



**St Aloysius College (Autonomous)**

**Mangaluru**

**Re-accredited by NAAC “A” Grade**

**Course structure and syllabus of**

**B.Sc.**

**BIOCHEMISTRY**

**CHOICE BASED CREDIT SYSTEM**

**(2019 – 20 ONWARDS)**

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(ಸ್ವಾಯತ್ತ)  
ಮಂಗಳೂರು- 575 003



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**Re-accredited by NAAC with 'A' Grade - CGPA 3.62**

**Recognised by UGC as "College with Potential for Excellence"**

**College with 'STAR STATUS' conferred by DBT, Government of India**

**3<sup>rd</sup> Rank in "Swacch Campus" Scheme, by MHRD, Govt of India**

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No: SAC 40/Syllabus 2019-20

Date: 18-07-2019

### NOTIFICATION

Sub: Syllabus of **B.Sc. Biochemistry** under Choice Based Credit System.

Ref: 1. Decision of the Academic Council meeting held on 02-05-2019 vide  
Agenda No: 28(2019-20)  
2. Office Notification dated 18-07-2019

Pursuant to the above, the Syllabus of **B.Sc. Biochemistry** under Choice Based Credit System which was approved by the Academic Council at its meeting held on 02-05-2019 is hereby notified for implementation with effect from the academic year **2019-20**.

**PRINCIPAL**

**REGISTRAR**

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

## **PREAMBLE**

This syllabus is one of a series prepared for use in a Bachelors Degree programme with a major in Biochemistry by the Board of Studies. The Board of Studies, together with its coordinating committees and industry representatives, is widely representative of the Indian educational/industrial community. Membership includes heads of departments and practicing faculty members from government and non-government colleges, heads of premier science research institutions, and the biotech industry in India.

All syllabi prepared by the Board of Studies for the BSc will lead to appropriate Advanced- and/or Advanced Supplementary-level examinations conducted by the college. This syllabus is recommended for use in BSc Biochemistry. Once the syllabus has been implemented, progress will be monitored by the Board of Studies. This will enable the Board of Studies to review the syllabus from time to time in the light of classroom experiences.

### **Program outcomes**

The present curriculum is designed to achieve the following outcomes:

1. It will help students to inculcate the basic concepts of biochemistry including an understanding of the fundamental biochemical principles and their applications in a systematic, scientific, evidence-based process. The programme will also provide a general understanding of the inter disciplines with a holistic approach in biological sciences.
2. Students will gain experience in basic laboratory methods, techniques and be able to apply the scientific method to the experimental processes, hypothesis testing, data interpretation and logical conclusions.
3. Develop problem solving and analytical skills through case studies, research papers and hands-on-experience, especially integrated into skill enhancement courses.
4. Provide requisite knowledge of laboratory safety, data replication and quality control, record keeping and other aspects of “responsible conduct of research”.
5. Ability to employ modern library search tools to locate and retrieve primary literature on a topic and critically evaluate the literature.
6. Students will be able to apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well-designed posters and slides in talks aimed at scientific audiences as well as the general public.
7. Students will learn to work collaboratively in a team.

8. Students will gain knowledge of ethical and good laboratory practices, health and biohazard regulations, plagiarism and intellectual property rights related issues practiced in modern era of scientific investigation.
9. Graduates will be able to apply the major theories and research procedures to contemporary social problems.
10. The programme will prepare students to plunge into various fields of higher education or related profession in various disciplines, armed with plethora of knowledge, hands-on-experience and scientific attitude, at national and global levels.

### **Program specific outcomes**

On successful completion of this program student will specifically able to

- Describe the chemical structures, properties, and biological functions of the molecules which make up living matter: water, amino acids and proteins, nucleic acids, carbohydrates, and lipids.
- Describe methods to study the structures of these molecules and to synthesize them.
- Describe the mechanisms by which the structures of proteins determine their functions and by which their functions are regulated.
- Explain how enzymes function in terms of thermodynamics, transition states, and kinetics. Perform calculations involving various kinetic parameters, including  $K_M$  and  $V_{max}$ .
- Contrast the effects of different types of inhibitors on enzymes and on their kinetic parameters.
- Describe the mechanisms of action of selected enzymes and the experimental evidence for these mechanisms.
- Explain how enzyme activity is regulated by various means.
- Define thermodynamic parameters, including free energy, entropy and reduction potentials. Perform calculations involving them.
- Discuss the role of ATP in the thermodynamics of metabolism.
- Describe the metabolic roles of NADH, NADPH, FADH<sub>2</sub>, coenzyme A, water & fat soluble vitamins and ribonucleotides.
- Name and describe the molecules which participate in selected metabolic pathways, such as glycolysis, citric acid cycle, and gluconeogenesis. Discuss the

enzymes and cofactors catalyzing each transformation in these metabolic pathways and the controls on the pathways studied.

- Summarize the pathways providing monosaccharides for glycolysis, emphasizing the interacting controls of these processes.
- Explain DNA replication, transcription, translation, DNA recombination and DNA damages
- Summarizes DNA mutation and cancer, radiotherapy.
- Describe basics in microbiology and immunology
- Demonstrate techniques in microbiology, immunology and cell biology.

## SCHEME OF CHOICE BASED CREDIT SYSTEM FOR B.SC. BIOCHEMISTRY

### I Semester

Paper	Instruction Hours		Duration Exam. Hr	Marks		Total Mark	Credits
	Theory	Pract.		Exam.	Int Ass.		
<b>G510.1 Bimolecules</b>	4	-	3	70	30	100	2
<b>G510.1E Protein Biochemistry</b>	2	-	2	40	10	50	1
<b>G510.1P</b>	-	3	3	40	10	50	1

### II Semester

Paper	Instr. Hours		Duration Exam. Hr	Marks		Total Mark	Credits
	Theory	Pract.		Exam.	Int. Ass.		
<b>G510.2 Human Physiology &amp; Nutrition</b>	4	-	3	70	30	100	2
<b>G510.2E Biochemistry of hormones</b>	2	-	2	40	10	50	1
<b>G510.2P</b>	-	3	3	40	10	50	1

### III Semester

Paper	Instr. Hours		Duration Exam. Hr	Marks		Total Mark	Credits
	Theory	Pract		Exam.	Int. Ass.		
<b>G510.3 Enzymology</b>	4	-	3	70	30	100	2
<b>G510.3E Stem Cells</b>	2	-	2	40	10	50	1
<b>G510.3P</b>	-	3	3	40	10	50	1

### IV Semester

Paper	Instr. Hours		Duration Exam. Hr	Marks		Total Mark	Credits
	Theory	Pract.		Exam.	Int. Ass.		
<b>G510.4 Metabolism</b>	4	-	3	70	30	100	2
<b>G510.4E Molecules of Life</b>	2	-	2	40	10	50	1
<b>G510.4P</b>	-	3	3	40	10	50	1

### V Semester

Paper	Instr. Hours		Duration Exam. Hr	Marks		Total Mark	Credits
	Theory	Pract		Exam.	Int. Ass.		
<b>G510.5a Molecular Biology</b>	3	-	3	70	30	100	2
<b>G510.5b Genetic Engineering &amp; Biotechnology</b>	3	-	3	70	30	100	2
<b>G510.5P</b>	-	4	4	80	20	100	2

