions of fermenter. Aseptic operation and Containment, Body construction, Aeration and agitation Agitators, Stirrer glands and bearing, Mechanical seals (Names and Functions, no diagrams), Magnetic Drive, - Baffles, Sparger: porous, orifice; nozzle; combined. Valves / Steam traps function in general and examples.</p> <p>b) Types of fermenters: Acetator, Cavitator, Tower fermenter, Cyllindro-conical, Air lift – outer loop / inner loop, Deep jet, Cyclone column, Packed tower (generator), Rotating disc, Bubble cap.</p> <p>2.2 Instrumentation and Control of variables Introduction, Types of sensors, Sensing and Control of pH, temp, Dissolved oxygen, Flow measurement and control, Pressure, Inlet / Exit gas analysis, Foam sensing, Oxygen.</p>	10L	
	UNIT III DOWNSTREAM PROCESSING AND ENVIRONMENTAL ASPECTS	5L	
	<p>3.1 Downstream processing</p> <p>i. Recovery and Purification of fermentation products</p> <p>ii. Introduction, Precipitation, Filtration - theory, filter-aids, batch filters (Plate and frame filters), continuous filters. (Rotary vaccum), Centrifugation flocculating agent, range of centrifuges - Basket, tubular bowl.</p> <p>iii. Cell disruption: Physico-chemical.</p> <p>iv. Liquid – Liquid extraction, Solvent recovery,</p> <p>v. Chromatography – Ion exchange and Adsorption</p> <p>vi. Membrane processes – Ultrafiltration, reverse osmosis, liquid membranes.</p> <p>vii. Drying , Crystallization</p> <p>viii. Whole broth processing.</p>	15L	15
		10L	

	3.2 .Environmental aspects i. Effluent treatment ii. Carbon Credits – Environmental Degradation issues and challenges	5L	
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	UNIT IV TRADITIONAL INDUSTRIAL FERMENTATIONS PART-I 4.1 Beer –Ale and Lager 4.2 Wine –Red and white and Champagne 4.3 Vinegar (acetator and Generator) 4.4 Alcohol from molasses 4.5 Baker's yeast 4.6 Fungal amylase by solid substrate fermentation	15 3L 3L 3L 2L 2L 2L	
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T.Y.B.SC. MICROBIOLOGY PRACTICALS (SEMESTER-V)

COURSE CODE: SIUSMICP51

[PRACTICALS BASED ON SIUSMIC51, CREDITS -1.5L- 60, NOTIONAL PERIODS-15]

1. UV survival curve – determination of exposure time leading to 90% reduction
2. Isolation of mutants using UV mutagenesis
3. Replica plate technique for selection and characterization of mutants – auxotroph and antibiotic resistant
4. Isolation and detection of plasmid DNA.
5. Preparation of competent cells and transformation

COURSE CODE: SIUSMICP52

[PRACTICALS BASED ON SIUSMIC52, CREDITS -1.5L-60, NOTIONAL PERIODS-15]

1. Study of iron sequestration- siderophore production in *Pseudomonas* spp.
2. Acid fast staining of *M.tuberculosis*.
3. To determine SLO and SLS activity of *S.pyogenes*
4. Identification of isolates obtained from nasal swabs, skin swab, pus, sputum, stool and urine by morphological, cultural and biochemical properties.
5. Antigen Preparation: O and H antigen preparation of *Salmonella*. Confirmation by slide agglutination
6. Study of germ tube formation in yeast *Candida albicans*
7. Demonstration experiments- Widal

COURSE CODE: SIUSMICP53

[PRACTICALS BASED ON SIUSMIC53; CREDITS-1.5, L- 60, NOTIONAL PERIODS-15]

1. Isolation and study of Bioluminescent organisms
2. Study of oxidative and fermentative metabolism
3. Qualitative and Quantitative assay of Phosphatase
4. Detection of organic acids by TLC
5. Study of Homo and Heterofermentation
6. Glucose detection by GOD/POD
7. β galactosidase activity

COURSE CODE: SIUSMICP54

[PRACTICALS BASED ON SIUSMIC54, CREDITS -1.5, L- 60, NOTIONAL PERIODS-15]

1. Alcohol fermentation.-
 - a) Efficiency of fermentation
 - b) Alcohol tolerance for yeast.
 - c) Sugar tolerance for yeast.
 - d) Chemical estimation –Sugar by Cole’s method
 - e) Chemical estimation–Alcohol
2. Gradient plate technique for analogue resistant mutants.
3. Production of amylase- detection, shake flask or solid substrate cultivation and estimation. (Qualitative)
4. Industrial visit

SEMESTER V: TEXT BOOKS AND REFERENCE BOOKS

SIUSMIC51: Text books

1. Benjamin A. Pierce (2008), “Genetics a conceptual approach”, 3rd ed., W. H. Freeman and company.
2. D., Nelson and M.Cox, (2005), “Lehninger’s Principles of biochemistry”, 4th ed., Macmillan worth Publishers.
3. Fairbanks and Anderson, (1999), “Genetics”, Wadsworth Publishing Company.
4. M.Madigan, J.Martinko, J.Parkar, (2009), “Brock Biology of microorganisms”, 12th ed., Pearson Education International.
5. Nancy Trun and Janine Trempey, (2004), “Fundamental bacterial genetics”, Blackwell Publishing
6. Peter J. Russell (2006), “Genetics-A molecular approach”, 2nd ed.
7. Prescott, Harley and Klein, “Microbiology”, 7th edition Mc Graw Hill international edition.
8. R. H. Tamarin, (2004), “Principles of genetics”, Tata McGrawHill.
9. Robert Weaver, “Molecular biology”, 3rd edn. Mc Graw Hill international edition.
10. Snustad, Simmons, “Principles of genetics”, 3rd edn. John Wiley and sons, Inc.

