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

ZOOLOGY (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 Zoology

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.

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AC/4.8.18/RS 1

SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022

(Autonomous)

Faculty: Science

Program: T.Y.B.Sc.

(3 units)

Subject: ZOOLOGY

Academic Year: 2018 – 2019

Credit Based Semester and Grading System approved by Board of Studies in Zoology to be brought into effect from June 2018

T. Y. B. Sc. Zoology Syllabus (Autonomous)
Credit Based Semester and Grading System
(With effect from academic year 2018-19)
Grid of Syllabus – Semester V

Theory				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
SIUSZO51	1	Levels of Organization	2.5	1
	2	Taxonomy of Phylum Protozoa to Phylum Nemathelminthes		1
	3	Taxonomy of Phylum Annelida to Phylum Echinodermata		1
	4	Type study: Sepia		1
SIUSZO52	1	Basic Hematology	2.5	1
	2	Applied Hematology		1
	3	Basic Immunology		1
	4	Applied Immunology		1
			05	**08**
Practical				
SIUSZOP51	Based on SIUSZO51 (Practical I)		1.5	4
SIUSZOP52	Based on SIUSZO52 (Practical II)		1.5	4
			03	**08**
		Total	**08**	**16**

T. Y. B. Sc. Zoology Syllabus (Autonomous)
Credit Based Semester and Grading System
(With effect from academic year 2018-19)

Grid of Syllabus – Semester VI

Theory				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
SIUSZO61	1	Minor Phyla and Protochordata	2.5	1
	2	Taxonomy of Subphylum Vertebrata - I		1
	3	Taxonomy of Subphylum Vertebrata - II		1
	4	Type study: Shark		1
SIUSZO62	1	Enzymology	2.5	1
	2	Homeostasis (Temperature and Ionic regulation)		1
	3	Histology		1
	4	General Pathology		1
			05	**08**
Practical				
SIUSZOP61	Based on SIUSZO61 (Practical I)		1.5	4
SIUSZOP62	Based on SIUSZO62 (Practical II)		1.5	4
			03	**08**
		Total	**08**	**16**

Semester V – Theory

Paper Code: SIUSZO51
Levels of Organization, Taxonomy of Invertebrates, Type Study

Learning Objectives

- *To attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones by a study of the levels of organization in animal kingdom. Also, to know the different modifications the animal life has made for its survival, through taxonomical study.*
- *To study the anatomical complexity in animals through animal type study.*

Unit 1: Levels of Organization **Lectures 15**

1.1 : Levels of Organization
1.1.1 : Unicellularity, multicellularity, formation of colonies
1.1.2 : Cellular grade of organization, tissue grade of organization, formation of germ layers

1.2 : Symmetry
1.2.1 : Evolutionary perspective and definition
1.2.2: Types –
a. Asymmetry – e.g. *Amoeba*
b. Radial – (1) Bi-radial – e.g. *Aurelia* (Jellyfish), (2) Penta-radial – e.g. *Asterais* (Starfish)
c. Bi-lateral – (1) Simple – e.g. *Planaria,* (2) Complex – e.g. *Mus* (Rat)
1.2.3: Significance and advantages

1.3 : Coelom
1.3.1 : Evolutionary perspective and definition
1.3.2: Development of Coelom -
a. Organization of tissues
b. Diploblastic and Triploblastic organization
1.3.3: Types –
a. Acoelomate – e.g. Platyhelminthes – *Planaria*
b. Pseudocoelomate – e.g. Nematoda – *Ascaris* (Round worm)
c. Coelomate – e.g. Annelida – *Pheretima* (Earthworm)
1.3.4: Significance and advantages

1.4 : Segmentation (Metamerism)
1.4.1 : Evolutionary perspective and definition
1.4.2: Theories of segmentation
1.4.3: Types of segmentation –
a. Homonymous – e.g. Annelida – *Pheretima* (Earthworm)
b. Heteronomous – e.g. Crustacea – *Panulirus* (Lobster)
1.4.4: Cephalization – e.g. Insecta – *Periplaneta* (Cockroach)
1.4.5: Tagmatization – e.g. Crustacea – *Panulirus* (Lobster)
1.4.6: Cephalothorax – e.g. Crustacea – *Penaeus* (Prawn)
1.4.7: Significance and advantages of segmentation

Unit 2: Taxonomy of Phylum Protozoa to Phylum Nemathelminthes Lectures 15

2.1 : Principles of Taxonomy
Linnaean Hierarchy, Binomial Nomenclature, Five Kingdom classification