### VI Semester

Paper	Instr. Hours		Duration Exam. Hr	Marks		Total Mark	Credits
	Theory	Pract.		Exam.	Int. Ass.		
<b>G510.6a Microbiology &amp; Immunology</b>	3	-	3	70	30	100	2
<b>G510.6b Clinical &amp; Membrane Biochemistry</b>	3	-	3	70	30	100	2
<b>G510.6P</b>	-	4	4	40	10	50	1
<b>Project Or Extra Experiments</b>	-	4	04	40	10	50	1
	-	4	04	40	10	50	1

## G510.1

# SEMESTER I BIOMOLECULES

### *Course Objectives*

The main aim of the course to provide students with an understanding of major four biomolecules, the basic building blocks of living organisms, focusing on their structure, unique properties, biological roles and functions. To obtain clarity on inter relations of biomolecules in the system. The course will outline the importance of protein, nucleic acid, carbohydrate and lipids as vital ingredients of life. Emphasis will be on the association between structure and function of various biomolecules at a chemical and molecular level and hands on approach in various laboratory techniques associated with it.

### *Course Outcomes*

On successful completion of the course students will be:

- Appreciate the role of biomolecular as building blocks of biological system.
- Thorough with chemical and molecular foundations of life.
- Able to write the structure, function and properties of amino acids.
- Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
- Aware of the biological importance of nucleic acid as genetic material.
- In the laboratory, able to independently apply various biochemical techniques to identify and quantify major biomolecules.

## UNIT I

### 1. CARBOHYDRATES

12 HOURS

Classification & biological importance of carbohydrates, Structure of Monosaccharides: Stereochemistry of monosaccharides (+) and (-), D and L, Epimers, anomers and diastereomers. Reactions of fructose and glucose, Elucidation of open chain structure of glucose. Mutarotation. Disaccharide: Establishment of glycosidic linkage in sucrose, maltose, lactose. Deoxy ribose & ribose sugar. Polysaccharides: Types, Partial structure, Occurrence of starch, glycogen, inulin, cellulose, chitin, pectin. Reactions of carbohydrates - Molisch's, Benedicts / Fehlings, picric acid, Barford's, Bials, Seliwanoff's, Osazone test.

## UNIT II

### 2. LIPIDS

12 HOURS

Classification and biological role. Fatty acids: nomenclature, structure & properties of saturated, unsaturated, essential fatty acids. Biological roles of, Prostaglandins and Thromboxane. Triacyl glycerols: nomenclature, physical properties, Chemical properties (hydrolysis, esterification, Rancidity of fats, saponification value, iodine value, Acid value) and significance. Biological significance of fats. Glycerophospholipids: Structure of lecithins, Cephalins, Phosphatidyl Serine, Phosphatidyl inositol, plasmalogens and cardiopin.



Biological role of phosphoglycerides. Sphingolipids: Structure and importance of Sphingomyelin, glycolipids-cerebrosides & gangliosides.

### UNIT III

#### 3. PROTEINS

12 HOURS

Proteins-Classification based on solubility, nutrition & functions. Protein structure- Primary, secondary (helix and pleated sheet), tertiary and quaternary structures of protein Amino acids- common structural features, stereoisomerism, R & S notations. Structure & classification of standard amino acids. Essential and non-essential amino acids. pH titration curve, isoelectric pH of amino acids & pKa value. Peptides: structure of peptide bond. Peptides- Glutathione, Valinomycin, leu-enkephalin, Synthetic peptides - polyglutamic acid, Polylysine. Forces stabilizing the secondary, tertiary and quaternary structures of proteins. Denaturation and renaturation of proteins.

### UNIT IV

#### 4. NUCLEIC ACIDS

12 HOURS

Nucleic acids: Introduction, nitrogenous bases - purines and pyrimidines. Nucleosides and nucleotides: structure and properties, phosphodiester bonds. Types and functions of DNA and RNA. Biological importance of DNA and RNA. Nucleic acid chemistry – UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

#### References:

- 1 Fundamentals of Biochemistry (2005) by J.L Jain, 6th Ed, S. Chand & Co Ltd.
- 2 Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-34148
- 3 Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
- 4 Biochemistry (2011) 4<sup>th</sup> ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd.(New Jersey), ISBN:978-1180-25024.
- 5 Biochemistry (2010) 4<sup>th</sup> ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston),ISBN-13:978-0-495-11464-2
- 6 Biochemistry (2013) by U. Satyanarayana and U. Chakrapani, 4<sup>th</sup> edition, Elsevier.
- 7 Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4.
- 8 Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN: 978-0-07-176-576-3.

**PROTEIN BIOCHEMISTRY****Course Objective**

The objective of this course is to provide overview of protein biochemistry and to introduce various techniques to the students, which are used in biological protein research as well as to provide them with an understanding of the underlying principles of these techniques.

**Course Outcomes**

- Students will acquire knowledge about the protein structure
- They will learn about principles and applications of chromatography techniques used in a biochemistry lab.
- Students will learn about the principle and application of electrophoresis, centrifugation techniques and advanced spectroscopic techniques.

**UNIT-I****15 hours**

**Introduction to proteins:** Proteins, classification based on location, biological importance. Structural organization of proteins. Integral and membrane associated proteins, intra cellular proteins. **Extraction of proteins:** Solubilization of proteins from their cellular and extracellular locations. Use of simple cell lysis methods: Physical methods (grinding methods, homogenization, and ultrasonication); Chemical methods (treatment with detergents). **Separation techniques:** Ammonium sulphate fractionation, dialysis.

**UNIT-II****15 hours**

**Characterization of Protein:** Ion-exchange chromatography, molecular sieve chromatography, affinity chromatography and HPLC. Determination of purity and molecular weight, Iso-electro focusing (IEF), Polyacrylamide gel electrophoresis (PAGE), SDS-PAGE and 2-D electrophoresis, Nuclear Magnetic Resonance (NMR) and Mass spectroscopy (Basic principle and applications).

**References:**

- 1 Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-3414-8.
- 2 Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
- 3 The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

- 4 Biochemistry (2011) 4<sup>th</sup> ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd.(New Jersey), ISBN:978-1180-25024.
- 5 Biochemistry (2010) 4<sup>th</sup> ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
- 6 Biophysical chemistry (2012), 8<sup>th</sup> ed., Upadhyay, A., Upadhyay, K and Nath, N. Himalaya publishing House, Mumbai, ISBN: 978-93-5024-919-2.
- 7 Principles and techniques of Biochemistry and Molecular Biology (2010) 7<sup>th</sup> ed., Wilson, K. and Walker. J., Cambridge University Press, New York, USA.ISBN:13978-0-521-17874-7.
- 8 Textbook of Biochemistry with Clinical Correlations (2011) 7<sup>th</sup> ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4.