SIUSMIC51: Reference books:

1. Benjamin Lewin, "Genes IX", , Jones and Bartlett publishers.
2. JD Watson, "Molecular biology of the gene" 5thedn.

SIUSMIC52: Text books:

1. Ananthanarayan and Panicker's, Textbook of Microbiology, 9thedition
2. Bacterial Pathogenesis –A molecular approach Abigail Salyer And Dixie Whitt 2nd Ed ASM press
3. Fahim Khan, Elements of Immunology, Pearson Education
4. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
5. Kuby Immunology, 6th Edition, W H Freeman and Company
6. Pathak and Palan, Immunology: Essential and Fundamental, 1stand 3rd Edition, Capital Publishing Company

SIUSMIC52: Reference books / Internet references:

1. Baron Samuel , Medical Microbiology, 4thedition
2. <http://www.macmillanlearning.com/catalog/static/whf/kuby/>
3. <http://www.ncbi.nlm.nih.gov/books/NBK7627/>
4. Kuby Immunology, 7th Edition, W H Freeman and Company

SIUSMIC53: Text books:

1. Conn, E.E., P. K.Stumpf, G.Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5th edition, 1987. John Wiley and Sons. New York.
2. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, SpringerVerlag
3. Mathews, C.K., K.E. van Holde, D.R. Appling, S,J, Anthony-Cahill (2012) Biochemistry, 4thedn.Pearson
4. Nelson D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry.4th edition, W. H. Freeman and Company
5. Rose, A.H. (1976) Chemical Microbiology, 3rdedn Butterworth-Heinemann
6. Stanier, R. Y.,M. Doudoroffand E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
7. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
8. Wilson and Walker, 4th edn
9. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers

SIUSMIC53: Reference books:

1. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edn, Springer
2. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers

SIUSMIC54: Text books

1. Casida L. E., "Industrial Microbiology"(2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi
2. Environmental degradation : issues and challenges by Shitole and Sable, Global research publication(2012)
3. H. A. Modi, (2009). ‘‘Fermentation Technology’’ Vols 1 and 2, Pointer Publications, India
4. Okafor Nakuda (2007) ‘‘Modern Industrial Microbiology and Biotechnology’’, Science Publications Enfield, NH, USA.
5. Pepler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 and 2, Academic Press
6. Stanbury P. F., Whitaker A. and Hall-S. J., (1997), "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.

SIUSMIC54: Reference books

1. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
2. Prescott and Dunn's ‘‘Industrial Microbiology’’(1982) 4th Edition, McMillan Publishers

**T. Y. B. Sc. MICROBIOLOGY THEORY
SEMESTER-VI**

COURSE CODE	TITLE	CREDITS AND L/SEM
SIUSMIC61	rDNA TECHNOLOGY, BIOINFORMATIC AND VIROLOGY	2.5 (60 L)
Unit I	RECOMBINANT DNA TECHNOLOGY	15 L
Unit II	BASIC TECHNIQUES IN MOLECULAR BIOLOGY AND BIOINFORMATICS	15 L
Unit III	VIROLOGY I	15 L
Unit IV	VIROLOGY II	15 L
SIUSMIC62	MEDICAL MICROBIOLOGY AND IMMUNOLOGY II	2.5 (60 L)
Unit I	MEDICAL MICROBIOLOGY III	15 L
Unit II	CHEMOTHERAPY	15 L
Unit III	IMMUNOLOGY III	15 L
Unit IV	IMMUNOLOGY IV	15 L
SIUSMIC63	MICROBIAL BIOCHEMISTRY : PART II	2.5 (60 L)
Unit I	LIPID METABOLISM AND CATABOLISM OF HYDROCARBONS.	15 L
Unit II	METABOLISM OF PROTEINS AND NUCLEIC ACIDS	15 L
Unit III	METABOLIC REGULATION	15 L
Unit IV	PROKARYOTIC PHOTOSYNTHESIS AND INORGANIC METABOLISM	15 L
SIUSMIC64	APPLIED AND INDUSTRIAL MICROBIOLOGY	2.5 (60 L)
Unit I	TRADITIONAL INDUSTRIAL FERMENTATIONS PART 2	15 L
Unit II	ADVANCES IN BIOPROCESSES TECHNOLOGY:	15 L
Unit III	BIOINSTRUMENTATION AND BIOSTATISTICS	15 L
Unit IV	QUALITY ASSURANCE AND REGULATORY PRACTICES	15 L

SIUSMIC-601 (rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY)

Learning Objectives

Microbial Genetics is an undergraduate T.Y. B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing and understanding biological genetic information. It develops knowledge of the underlying theories of genetics which exhibits a broad understanding of genetic exchange among prokaryotes. It also gives students hands-on competence in fundamental molecular biology theories and laboratory techniques. It gives an overview of recombinant DNA technology and biotechnology applications utilizing genetic manipulation. It also provides practical experience of the major analytical techniques used in bioinformatics. It also deals with basic structure and life cycle of different types of viruses and explains different terminologies like cancer, prions, virioids and their mechanism.