2.2 : Phylum Protozoa
2.2.1 : General characters and classification
2.2.2 : Locomotion in Protozoa – amoeboid, flagellar, ciliary, gliding movements
2.2.3: Reproduction in Protozoa – asexual and sexual
2.2.4: Morphology, life cycle, pathogenicity and control measures of: *Entamoeba, Plasmodium*

2.3 : Phylum Porifera
2.3.1 : General organization and classification
2.3.2: Skeleton in sponges
2.3.3: Canal system in sponges

2.4 : Phylum Cnidaria
2.4.1 : General characters and classification
2.4.2 : *Obelia* – Polymorphism, life cycle and alternation of generations

2.5 : Phylum Platyhelminthes
2.5.1 : General characters and classification
2.5.2 : Life history of *Fasciola hepatica* and its parasitic adaptations

2.6 : Phylum Nemathelminthes
2.6.1 : General characters and classification
2.6.2 : Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 3: Taxonomy of Phylum Annelida to Phylum Hemichordata Lectures 15

3.1: Phylum Annelida
3.1.1: General characters and classification
3.1.2: Diversity in habit and habitat
3.1.3: Adaptive radiation in class Polychaeta

3.2 : Phylum Arthropoda
3.2.1 : General characters and classification
3.2.2 : Larval forms in class Crustacea; social life and moulting in class Insecta; vision in phylum Arthropoda
3.2.3 : Affinities of class Onychophora

3.3 : Phylum Mollusca
3.3.1 : General characters and classification
3.3.2: Torsion and detorsion

3.4 : Phylum Echinodermata
3.4.1 : General characters and classification
3.4.2: Water vascular system

3.5 : Phylum Hemichordata
General characters and classification, e.g. Balanoglossus

3.6:
Basic concepts of Phylogeny

Unit 4: Type study: Sepia **Lectures 15**

4.1:
General characters and classification, habit and habitat, external characters, mantle cavity, locomotion, economic importance

4.2:
Digestive system, respiratory system, circulatory system, excretory system, nervous system, sense organs and reproductive system

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- Invertebrate Zoology; E.L. Jordan and P.S. Verma
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Semester V – Theory

Paper Code: SIUSZO52
Haematology and Immunology

Learning Objectives

- *To introduce Haematology, a branch of medicine concerned with the study, diagnosis, treatment, and prevention of diseases related to the blood, and to know about the diagnostic techniques used in Haematology.*
- *To acquaint with the body's defense system (immune system) and its combat against intruders, the invading pathogens, and to apply this knowledge in medical science in vaccination, organ transplant and tumour treatment.*

Unit 1: Basic Hematology **Lectures 15**

1.1 : Composition of blood
Plasma and formed elements

1.2 : Blood volume
Total quantity and regulation; haemorrhage

1.3 : Plasma proteins
Inorganic constituents, respiratory gases, organic constituents other than proteins (including internal secretions, antibodies and enzymes)

1.4 : RBCs
Structure and functions, abnormalities in structure, total count, variation in number; ESR; types of anaemia; thalassemia

1.5 : Hemoglobin
Structure, formation and degradation, role in transport of oxygen and carbon dioxide (Chloride shift and Bohr's effect); types of hemoglobin (foetal, adult and sickle)

1.6 : WBCs
Types of leukocytes and function, total count and variation in number; leucopoiesis; leukemia and its types

1.7 : Blood clotting
Thrombocytes; factors and mechanism of coagulation; anticoagulants; formation of blood platelets (thrombopoiesis); clotting mechanism; bleeding and clotting time; failure of clotting mechanism; Haemophilia and Purpura

Unit 2: Applied Hematology **Lectures 15**

2.1 : Introduction to Applied Hematology
Definition, scope and brief introduction of basic branches: clinical, microbiological, oncological and forensic hematology

2.2 : Diagnostic techniques used in Hematology
2.2.1 : Microscopic examination of blood: For detection of blood cancers (lymphoma, myeloma), infectious diseases (Malaria, Leishmaniasis), hemoglobinopathies (Sickle cell anaemia, Thalassemia)
2.2.2 : Coagulopathies: Diagnostic methods (Hemophilia and Purpura)
2.2.3 : Microbiological examination: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB)
2.2.4 : Biochemical examination of blood:
Liver function tests: AST, ALT, Total bilirubin, Prothrombin time/ International normalized ratio (PT/ INR), LDH and Alkaline phosphatase
Kidney function tests: Serum creatinine, blood urea nitrogen (BUN)
Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated hemoglobin test
Other biochemical tests: Blood hormones (Thyroid, FSH, LH), Cancer Antigen test (CA124 or CA125)
2.2.5 : Blood Bank: Collection, storage and preservation of blood components
2.2.6: Blood transfusion: Cross matching, Transfusion of blood

