SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: B.Sc. (Double Majors)

Subject: BIOCHEMISTRY (3 Units)

(INTERDISCIPLINARY)

And

MICROBIOLOGY (3 Units)

Academic Year: 2019 – 2020

T.Y.B.Sc.

Semester V & VI

Credit Based Semester and Grading Syllabi approved by Board of Studies in Biochemistry and Board of Studies in Microbiology

with effect from 2018-2019

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Preamble

The 3 units Biochemistry course is offered at the third year of B.Sc. program as an interdisciplinary subject along with three units of either Chemistry/ Microbiology/ Botany/ Zoology.

The goal of the 3 Units interdisciplinary Biochemistry course is to build in the learner, the basic foundation of Biochemistry and encourage the student to pursue Biochemistry at higher level.

By the end of the course, a student should be able to:

- Understand both the physical as well as chemical properties of biomolecules
- Explain how proteins, carbohydrates, lipids and nucleic acids contribute to structural integrity of the cell
- Detail on various metabolic and information pathways
- Comprehend the concepts in nutrition and importance of proper nutrition thus laying a foundation for the field of nutrition and dietetics
- Co-relate the properties of biomolecules with their applications in industrial biochemistry
- Learn basic experimental skills in biochemistry and use basic statistics for the analysis of data
- Appreciate the role of computers in biology and get motivated towards learning the ever-expanding fields of Clinical Biochemistry, Genomics, Proteomics and Bioinformatics

T.Y.B.Sc. Biochemistry (3 units) Syllabus

Credit Based Semester and Grading System

To be implemented from the academic year 2018 – 2019

Summary of Course-wise Units of Semester V

Course Code	Unit	Topics	Credits	L/week
SIUSBCH51	NUTRITION, BIOMOLECULES AND BIOPHYSICAL CHEMISTRY-I		2.5	
	I	Basic concepts in nutrition; Carbohydrates		1
	II	Amino acids and Proteins		1
	III	Nucleic acids; Enzymes		1
	IV	Spectroscopy; Centrifugation		1
SIUSBCH52	PHYSIOLOGY, METABOLISM, AND APPLIED BIOCHEMISTRY-I		2.5	
	I	Carbohydrate metabolism		1
	II	Amino acid metabolism; Bioenergetics		1
	III	Plant growth regulators; Endocrinology		1
	IV	Fundamentals of Molecular Biology		1
SIUSBCHP5		Practical of course SIUSBCH51 and SIUSBCH52	3	8

Summary of Course-wise Units of Semester VI

Course Code	Unit	Topics	Credits	L/week
SIUSBCH61	NUTRITION, BIOMOLECULES AND BIOPHYSICAL CHEMISTRY-II		2.5	
	I	Basic concepts in nutrition; Lipids		1
	II	Membrane biochemistry; Concept of pH and Buffers		1
	III	Chromatography		1
	IV	Electrophoresis		1
SIUSBCH62	PHYSIOLOGY, METABOLISM AND APPLIED BIOCHEMISTRY-II		2.5	
	I	Lipid metabolism		1
	II	Basics of Immunology		1
	III	Industrial Biochemistry; Basics of tissue culture		1
	IV	Recombinant DNA technology; Introduction to Bioinformatics		1
SIUSBCHP6		Practical of course SIUSBCH61 and SIUSBCH62	3	8

T.Y.B.Sc.- BIOCHEMISTRY
3 – UNITS INTERDISCIPLINARY SUBJECT
Semester V (SIUSBCH5)

COURSE TITLE: **NUTRITION, BIOMOLECULES AND BIOPHYSICAL CHEMISTRY -I**
COURSE CODE: **SIUSBCH51**
CREDITS: 2.5

Unit No.	Topic No.	Contents	NOL
		Objectives: 1. To comprehend the concepts in nutrition and the importance of proper nutrition, thus laying a foundation for the field of nutrition and dietetics. 2. To help students understand the physico-chemical properties and biochemical role of carbohydrates, proteins and nucleic acids. 3. To lay a strong foundation of concepts in enzyme and enzyme kinetics. 4. To understand the principle, instrumentation and applications of various biophysical techniques like centrifugation and spectroscopy	
I		**Basic Concepts in nutrition ; Carbohydrates**	15
	1.1	**Basic Concepts in human nutrition**: Proximate principles, energy content of food and calorific value	
	1.1.1	Utilization of energy, Units of energy, BMR, factors affecting BMR and its significance. Concept of thermic effect of food (SDA)	
	1.1.2	Physical activity and energy requirements of man.	
	1.2	**Carbohydrates**	
	1.2.1	classification of carbohydrates (mono, oligo & poly) with examples	
	1.2.2	Properties and classification of monosaccharides in terms of – A) functional group and B) Number of carbon atoms	
	1.2.3	Carbohydrate chemistry: Fischers and Haworth formula of glucose Isomers of glucose: D and L, aldose-ketose, optical isomers, epimers and anomers	