Learning Outcomes

Students should be able to-

1. Understand the basic concepts and techniques of recombinant DNA technology
2. Understand the basic concepts of Bioinformatics.
3. Understand the basic structure, classification, enumeration, cultivation and life cycle of viruses
4. Understand the terms like cancer, prions, virioids and their mechanisms
5. Understand regulation of lambda phage

SIUSMIC-61: DETAIL SYLLABUS

Course Code	Title	L/ Semester	Notional Periods
SIUSMIC601	RECOMBINANT DNA TECHNOLOGY, BIOINFORMATICS and VIROLOGY	2.5 Credits (60 L)	Self Study (60)
	UNIT I RECOMBINANT DNA TECHNOLOGY	15	15
	1. 1 Recombinant DNA technology:	3L	
	i. Site specific mutagenesis of DNA, Uses of DNA polymorphism, STRS and VNTRS, DNA molecular testing for human genetic diseases(Only RFLP), DNA typing, gene therapy, Genetic engineering of plants and		
	ii. Animals.		
	1.2 Basic steps in Gene Cloning.	1L	
	1.3 Cutting and joining DNA molecules-- Restriction and modification systems, restriction endonucleases, DNA ligases	2L	
	1.4 Vectors	4L	
	i. Plasmids as cloning vectors. The plasmid vectors, pBR322 vector		
	ii. Cloning genes into pBR322		
	iii. Phage as cloning vectors, cloning genes into phage vector		
	iv. Cosmids		
	v. Shuttle vectors- YAC, BAC		
	1.5 Methods of artificial transformation	2L	
	1.7. Screening and selection methods for identification and isolation of recombinant cells	3L	

	<p style="text-align: center;">UNIT II <u>MOLECULAR BIOLOGY AND BIOINFORMATICS</u></p> <p>2.1 Molecular Biology Techniques</p> <ol style="list-style-type: none"> i. Southern, Northern and Western blotting. ii. Autoradiography (explain the term) iii. PCR- basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR) <p>2.2 Bioinformatics</p> <p>A. Introduction</p> <ol style="list-style-type: none"> i. Definition, aims, tasks and applications of Bioinformatics ii. Database, tools and their uses iii. Types and classification of databases iv. Nucleic acid sequence databases-EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. v. Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D. Protein structure databases- SCOP, CATH, PROSITE, PRINTS and BRENDA. KEGG. <p>B. Brief introduction to Transcriptome, Metabolomics, Pharmacogenomics,</p> <ol style="list-style-type: none"> i. Phylogenetic analysis, Phylogenetic tree, Annotation ii. Sequence alignment-- global v/s local alignment, FASTA, BLAST. iii. Genomics- structural, functional and comparative genomics. iv. Proteomics- structural and functional proteomics. 	<p style="text-align: center;">15L</p> <p style="text-align: center;">5L</p> <p style="text-align: center;">7L</p> <p style="text-align: center;">3L</p>	<p style="text-align: center;">15</p>
	<p>UNIT III <u>BASIC VIROLOGY</u></p> <p>3.1. Viral architecture- Capsid, viral genome and envelope Structure of TMV, T4, Influenza virus, HIV.</p>	<p style="text-align: center;">15L</p> <p style="text-align: center;">4L</p>	<p style="text-align: center;">15</p>

	3.2 Viral classification (Baltimore)	2L	
	3.3 The viral replication cycle- attachment, penetration, uncoating, types of viral genome and their replication, assembly, maturation and release.	4L	
	3.4 Cultivation of viruses- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue	5L	
	UNIT IV <u>ADVANCED VIROLOGY</u>	15L	15
	4.1 Life cycle of animal virus:- Influenza, HIV, Polio		
	4.2 Life cycle of Plant viruses:- TMV	5L	
	4.3 Visualization and enumeration of virus particles		
	4.4 A) Measurement of infectious units		
	i. Plaque assay		
	ii. Fluorescent focus assay		
	iii. Infectious center assay		
	iv. Transformation assay		
	v. Endpoint dilution assay.	3L	
	4.4 B) Measurement of virus particles and their components		
	i. Electron microscopy		
	ii. Atomic force microscopy		
	iii. Haemagglutination		
	iv. Measurement of viral enzyme activity.		