Unit 3: Basic Immunology **Lectures 15**

3.1: Introduction to Immunology and historical perspective

3.2: Components of Immune system
3.2.1: Innate immunity – Factors affecting innate immunity
Mechanisms of innate immunity – Physical barriers, chemical barriers and cellular barriers
3.2.2: Adaptive or Acquired immunity – Active Acquired immunity – Natural and Artificial; Passive Acquired immunity – Natural and Artificial

3.3 : Cells and Organs of Immune system
3.3.1 : Cells of immune system – Lymphoid cells: B lymphocytes (Humoral immunity), T lymphocytes (Cell-mediated immunity) and Natural killer cells; Mononuclear phagocytes; Dendritic cells and Mast cells
3.3.2 : Organs of immune system – Primary – Thymus and bone marrow
Secondary – Lymph node and spleen

3.4 : Hypersensitivity, Autoimmunity and Immunodeficiency
3.4.1 : Introduction to hypersensitivity, brief account of types of hypersensitivity
3.4.2: Introduction to autoimmunity, brief account of autoimmune diseases
3.4.3: Introduction to immunodeficiency, brief account of primary immunodeficiency, e.g. SCID; brief account of secondary immunodeficiency, e.g. AIDS

Unit 4: Applied Immunology **Lectures 15**

4.1 : Antigens
Immunogenicity versus Antigenicity, factors that influence immunogenicity, Epitopes, Haptens

4.2 : Antibodies
Basic structure and function, Antibody classes and biological activities, Antigenic determinants on immunoglobulins

4.3 : Antigen-Antibody interaction
General features of antigen-antibody interaction; Precipitation reactions: Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlony method), Immunoelectrophoresis; Agglutination reactions: Haemagglutination, Agglutination inhibition; RIA, ELISA

4.4 : Vaccines and Vaccination
Introduction to vaccines, Vaccination: Development and challenges; Brief account of designing vaccines for active immunization: Whole organism vaccines, Purified macromolecules as vaccines, Recombinant vector vaccines, DNA vaccines, Subunit vaccines

4.5 : Transplantation Immunology
Introduction to transplantation; Immunological basis of graft rejection; Clinical manifestations of graft rejection; General immunosuppressive therapy

4.6 : Cancer and Immune system
Oncogenes and cancer induction; Tumour antigens; Brief account of cancer immunotherapy

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Articles on Haematology -

- *"India facing shortage of life-saving albumin serum"; written by Abantika Ghosh, New Delhi;The Indian Express, October 16, 2014, 2:25 am*
- *Articles on "Blood groups"; (1)The Indian Express, August 15, 2012/ Times of India, August 16, 2012; (2)Times of India, September 11, 2014*

Article on Immunology –

- *"Nanoparticle vaccine shows potential as immunotherapy to fight multiple cancer types"; UT Southwestern Medical Center; ScienceDaily, April 24 2017; https://www.sciencedaily.com/*

Semester V – Practical (SIUSZOP51)

Practical I based on SIUSZO51

1. Levels of Organization
a) Symmetry:
i. Asymmetry, e.g. Sponge
ii. Radial: Bi-radial, e.g. Comb jelly
Penta-radial, e.g. Adult Brittle star
iii. Bi-lateral, e.g. Larva of Brittle star; Human

b) Coelom:
i. Acoelomate, e.g. Tapeworm
ii. Pseudocoelomate, e.g. *Ascaris*
iii. Coelomate, e.g. Frog

c) Segmentation:
i. Homonymous, e.g. *Nereis*
ii. Heteronomous, e.g. Cockroach

d) Cephalization:
i. Cephalization, e.g. Honey bee
ii. Cephalothorax, e.g. Crab

2. Taxonomy of Protozoa to Hemichordata
a) Phylum Protozoa:
i. Class Rhizopoda, e.g. *Amoeba* - amoeboid locomotion, asexual reproduction – binary fission
ii. Class Ciliophora, e.g. *Vorticella* - ciliary locomotion, sexual reproduction – conjugation
iii. Class Flagellata, e.g. *Noctiluca* - flagellar locomotion
iv. Class Sporozoa, e.g. *Monocystis* - gliding locomotion