	1.2.4	Structure and occurrence of Glucose, Fructose, Galactose, ribose and deoxyribose Disaccharides: maltose, lactose, sucrose	
	1.2.5	Polysaccharides- Classification based on function (storage & structural), composition (homo & hetero) giving examples Storage polysaccharides (Starch and Glycogen), action of amylase on starch. Structural polysaccharides - Cellulose, Chitin	
	1.2.6	Bacterial cell wall polysaccharide: Peptidoglycan framework (With structures of NAG & NAMA), beta lactam antibiotics- Penicillin and cephalosporin	
	1.2.7	Extracellular matrix proteoglycan - Hyaluronate, Chondroitin sulphate and Heparin (monomers and occurrence/Biomedical significance)	
	1.2.8	Nutritional importance of carbohydrates Functions of carbohydrates, Requirement, Dietary sources, Glycemic index, Significance of fiber	
	1.2.9	Commercial importance of carbohydrates: Starch, Cyclodextrin, chitosan, modified cellulose, pectin ;	
II		**Amino acids and Proteins**	15
	2.0	**Amino acids**	
	2.1.1	Classification of amino acids based on the polarity of R-groups (structure of 20 amino acids with three letter and single letter code words)	
	2.2	**Proteins**	
	2.2.1	Proteins: ASBC-APS classification on the basis of shape and function.	
	2.2.2	Structural hierarchy of proteins Primary structure: Formation and characteristics of peptide bond, phi and psi angles Secondary structure: alpha helix- characteristics, forces stabilizing, factors influencing helix stability. Example: keratin beta sheet: characteristics, parallel/ antiparallel, forces stabilizing, example: silk fibroin Tertiary structure - forces stabilizing, example myoglobin Quaternary structure - forces stabilizing, example hemoglobin	
	2.2.3	Primary structure determination Separation of polypeptide chains, breaking disulphide bonds by mercaptoethanol, End group analysis: Sanger reaction, Edman reaction, Dansyl chloride. Cleavage of polypeptide- Trypsin, Chymotrypsin,	

		Pepsin, Aminopeptidase, Carboxypeptidase.	
	2.2.4	Protein denaturation	
	2.2.5	Nutritional significance of proteins Functions of proteins, Requirement, Dietary sources, essential amino acids, Nutritive value of proteins: BV and PER	
III	3.0	**Nucleic acid; Enzymes**	15
	3.1	**Nucleic acids:**	
	3.1.1	Structure of purine and pyrimidine bases, nucleosides and nucleotides, formation of polynucleotide strand with its shorthand representation.	
	3.1.2	RNAs- (various types in pro and eukaryotes), rRNA, t-RNA, m-RNA, their structure and function. Action of alkali on RNA	
	3.1.3	DNA: double helix, Watson –Crick model of DNA and its characteristic features, Forces stabilizing the secondary structure. Structure elucidation: Rosalind Franklin- X-ray diffraction pattern (Physical evidence), Chargaff's rules (Chemical evidence), A, B and Z forms of DNA, Organization of DNA as Chromatin	
	3.1.4	Physical properties of DNA - UV absorption, Hypochromism, Hyperchromism, Denaturation of DNA, Tm.	
	3.2	**Enzymes and Enzyme kinetics**	
	3.2.1	General properties of enzymes, Classification of enzymes- IUB/EC classification (up to I digit)	
	3.2.2	Active site of enzyme, mechanism of action: lock and key, induced fit, transition state theory. Cofactors, Coenzymes (role of vitamins), Prosthetic groups, Apoenzyme and Holoenzyme	
	3.2.3	Enzyme kinetics Factors affecting enzyme-catalysed reaction Derivation of Michaelis- Menten equation, Km, Lineweaver Burk plot, Catalytic efficiency- turn over number, Enzyme activity: Katal, IU Specific activity of enzyme.	
	3.2.4	Enzyme inhibition: Competitive and Noncompetitive.	
IV	4.0	**Centrifugation; Spectroscopy**	15
	4.1	**Centrifugation**	
	4.1.1	General Principle, rpm, RCF, derivation of equation relating RCF and rpm	
	4.1.2	Types of centrifuges and rotors - Clinical, High Speed,	

Ultra –preparative and Analytical

4.1.3 Components and working of - Analytical Ultracentrifuge.

4.1.4 Applications of centrifugation – Use of preparative centrifuge in the separation of cell organelles by differential centrifugation, proteins by rate zonal centrifugation and nucleic acids by isodensity centrifugation.

4.1.5 Use of Analytical Ultracentrifugation in the determination of molecular weights (sedimentation velocity method), conformational studies and purity of a sample.

4.1.6 Numerical problems based on above concepts

4.2 Spectroscopy

4.2.1 General Principle, derivation and limitations of Beer-Lambert law, significance of Lambda max, molar extinction coefficient

4.2.2 Construction and working of simple colorimeter (Single beam) and a spectrophotometer.

4.2.3 Applications of Beer Lambert Law in estimation of Proteins (Biuret method), Sugars (DNSA method).

4.2.4 Numerical problems based on above concepts

Semester V

COURSE TITLE: **PHYSIOLOGY, METABOLISM, AND APPLIED BIOCHEMISTRY-I**

COURSE CODE: **SIUSBCH52**

CREDITS: 2.5

Unit No.	Topic No.	Contents	NOL
		Objectives: 1. To provide an insight about metabolism of carbohydrates and amino acids/proteins 2. To understand the concepts of thermodynamics and its application in living system 3. To study the energy synthesis pathways in plants and animals 4. To study the molecular biology and processes of information transfer 5. To comprehend the role of growth regulators in plants and the chemistry and function of hormones in animals.	
I	1.0	**Carbohydrate metabolism**	15
	1.1	Introduction to metabolism: Catabolism, anabolism, role of high energy phosphates viz. ATP and thioesters, role of reduced coenzymes NADH and NADPH.	
	1.2	Digestion and absorption of carbohydrates Overview of catabolism, Glycogenolysis (Schematic) Catabolism of glucose: Glycolysis- cellular location, sequence of reactions, products, energetics Fate of pyruvate in aerobic and anaerobic conditions. Kreb's cycle: cellular location, sequence of reactions, products, energetics, amphibolic nature.	
	1.3	Anabolism - HMP Shunt (Synthesis of pentose phosphates) -Cellular location, sequence of reactions, oxidative and non-oxidative phases of pathway and multifunctional nature. Gluconeogenesis, Glyoxylate pathway. Glycogenesis (Schematic)	
	1.4	Anaplerotic reactions – Role of Pyruvate carboxylase, PEP carboxykinase, Malic enzyme.	