<p>4.3 Regulation of lytic and lysogenic pathway of lambda phage</p>	<p>3L</p>	
<p>4.4 Role of viruses in cancer Definitions, Characteristics Of Cancer Cell, Cancer Multi Step Process, Human DNA Tumor Viruses- EBV, Kaposi's Sarcomavirus, Hepatitis B And C Virus, Papilloma Virus</p>	<p>2L</p>	
<p>4.5 Prions and viroids</p>	<p>2L</p>	

SIUSMIC-62 (MEDICAL MICROBIOLOGY and IMMUNOLOGY-II)

Learning objectives:

One of the most important areas of microbiology, medical microbiology encompasses the aetiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases that are enlisted in the syllabus. This course will help students to build on the basic information regarding host defence mechanisms that they have gained in F.Y.BSc.

Immunology is an integral part of Medical Microbiology and this course is designed for T.Y.B.Sc. Microbiology students and it is assumed that the students have achieved a basic understanding of Innate Immunity and Host Defence mechanisms. The course has been designed to help understand the ability of our immune system to defend against invading pathogens in a logical fashion. This includes our innate ability to defend against microorganisms (innate immunity); should this first line of defence fail, how we can fight infections (acquired immunity); if we react excessively, what price we pay (hypersensitivity); and very importantly, can we prevent pathogens from infecting us (vaccination).

Learning Outcomes: (Medical Microbiology)

Students should be able to-

- Give details of the virulence factors and other features of the pathogen
- Correlate these virulence factors with the pathogenesis and clinical features of the disease
- Comment on the mode of transmission, epidemiology and therefore modes of prophylaxis of these diseases
- Given a few key clinical features, identify the likely causative agent.
- Comment on the methods of diagnosis of the disease.

Learning Outcomes: (Immunology)

Students should be able to-

- Understand the effector responses- Humoral Immunity and Cell Mediated Immunity and differentiate between them
- Acquire an understanding of the role of immune system in disease:
- Unregulated response resulting in Hypersensitivity
- Apply the concept of immunity to prevention of disease by development of vacc

SIUSMIC-62: DETAILSYLLABUS

Course Code	Title	L/ Semester	Notional Periods
SIUSMIC 602	MEDICAL MICROBIOLOGY AND IMMUNOLOGY II	2.5 Credits (60L)	Self Study (60)
	<u>UNIT I</u> <u>MEDICAL MICROBIOLOGY III</u> Study of a few diseases with emphasis on cultural characteristics of the aetiological agent, pathogenesis, laboratory diagnosis and prevention.	15	15
	<ol style="list-style-type: none"> 1. Study of vector-borne infections -Malaria 2. Study of sexually transmitted infectious diseases -Syphilis, AIDS, Gonorrhoea 3. Study of emerging infections- Dengue, chikungunya, leptospirosis 	02 08 05	
	<u>UNIT II</u> <u>CHEMOTHERAPY</u> 2.1.Attributes of an ideal chemotherapeutic agent and related definitions 2.2 Selection and testing of antibiotics for bacterial isolates by Kirby-Bauer method Mode of action of antibiotics on-	15	15
	<ol style="list-style-type: none"> i. Cell wall (Beta-lactams- Penicillin and ii. Cephalosporins, Carbapenems) iii. Cell Membrane (Polymyxin and Imidazole) iv. Protein Synthesis (Streptomycin, v. Tetracycline and Chloramphenicol) vi. Nucleic acid (Quinolones, Nalidixic acid, Rifamycin) vii. Enzyme inhibitors (Sulfa drugs, Trimethoprim) viii. List of common antibiotics used for treating viral, fungal and parasitic diseases. ix. New generation antibiotics 	03 09	

	2.3 Mechanisms of drug resistance- Its evolution, pathways, origin and prevention	03	
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	<p style="text-align: center;">UNIT III IMMUNOLOGY – III</p> <p>1. Tcells</p> <ul style="list-style-type: none"> i. T Cell Receptor-structure (alpha-beta, gamma-delta TCR) ii. TCR-CD₃ complex - structure and functions. Accessory molecules iii. T cell activation iv. TCR mediated signaling –Overview Costimulatory signals v. Superantigens induced T cell activation vi. T cell differentiation (Memory and Effector cells) <p>2. Cell mediated effector response</p> <ul style="list-style-type: none"> i. General properties of effector Tcells Cytotoxic Tcells and destruction of ii. Target cel by perforin/granzyme pathway and Fas pathway iii. Killing mechanism of NK cells iv. Antibody mediated cell cytotoxicity (ADCC) <p>3. B cells</p> <ul style="list-style-type: none"> i. B cell receptor and co-receptor-structure and function ii. B cell activation and Differentiation iii. Thymus dependant and independent antigens Signal transduction pathway activated by BCR- overview iv. Role T_H cell in B cell response-Formation of T-B conjugates, CD40/CD40L interaction, T_H cells cytokine signals. <p>4. Humoral Response</p> <ul style="list-style-type: none"> i. Primary and secondary responses ii. In vivo sites for induction of Humoralresponse Germinal centers and antigen induced B cell Differentiation 	<p style="text-align: center;">15L</p> <p style="text-align: center;">4L</p> <p style="text-align: center;">3L</p> <p style="text-align: center;">4L</p> <p style="text-align: center;">4L</p>	<p style="text-align: center;">15</p>
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| | <ul style="list-style-type: none">iii. Cellular events within germinal centers-
Overview Affinity maturation, somatic hyper-mutation and class switchingiv. Generation of plasma cells and memory cells | | |
|--|--|--|--|