## **PRACTICALS – G 510.1P**

### **(Assay of Biomolecules)**

#### **1. QUALITATIVE ANALYSIS OF BIOMOLECULES**

1. Carbohydrate – Glucose, Fructose, Lactose, Maltose and Sucrose.
2. Amino acids -Tryptophan, tyrosine or cysteine
3. Proteins –. Albumin or casein
4. Nucleic acids DNA/RNA

#### **2. QUANTITATIVE ANALYSIS OF BIOLOMECECULES**

1. Determination of acid value of an oil or fat.
2. Determination of Saponification value of an oil or fat.
3. Determination of Iodine value of an oil or fat.
4. Identification of amino acids by circular chromatography.
5. Ascending (amino acids) and descending (carbohydrates)
6. Circular Paper Chromatography.
7. Demonstration of separation of plant pigments by column chromatography
8. Thin Layer Chromatography

## G510.2

## SEMESTER II HUMAN PHYSIOLOGY & NUTRITION

### *Course Objectives:*

The course in human physiology and nutrition is aimed at to understand the molecular and cellular mechanisms that control various organ systems in the human body and nutritional impact on them. The course will provide a foundation of the human physiology, nutritional requirements and disorders associated with it in real life. It also outlines the factors and biochemical events that play role in associated pathophysiology. This course will prepare students for higher education in any field related to biomedicine and nutrition.

### *Course Outcomes*

On completion of this paper, students should be able to:

- ✓ Understand the basic organization and functions of various organ systems and the functioning of the whole body.
- ✓ Comprehend and appreciate the importance of the fluid components of the body in regulating and connecting the various organ systems; particularly the heart and vascular system, CSF, lymph.
- ✓ Appreciate and understand the biochemical, molecular and cellular events that orchestrate the functioning of neurons.
- ✓ Get a holistic understanding of understanding of the characteristics, function, distribution and deficiency of macro and micronutrients in the human body.
- ✓ Develop in students an inquisitive learning approach to understand vitamin and associated disorder, the mechanism digestion and food adulterants at its basic level.

### UNIT I

#### 1. PHYSIOLOGY

**12 HOURS**

**Water metabolism & body fluids:** Distribution of water in body fluids, factors influencing water metabolism. Blood volume, composition and functions. RBC, WBC and platelets, their structure and functions. Mechanism of blood coagulation. Biochemical events in transport of CO<sub>2</sub> and O<sub>2</sub> in blood. role of Fe in Hb. Cerebrospinal fluids, Lymph and its function.

**Acid base balance:** Maintenance of normal pH of the body fluids. Blood buffers. Role of lungs and kidney in acid base balance. Acidosis and alkalosis.

**Liver:** Structure of a lobule, Liver functions- metabolic, storage and detoxification.

**Neurons & Neurotransmitter:** Structure & types of neurons, Resting membrane potential, action potential, Transmission of nerve impulse along an axon and across synapse. Neurotransmitters. Inhibitors of neurotransmission, Parkinson disease.

### UNIT II

#### 2. NUTRITION

**12 HOURS**

Concept of nutrition, Calorific value of foods and its determination (bomb calorimeter), respiratory quotient, basal metabolic rate, determination of BMR, factors affecting BMR, specific dynamic action of foods.

**Dietary proteins:** Dietary sources, nutritional classification, nutritional value of protein- PER (protein efficiency ratio), NPU (Net Protein Utilization) and biological value of proteins. Essential amino acids, malnutrition –Kwashiorkor and Marasmus.

**Dietary fat:** Dietary sources of fats, invisible fats, essential fatty acids and their biological importance, obesity.

**Minerals:** Macronutrients-Ca, P, Na, K, Cl and Mg. Micronutrients-Fe, Zn, Cu, I-dietary sources, physiological functions, deficiency disorders, absorption and excretion. Importance of selenium and fluorine. Metals in biological system: Fe, Co, Ca, Mb, Cu.

### UNIT III

#### 3. VITAMINS

12 HOURS

**Fat soluble** - A, D, E, & K, - structural formula, dietary sources, requirements, deficiency symptoms and biological role. **Water soluble vitamins** –B complex (B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, Niacin, Folic Acid, Biotin, Pantothenic acid, Vitamin B<sub>12</sub>) and Vitamin C: Structural formula, co-enzyme forms, biological role, deficiency symptoms and dietary sources. Vitamin C as a Redox reagent.

### UNIT IV

#### 4. FOOD ADULTERATION & DIGESTION

12 HOURS

Sources and harmful effects of anti vitamins (Avidin and Dicoumarol), natural toxicants (Lathyrus sativus) and adulterants (Butter yellow, Lead chromate & malachite green), carcinogens, procarcinogens, anti metabolites, trypsin inhibitors and lectins.

**Digestion:** Digestion, absorption and transport of carbohydrates, proteins and fats. Composition and function of-saliva, gastric, bile, pancreatic and intestinal juices. Gastrointestinal hormones.

#### References:

- 1 Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1. 2.
- 2 Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4. 3.
- 3 Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN: 10:1-4292-2936-5, ISBN: 13:978-1-4292-2936-4.
- 4 Fundamentals of Biochemistry (2005) by J.L Jain, 6th Ed, S. Chand & Co Ltd.
- 5 Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
- 6 Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5. 4.
- 7 The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300- 6.

- 8 Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.
- 9 Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
- 10 Fundamental of Anatomy and Physiology (2009), 8th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13: 978-0321- 53910-6.
- 11 Food and Nutritional (Volume 1 and 2) by Swaminathan.
- 12 Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press. ISBN: 978019517169.
- 13 Gangong's Review of Medical Physiology (2010) 25<sup>th</sup> ed., Barret K.E., Boitano S., Barman S.M and Brooks H.L, McGraw Hills Publishers Newyork, ISBN: 978-0-07-160568-7

G. 510.2E

30 Hours (1 credit)

## BIOCHEMISTRY OF HORMONES

### Course Objective

The course is designed to provide an understanding of the process of cellular communication including signal transduction and intracellular response. It imparts an understanding of the different endocrine receptors and other factors that regulate metabolism and normal body functioning. It includes disease/disorders associated with endocrine imbalance.

### Course Outcomes

On successful completion of the course, a student will:

- Understand and appreciate the different modes of communication between cells in a multi-cellular organism
- Understand the role of endocrine system in maintaining homeostasis
- Should be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.
- Understand the disease and disorders associated with endocrine imbalance.

### UNIT-I

15 hours

**Hormones:** Hormone (Definition) and its biological importance. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy.

**Endocrine glands:** Hormones of Hypothalamus, Pituitary, Adrenal, Thyroid, Pancreas and Gonads and their functions

### UNIT-II

15 hours

**Hormone mediated signaling:** Steroid hormone/ thyroid hormone (general Mechanism), Hormone receptors - extracellular and intracellular. Receptor hormone binding. G protein coupled receptors, second messengers - cAMP, IP<sub>3</sub>, DAG, Ca<sup>2+</sup>, NO. Receptor cross talk.

**Endocrine disorders:** Goiter, Graves disease, myxedema, Hashimoto's disease, Gigantism, acromegaly, dwarfism, Addison's disease, Cushing syndrome (Causes, symptoms and treatment).

### References:

1. Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10-14641-0962.
2. Vander's Human Physiology (2008) 11<sup>th</sup> ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.

3. Endocrinology (2007) 6<sup>th</sup> ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. The Cell: A Molecular Approach (2009) 5<sup>th</sup> Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN: 978-0-87893-300-06.
5. Biochemistry (2013) 4<sup>th</sup>ed.,U. Satyanarayana and U. Chakrapani, , Elsevier, ISBN:
6. Gangong's Review of Medical Physiology (2010) 25<sup>th</sup> ed., Barret K.E., BoitanoS.,Barman S.M and Brooks H.L, McGraw Hills Publishers Newyork, ISBN:978-0-07-160568-7.
7. Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
8. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4. 3.