II **2.0** **Amino acid metabolism; Bioenergetics** **15**

2.1 Amino acids and Protein Metabolism

2.1.1 Digestion and absorption of proteins and amino acids

2.1.2 Catabolism - reactions –Transamination (GOT/GPT and mechanism of transamination)

2.1.3 Decarboxylation of His,Trp, Glu and physiological significance of the products

2.1.4 Deamination: Oxidative (NAD, FAD, FMN-linked oxidases) & Non-oxidative – Asp, Cys, Ser

2.1.5 Urea Cycle - Cellular location, sequence of reactions, labeling of N-atom, formation and transport of ammonia.

2.2 Bioenergetics

2.2.1 **Mitochondrial ETC**

Free energy, free energy change, exergonic and endergonic reactions.
High energy compounds, ATP, Synthesis of ATP, Substrate level and oxidative phosphorylation

Oxidative Phosphorylation:
Electron transport chain: electron carriers, redox potentials, basic chemistry, sequence and location of these electron carriers in mitochondrial membrane, Q cycle.
Inhibitors of ETC:–Antimycin A, Amytal, Rotenone, CN,
Mechanism of ATP synthesis:
Chemiosmotic hypothesis, Proton motive force, Structure of ATPase (F_oF_1 ATPase)

2.2.2 **Photosynthesis**

Light-dependent and Light-independent reactions.
Light dependent reactions, chloroplast, role of reaction center and accessory pigments
Photophosphorylation:
Linear ETC / Z scheme, two reaction centers, production of oxygen and NADPH, proton gradient and ATP synthesis
Cyclic ETC in purple bacteria
Light-independent reactions: Calvin cycle (schematic representation only)

III	**3.0**	**Plant growth regulators; Endocrinology**	**15**
	3.1	**Plant growth regulators:** Role of auxins, cytokinins, abscissic acid, gibberellins and ethylene	
	3.2	**Endocrinology:**	
	3.2.1	Hormones, hormone receptor,	
	3.2.2	classification of hormone on the basis of chemistry, organization of the endocrine system	
	3.2.3	Chemistry, synthesis, secretion and metabolic effects of thyroxine, insulin.	
	3.2.4	Chemistry & physiological role of oxytocin and	
	3.2.5	vasopressin. Physiological role of Glucocorticoids,	
	3.2.6	Epinephrine Endocrine disorders – Diabetes mellitus, Diabetes insipidus, Hypothyroidism (Cretinism & myxedema), Hyperthyroidism (Goitre – Simple & Toxic)	
	3.2.7	Role of second messengers: cAMP, Ca and IP3, Mechanism of action of epinephrine (on glycogenolysis) and steroid hormone (on gene expression).	
IV	**4.0**	**Fundamentals of molecular biology**	**15**
	4.1	**Cell cycle : phases and significance**	
	4.2	**Replication of DNA** - mechanism of replication, modes of DNA replication, experimental evidence for semi-conservative replication, Mechanism, discontinuous DNA synthesis, termination of replication.	
	4.3	**Transcription of DNA** - in prokaryotes, prokaryotic RNA polymerases, Steps in transcription, processing of RNA species, concept of split genes, reverse transcription	
	4.4	**Translation** (protein biosynthesis) in prokaryotes - activation of amino acids, chain initiation, chain elongation, chain termination, post translational modifications of proteins	
	4.5	**Gene regulation**: Promoters, enhancers, Concept of operon, Lac operon	

PRACTICAL based on SIUSBCH51& SIUSBCH52
SIUSBCHP5

Sr No.	Experiments
I	**Preparation of solution** Units for expressing concentration Preparation of solution of given concentration and problems based on the above concepts.
II	**Qualitative Analysis: -** 1.Carbohydrates - Glucose, Fructose, Maltose, Lactose, Sucrose, Starch, Dextrin. 2. Proteins - Albumin, Casein, Gelatin, Peptone.
III	**Estimation of biomolecules** **Volumetric analysis:-** 1.Lactose by Cole's method/Glucose by Benedict's method **Colorimetric analysis: -** 1. Verification of Beer-Lambert law and determination of lambda max of colored solution 2. Soluble proteins by Biuret method 3.RNA by Orcinol method 4. Glucose / Maltose by DNSA method
IV	**Isolation** 1. Starch from potato. 2. Casein from milk
V	**Enzymology** 1. Optimum pH of amylase 2. Amylase: Km of amylase
VI	**Biostatistical analysis:** 1.Collection of data, types of data and presentation 2. Frequency distribution 3. Determination of mean, median and mode
VII	**Demonstration Experiments** 1. Preparation of buffers and use of pH meter 2. Extraction of a phytoconstituent (alkaloid/ flavonoid/pigment) by any one extraction method; distillation, Soxhlet/ solvent 3. Immobilization /entrapment of enzyme (amylase) in alginate 4. Glucose by Folin –Wu method

Semester VI
(SIUSBCH6)