b) Phylum Porifera:
i. Class Calcarea - Canal system, e.g. Scypha - Sycon type; Leucosolenia - Ascon type
ii. Class Demospongia - Canal system, e.g. Spongilla larva - Rhagon type, adult - Leuconoid type
iii. Class Hexactinellida - Observation of sponge spicules (permanent slide/ photograph), e.g. Hyalonemma

c) Phylum Cnidaria:
i. Class Hydrozoa, e.g. *Vellela*
ii. Class Scyphozoa, e.g. *Rhizostoma*
iii. Class Anthozoa, e.g. *Corallium* (Red coral)

d) Phylum Platyhelminthes:
i. Class Turbellaria, e.g. *Planaria*
ii. Class Trematoda, e.g. Liver fluke
iii. Class Cestoda, e.g. Tape worm (*Taenia*)

e) Phylum Nemathelminthes, e.g. *Trichinella*

f. Phylum Annelida:
i. Class Polychaeta, e.g. *Arenicola*/ *Nereis*
ii. Class Oligochaeta, e.g. Tubifex/ Earthworm
iii. Class Hirudinea, e.g. *Pontobdella*/ Leech

g) Phylum Arthropoda:
i. Class Merostomata, e.g. *Limulus* (King crab)
ii. Class Crustacea, e.g. *Balanus*
iii. Class Insecta, e.g. *Coccinella* (Ladybird beetle)
iv. Class Arachnida, e.g. Scorpion
v. Class Myriapoda, e.g. *Scolopendra* (Centipede)
vi. Class Onychophora, e.g. *Peripatus*
vii. Observation and identification of planktonic crustaceans

h) Phylum Mollusca:
i. Class Aplacophora, e.g. *Chaetoderma*
ii. Class Polyplacophora, e.g. *Tonicella*/ Chiton
iii. Class Monoplacophora, e.g. *Neopilina*
iv. Class Scaphopoda, e.g. *Dentalium*
v. Class Gastropoda, e.g. *Achatina*
vi. Class Pelecypoda, e.g. *Donax*/ *Unio*
vii. Class Cephalopoda, e.g. Octopus

i) Phylum Echinodermata:
i. Class Asteroidea, e.g. Starfish
ii. Class Ophiuroidea, e.g. Brittle star
iii. Class Echinoidea, e.g. *Echinus*
iv. Class Holothuroidea, e.g. *Holothuria* (Sea cucumber)
v. Class Crinoidea, e.g. Crinoid (Sea lily)

j) Phylum Hemichordata (Acorn worms):
i. Class Enteropneusta, e.g. *Saccoglossus*/ *Balanoglossus*
ii. Class Pterobranchia, e.g. *Rhabdopleura*
iii. Class Planctosphaeroidea, e.g. *Planctosphaera*

Note: Visit a local fish market, local zoo or other local places/ institutes of educational value to study available invertebrates.

Semester V – Practical (SIUSZOP52)

Practical II based on SIUSZO52

1. Enumeration of erythrocytes – Total count.

2. Determination of Erythrocyte Sedimentation Rate by suitable method – Westergren or Wintrobe method.

3. Estimation of haemoglobin by Sahli's acid haematin method.

4. Enumeration of leucocytes –Total Count.

5. Differential count of WBC.

6. Determination of serum LDH.

7. Estimation of total plasma proteins by Folin's method.

8. Estimation of serum/ plasma total triglycerides by Phosphovanillin method.

9. Latex agglutination test – Rheumatoid Arthritis; Slide test for pregnancy.

10. Study of T.S. of lymphoid organs: Thymus, spleen and lymph nodes, and leukemic cells from permanent slides.

Semester VI – Theory

Paper Code: SIUSZO61
Minor Phyla, Taxonomy of Chordates, Type Study

Learning Objectives

- *To attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones and to know the different modifications the animal life has made for its survival, through taxonomical study.*
- *To study the anatomical complexity in animals through animal type study.*

Unit 1: Minor Phyla and Protochordata **Lectures 15**

1.1: Minor Phyla
General features:
a) Acoelomate – Phylum Acanthocephala, e.g. *Macracanthorynchus, Moniloformis*
b) Coelomate – Phylum Chaetognatha, e.g. *Sagitta*