### **PRACTICALS - G 510.2P (Human Physiology & Nutrition)**

1. Estimation of inorganic phosphorous
2. Estimation of calcium in ragi.
3. Estimation of Iron in curry leaves/ drum stick leaves
4. Estimation of Nitrogen
5. Estimation of vitamin E
6. Estimation of vitamin C
7. Estimation of chlorine in tap water
8. Estimation of sulphate in the water sample
9. Estimation of phosphate in the water sample
10. Estimation of Copper ions (Beer Lamberts Law)
11. Estimation of Hemoglobin Sahli's method
12. Qualitative analysis of food adulterants



## G510.3

## SEMESTER III ENZYMOLGY

### *Course Objectives*

The objective of the course is to provide basic knowledge about enzymes and its role as biological catalysts. It is also aimed at understanding enzyme kinetics and regulation. The course also designed to outline the numerous applications of enzymes in industry for disease diagnosis, process development and therapy.

### *Course Outcomes*

On successful completion of this course students will

- ✓ learn the types, nature and biological importance of enzymes in living systems
- ✓ gain insight into the classification, theories of enzyme specificity
- ✓ learn about the enzyme isolation, activity, units and catalysis
- ✓ It will throw lights on mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and importance of enzyme inhibitors
- ✓ learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
- ✓ The course will introduce students to the applications of enzymes in research, medicine and industry.

### UNIT I

#### 1. INTRODUCTION

12 HOURS

History, general characteristics, nomenclature, IUB enzyme classification with suitable example, Definitions with example- Holoenzyme, apoenzyme, coenzyme, cofactors, Prosthetic groups, activators, inhibitors, metalloenzymes. Active site characteristics, Isoenzymes, monomeric enzymes, oligomeric enzymes, multienzyme complexes. **Enzyme specificity**, different types with suitable example, Theories of enzyme specificity- Lock and key model and Koshland's induced fit.

### UNIT II

#### 2. ENZYME ACTIVITY & PURIFICATION

12 HOURS

Enzyme activation-Zymogen activation, Eg Chymotrypsin, its physiological significance .Measurement & expression of enzyme activity- enzyme assays, **units of enzyme activity (unit & Katal), specific activity**, Methods of enzyme isolation, criteria, purification & characterization.( basis of selection of method for purification & principle). **Enzyme catalysis** -Mechanism of enzyme catalysis- acid-base catalysis, covalent catalysis. Role of cofactors in enzyme catalysis (Eg. NAD<sup>+</sup>/NADH, pyridoxal phosphate), role of metal ions as cofactors.

### UNIT III

#### 3. ENZYME KINETICS

12 HOURS

Factors affecting rate of enzyme catalyzed reaction: substrate concentration, enzyme concentration, pH and temperature. Michaelis-Menten equation (derivation not required). Lineweaver - Burk plot, Significance of Km & Vmax. **Allosteric enzymes**-characteristic sigmoidal graph, effect of positive & negative modulators on sigmoidal kinetics of allosteric enzymes. **Enzyme Inhibition** - Reversible and irreversible inhibition, Competitive, non-competitive and uncompetitive inhibition. Graphical representation by

L-B plot, Application of competitive and irreversible inhibitors with suitable examples. Multienzymes, Isoenzymes, Allosteric enzymes. Enzyme regulations.

#### UNIT IV

#### 4. ENZYME IMMOBILIZATION

12 HOURS

Different methods of immobilization. Industrial & clinical applications of enzyme - Application in dairy, food, leather & detergent industry, enzymes for glucose production from starch, cellulose. Application of enzymes in medicine, therapeutic enzymes, diagnostic enzymes.

#### REFERENCES:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641-0962-1.
2. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
3. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2
4. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN: 0 19 850229.
5. Enzymes ( 2007 ) 2<sup>nd</sup> ed., Trvor Plamer and Philip Boner., Horwood Publishing Ltd., Chichester, UK, United Kingdom ISBN: 1904275273.
6. Biochemistry (2013) 4th ed., U. Satyanarayana and U. Chakrapani , Elsevier.
7. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN: 978-0-07-176-576-3.

#### PRACTICALS – G 510.3P (Bioquantitation & Enzyme assay)

##### ENZYME ASSAYS

1. Estimation of sugar by DNS method
2. Estimation of protein by Lowry's method
3. Estimation of proteins by Biuret method
4. Salivary amylase
  - a) Qualitative determination of salivary amylase enzyme activity.
  - b) Determination of Unit activity of salivary amylase by DNS method.
  - c) Determination of specific activity of salivary amylase
  - d) Determination of pH optimum of salivary amylase
  - e) Effect of enzyme concentration of salivary amylase
  - f) Effect of time on salivary amylase activity
  - g) Effect of substrate concentration on salivary amylase enzyme activity

5. Acid phosphatase
  - a) Determination of Unit activity of Acid phosphatase with PNPP as substrate.
  - b) Determination of specific activity of acid phosphatase.
  - c) Determination pH optimum of acid phosphatase.
6. Isolation and Estimation of Urease enzyme from Soya bean
7. Glucose Oxidase assay by microtiter plate
8. Assessment of purity of starch.

**STEM CELLS****Course Objective**

The course is aimed to impart basic understanding of stem cells and its applications in the field of medicine.

**Course Outcomes**

- Students will acquire basic information about the stem cells and its types
- Gain knowledge of ethical concerns in stem cell research
- Comprehend the applications of stem cell in regenerative medicine

**UNIT-I****15 hours**

Definition of Stem cells and characteristics. General applications. Pluripotent, Multipotent and Totipotent Stem cells; Primordial Germ Cells, Embryonic Stem Cells; Amniotic Fluid Derived Stem Cells. Characterization of Human stem Cells; FACS, Maintenance of Human Embryonic Stem Cells. Genomic Reprogramming, Fate Mapping of Stem Cells.

**UNIT-II****15 hours**

Neural Stem Cells in Neurodegenerative Diseases; Hematopoietic Stem Cell in Transplantation; Epithelial Stem Cells and Burns; Stem Cells and Heart Disease; Pancreatic Stem Cells and Diabetes. Embryonic Stem Cells in Tissue Engineering, Cancer Stem Cells, Aging and stem cell renewal, Stem Cell Banking, Ethical Concerns in Stem Cell Research.

**References:**

1. Essentials of Stem Cell Biology (2013), 3<sup>rd</sup> ed., Edited by Robert Lanza and Anthony Atala. Academic Press, CA, USA, ISBN:9780124095038.
2. Stem Cell Biology (2001) - Edited by Daniel R Marshak, Richard L. Gardner and David Gottlieb. Cold Spring Harbor Press, NY, USA, ISBN:978-0879695750
3. Stem Cell Now (2006) 2<sup>nd</sup> ed., Christopher Thomas Scott, Pearson Education, NJ, USA. ISBN: 978-0452287853
4. Biotechnology (2011) 1<sup>st</sup>ed.,USatyanarayana, Books& Allied (P) Ltd. ISBN:81-87134-90-9.
5. Stem cell Technologies: Basics and applications (2009) 1<sup>st</sup> ed.,Satish T and Kaushik D. D.,McGraW-Hill publishers, New Delhi ISBN:9780071635721.
6. The World of the Cell (2009), 7th ed., Becker W.M., Kleinsmith, L.J., Hardin., J., Bertoni, and G.P., Pearson Benjamin Cummings (CA), ISBN: 978-0-321-55418-5.

7. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN: 978-0-87893-300-6.
8. Molecular Cell Biology (2013) 7th Ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Macmillan International Edition (New York), ISBN: 978-1-4641-0981-2.

## G510.4

## SEMESTER IV METABOLISM

### Course Objective

The objective of this course is to provide an understanding of metabolism of biomolecules like, carbohydrate, lipids, amino acids and nucleic acids, the enzymes involved in various metabolic pathways and regulation. The course also aims to outline the importance of such pathways in relation to metabolic defects.

### Course Outcomes

The students will be able to:

- ✓ Understand the concepts of general metabolism, characteristics of each metabolic pathways and methods used to study these pathways.
- ✓ Gain holistic knowledge of various catabolic and anabolic pathways in the body
- ✓ Understand mechanism of the regulation of various pathways
- ✓ Able to obtain knowledge about the diseases caused by defects in metabolism.
- ✓ Understand different assays in the laboratory to obtain compressive knowledge on the metabolic pathways.

### UNIT I

#### 1. INTRODUCTION TO METABOLISM

12 HOURS

General features of metabolism, use of bacterial mutants & radioactive isotopes to study metabolism.

**Carbohydrate metabolism:** Glycolysis- reactions & energetics, Fates of pyruvate, alcoholic & lactic acid fermentation, Gluconeogenesis and its physiological significance. Importance of Cori's cycle, Reactions & energetic of TCA cycle. Glycogen metabolism – glycogenolysis & glycogenesis. Reactions of Pentose phosphate pathway & its physiological significance.

### UNIT II

#### 2. PHOTOSYNTHESIS

12 HOURS

**Photosynthesis**-Ultra structure of Chloroplast, photosynthetic pigments, photoreaction & calvin cycle in brief review, cytochrome, phytochrome & Bacterial photosynthesis.

**Mitochondrial electron transport:** Electron transport chain & oxidative phosphorylation-structure of mitochondria, sequence of electron carriers, flow chart of transport of electrons from reducing potential to O<sub>2</sub>. inhibitors of ETC, oxidative phosphorylation, uncouplers of oxidative phosphorylation, ATP synthase- structure, Hypothesis of ATP synthesis – Binding change mechanism.

### UNIT III

#### 3. LIPID METABOLISM

12 HOURS

Hydrolysis of triacylglycerols, transport of fatty acids into mitochondria, Beta-oxidation of even numbered saturated fatty acids, Energetics of  $\beta$ -oxidation. Biosynthesis of even number saturated fatty acids (Scheme only). Significance & source of Ketone bodies and ketosis. Outline of Cholesterol biosynthesis & regulation. Biosynthesis of phospholipids (scheme only).

## UNIT IV

### 4. AMINOACID & NITROGEN METABOLISM

12 HOURS

General reactions of aminoacid metabolism- transamination, oxidative deamination & decarboxylation, Urea cycle, flow chart of degradation & biosynthesis of amino acids, gluogenic & ketogenic aminoacids.

Sources of the atoms in the purine & pyrimidine molecules, Schematic flow chart of purine & pyrimidine *denovo* synthesis, salvage pathway of purines, role of thymidylate synthase and its inhibitors in cancer therapy, end products of purine & pyrimidine catabolism, cause of gout.

#### References:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1. 2.
2. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN: 10:1-4292-2936-5, ISBN: 13:978-1-4292-2936-4.
3. Fundamentals of Biochemistry (2005) by J.L Jain, 6th Ed, S. Chand & Co Ltd.
4. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
5. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN: 13: 978-0470-23396-2.
6. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4. 3.
7. Biochemistry (2013) 4th ed., U. Satyanarayana and U. Chakrapani, Elsevier.
8. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN: 978-0-07-176-576-3.

**MOLECULES OF LIFE****Course Objectives**

The course aims to provide students with an understanding of four biomolecules, which are the basic building units of human body. It emphasizes on structure, types and biological importance molecules protein carbohydrate, lipids and nucleic acids.

**Course Outcomes**

On successful completion of the course students will be:

- Able to understand the structure and importance of biomolecules. .
- Aware of the significance individual biomolecules.
- Able to independently identify various biomolecules based on structures and associated disorders.

**UNIT-I****15 hours**

**Carbohydrate:** Introduction, Biological importance, classification. Monosacharides, Disaccharides and polysaccharides (Definition, sources and examples). Blood sugar and diabetes mellitus, obesity (causes, symptoms and treatment). **Amino acids:** Definition and nutritional classification. Amino acid metabolic disorders: Phenylketonuria and albinism. **Protein:** Definition, biological importance and nutritional classification. Peptide bond, biologically important peptides. Malnutrition: Kwashiorkor and Marasmus.

**UNIT-II****15 hours**

**Lipids:** Classification and properties. **Fatty acids:** Classification and properties of fatty acids (rancidity and Saponification). Lipoproteins: types and function. Serum lipid profile, Hypercholesterolemia and atherosclerosis. **Nucleic acids:** Introduction, nitrogenous bases - purines and pyrimidines, nucleosides, nucleotides, phosphodiester bonds. Types and functions of DNA and RNA. Biological importance of DNA and RNA. Gout (Causes, symptoms and treatment).

**References:**

1. Fundamentals of Biochemistry (2005) by J.L Jain, 6th Ed, S. Chand & Co Ltd. ISBN:81-219-2453-7.
2. Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-3414-8.
3. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.



4. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.
5. Biochemistry (2011) 4<sup>th</sup> ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN: 978-1180-25024.
6. Biochemistry (2010) 4<sup>th</sup> ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2
7. Biochemistry (2013) by U. Satyanarayana and U. Chakrapani, 4th edition, Elsevier.
8. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4. 3.

### **PRACTICALS –G 510.4P (Estimation of metabolites)**

1. Estimation of pyruvate
2. Estimation of lactate
3. Estimation of tryptophan
4. Estimation of phenolics
5. Estimation of amino acid (glycine) by formal titration
6. Estimation of amino acid by Ninhydrin method
7. Estimation of cholesterol by Zak's method
8. Estimation of glucose by Nelson Somogyi method / Folin Wu method
9. Estimation of nucleic acid
10. Isolation & Estimation of glycogen

## MOLECULAR BIOLOGY

### *Course Objective*

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

### *Course Outcomes*

- ✓ Students will acquire basic information about the structure of DNA and various forms of DNA, about organization of genome in various life forms, supercoiling of DNA and its significance
- ✓ Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes
- ✓ acquire basic knowledge about the processes of transcription and translation in prokaryotes and eukaryotes
- ✓ learn about the features of the genetic code and various experimental approaches used to crack the code
- ✓ develop understanding of the molecular basis of RNA processing and RNA splicing
- ✓ learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms
- ✓ Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage, DNA recombination.