COURSE TITLE: **NUTRITION, BIOMOLECULES AND BIOPHYSICAL CHEMISTRY-II**

COURSE CODE: **SIUSBCH61**
CREDITS: 2.5

Unit No.	Topic No.	Content	NOL

Objectives:

1. To study the basic concepts in nutrition and understand the importance of vitamins and minerals in nutrition.
2. To familiarize the students to the physic-chemical properties and biochemical role of lipids
3. To emphasize on the structure and function of cell membrane and the role of proteins involved in transport of molecules across membrane.
4. To understand the principle, working and applications of various biophysical techniques like chromatography and electrophoresis

I **1.0 Basic Concepts in Nutrition; Lipids** **15**

1.1 Concepts in nutrition:

1.1.1 Energy balance: Normal weight, underweight and obesity, BMI, Nutritional significance of

- vitamins, Deficiency disorders
- Minerals: Fe, Ca, P, Mg

1.2 Lipids

1.2.1 Fatty acids & TAG :
Saturated fatty acids –classification, C2 to C20 (only even C chain fatty acids)
Unsaturated fatty acids – MUFA, PUFA (2,3,4 db), Omega 3, Omega 6 and Omega 9 fatty acids.
Triacylglycerols - Simple and mixed.

1.2.2 Chemical reactions - Saponification, Iodination, Auto-oxidation, Rancidity of fats. Definition and significance - Acid Number, Saponification Number, Iodine Number and Reichert- Meissel Number

1.2.3 Compound lipids –
Structure and function of Glycerophospholipids (Cephalin, Lecithin and Phosphotidyl inositol), Action of Phospholipases Functions of p hosphosphingolipids (ceramide, Sphingomyeline), Glycolipids or Cerebrosides (Galacto and Glucocerebrosides)

1.2.4 Steroids and Lipoproteins
Steroids - Cholesterol structure and biochemical significance
Lipoproteins –Types (Chylomicron, VLDL, LDL, HDL) and biochemical significance.

1.2.5 Nutritional significance of lipids

II 2.0 Membrane biochemistry ; Concept of acids, bases and buffers 15

2.1 **Membrane biochemistry**

2.1.1 Biological membrane -Membrane constituents and assembly: Fluid-mosaic model, Lipid bilayer, asymmetric distribution of lipids Membrane

2.1.2 proteins : integral/transmembrane, Lipid-linked and peripheral

2.1.3 Erythrocyte membrane model

2.1.4 Membrane transport:
Active and Passive, pumps and channels Na^+ – K^+ pump, inhibitors, Secondary transporters- antiporters, symporters.

2.2 **Concept of acids, bases and buffers**

2.2.1 Water –properties and role, dissociation and ionic Product.

2.2.2 Acids and bases, hydrogen ion concentration and pH, dissociation, Hendersen –Hasselbalch equation Titration curve of acetic acid, pKa value.

2.2.3 Ionization and titration curve of ala, Gly, Lys and Asp, pI and pKa values of these amino acids.

2.2.4 Importance of pH in cells,
Buffers, buffer value/capacity, common laboratory buffers, physiological Buffers (Carbonate buffer, phosphate buffer and protein buffer).

2.2.5 Numerical problems based on above concepts.

III	**3.0**	**Chromatography**	**15**
	3.1	**Chromatography :** Principle, requirements, technique and applications of - Partition chromatography (Paper), Adsorption chromatography (TLC and Column), Ion exchange chromatography (Column) and Gel filtration chromatography.	
	3.2	Introduction to GLC, HPLC and Affinity Chromatography -Principles only.	
	3.4	Numerical problems based on above concepts.	
IV	**4.0**	**Electrophoresis**	**15**
	4.1	Principles of electrophoresis, factors affecting the Electrophoretic mobility.	
	4.2	Types of electrophoresis: Moving boundary, Zone electrophoresis (horizontal), set up, Support media (paper, cellulose acetate, agar, agarose and polyacrylamide), technique, detection and recovery.	
	4.3	PAGE: Native and SDS, discontinuous electrophoresis for separation of proteins.	
	4.4	Applications of electrophoresis - Separation of proteins and nucleic acids, Purity determination, Molecular weight determination using PAGE.	
	4.5	Isoelectric focusing	

Semester VI

COURSE TITLE: **PHYSIOLOGY, METABOLISM, AND APPLIED BIOCHEMISTRY-II**
COURSE CODE: **SIUSBCH62**
CREDITS: 2.5

Unit No.	Topic No.	Contents	NOL
		Objectives: 1. To study biochemical oxidation and synthesis of fats 2. To understand the basics of immunology 3. To familiarize the students to bioprocess technology and its applications 4. To study the basic techniques of tissue culture 5. To study recombinant DNA technology and its applications 6. To introduce the field of bioinformatics and make understand the scope, applications and potentials of bioinformatics.	
I	1.0	**Lipid metabolism**	15
	1.1	Digestion and absorption of lipids	
	1.2	Catabolism - Knoop's experiment, Beta – oxidation of even carbon saturated fatty acids, role of carnitine, energetics from C4 to C20	
	1.3	Anabolism - Fatty acid biosynthesis (only Palmitic acid), fatty acyl synthetase complex.	
	1.4	Ketone bodies formation, utilization. Ketosis, physiological significance in Diabetes mellitus, starvation, alcoholism and pregnancy.	
	1.4	Lipoprotein metabolism.	
II	2.0	**Basics of immunology**	15
	2.1	Immunity, antigen, hapten and antibody. Types of immunity: Innate, Acquired, Active and Passive Innate immunity: External barriers, Phagocytosis, Complement, Natural Killer cells	
	2.2	Acquired immunity: Humoral and Cell-mediated Specificity, Self-Nonself recognition Humoral immunity: B cells, plasma cells, functions of antibody. Cell-mediated: T cells, subsets-T helper and cytotoxic T cells, MHC – class I and II.	
	2.3	Cells and organs of immune system.	