1.2 : Protochordata
1.2.1 : General overview, characteristics and salient features of urochordates and cephalochordates
a) Subphylum Urochordata, e.g. *Ascidia*
b) Subphylum Cephalochordata, e.g. *Branchiostoma*
1.2.2 : Retrogressive metamorphosis in ascidian
1.2.3 : Phylogeny of urochordates and cephalochordates

Unit 2: Taxonomy of Subphylum Vertebrata - I **Lectures 15**

2.1: Division – Agnatha
2.1.1 : Classification of living Agnatha up to classes
2.1.2 : General characters of the jawless fishes, e.g. *Petromyzon* (lamprey) and *Myxine* (hagfish)

2.2 : Division – Gnathostomata: Superclass – Pisces
2.2.1 : General characters and classification up to order – Placodermi, Chondrichthyes and Osteichthyes
2.2.2 : Examples:
a) Armoured fish, e.g. *Bothriolepis*
b) Sharks, e.g. *Sphyrna* (Hammer-headed shark)
c) Skates and rays, e.g. *Pristis* (Sawfish), *Dasyatis* (Stingray)
d) Chimeras, e.g. *Hydrolagus* (Spotted rat fish)
e) Lung fish, e.g. *Lepidosiren* (Australian lungfish)
f) Flying fish, e.g. *Exocoetus*

2.3 : Superclass Tetrapoda: Class Amphibia
2.3.1 : General overview, classification, characteristics and salient features up to orders
2.3.2: Examples of each order namely:

a) Limbless amphibian, e.g. *Ichthyophis*
b) Tailed amphibian, e.g. *Tylototriton* (Himalayan newt)
c) Tailless amphibian, e.g. *Hyla*
2.3.3: Neoteny in Amphibia, e.g. Axolotl larva

Unit 3: Taxonomy of Subphylum Vertebrata - II **Lectures 15**

3.1: Class Reptilia
3.1.1 : General overview, classification, characteristics and salient features of subclasses and orders
3.1.2 : Examples of each order namely:
a) Aquatic reptile, e.g. *Chelone*
b) Extinct reptile, e.g. *Ichthyosaurus*
c) Living fossil, e.g. *Sphenodon*
d) Arboreal reptile, e.g. *Chameleon*

3.2 : Class Aves
3.2.1 : General overview, classification, characteristics and salient features of orders
3.2.2: Examples of each order in accordance to groups:
a) Arboreal birds, e.g. *Treron* (Green pigeon)
b) Terrestrial birds, e.g. *Gallus* (Jungle fowl)
c) Swimming/ diving birds, e.g. *Pelicanus/ Phalacrocoracidae* (Pelican/ Cormorant)
d) Shore birds and wading birds, e.g. *Scolopacidae* (Sandpiper), *Ardeola grayii* (Pond heron)
e) Birds of prey, e.g. *Strigiformes* (Owl), *Accipitriformes* (Eagle)

3.3 : Class Mammalia
3.3.1 : General overview, classification, characteristics and salient features (habitat types, feeding habits, taxonomical differences) of orders: Monotremata, Marsupialia and Placentalia
3.3.2 : Examples of each order in accordance to groups:
a) Egg-laying mammals, e.g. *Ornithorhynchus anatinus* (Duck-billed platypus)
b) Pouched mammals, e.g. *Macropus* (Kangaroo)
c) Insect eating mammals, e.g. *Sorex araneus* (Common shrew)
d) Toothless mammals, e.g. *Folivora* (Sloth)
e) Gnawing mammals, e.g. *Sciuridae* (Squirrel)
f) Aquatic mammals, e.g. *Delphinus* (Dolphin)
g) Primates, e.g. *Lemuroidea* (Lemur); *Lorisidae* (Slow and Slender Loris)

Unit 4: Type study: Shark **Lectures 15**

4.1:
Habit and habitat, distribution, external characters, classification and economic importance

4.2:
Skin, exoskeleton, endoskeleton, digestive system, respiratory system, blood vascular system, nervous system, receptor organs, urinogenital system, copulation, fertilization and development

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ADDITIONAL READING:

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- World Encyclopedia of Animals; English language edition; Elena Marcon & Manuel Mongini; Orbis Publishing Limited; 1984

Semester VI – Theory

Paper Code: SIUSZO62
Enzymology, Homeostasis, Histology, General Pathology

Learning Objectives

- *To study enzymes, the biocatalysts in living systems and to know about their application in medicine and industry.*
- *To familiarize with the concept of homeostasis and to comprehend the adaptive responses of animals for thermoregulation and maintaining water and ionic balance.*
- *To study Histology to comprehend the architecture of various organs in the body.*
- *To introduce the basics of General pathology to know about the retrogressive, necrotic, circulatory, neoplastic pathological conditions in the body.*