### UNIT I

#### 1. DNA & RNA

**10 HOURS**

Nucleic Acids: Isolation of DNA from tissue sample. Chargaff's rule. Watson and Crick model of DNA, Circular DNA, hyperchromicity,  $T_m$  & Cot curve. RNA: Isolation of total cellular RNA. Composition & types of RNA mRNA, tRNA, and rRNA, Secondary structures of tRNA- clover leaf model, Ribozymes. **Chromosomes:** Circular & linear chromosomes, structure of eukaryotic chromosome and nucleosome.

### UNIT II

#### 2. CENTRAL DOGMA DNA REPLICATION

**10 HOURS**

Central dogma of molecular biology and its modification (reverse transcription). DNA as genetic material- Griffith, **Avery–MacLeod–McCarty** & Hershey Chase experiment. DNA replication: Meselson and Stahl experiment. Over view of DNA replication- Semi conservative mechanism, replication fork, Okazaki fragments. Mechanism of replication in prokaryotes and special features of eukaryotic replication. Transcription: Prokaryotic RNA synthesis: Role of RNA polymerase, promoters, initiation, elongation and termination of RNA synthesis. Reverse transcription, outlines of mRNA splicing, characteristics of eukaryotic pre-mRNA (introns & exons) and mature mRNA - 5' cap, poly A tail.

### UNIT III

### 3. GENETIC CODE & TRNASLATION

10 HOURS

General features of genetic code, Khorana's experiment and Wobble hypothesis. Ribosome structure, A- & P- sites, activation of amino acids, aminoacyl tRNA synthesis & its role in decreasing the translational errors. Translational initiation, elongation and termination in prokaryotes. Special features of eukaryotic translation & post translational modification in eukaryotes- glycosylation. Antibiotics as translation inhibitors (Eg: Tetracycline, puromycin & chloramphenicol)

## UNIT IV

### 4. REGULATION OF GENE EXPRESSION & MUTATION

10 HOURS

Concept of Operon, Lac operon and catabolite repression. Molecular basis of mutation and types of mutations- Eg: Transition, Transversion, frame shift, insertion, deletion, germinal & somatic, dominant & recessive mutations, spontaneous & induced mutations. Mutagens - effect of HNO<sub>2</sub>, Alkylating agents, interchelating agents and UV-radiation. DNA repair- UV repair systems in *E. coli*, Significance of thymine in DNA. **DNA recombination mechanism:** Mechanism in prokaryotes - Homologous and non homologous types (Holliday model). Mechanisms of Gene transfer in bacteria - conjugation, transformation and transduction.

#### References:

- 1 Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN: 0-321-50781 / ISBN: 978-0-321-50781-5.
- 2 Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
- 3 Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia, ISBN: 978-0-470-39842-5.
- 4 Molecular Biology-Instant notes. P.C. Tumer, A.G. McLennan, A.D. Bates and M.R.H. White, 2001. Viva Books Pvt. Ltd., New Delhi.
- 5 Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1. 2.
- 6 Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN: 10:1-4292-2936-5, ISBN: 13:978-1-4292-2936-4.
- 7 Fundamentals of Biochemistry (2005) by J.L Jain, 6th Ed, S. Chand & Co Ltd.

- 8 The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300- 6.
- 9 Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.
- 10 The World of the Cell (2009), 7th ed., Becker W.M., Kleinsmith, L.J., Hardin., J., Bertoni, and G.P., Pearson Benjamin Cummings (CA), ISBN: 978-0-321-55418-5.
- 11 Molecular Cell Biology (2013) 7th Ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M.,Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Macmillan International Edition (NewYork), ISBN:13: 978-1-4641-0981-2.

**G510.5b**

**SEMESTER V**

**GENETIC ENGINEERING AND BIOTECHNOLOGY**

***Course objectives***

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and eukaryotes. Plant tissue culture and plant manipulation techniques are also outlined in this course. Applications of these techniques in production of beverages, vitamins and other therapeutic agents at industrial scale.

***Course Outcome***

The students will be able to understand:

- ✓ The process for isolation and engineering of DNA using restriction and modification enzymes.
- ✓ Use of cloning and expression vectors.
- ✓ The methods for creation of genomic and cDNA libraries, their applications and use.
- ✓ Understand IPR and ethical issues in Biotechnology
- ✓ Gain knowledge on tissue culture media and techniques
- ✓ Understanding the methods for antibiotic alcoholic and non alcoholic production at industry.

**UNIT I**

**1. GENETIC ENGINEERING**

**10 HOURS**

Scope of genetic engineering, Cutting of DNA by Restriction Endonucleases –staggered cut and blunt end. Steps in DNA cloning, Characteristics of plasmids: pBR322 & pUC 19, insertion of foreign DNA into vectors- transformation & Transfection, CRISPER-Cas 9 gene editing. Principle of polymerase chain reaction and application. Blotting techniques- Principle of Southern, Northern blotting and Western Blotting. Application of Genetic engineering- transgenic plants, transgenic animals and gene therapy.

**UNIT II**

**2. PLANT BIOTECHNOLOGY**

**10 HOURS**

Introduction, *Agrobacterium* mediated gene transfer. Selection, identification and recovery of transformed cells. Applications of gene transfer in plants (e.g.: insect resistant -Bt cotton, Bt brinjal, Golden Rice and edible vaccines). Cybrids, Germplasm conservation: Introduction, methods and types of cryoprotectants and applications. Biotechnology: Ethical issues and necessity of bioethics. Basic concepts of IPR (Context of India).

**UNIT III**

**3. TISSUE CULTURE**

**10 HOURS**

Brief history of plant tissue culture, Principle, Laboratory requirements and general techniques involved in micro propagation techniques (Equipments, Media-types, preparation, explants, sterilization techniques) role of micro, macronutrients, pH and gelling agents and growth regulators. Protoplast Isolation Culture - Principles, isolation of protoplasts, factors affecting the viability, testing of viability of isolated protoplast and applications.

## UNIT IV

### 4. INDUSTRIAL BIOTECHNOLOGY

10 HOURS

Methods for screening and selecting micro-organisms for the purpose of production. Primary and secondary metabolites. Continuous culture methods; principles and applications; the Chemostat and its application in industrial fermentations – alcoholic beverages (beer and wine), cheese, amino acids (lysine), antibiotics (penicillin and tetracycline) and vitamins (Riboflavin). Single cell protein- spirulina.

#### References:

- 1 Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
- 2 Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN: 13: 978-1-4051-3544-3.
- 3 Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
- 4 Principles of Gene Manipulation and Genomics (2006) 7th ed., Sandy Primrose, By Black Well Publishers.
- 5 Gene Cloning and DNA analysis (2004) 2nd ed., Brown T.A. By ASM press.
- 6 Molecular biotechnology: Principles and applications of recombinant DNA, (2010) 4th ed., Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten., By ASM press.
- 7 Molecular cloning: a laboratory manual (2001) 3rd ed., Joseph Sambrook, David William Russell, Volume 3, By CSHL Press, New York.
- 8 Recombinant DNA. (1992) 2<sup>nd</sup> ed., James D. Watson, Michael Gilman, Jan Witkowski, Mark Zoller, W. H. Freeman and Company, New York.
- 9 Introduction to Plant Biotechnology (2015) 3<sup>rd</sup> ed., H.S Chawla, Oxford & IBH Publishing Co.Pvt.Ltd New Delhi ISBN:974-81-204-1732-8.
- 10 A Text Book Microbiology (2014) 3<sup>rd</sup> ed., R.C Dubey & D.K Maheshwari, S.Chand & Company Pvt .Ltd. ISBN: 81-219-2620-3.
- 11 Biotechnology (2012) 4<sup>th</sup> ed., B.D Singh Kalyni Publishers, New Delhi, ISBN:978-93-272-2298-2.
- 12 Biotechnology (2011) 1<sup>st</sup> ed., U Satyanarayana, Books & Allied (P) Ltd. ISBN:81-87134-90-9.