2.4 Immunoglobulins general structure, classes and sub-Classes- their structure and functions.

2.5 Antigen– antibody reactions - Precipitation and agglutination.

III 3.0 Industrial biochemistry ; Tissue culture techniques **15**

3.1 Bioprocess technology – Introduction, Steps in setting
3.1.1 up an industrial process, parameters, Selection of organism, screening, types of media, Batch and continuous fermentation, Basic components of a typical fermenter, Downstream processing

3.1.2 Applications

3.1.3 Fermentation process for production of alcohol/wine/beer

3.2 Tissue Culture: Plant and Animal

3.2.1 Requirements: Physical conditions, Nutritional requirements, General technique, explant, callus, totipotency, dedifferentiation, redifferentiation, role of plant growth regulators.

3.2.2 Different types of tissue culture techniques, protoplast fusion

3.2.3 Applications of tissue culture

IV 4.0 Recombinant DNA technology; Introduction to bioinformatics **15**

4.1 Recombinant DNA technology

4.1.1 Genetic engineering – Steps in DNA cloning, Restriction enzymes, Isolation of gene from cellular chromosomes, Cloning vectors (Plasmid, Phage, Cosmid, Improved vectors, and shuttle vectors), transformation, and selection of recombinant cells.

4.1.2 Cloning of insulin gene

4.1.3 Transgenic plants – Bt cotton, Cloning in plants using Ti plasmid.

4.1.4 Gene libraries, DNA probes

4.1.5 DNA amplification by PCR, applications of PCR

4.1.6 Applications of recombinant DNA technology.

4.2 Introduction to bioinformatics

4.2.1 History of Bioinformatics, Genomics and Proteomics

4.2.2 Databases- types – Public domain database, Sequence database, Structural database, Motif database, Genome database, Proteome database, Annotated sequence database – Gen Bank, EMBL, PIR, SWISS PROT, PDB, GDB.

4.2.3 Sequence analysis Tools - BLAST, FASTA, L-ALIGN, CLUSTAL-X & W, RASMOL, Software for protein sequencing - PROPECT, AMMP, COPIA

4.2.4 Applications of Bioinformatics in – Sequence analysis, Molecular modeling and drug designing, Phylogeny/evolution, Ecology & population studies, Medical informatics and agriculture.

4.2.5 Micro-array analysis-concept

PRACTICALS based on SIUSBCH61 & SIUSBCH62
SIUSBCHP6

S.No.	Experiments
I	**Isolation** 1. Isolation of DNA and detection
II	**Food analysis** **Mineral Estimation :-** Preparation of food ash 1. Calcium by EDTA method 2. Iron by Wongs method 3. Phosphorus by Fiske-Subbarow method **Vitamin estimation** 1. Estimation of vitamin C / V itamin B1 2. Tests for lipid quality: Acid number
III	**Chromatography** 1. Circular paper chromatography of amino acids 2. Circular paper chromatography of sugars
IV	**Antigen-antibody reactions** Immunodiffusion (Precipitation)
V	**Microbiology** 1. Monochrome, Gram and negative staining 2. Isolation of bacteria : streaking and spreading
VI	**Biostatistical analysis (measures of dispersion)** Determination of SD and variance
VII	**Demonstration Experiments:-** 1. Separation of DNA by agarose gel electrophoresis 2. Column chromatography - separation of chlorophylls 3. Agglutination reaction: Blood grouping or Widal qualitative 4. 2D paper/2D TLC chromatography of complex mixture of amino acids/sugars 5. Preparation of media 6. Bioinformatics: Sequence retrieval, Introduction to protein structure database

SCHEME OF EXAMINATION

Biochemistry, as an interdisciplinary subject, consists of 03 (Three) Units of T.Y.B.Sc. carrying 600 marks as follows :

THEORY				
COURSE CODE	**Title of Paper**	**Internal Assessment marks**	**Semester end Examination marks**	**Total Marks**
SIUSBCH51	Nutrition, Biomolecules and Biophysical Chemistry I	40	60	100
SIUSBCH52	Physiology, Metabolism and Applied Biochemistry I	40	60	100
	TOTAL			**200**
SIUSBCH61	Nutrition, Biomolecules and Biophysical Chemistry II	40	60	100
SIUSBCH62	Physiology, Metabolism and Applied Biochemistry II	40	60	100
	TOTAL			**200**

PRACTICAL		
COURSE CODE	**Marks per course**	**Total per semester**
SIUSBCH5	100 for SIUSBCH51 and SIUSBCH52	**100**
SIUSBCH6	100 for SIUSBCH61 and SIUSBCH62	**100**
TOTAL		**200**

SCHEME OF PRACTICAL EXAMINATION
SEMESTER V

Course SIUSBCHP5	Experiments	Marks
	a. Isolation	20
	b. Estimation of biomolecule: Colorimetry/ Volumetry	15
	c. Enzymology	20
	d. Spots (Statistical analysis -10M; Qualitative and Demonstration experiments-15M)	25
	e. Certified Journal*	10
	f. *Viva voce*	10
	TOTAL	**100**

* Candidate without duly certified Journals **shall not** be allowed to appear for the University Practical Examination.