Unit 1: Enzymology **Lectures 15**

1.1:
Definition, nomenclature and classification (based on Enzyme Commission) of enzymes; cofactors and coenzymes; the concept and properties of active site

1.2:
Factors affecting enzyme activity – pH and temperature; concept of activation energy; Enzyme structure (lysozyme and serine protease)

1.3:
Enzyme kinetics, concept of steady state, derivation of Michaelis-Menten equation and Lineweaver-Burk plot, enzyme assay, concept and significance of k_m, V_{max} and k_{cat}; modulation of enzyme activity with reference to GDH

1.4:
Enzyme inhibitors – Competitive and non-competitive inhibitors and their kinetics, therapeutic applications of enzyme inhibitors

1.5:
Regulation of enzyme activity; Hill equation; allosteric regulation and regulation by covalent modification of enzymes; zymogens (pepsinogen and proelastase); isozymes (LDH)

1.6:
Clinical significance and industrial application of enzymes

Unit 2: Homeostasis (Temperature and Ionic regulation) **Lectures 15**

2.1 : Homeostasis
External and internal environment; Acclimation and acclimatization
Control systems in biology: Feedback mechanisms – Negative feedback and positive feedback mechanisms and examples of each

2.2 : Thermoregulation
Endothermy, ectothermy (relation between temperature and biological activities); temperature balance; heat production – shivering and nonshivering thermogenesis; brown fat – special thermogenic tissue in mammals; mechanisms of heat loss; adaptive response to temperature – daily torpor, hibernation, aestivation

2.3 : Osmotic and Ionic regulation
Maintaining water and electrolyte balance; ionic regulation in iso-osmotic environment; living in hypo-osmotic and hyper-osmotic environment; problems of living in terrestrial environment; water absorption, salt water ingestion and salt excretion, salt glands, role of kidney in ionic regulation, metabolic water

Unit 3: Histology **Lectures 15**

3.1 : Vertical section (V.S.) of skin
Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors

3.2 : Digestive System
3.2.1 : Vertical section (V.S.) of tooth – Hard tissue – Dentine and enamel; Soft tissue – Dentinal pulp and periodontal ligaments
3.2.2 : Transverse section (T.S.) of tongue – Mucosal papillae and taste buds
3.2.3 : Alimentary canal – Basic histological organization with reference to transverse section (T.S.) of oesophagus, stomach, duodenum, ileum and rectum of mammal
3.2.4 : Glands associated with digestive system – Histology with reference to transverse section (T.S.) of salivary glands, liver, pancreas

3.3 : Respiratory system
Respiratory organs – Transverse section (T.S.) of trachea and lungs

Unit 4: General Pathology **Lectures 15**

4.1 : Infectious diseases
Aetiology; infectious agents: viruses – hepatitis, bacteria – tuberculosis, fungi – skin diseases

4.2 : Retrogressive changes
Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)

4.3 : Disorders of pigmentation
Endogenous: Normal process of pigmentation, melanosis, jaundice (causes and effects)

4.4 : Necrosis
Definition and causes; nuclear and cytoplasmic changes; Types: Coagulative, Liquefactive, Caseous, Fat and Fibroid

4.5 : Gangrene
Definition and types – Dry, moist and gas gangrene

4.6 : Circulatory disturbances
Causes and effects of Hyperaemia, Ischaemia, Thrombosis, Embolism, Oedema and Infarction

4.7 : Inflammation
Definition and causes (pathogenic and immune); cardinals of inflammation; acute and chronic inflammation

4.8 : Applied pathology
Anatomical, clinical and molecular; investigating methods: biopsy and surgery (for pathological examination of tissue)

4.9 : Forensic pathology
Autopsy; Post-mortem changes – Algor mortis: body cooling, Rigor mortis – stiffening of limbs, state of decomposition – Autolysis (process of self-digestion) and putrefaction

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- Essentials of General Pathology; Dr. Sudha Shivraj, Dr. Satish Kumar Amarnath, Dr. Sheela Devi; Exclusively distributed by CBS Publishers & Distributors
- Textbook of Pathology; Harsh Mohan; Jaypee Publishers

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- *Disease & Medicine in India – A Historical Overview; Deepak Kumar; Tulika Books, India; 2012*

Semester VI – Practical (SIUSZOP61)