	<p style="text-align: center;">UNIT IV IMMUNOLOGY IV</p> <p>1. Vaccines</p> <p>i. Active and passive immunization</p> <p>ii. Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines</p> <p>iii. Use of adjuvants in vaccine</p> <p>iv. New vaccine strategies</p> <p>2. Immunohaematology</p> <p>i. Human blood group systems, ABO, secretors and non secretors, Bombay Blood group. Rhesus system and list of other blood group systems Haemolytic disease of newborn, Coombs test.</p> <p>3. Complement System- classical, alternative, lectin induced pathway</p> <p>4. Hypersensitivity,</p> <p>i. Coombs and Gells classification Type I to Type IV examples of each type of hypersensitivity</p>	<p style="text-align: center;">15L</p> <p style="text-align: center;">4L</p> <p style="text-align: center;">3L</p> <p style="text-align: center;">3L</p>	<p style="text-align: center;">15</p>
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SIUSMIC-63 (MICROBIALBIOCHEMISTRY: PART-II)

Learning objectives:

There are a large number of macromolecules such as lipids, carbohydrates, proteins and nucleic acids which are catabolised by the living cells. Cells also bring about biosynthesis of these macromolecules. Various enzymes play a major role in these biochemical reactions. These enzymatic reactions are regulated. The learner must be made aware of the mechanisms of catabolism, anabolism as well as the regulation of this mechanism in the living cell. There are prokaryotic cells which bring about photosynthesis to generate energy. Prokaryotic cells are also involved in metabolism of inorganic compounds.

This course is designed for TYBSc Microbiology students and it is assumed that the students already have a basic understanding of macromolecules. The course will help students to understand the metabolism of macromolecules as well as the regulation of metabolic reactions. The students would also learn photosynthetic reactions in prokaryotic cells and metabolism of inorganic compounds.

Learning Outcomes: Students should be able to-

- Understand the reactions involved in metabolism of lipids and hydrocarbons.
- Describe and explain protein catabolism as well as anabolic processes in the cell.
- Explain nucleic acid metabolism and recycling of nucleotides.
- Discuss the mechanism of regulation with regards to allosteric proteins, gene expression as well as through other mechanisms like end product inhibition and covalent modification.
- Describe prokaryotic photosynthesis with respect to photosynthetic pigments, photochemical apparatus and light and dark reactions.
- Describe metabolism of inorganic compounds and Lithotrophy

SIUSMIC-63 : DETAIL SYLLABUS

Course Code	Title	L/ Semester	Notional Periods
SIUSMIC 63	MICROBIAL BIOCHEMISTRY PART II	2.5 Credits (60L)	Self Study (60)
	UNIT I	15	15
	LIPID METABOLISM AND CATABOLISM OF HYDROCARBONS		
	1.1 General introduction to Lipids	02	
	1.1.1. Lipids and their functions		
	1.1.2. Action of lipases on triglycerides /tripalmitate		
	1.1.3. Phospholipids and their properties		
	1.1.4. Common phosphoglycerides in bacteria		
	1.2 Catabolism of Lipids	05	
	1.2.1. Oxidation of saturated fatty acid		
	• β oxidation pathway		
	• Energetics of β oxidation of Palmitic acid		
	1.2.2. Oxidation of propionic acid.		
	1.2.3. Degradation of poly beta hydroxy butyrate		
	1.3 Anabolism of Lipids	06	
	1.3.1. Biosynthesis of straight chain even carbon Saturated fatty acid (palmitic acid)		
	1.3.2. Biosynthesis of phosphoglycerides in bacteria		
	1.3.3. Biosynthesis of PHB		
	1.4 Catabolism of aliphatic hydrocarbons	02	
	1.4.1. Oxidation of saturated aliphatic Hydrocarbon (n-alkane)		
	1.4.2. Omega oxidation pathway-		
	i) Pathway in <i>Corynebacterium</i> and yeast		
	ii) Pathway in <i>Pseudomonas</i>		

	UNIT II <u>METABOLISM OF PROTEINS AND NUCLEIC ACIDS</u>	15	15
	2.1 Protein catabolism	05	
	<ul style="list-style-type: none"> i. Enzymatic degradation of proteins ii. Metabolic fate of amino acids (schematic only) iii. Metabolism of single amino acids iv. Deamination reactions v. Decarboxylation vi. Transamination vii. Fermentation of single amino acid - Glutamic acid by <i>Clostridium glutamicum</i> viii. Fermentation of pair of amino acids -Stickland reaction 		
	2.2 Anabolism of amino acids	04	
	<ul style="list-style-type: none"> i. Schematic representation of amino acid families ii. Synthesis of amino acids of Aspartate family 		
	2.3 Nucleic acid Catabolism	03	
	<ul style="list-style-type: none"> i. Degradation of purine nucleotides up to uric acid formation ii. Recycling of purine and pyrimidine nucleotides by salvage pathway 		
	2.4 Anabolism of Nucleic Acids	03	
	<ul style="list-style-type: none"> i. Metabolic origin of atoms in purine and Pyrimidine ring. ii. Biosynthesis of pyrimidine nucleotides. iii. Biosynthesis of purine nucleotides. iv. Formation of deoxyribonucleotides. v. Synthesis of nucleotide diphosphates and triphosphates. vi. Role of nucleotides (high energy triphosphates) 		