#### **PRACTICALS – G 510.5P (Molecular Biology and Biotechnology)**

1. Extraction of DNA from coconut onion.
2. Quantification of extracted DNA by diphenylamine method.
3. Extraction of total RNA from yeast/Liver.
4. Quantification of extracted RNA by Orcinol method
5. Isolation of mitochondria / chloroplast.
6. Estimation of DNA/ RNA / protein using UV Spectroscopy.
7. Preparation of MS Media.
8. Explant culture
9. Embryo culture
10. Preparation of synthetic seeds
11. Agarose gel electrophoresis

12. Wine production
13. SDS PAGE
14. Estimation of alcohol by specific gravity method

## G510.6a

## SEMESTER VI MICROBIOLOGY AND IMMUNOLOGY

### Course Objective

This course describes the basic concepts in microbiology and immunology. It emphasizes on molecular and cellular basis of the development and function of the immune system. The course will provide the basic framework in techniques of microbiology and immunology. It also cover the major topics including bacteria, fungus, viruses, microbial staining and culture, sterilization, types of immunity, antibodies and antigens, Humoral and cell mediated adaptive immune response, hypersensitivity, autoimmunity, immune deficiency disorder, complement system and grafting.

### Course Outcomes

Upon completion of this course, a student will be able to

- ✓ Trace the history and developments in microbiology.
- ✓ Have an overview of the culture and staining techniques for bacteria, viruses and microbial nutrition
- ✓ Understand the immune system including cells, organs and types of immunity.
- ✓ Describe the basic mechanism, differences and functional interplay of innate and adaptive immunity
- ✓ Understand Antigens & its Recognition, antigen processing and presentation
- ✓ Understand the structure & functions of different classes of Immunoglobulins, and techniques like ELISA, RIA and immunodiffusion
- ✓ Define the cellular and molecular pathways of humoral and cell-mediated immune responses
- ✓ Describe the mechanisms involved in different types of hypersensitivity
- ✓ Explain the autoimmunity and grafting
- ✓ Understand complement pathways in detail

### UNIT I

#### 1. HISTORY & TECHNIQUES IN MICROBIOLOGY 10 HOURS

Definition, Scope and History of Microbiology (Antony van Leeuwenhoek, Spallanzani, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Flemming); Differences between the prokaryotic and eukaryotic microorganisms. Sterilization – Physical and chemical methods of sterilization. Serial dilution, pour plate method, spread plate method and streak plate method. Culture media preparation: simple and complex media. Classes of microorganisms- bacteria- Gram positive and Gram negative, fungi-yeast and mold. General structure and bacterial differentiation based on morphology, shape, and colony characteristics. Staining- Gram stain and acid fast stain, endospore staining.

### UNIT-II

#### 2. MICROBIAL GROWTH & NUTRIENTS 10 HOURS

Growth of microorganisms, factors influencing growth- nutrition, carbon source, nitrogen source, temperature, pH, oxygen. Growth curve, phases of growth curve. **Viruses:** Classification based on genetic material with examples. Plant viruses –TMV, morphology, General characteristics and its replication, Animal viruses- RNA (Eg: HIV) and DNA viruses (Eg: Herpes simplex virus). **Bacteriophage:** Morphology, general characteristics of bacteriophage. Lysogenic and lytic life cycle of T4 phage.



### UNIT III

#### 3. BASIC IMMUNOLOGY

10 HOURS

**Introduction to immunology:** Innate & adaptive immune system and its components, Role of immunologically important organs and cells -bone marrow, thymus, spleen and lymphocytes. **Antigens & antibodies:** Antigens, Antigenicity and immunogenicity. Definition of Haptens and Epitopes. Adjuvants and its effects. Antibodies- basic structure, Classes of antibodies and their biological functions. Monoclonal & polyclonal antibodies. Abzymes-characteristics. Antigen - antibody interactions-principle, precipitation reaction in gels and agglutination reactions, their applications, Principle & applications of RIA & ELISA. **Cellular basis of immunity:** Cellular and Humoral immunity, Functions of T-lymphocytes, (Helper T-cells and Killer T-cells), B –lymphocytes and macrophages

### UNIT IV

#### 4. COMPLEMENT & IMMUNE DISORDER

10 HOURS

**Complement system:** Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation. **Immune disorder:** Autoimmunity, Organ specific (Myasthenia gravis & Hashimoto's thyroiditis) & systemic (Rheumatoid arthritis & Systemic lupus erythematosus) autoimmune diseases. Immune deficiency diseases- AIDS and SCID. Hypersensitive reactions- 4 types based on immune mechanism. **Transplantation:** Types of transplants, Graft rejection, process of graft rejection-sensitization and effector stage, role of immunosuppressive agents in clinical situation.

#### References:

- 1 Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
- 2 Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.
- 3 Klein's Microbiology (2008) 7th Ed., Prescott, Harley, Willey, J.M., Sherwood, L.M., Woolverton, C. J. Mc Graw Hill International Edition (New York) ISBN: 978-007-126727.
- 4 Immunology, Roitt, L., Brostoff, J. and Male, (1990). D. Grower Medical Publishing, London.
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- 6 Techniques in Clinical Immunology. Thomson, R.A. (1997). Blackwell scientific Publications, Oxford.
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**CLINICAL & MEMBRANE BIOCHEMISTRY*****Course Objective***

The objective of this paper is to offer insights into the basic clinical aspects, associated disorder, and structure as well as function of a cell membrane. It also covers topics of radiochemistry and cancer. The course also aims to impart understanding of cell transport, cell death, endocytosis and various techniques of cell biology. It describes mechanism of cancer, treatment, carcinogens and properties of radioactive materials.

***Course Outcomes***

- ✓ Learn about urine, blood and related disorder in detail.
- ✓ They will understand the cell membrane structure, functions, ionophores and active transport mechanism
- ✓ Introduced to basic concepts radioactivity, its measurements
- ✓ Gain knowledge about the radiation hazards and safety
- ✓ Get knowledge about the carcinogens, cancer and its types
- ✓ Acquire insight into cancer diagnosis and treatment

**UNIT I****1. CLINICAL BIOCHEMISTRY****10 HOURS**

**Urine:** Normal and abnormal constituents of urine-volume, pH, specific gravity. Constituents-urea uric acid, creatinine, pigments and their clinical significance in brief.

**Blood:** Normal constituents of blood-Glucose, bilirubin, urea, uric acid, creatinine, cholesterol and their variation in pathological conditions particularly Atherosclerosis and Diabetes mellitus. Serum lipid profile- and its significance. Differentiation of Serum and plasma. **Clinical enzymology:** Clinical application of enzyme- Alkaline and acid phosphatase, SGOT and SGPT for liver test, CPK and LDH, Amylases and lipases for pancreatitis. **Genetic disorder:** Sickle cell anemia, Phenylketonuria, Neimannpick disease and Haemophilia.