1. The Sem V practical examination shall be conducted by the college
2. There shall be 02 (Two) examiners to conduct the practical examination, one Internal examiner and other external examiner
3. The external examiner shall be on the panel of examiner
4. The college shall invite one such examiner from approved panel as an external examiner
5. Duration for the Practical examination for Sem V
   a) One day of 02 sessions of 3 ½ hours each
   b) Morning session: 09.00 am to 12.30 pm
      Afternoon session: 01.00 pm to 4.30 pm

SCHEME OF PRACTICAL EXAMINATION

SEMESTER VI

Course SIUSBCHP6	Experiments	Marks
	a. Chromatography	20
	b. Colorimetric Analysis/Isolation of DNA	15
	c. Volumetric Analysis	15
	d. Spots (statistical Analysis – 15 M; Microbiology, Immunodiffusion and Demonstration- 15M)	30
	e. Certified Journal*	10
	f. Viva voce	10
	TOTAL	**100**

* Candidate without duly certified Journals **shall not** be allowed to appear for the Sem end Practical Examination.

1. The Sem VI practical examination shall be conducted by the College.
2. There shall be 02 (Two) examiners, one internal and other appointed from the panel of approved examiners.
3. Duration for the Practical examination for Sem VI

a) One day of 02 sessions of 3 ½ hours each
b) Morning session: 09.00 am to 12.30 pm
c) Afternoon session: 01.00 pm to 4.30 pm.

I. Scheme of Examination for Third year Science Undergraduate

External Examination : 60%
Internal Examination : 40%

A. Scheme of External Theory examination at TYBsc. (Sem V and Sem VI)

1) Each theory paper shall carry **60 marks**
2) Each theory paper shall be **2 hours** duration
3) Each theory paper shall contain **04 questions of 15 marks each** as follows: -

Q1 Based on Unit I
Q2 Based on Unit II
Q3 Based on Unit III
Q4 Based on Unit IV

4) Marking system for **Questions I to IV**

Sub Q A: Attempt any three out of four (Objectives/MCQs)------- 03marks each

Sub Q B: Attempt any one out of two ------- 02 marks each

Sub Q C: Attempt any one out of two ------- 04marks each

Sub Q D: Attempt any one out of two ------- 06 marks each

B. Internal Assessment:

Sr. No.	Particulars	40 Marks
1	ONE class test to be conducted in the given semester (Objectives and /or MCQs/answer in one or two sentences: 20M)	20 Marks
2	One activity/oral presentation/assignment based on curriculum/ report etc.to be assessed by the teacher	20 Marks

C. For Courses with Practical: There will not be any Internal Examination for practicals

D. External Examination for practicals:

Sr. No.	Particulars for External Practical Examination		Marks
	Particulars for External Practical Examination Semester End		100 Marks
1	Laboratory	80 Marks	
2	Journal	10 Marks	
3	Viva	10 Marks	

II. Educational tour /Industrial Visit

It is recommended that the TYBSc students be taken for an Educational tour / Industrial visit in Mumbai /Maharashtra/ other States in India to visit various Universities/ research centers/Industries (Pharma, Food, chemical, Biochemical, Beverages, Oil, etc.) to give first-hand knowledge of current trends in research and the exposure to the working of industry, academia and research centers.

A summary report of this Educational tour / Industrial visit may be evaluated for 10 marks as a part of the 20 marks activity-based internal assessment.

Suggested Reading

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: life at the molecular level. John Wiley & sons.
3. Zubay, G. (1993). Biochemistry, Wm. C. *Brown Publishers, Dubuque*, *302312223*, 2.
4. Berg, J. M., Tymoczko, J. L., Stryer, L., & Clarke, N. D. (2002). Biochemistry. 2002. *New York, New York*, *10010*.
5. White, A., Handler, P., & Smith, E. L. (1964). Principles of biochemistry. *Academic Medicine*, *39*(12), 1136. Mc Graw and Hill publishers
6. Murray, R. K., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2003). Harper's illustrated biochemistry. A Lange medical book. *Section*, *3*, 254.
7. Upadhyay, A. (2009). *Biophysical chemistry*. Himalaya Publishing House.
8. Wilson, K., & Walker, J. (Eds.). (2000). *Principles and techniques of practical biochemistry*. Cambridge University Press.
9. Cooper, T. G. (1977). *The tools of biochemistry* (No. 574.192028 C6).
10. Conn, E., & Stumpf, P. (2009). *Outlines of biochemistry*. John Wiley & Sons.
11. Boyer, R. F., & Boyer, R. (1986). *Modern experimental biochemistry* (pp. 119-144). Reading: Addison-Wesley.
12. Sawhney, S. K., & Singh, R. (Eds.). (2000). *Introductory practical biochemistry*. Alpha Science Int'l Ltd..
13. Segel, I. H., & Segel, A. H. (1976). *Biochemical calculations: how to solve mathematical problems in general biochemistry* (No. 04; QD415. 3, S4 1976.). New York:: Wiley.
14. Hall, J. E. (2015). *Guyton and Hall textbook of medical physiology e-Book*. Elsevier Health Sciences.
15. Hall, J. E. (2015). *Guyton and Hall textbook of medical physiology e-Book*. Elsevier Health Sciences.
16. Orten, J. M., Neuhaus, O. W., & Kleiner, I. S. (1975). *Human biochemistry* (No. 574.192 O7). CV Mosby.