	<p style="text-align: center;">UNIT III <u>METABOLIC REGULATION</u></p> <p>Overview and major modes of regulation Examples of cellular control mechanism acting at various levels of metabolism (tabulation only)</p> <p>3.1 Allosteric proteins</p> <ol style="list-style-type: none"> i. Definition ii. Allosteric enzymes - Role of allosteric enzymes using ATCase as example (no kinetic study) iii. Regulatory allosteric proteins iv. Interaction of proteins with DNA v. Structure of DNA Binding proteins vi. Examples - Lac repressor, Trp repressor, CAP protein vii. Definition and examples of alarmones <p>3.2 Regulation of gene expression (Transcription)</p> <p>Introduction to operon model Common patterns of regulation of transcription - General concept of positive and negative regulation of operons</p> <ol style="list-style-type: none"> i. Lac operon -Mechanism of regulation – Induction, ii. Catabolite repression iii. Trp operon - End Product Repression, Attenuation. iv. Multiple Sigma Factors v. Riboswitches <p>3.3 Regulation of enzyme activity (Post translational regulation)</p> <p>End-Product Inhibition and Mechanism of End Product Inhibition in branched pathways with examples</p> <ol style="list-style-type: none"> i. Isofunctional enzymes ii. Concerted feedback inhibition iii. Sequential feedback inhibition iv. Cumulative Feedback inhibition v. Combined activation and inhibition 	<p>15</p> <p>01</p> <p>03</p> <p>06</p> <p>04</p>	<p>15</p>
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Covalent modification of enzymes i. General examples without structures ii. Monocyclic cascade and interconvertible enzyme definition iii. Glutamine synthetase system of <i>E. coli</i> 3.4. Regulation by proteolytic cleavage 3.5 Regulation of EMP and TCA (Schematic and Role of Pyruvate dehydrogenase Complex)	01	
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SIUSMIC-64 (APPLIED and INDUSTRIAL MICROBIOLOGY)

Learning Objectives

Bioprocess Technology and Environmental Microbiology course is designed to develop the learner's ability to study the techniques used in the different phases of industrial microbiology such as strain improvement, basic fermentation equipment and its sterilization aspects. It gives an in depth focus of the different types of fermenters used in industry for production of different products, and also emphasizes its process parameters. It includes the principles and describes the main steps and processes in the industrial production of beverages and enzymes. The downstream process and the environmental aspects of the final product are also included.

Industrial and Environmental Microbiology becomes an important application based paper covering microbial fermentations as well as applying the techniques of molecular biology to enzyme technology, animal tissue culture as well as plant tissue culture. Thus, it becomes a laboratory to market scenario where the entire products reach. The learner is provided with the details of productions of important products like antibiotics, vitamins, organic acid and enzymes along with the analysis techniques using various instruments and statistical tools.

The learner is expected to learn the need of Quality management and regulatory bodies as the products need to fulfill these requirements. Thus this paper readies the learner to understand and apply the knowledge of fermentation technology and related products. This course aims to enable graduates to enter industry with an appropriate level of understanding of the need for both the science and business aspects to be achievable to make a viable product and enhance their entrepreneurial skills.

Learning Outcomes

Students should be able to-

- Understand the actual process involved in fermentations of important products.
- To apply the knowledge of applications of animal and plant tissue culture techniques.
- Learn the applications of enzymes in various fields.
- Understand the working of important instruments used in biochemical analysis and also learn to analyze the results using statistical tools.
- Learn the salient features of quality management and regulatory procedures.
- Understand the commercial and economic aspects of applied microbiology.

SIUSMIC-64: DETAIL SYLLABUS

Course Code	Title	L/ Semester	Notional Periods
SIUSMIC64	APPLIED MICROBIOLOGY	2.5 Credits(60 L)	Self Study (60)
	UNIT I TRADITIONAL FERMENTATIONS- II	15	15
	<ul style="list-style-type: none"> i. Penicillin and Semisynthetic Penicillin ii. Vitamin B12 from <i>Propionibacterium</i> and iii. <i>Pseudomonas</i> iv. Glutamic Acid(direct) v. Citric acid vi. Mushroom 	<ul style="list-style-type: none"> 04 03 02 03 03 	
	UNIT II ATC, PTC, ENZYME TECHNOLOGY	15	15
	<p>2.1 Animal Cell Cultivation and applications</p> <ul style="list-style-type: none"> i. Animal Cell Lines, ii. Methods of cultivation and establishment of cell lines iii. Animal cell culture fermenters, Large scale cultivation procedures 	05	
	<p>2.2. Plant Tissue Culture</p> <ul style="list-style-type: none"> i. Methods of cultivation of organ culture, callus culture and cell suspension culture, ii. Application in Agriculture <ul style="list-style-type: none"> a) (Disease resistant plants, virus free plants) b) Horticulture (Micropropagation) c) Industry (secondary metabolites production), Transgenic plant (Insect resistant plants) 	05	