Practical I based on SIUSZO61

1. Levels of Organization: Minor Phyla
a) Acoelomate: Phylum Acanthocephala (Spiny-headed worms), e.g. *Echinorhyncus*
b) Coelomate: Phylum Chaetognatha (Arrow worms), e.g. *Sagitta*

2. Taxonomy of Phylum Chordata
a) Subphylum Urochordata (Sea squirts):
1. Class Larvaceae, e.g. *Oikopleura*
2. Class Ascidiacea, e.g. *Ciona*/ *Herdmania*
3. Class Thaliacea, e.g. *Salpa*/ *Doliolum*

b) Subphylum Cephalochordata:
Class Leptocardii, e.g. *Branchiostoma* (*Amphioxus*)

c) Subphylum Vertebrata:
I. Group Agnatha:
1. Class Ostracodermi, e.g. *Pharyngolepis*
2. Class Cyclostomata, e.g. *Petromyzon*

II. Group Gnathostomata:
i. Superclass - Pisces:
1. Class Placodermi (Armoured fishes), e.g. *Bothriolepis*
2. Class Elasmobranchi (Chondrichthyes), e.g. *Rhinobatos*
3. Class Holocephali (Chimaera), e.g. Rabbit fish/ Rat fish
4. Class Dipnoi (Lung fishes), e.g. *Protopterus* (African lungfish)
5. Class Teleostomi, e.g. *Latimeria* (Coelacanth), Catfish

ii. Superclass - Tetrapoda:
A) Class Amphibia:
a) Order Apoda, e.g. *Siphonops*/ *Ichthyophis*
b) Order Anura, e.g. *Alytes* (Midwife toad)
c) Order Urodela, e.g. Triton (Semi-aquatic salamander)

B) Class Reptilia:
a) Order Synapsida, e.g. *Dimetrodon*
b) Order Parapsida, e.g. *Chasmosaurus* (Dinosaur)
c) Order Anapsida, e.g. *Geochelone* (Indian star tortoise)
d) Order Diapsida, e.g. *Mabuya* (Skink)

C) Class Aves:
a) Subclass Archaeornithes, e.g. *Archaeopteryx*

b) Subclass Neornithes

- Superorder Paleognathae (Flightless birds), e.g. Emu, Penguin
- Superorder Neognathae (Flying birds), e.g. Flamingo, Vulture

D) Class Mammalia:

a) Subclass Prototheria (Egg-laying mammals), e.g. Duck-billed platypus

b) Subclass Theria

- Infraclass – Metatheria (Marsupials/ Pouched mammals), e.g. *Dasyurus* (Tiger cat)
- Infraclass – Eutheria (Placental mammals), e.g. Gangetic dolphin, Gorilla

3. Study of endoskeleton of shark:

a) Axial (skull and vertebral column)

b) Appendicular (pelvic and pectoral fins, pelvic and pectoral girdles)

Note: Visit a local fish market, local zoo or other places/ institutes of educational value to study available vertebrates.

Semester VI – Practical (SIUSZOP62)

Practical II based on SIUSZO62

1. Effect of pH on activity of enzyme Acid Phosphatase.

2. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase.

3. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase.

4. Effect of inhibitor (drug as an enzyme inhibitor) on activity of enzyme Acid Phosphatase.

5. Study of separation of LDH isozymes by agarose gel electrophoresis.

6. To study the effect of enzymes (and/ drugs) in detergents.

7. Study of mammalian tissues:
i. V.S. of Skin
ii. V.S. of Tooth
iii. T.S. of Stomach
iv. T.S. of Ileum
v. T.S. of Liver
vi. T.S. of Pancreas
vii. T.S. of Lung

8. Identification of following diseases or conditions (from slides or pictures):
Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis

9. Vidal's Test

10. Study and interpretation of pathological reports: Blood, urine and stool (faeces).

Practical Examination Question Paper Pattern
Semester V – Practical (SIUSZOP51)

Practical I based on SIUSZO51

Time: 5 hours **Marks: 50**

Q.1 Identify and describe **06**
a) Identify and describe w.r.t. levels of organization
b) Identify and classify giving reasons

Q.2 Identify and describe w.r.t. phylogeny and adaptations **12**
a) Protozoa/ Porifera/ Cnidaria
b) Platyhelminthes/ Nemathelminthes
c) Annelida/ Arthropoda
d) Mollusca/ Echinodermata