17. Davidson, S., & Passmore, R. (1963). Human nutrition and dietetics. *Human nutrition and dietetics.*, (2nd ed).
18. Joshi, S. A. (1995). *Nutrition and dietetics*. McGraw-Hill Education.
19. Srilakshmi, B. (2006). *Nutrition Science*. New Age International.
20. Lewin, B. (2004). *genes VIII* (No. 04; QH430, L4.
21. Russell, P. J., & Gordey, K. (2002). *IGenetics* (No. QH430 R87). San Francisco: Benjamin Cummings.
22. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology* (p. 692). New York: WH Freeman.
23. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Essential immunology*. John Wiley & Sons.
24. Gajera, H. P., Patel, S. V., & Golakiya, B. A. (2008). *Fundamentals Of Biochemistry Textbook Student Edition*. IBDC Publishers.
25. Casida, L. E. (1968). Industrial microbiology. *Industrial microbiology.*
26. Mahajan, B. K., & Lal, S. (1999). Methods in biostatistics for medical students and research workers. *Indian Journal of Community Medicine*, *24*(03), 140.
27. Rastogi, S. C., Rastogi, S. C., Mendriratta, N., & Rastogi, P. (2006). *Bioinformatics: Concepts, Skills & Applications*. CBS Publishers & Distributors Pvt. Limited.
28. Jogdand, S. N. (2010). *Environmental biotechnolog*. Himalaya Pub. House,
29. Gupta, P. K. (1994). *Elements of biotechnology*. Rastogi publications.
30. Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

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 2019-2020

(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. SIUSMIC51and 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**

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, viriods 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)**
	UNIT I <u>DNA REPLICATION</u> 1.1. **Historical perspective**— conservative, dispersive, semi-conservative, Bidirectional and semi- discontinuous 1.2. **Prokaryotic DNA replication** – Details of molecular mechanism involved in Initiation, Elongation nd Termination 1.3. **Enzymes and proteins associated with DNA replication**- primase, helicase, topoisomerase, SSB, DNA polymerases, ligases, Ter and Tus proteins 1.4. **Eukaryotic DNA replication--** Molecular details of DNA synthesis, replicating the ends of the chromosomes 1.5. **Rolling circle mode of replication**	**15L** **4L** **4L** **4L** **2L** **1L**	**15**
	UNIT II <u>MUTATION AND REPAIR</u> **2.1. Mutation** 2.1.a.**Terminology:** alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes **2.1. b. Fluctuation test**.	**15 L** **2L** **1L**	**15**
	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**	

	2.1.d. **Causes of mutation:** Natural/spontaneous mutation--replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for – i. Chemical mutagens- base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. ii. Physical mutagen iii. Biological mutagen(only examples) 2.1. e. **Ames test** **2.2 DNA Repair** a. Mismatch repair b. Light repair c. Repair of alkylation damage d. Base excision repair e. Nucleotide excision repair f. SOS repair	**5 L** **1L** **4L**	
	UNIT III <u>GENETIC EXCHANGE</u> **3.2.a. Transformation** i. Introduction and History ii. Types of transformation in prokaryotes- Natural transformation in *Streptococcus pneumoniae, Haemophilus influenzae,* and *Bacillus subtilis* iii. Mapping of bacterial genes using transformation. iv. Problems based on transformation **3.2.b. Conjugation** 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	**15L** **4L** **5L**	**15L**

	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 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)**
	Unit I: MEDICAL MICROBIOLOGY- I 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. **1. Respiratory tract infections** i. *S. pyogenes* infections ii. Influenza iii. Tuberculosis *iv.* Pneumonia caused by *K.pneumoniae and S.pneumoniae* **2. Study of urinary tract infections** **3. CNS infections** i. Tetanus ii. Polio iii. Bacterial meningititis	**15L** **8L** **3L** **4L**	**15**
	UNIT II : MEDICAL MICROBIOLOGY- II Study of few diseases (w.r.t. Cultural characteristics of the etiological agent, pathogenesis and clinical features, laboratory diagnosis, treatment and prevention only) **2.1 Study of skin infections** *i.* Pyogenic skin infections caused by *Pseudomonas and S.aureus* ii. Leprosy	**15** **7L**	**15**

	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**	

	UNIT III : GENERAL IMMUNOLOGY-I	**15L**	**15**
	3.1 Antigens Immunogenicity versus antigenicity: Concepts-Immunogenicity, Immunogen, Antigencity, 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 Bcells Types of antigens – heterophile antigens, isophile antigens, sequestered antigens, super antigens, bacterial and viral antigens	**6L**	
	3.2 Immunoglobulins Basic structure, types of heavy and light chains, constan variable regions, Immunoblobulin domains-hinge region Basic concepts - hypervariable region, complementarity determining regions (CDRs), framework regions (FRs) and their importance. Immunoglobulin classes and biological activities - Immunogloublin G, Immunogloublin M, Immunogloublin A, Immunogloublin E, Immunogloublin D, (including diagrams)	**6L**	
	Antigenic determinants on immunoglobulins – isotypes, allotypes,idiotypes. Immunoglobulin Superfamily **3.3 Monoclonal antibodies** Production and application	**3L**	

	UNIT IV : GENERAL IMMUNOLOGY- II	**15L**	**15**
	4.1 Antigen Antibody reactions Precipitation reaction -Immunoelectrophoresis 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.	**8L** **3L**	
	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	**4L**	
	4.3 Antigen presenting cells Types of APC's Endogenous antigens: The cytosolic pathway Exogenous antigens: The endocytic pathway		