<p>2.3 Enzyme Technology</p> <ul style="list-style-type: none"> i. Enzyme Immobilization methods, Applications in therapeutic uses, ii. Analytical uses and Industrial uses 	<p>05</p>	
<p>UNIT III BIOINSTRUMENTATION AND BIOSTATISTICS</p>		
<p>3.1. Bioinstrumentation – Principles, working and applications of:</p> <ul style="list-style-type: none"> 3.1.1 Flow cytometry 3.1.2 Atomic absorption (AAS) and Atomic Emission (Flame photometry) 3.1.3 Radioisotopes and autoradiography 3.1.4 Microbiological Assays 	<p>15L 10 05</p>	
<p>3.2 Biostatistics Standard Deviation, Variance, Q-Test, t- test and F-test., ANOVA, Chi-square test Linear regression</p>		
<p>UNIT IV QUALITY ASSURANCE and REGULATORY PRACTICES :</p>		
<p>4.1 Intellectual Property Rights: Introduction to Intellectual Property Genesis of IPR - GATT, WTO, TRIPS, The World Intellectual Property Rights Organization (WIPO) Types of Intellectual Property – Patents, Copyright, Trademark, Trade secret Plant varieties protection act, Designs, Geographical Indications Indian Patent office site- http://www.ipindia.nic.in/</p>	<p>07</p>	
<p>4.2 QA, QC, GMP</p> <ul style="list-style-type: none"> i. Definitions- Manufacture, Quality, Quality Control, In-Process Control, Quality Assurance, Good Manufacturing ii. Practices. Chemicals, Pharmaceuticals, 	<p>04</p>	

	<p>Chemicals and Pharmaceutical production</p> <ul style="list-style-type: none"> iii. The five variables, In process Items, Finished Products, Labels and Labeling, Packaging materials iv. Documentation, Regulations, Control of Microbial contamination during manufacture, Premises and contamination control Manufacture of sterile products, Clean and Aseptic Area. Important publications related to QA <p>4.3 Sterilization Control and Sterility Assurance:</p> <ul style="list-style-type: none"> i. Bio-burden determinations Environmental monitoring Sterilization ii. Monitors – Physical, Chemical and Biological indicators iii. Sterility Testing 	04	
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**T.Y.B.SC. MICROBIOLOGY PRACTICALS (SEMESTER-VI) COURSE CODE:
SIUSMICP07**

[PRACTICALS BASED ON SIUSMIC61; CREDITS: 1.5, L:60, NOTIONAL PERIODS-15]

1. Enrichment of coliphages, phage assay (pilot and proper).
2. Restriction digestion of lambda phage /any plasmid DNA
3. Amplification of DNA by PCR and confirmation of it by gel electrophoresis [Demo.]
4. Western Blot.(Demo)
5. Bioinformatics practical
6. Animal cell culture(demo)
7. On Line Practical
 - a) Visiting NCBI and EMBL websites and list services available, software tools available and databases maintained
 - b) Visiting and exploring various databases mentioned in syllabus and
 - i. Using BLAST and FASTA for sequence analysis
 - ii. Fish out homologs for given specific sequences (by teacher – decide sequence of some relevance to their syllabus and related to some biological problem e.g. evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology)
 - iii. Six frame translation of given nucleotide sequence
 - iv. Restriction analysis of given nucleotide sequence
 - v. Pair-wise alignment and multiple alignment of a given protein sequences
 - vi. Formation of phylogenetic tree

COURSE CODE: SIUSMICP62

[PRACTICALS BASED ON SIUSMIC62; CREDITS -1.5,L- 60,NOTIONAL PERIODS-15]

1. Demonstration of malaria parasite in blood films
2. Selection and testing of antibiotics using the Kirby-Bauer method
3. Determination of MBC of an antibiotic.
4. Blood grouping – Direct and Reverse typing
5. Coomb's Direct test
6. Determination of Isoagglutinin titre
7. Demonstration experiments-VDRL

COURSE CODE: SIUSMICP63

[PRACTICALS BASED ON SIUSMIC63; CREDITS -1.5, L- 60, NOTIONAL PERIODS-15]

1. To study catabolite repression by diauxic growth curve.
2. Protein estimation by Lowry's method
3. Estimation of uric acid
4. Qualitative and Quantitative assay of Protease
5. Qualitative assay of Lipase
6. Study of breakdown of amino acids – Lysine decarboxylase and Deaminase activity
7. Study of Lithotrophs – Nitrosification and Nitrification

COURSE CODE: SIUSMICP64

[PRACTICALS BASED ON SIUSMIC64; CREDITS: 1.5, L: 60, NOTIONAL PERIODS 15]