Q.3 Identify and describe w.r.t. phylogeny and adaptations **03**
Hemichordata

Q.4 Identify and describe **09**
a) Locomotion/ Reproduction in Protozoa
b) Canal system in Sponges/ Metamorphosis in insects
c) Spicules in sponges/ Planktonic crustaceans

Q.5 Field report and viva based on theory paper **10**

Q.6 Journal **10**

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Practical Examination Question Paper Pattern
Semester V – Practical (SIUSZOP52)

Practical II based on SIUSZO52

Time: 5 hours **Marks: 50**

Q.1 Enumeration of erythrocytes – Total count **15**

OR

Q.1 Enumeration of leucocytes – Total count

OR

Q.1 Differential count of leucocytes

Q.2 Estimation of serum/plasma total proteins by Folin's method **10**

OR

Q.2 Estimation of serum/plasma total triglycerides by Phosphovanillin method

OR

Q.2 Determination of serum LDH

Q.3 Estimation of haemoglobin by Sahli's acid haematin method **10**

OR

Q.3 Estimate Erythrocyte Sedimentation Rate by suitable method

Q.4 Latex agglutination test – Rheumatoid Arthritis **05**

OR

Q.4 Slide test for pregnancy

Q.5 Viva **05**

Q.6 Journal **05**

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Practical Examination Question Paper Pattern
Semester VI – Practical (SIUSZOP61)

Practical I based on SIUSZO61

Time: 5 hours **Marks: 50**

Q.1 Identify and describe **06**
a) Identify, classify and describe
(Any one example from Urochordates/ Cephalochordates/ Ostracodermi/ Cyclostomata/ Minor Phyla)
b) Identify and classify giving reasons (Any one example from Superclass Pisces or Tetrapoda)

Q.2 Identify and describe w.r.t. phylogeny and adaptations **15**
a) Pisces
b) Amphibia/ Reptilia
c) Aves/ Mammalia

Q.3 Identify, sketch and label/ Identify and label marked portion in the given diagram **09**
a) Skull or vertebra of shark
b) Fin of shark (Pectoral/ Pelvic)
c) Girdle of shark (Pectoral/ Pelvic)

Q.4 Field report and viva based on it **10**

Q.5 Journal and viva based on theory **10**

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Practical Examination Question Paper Pattern
Semester VI – Practical (SIUSZOP62)

Practical II based on SIUSZO62

Time: 5 hours **Marks: 50**

Q.1 Demonstrate the effect of_____on the activity of Acid phosphatase **15**
(Substrate concentration/ pH variation/ Enzyme concentration/ Inhibitor concentration)

Q.2 Study of separation of LDH isozymes by agarose gel electrophoresis. **10**

OR

Q.2 To study the effect of enzymes in detergents.

OR

Q.2 Perform Vidal test and give the clinical significance of the result.

Q.3 Identify and describe a, b, c, d, e (3 marks each) **15**
a) and b) Mammalian tissues: V.S. of Skin, V.S. of Tooth, T.S. of Stomach, T.S. of Ileum, T.S. of Liver, T.S. of Pancreas, T.S. of Lung
c) and d) Diseases or conditions (from slides or pictures): Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis
e) Interpret the pathological report of blood/ urine/ stool

Q.4 Viva **05**

Q.5 Journal **05**

T. Y. B. Sc. Zoology Syllabus (Autonomous) Credit Based Semester and Grading System
(With effect from academic year 2018-19)

Scheme of Examination

The performance of learners will be evaluated in two parts for the Theory component of the Course:
1. Internal Assessment with 40% marks
2. Semester End Examination (written) with 60% marks
The Practical component of the Course will be evaluated by conducting Semester End Practical Examination of 50 marks.

Internal Assessment Theory (40%)
It is the assessment of learners on the basis of continuous evaluation as envisaged in the Credit Based System by way of participation of learners in various academic and correlated activities in the given semester of the program.

Marks: 40

1. Class test (Centralized Examination): **20 Marks**
2. At the departmental level evaluation will be conducted on the basis of Review submitted by the student of any research paper/ article relevant to each paper: **20 Marks**

Semester End Assessment Theory (60%)

Marks: 60
Duration: 2 hours
Theory question paper pattern:

- There shall be five questions of 12 marks each. On each unit there will be one question and the 5th question will be based on the entire syllabus.
  OR
  There shall be four questions of 15 marks each, each question based on one unit.
- All questions are compulsory with internal choice within the questions.
- Questions may be subdivided and the allocation of marks depends on the weightage of the topic.

Semester End Assessment Practical

Marks: 50
Duration: 5 hours

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