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

SEMESTER V: TEXT BOOKS AND REFERENCE BOOKS

SIUSMIC51: Text books

1. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., W. H. Freeman andcompany.
2. D,.Nelson and M.Cox, (2005), "Lehninger's Principles of biochemistry", 4th ed.,Macmillan worth Publishers.
3. Fairbanks and Anderson, (1999), "Genetics", Wadsworth PublishingCompany.
4. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th ed., Pearson Education International.
5. Nancy Trun and Janine Trempy, (2004), "Fundamental bacterial genetics",Blackwell Publishing
6. Peter J. Russell (2006), "Genetics-A molecular approach", 2nded.
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", 3rdedn. 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

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)**
Unit1	MEDICAL MICROBIOLOGY III	**15 L**
Unit II	CHEMOTHERAPY	**15 L**
Unit III	IMMUNOLOGY III	**15 L**
Unit IV	IMMUNOLOGY IV	**15 L**

SIUSMIC-61 (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, viriods 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, viriods and their mechanisms
5. Understand regulation of lambda phage

SIUSMIC-61: DETAIL SYLLABUS

Course Code	Title	L/ Semester	Notional Periods
SIUSMIC601	**RECOMBINANT DNA TECHNOLOGY, BIOINFORMATICSandVIROLOGY**	**2.5 Credits (60 L)**	**Self Study (60)**
	UNIT I **RECOMBINANT DNA TECHNOLOGY** **1. 1 Recombinant DNA technology:** 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.** **1.3 Cutting and joining DNA molecules**--Restriction and modification systems, restriction endonucleases, DNA ligases **1.4 Vectors** i. Plasmids as cloning vectors. The plasmid vectors, pBR322 vector ii. Cloning genes into pBR322 ii. Phage as cloning vectors, cloning genes into phage vector iv. Cosmids v. Shuttle vectors- YAC, BAC **1.5 Methods of artificial transformation** **1.7.Screening and selection methods for identification and isolation of recombinant cells**	**15** **3L** **1L** **2L** **4L** **2L** **3L**	**15**

	UNIT II **MOLECULAR BIOLOGY & BIOINFORMATICS** **2.1 Molecular Biology Techniques** 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) **2.2 Bioinformatics** A. Introduction 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. B. Brief introduction to Transcriptome, Metabolomics, Pharmacogenomics, 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.	**15L** **5L** **7L** **3L**	**15**
	UNIT III BASIC VIROLOGY **3.1. Viral architecture-** Capsid, viral genome and envelope Structure of TMV, T4, Influenza virus, HIV.	**15L** **4L**	**15**

	3.2 Viral classification (Baltimore) **3.3 The viral replication cycle**- attachment, penetration, uncoating, types of viral genome and their replication, assembly, maturation and release. **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	**2L** **4L** **5L**	
	UNIT IV **ADVANCED VIROLOGY** **4.1 Life cycle of animal virus:-** Influenza, HIV, Polio **4.2 Life cycle of Plant viruses:**-TMV **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. **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.	**15L** **5L** **3L**	**15**

	4.3 Regulation of lytic and lysogenic pathway of lambda phage	**3L**
	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	**2L**
	4.5 Prions and viroids	**2L**

SIUSMIC-62 (MEDICAL MICROBIOLOGY andIMMUNOLOGY-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 ofprophylaxis 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)**
	UNIT I **MEDICAL MICROBIOLOGY III** Study of a few diseases with emphasis on cultural characteristics of the aetiological agent, pathogenesis, laboratory diagnosis and prevention. 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	**15** **02** **08** **05**	**15**
	UNIT II **CHEMOTHERAPY** 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- 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, Rifamyicn) vii. Enzyme inhibitors (Sulfa drugs, Trimethoprim) viii. List of common antibiotics used for treating viral, fungal and parasitic diseases. ix. New generation antibiotics	**15** **03** **09**	**15**

	2.3 Mechanisms of drug resistance- Its evolution, pathways, origin and prevention	**03**	

	UNIT III **IMMUNOLOGY – III**	**15L**	**15**
	1. Tcells i. T Cell Receptor-structure (alpha-beta, gamma-delta TCR) ii. TCR-CD_3 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)	**4L**	
	2. Cell mediated effector response 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)	**3L** **4L**	
	3. B cells 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.	**4L**	
	4. Humoral Response i. Primary and secondary responses ii. In vivo sites for induction of Humoralresponse Germinal centers and antigen induced B cell Differentiation		

	iii. Cellular events within germinal centers- Overview Affinity maturation, somatic hyper-mutation and class switching iv. Generation of plasma cells and memory cells		

	UNIT IV **IMMUNOLOGY IV** **1. Vaccines** i. Active and passive immunization ii. Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines iii. Use of adjuvants in vaccine iv. New vaccine strategies **2. Immunohaematology** 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. **3. Complement System**- classical, alternative, lectin induced pathway **4. Hypersensitivity,** i. Coombs and Gells classification Type I to Type IV examples of each type of hypersensitivity	**15L** **4L** **3L** **3L** **3L**	**15**

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

Semester-VI: Text Books and Reference

Books SIUSMIC 61: Text books:

1. A textbook of biotechnology R.C.Dubey 4 thed. 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, 4th edition- 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/

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			Grand Total
	Internal	External	Total	Internal	External	Tot al	
Theory	40	60	100	40	60	100	**400**
Practicals	-	50	50	-	50	50	**200**

Semester VI

Course	SIUSMIC61			SIUSMIC62			Grand Total
	Internal	External	Total	Internal	External	Tot al	
Theory	40	60	100	40	60	100	**400**
Practicals	-	50	50	-	50	50	**200**