1. Bioassay of an antibiotic (Ampicillin)
2. Bioassay of Cyanocobalamin.
3. Immobilization of yeast cells for invertase activity- making of beads, Determination of activity and count by haemocytometer.
4. Carrot explants culture (Demo).
5. Sterility testing of injection water.
6. Chemical estimation of Penicillin
7. Estimation of Phenol
8. Biostatistics problem

Semester-VI: Text Books and Reference

Books SIUSMIC 61: Text books:

1. A textbook of biotechnology R.C.Dubey 4thed. S.Chand.
2. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd Edition, Oxford University Press
3. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., W. H. Freeman and company. ed., Pearson Education International.
4. Edward Wagner and Martinez Hewlett, (2005) "Basic Virology", 2nd edition, Blackwell Publishing
5. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
6. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th
7. Peter J. Russell (2006), "Genetics-A molecular approach", 2nded.
8. Prescott, Harley and Klein, "Microbiology",. 7th edition Mc Graw Hill international edition.
9. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6thed, Blackwell Publishing
10. R. H. Tamarin, (2004), "Principles of genetics", Tata McGrawHill..
11. Robert Weaver, (2008), "Molecular biology", , 3rd edn. Mc Graw Hill international edition.
12. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
13. Snustad, Simmons, "Principles of genetics", 3rdedn. John Wiley and sons, Inc.
14. Teri Shors,.(2009) , "Understanding viruses", Jones and Bartlett publishers.

Reference books:

1. Benjamin Lewin, (9th edition), "Genes IX", , Jones and Bartlett publishers.
2. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2ndedn. ASM press.
3. JD Watson, "Molecular biology of the gene", 5thedn.
4. T. K. Attwood and D. J. Parry-Smith, (2003), "Introduction to bioinformatics", Pearson education

SIUSMIC62 : TEXT BOOKS:

1. Ananthanarayan and Panicker's, Textbook of Microbiology, 9thedition
2. Bacterial Pathogenesis –A molecular approach Abigail Salyer And Dixie Whitt 2nd Ed ASM press
3. Fahim Khan, Elements of Immunology, Pearson Education
4. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
5. Kuby Immunology, 6th Edition, W H Freeman and Company
6. Pathak and Palan, Immunology: Essential and Fundamental, 1stand 3rd Edition, Capital Publishing Company

REFERENCES:

1. Baron Samuel , Medical Microbiology, 4thedition-
<http://www.ncbi.nlm.nih.gov/books/NBK7627/>
2. Kuby Immunology, 7th Edition, W H FreemanandCompany
3. <http://www.macmillanlearning.com/catalog/static/whf/kuby/>

SIUSMIC603: TEXT BOOKS

1. Cohen, G.N. (2011). Microbial Biochemistry. 2ndedn, Springer
2. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5th edition, 1987. John Wiley and Sons. New York.
3. Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag H. Freeman and Company.
4. Madigan, M.T. and J.M. Martinko 2006. Brock Biology of Microorganisms. Pearson Prentice Hall;
5. Nelson, D.L. and M.M. Cox (2005), Lehninger, Principles of biochemistry. 4th edition, W.
6. Salle, A.J. Fundamental Principles of Bacteriology, 7thedn McGraw Hill Book Co.
7. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
8. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press

REFERENCE BOOKS:

1. Principles of Biochemistry, Lehninger, 5th edn W. H. Freeman and Company
2. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers

SIUSMIC604: TEXT BOOKS

1. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International (P) Ltd, Publishers, New Delhi
2. Crueger W. and Crueger A. 2000 "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
3. H. A. Modi, 2009. "Fermentation Technology" Vol: 1 and 2, Pointer Publications ,India
4. Prescott and Dunn's "Industrial Microbiology" (1982) 4th Edition, McMillan Publishers
5. R. C. Dubey, 2005 A Textbook of "Biotechnology" S. Chand and Company, New Delhi
6. Research Methodology: Methods and Techniques By C. R. Kothari, New Age International, 2004
7. Stanbury P. F., Whitaker A. and Hall--S. J., 1997, "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.

REFERENCE BOOKS:

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology". Vol 1 and 2, Academic Press.
2. Principles and application of Statistics in Biosciences by Dr D.V.Kamat (2012),Manan Prakashan

MODALITY OF ASSESSMENT: THEORY EXAMINATION PATTERN

A) Internal Assessment - Theory 40 marks

Sr No	Evaluation type	Marks
1	One Assignment/Case study/Project	15
2	One class Test (multiple choice questions / objective)	20
3	Attendance	05

B) External examination - Theory 60 marks

1. Unit I-15
2. Unit II-15
3. Unit III-15
4. Unit IV-15

All the above questions will have internal choice

Practical Examination Pattern:

- A. Internal Examination:-There will not be any internal examination/ evaluation for practicals.
- B. External (Semester end practical examination) :-

Sr. No.	Particulars	Marks
1.	Laboratory work	40
2.	Journal	05
3.	Viva/Quiz	05

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern for Semester V

Course	SIUSMIC51			SIUSMIC52			SIUSMIC53			SIUSMIC54			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

SEMESTER VI

Course	SIUSMIC61			SIUSMIC62			SIUSMIC63			SIUSMIC64			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