**UNIT II****2. MEMBRANE BIOCHEMISTRY****10 HOURS**

Structure, composition and functions of biological membranes – fluid mosaic model & sandwich model; chemistry and molecular organization of membrane components. The unit membrane hypothesis; Membrane transport system – active versus passive transport systems; Transport of Glucose; Ion channels - voltage-gated ion channels ( $\text{Na}^+ / \text{K}^+$  voltage-gated channel), ligand-gated ion channels (acetyl choline receptor). Ionophores. Functions of plasma membrane – Receptor mediated endocytosis and phagocytosis.

### UNIT III

#### 3. RADIOACTIVITY

10 HOURS

Radioactivity, types, properties, radioactive decay, half life, measurement of radioactivity & its units. Detection of radioactivity– GM Counter; Solid & liquid scintillation counter. Commonly used radioactivity in medicines, radiation hazards. Safety measures, Free radicals: generation, detection & uses.

### UNIT IV

#### 4. BIOCHEMISTRY OF CANCER

10 HOURS

Definition, types, properties of cancer cells, characteristics, carcinogens, mechanism of carcinogenesis. Oncogenes and tumour suppressor genes. Role of drugs & enzymes in cancer treatment. Tumour markers – Definition, characteristics, classification & clinical significances.

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## **PRACTICALS – G510.6P (Microbiology & Clinical Biochemistry)**

1. Qualitative analysis of normal and abnormal constituents in urine.
2. Estimation of uric acid
3. Estimation of Urea by DAM method.
4. Estimation of creatinine
5. Culturing of microorganisms by streak plate, spread plate & pour plate method
6. Gram staining
7. Spore staining
8. Simple staining (methylene blue)
9. Micrometry-Determination of size of micro organisms (Ocular, stage micrometers).
10. Antimicrobial activity / test – Disc diffusion method
11. Radial immunodiffusion
12. Double immunodiffusion
13. Staining of human blood cells
14. Estimation of antioxidant activities by DPPH method
15. Glucose utilization assessment in yeasts cells by using glucose Oxidase method
16. Determination of esterase enzyme activity (Time based estimation).

### **PROJECT REPORT - 50 MARKS**

OR

### **EXTRA EXPERIMENTS– 50 MARKS**

1. Estimation of total lipid from egg yolk / liver
2. Isolation & quantification of mitochondria
3. Enzyme assay urease
4. Extraction of oil by Soxhlet extraction
5. Estimation of minerals
6. Antimicrobial activity of essential oils
7. Preparation of aspirin .Estimation of salicylic acid in urine sample (veg / non veg)
8. Erythrocytic lysis
9. Agglutination reaction
10. LDH Assay
11. Extraction of invertase from yeast, precipitation & purity check
12. Determination of catalase activity

### **SCHEME OF VALUATION**

**The scheme is applicable from semester I to semester IV**

<b>1. Practical exam (external)</b>	<b>Time: 3hrs</b>
a) Major experiment	15 marks
b) Minor experiment	08 marks
c) Viva	02 marks
d) Procedure writing	05 marks
e) Class record	10 marks
	<b>Total – 40 marks</b>

**2. Practical internal assessment (10 marks)**

- |                            |  |          |
|----------------------------|--|----------|
| a) Internal Practical test |  | 08 marks |
| b) Continuous assessment   |  | 02 marks |

**Total – 10 marks**

**Total (external + internal) = 50 marks**

**3. Practical question paper model for V semester**

**Practical exam (external)**

**Time: 4hrR**

- |                         |          |
|-------------------------|----------|
| a) Major experiment (1) | 30 marks |
| b) Minor experiment (1) | 20 marks |
| c) Viva                 | 05 marks |
| d) Procedure writing    | 05 marks |
| e) Class record (10x2)  | 20 marks |

**Total-80marks**

**4. Practical internal assessment (20 marks)**

- |  |          |
|--|----------|
| a) Regularity and class participation              | 04marks  |
| b) Internal practical test and record maintenance. | 16 marks |

**Total – 20 marks**

**Total (external + internal) = 100 marks**

**Practical question paper model for VI semester**

**Project + Practical (50+50) = 100 marks**

**5. Practical exam (external)**

**Time: 4hrs**

- |                         |          |
|-------------------------|----------|
| a) Major experiment (1) | 12 marks |
| b) Minor experiment (1) | 08 marks |
| c) Viva                 | 05 marks |
| d) Procedure writing    | 05 marks |
| e) Class record         | 10 marks |

**Total-40marks**

**6. Practical internal assessment (10 marks)**

- |                            |           |
|----------------------------|-----------|
| a) Internal Practical test | 0 8 marks |
| b) Continuous assessment   | 02 marks  |

**Total – 10 marks**

**Total (external + internal) = 50 marks**

**Project report:** Project report shall be typed and bound by bonafide certificate and shall be submitted during practical examination for valuation and return.

**Students Project**

- |  |          |
|--|----------|
| a) Internal assessment:                                      | 10 marks |
| b) Continuous assessment based on involvement in the project |          |

c) Project work (External) 40 marks

**Project report - 30 marks**

**Viva - 10marks**

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**Total (internal assessment & external exam) = 50 marks**

**OR**

**Additional experiments (40+10=50 Marks)**

- a) **Experimentation=20 Marks**
- b) **Internal Assessment = 10 Marks**
- c) **Record=10 marks**
- d) **Viva=10 marks**

## **B.Sc. VI SEMESTER**

### **PART A: COMPULSORY SET OF EXPERIMENTS PART 2: PROJECT/ ADDITIONAL PRACTICAL EXPERIMENTS**

#### **NOTE:**

- All Students will have regular practicals (Part A).
- Every student shall have 1 project in any one of the discipline for 50 Marks.
- Project topics can be given to the students in the beginning of V semester.
- Students who do not opt for project (Part B) in a particular subject, along with regular practicals (Part A) will have additional experiments (Part B) for 50 marks.

**PART I: Compulsory set of experiments:**

**50 marks**

**Total marks: 40 Marks**

**Internal Assessment: 10 Marks**

**PART II: Project OR Additional Experiments**

**50 Marks**

**Project (40+10=50 Marks)**

**Continuous Assessment=10 Marks**

**Report=30 Marks**

**Viva= 10 Marks**

**TOTAL=50 Marks**

**OR**

**Additional experiments (40+10=50 Marks)**

**Experimentation=20 Marks**

**Internal Assessment = 10 Marks**

**Record=10 marks**

**Viva=10 marks**



**QUESTION PAPER PATTERN (THEORY)**  
**CHOICE BASED CREDIT SYSTEM (CBCS)**  
**BIOCHEMISTRY**

**TIME: 1.5 HOURS**

**MAX MARKS: 50**

I. ANSWER ANY FIVE OF THE FOLLOWING

5 / 7 x 2 = 10 MARKS

II. ANSWER ANY FOUR OF THE FOLLOWING

4 / 5 x 5 = 20 MARKS

III. ANSWER ANY TWO OF THE FOLLOWING

2 / 3 x 10 = 20 MARKS

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