Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of Syllabus

Program B.Sc.

T. Y. B. Sc. (Biochemistry)

Choice Based Credit System (CBCS)

2020-21

T.Y.B.Sc. Biochemistry

Preamble

The cumulative demand for trained and skilled manpower in the area of Biochemistry requires in depth functional knowledge of modern biology through hands-on training to the students.

The syllabus has been prepared anticipating the requirements of B.Sc. Biochemistry students under CBCS Program. The contents have been drawn to accommodate the widening horizons of the Biochemistry discipline and reflect the changing needs of the students. The detailed syllabus for each course is appended with a list of suggested readings.

The degree of Bachelor of Science in Biochemistry (Choice Based Credit System) aims to introduce various aspects of Biochemistry and interdisciplinary subjects to the students. The program in Biochemistry as one of the core subjects is designed to cultivate a scientific attitude and interest towards the modern areas of Biochemistry and life science in general. This will help the students to become critical and curious in their outlook. The courses are designed to impart the essential basics in Biochemistry, Chemistry, Botany, Microbiology, Zoology and Biotechnology at the initial level of graduation. The basic courses are infused with application in modern life sciences, and awareness on Biochemistry and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Biochemistry and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about Biochemistry and contribution of Biochemistry among the society. At the end of the course, the students are expected to have good working knowledge in the field of Biochemistry and in addition knowledge gained from courses of interdisciplinary in nature. Students will surely have an urge to continue higher studies in Biochemistry and contribute significantly in the development.

The present syllabus is restructured anticipating the future needs of Biochemistry with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biochemistry.

Hence, Board of Studies in Life Sciences in its meeting accepted the revised syllabus for T. Y. B. Sc. (Biochemistry) based on Choice Based Credit System (CBCS) of UGC guidelines. The path for a bright future of Biochemistry has been emphasized to build up with a hope to achieve the goals in the form of fruitful program outcomes in the coming days.

There are 08 core courses which encompass all important aspects of the discipline of Biochemistry and are all compulsory courses. 04 choice-based Discipline Specific Elective (DSE) courses are designed which give the students a chance to apply their knowledge of Biochemistry to study societal problems. The students have a freedom to select the courses of their choice while Skill based Elective Courses (SEC) are also included to develop skills in areas which are related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

Programme Outcome (PO)

As an outcome, the graduate students are expected to gain the following competencies upon completion of this program B.Sc.

- Students will understand the concepts and significance in the field of Biochemistry / Biotechnology / Microbiology that can be used for solving the real time problems.
- Students will acquire skills and ability in their field and find professional opportunities in industry, agriculture and higher studies.
- Students will have improved personal qualities and transferable skills to help them to groom as responsible citizens.

Program Specific Outcomes (PSO):

- T.Y. B.Sc. (Biochemistry) graduates will have basic and applied knowledge of Biochemistry.
- They can further continue their education as PG and then Ph.D.
- After successful completion of the program, students will acquire laboratory and transferable skills which will help them to boost their career.
- Students can apply their knowledge in public as well as private sector and build successful career.

Learning Objectives

- To acquaint the students with various disciplines of Biochemistry.
- To articulate foundation and pillar level knowledge of Biochemistry for the beneficiaries to apply them for advanced studies in the subject.
- To develop practical skills with a sound theoretical background.

- To apply the knowledge gained for higher education, research and profession of their choice.
- To analyse their interests among the various disciplines and implement them in their professional endeavours.

Programme Structure:

The programme includes 8 Discipline Specific Core Courses (DSC) of 3 credits each, 4 each for the two semesters (Semester V and VI). There shall be inclusion of 02 Skill Enhancement Course (SEC) of 3 credits each, one for each Semester. The course has incorporated 4 Discipline Specific Elective Courses of 3 credits each, two for each Semester. The student shall have liberty to choose one of the two courses. There shall be 6 Discipline specific Core Practical courses of 2 credits each; 3 courses for each semester.

Eligibility:

Students completing Second Year CBCS (Semester III and IV) of B.Sc. (44 credits) shall be eligible for admission to T.Y.B.Sc. CBCS Degree course. However, the candidate must pass all subjects of first year.

Course Fee: As per University norms

Duration: The duration of B.Sc. (Biochemistry) degree program shall consist of three years.

Medium of instruction: The medium of instruction for the program shall be English.

Credit to contact hour/Duration of Lecture: 45 Lectures of 60 minutes or 54 Lectures of 50 minutes shall be conducted for 08 Discipline Specific Core courses, 02 Skill Enhancement Courses and 02 Discipline Specific Elective courses of 3 credits each. Each theory and practical course must be completed in 45 and 60 lectures, respectively of 60 minutes duration. The score allotted for 06 Discipline Specific Core practical courses is 2 credits for each course.

Attendance:

The candidates appearing for the final year examinations of B.Sc. Biochemistry need to fulfill a regular attendance record in theory and practical of not less than 80 %. Failing to fulfill the criteria the student shall not be eligible for appearing for the T.Y.B.Sc. CBCS examination.

Exam Pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal (College assessment) and 60 marks external examination (University assessment).
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, III and IV, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 4 units, Each 4 marks.

Internal examination (40 marks each semester):

Internal assessment (College assessment) of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.

Practical Examination:

Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule with some flexibility; if required. There shall be 10 marks for laboratory logbook and well written journal, 10 marks for *viva-voce* and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one/ two expert and two examiners (external and internal) per batch for the practical examination.

Scheme

Scheme for T. Y. B. Sc. program under the Faculty of Science and Technology includes in continuation with the First and Second Year's two semesters namely Semester V and VI. Each semester shall include four Core courses; one Skill based course, one Elective course, three Core practicals and one non-credit Elective Audit course.

Scheme for B.Sc. Program under Faculty of Science and Technology

Sr. No	Year → / Course ↓	First Year				Second Year				Third Year				Total Credit Value
		Sem I		Sem II		Sem III		Sem IV		Sem V		Sem VI		
1	Core Courses (16)	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	
	i. Theory	4	4	4	4	4	3	4	3	3	4	3	4	4x14=56 3x8=24
	ii. Practical	2	4	2	4	2	3	2	3	2	3	2	3	2x14=28 2x6=12
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2x2x2x2 =08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	3	1	3	1	2x2=04 3x2=06
4	Discipline Specific Elective (DSE) (6)									3	1	3	1	3x2=06
5	Elective Audit									No credit	Any 1	No credit	Any 1	--
6	Total Credit Value (Credit x No. of courses)	26		26		22		22		24		24		**144**

Structure of T.Y.B.Sc. (Biochemistry) Curriculum Semester V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	BC-501	Genetics	3	3	45	40	60
	Core II	BC-502	Plant Biochemistry and Biofertilizers	3	3	45	40	60
	Core III	BC-503	Clinical Biochemistry	3	3	45	40	60
	Core IV	BC-504	Metabolism	3	3	45	40	60
SEC	Skill Based	BC-505	Biophysical Chemistry	3	3	45	40	60
DSE	Elective Course (Anyone)	BC-506A	Fermentation Technology	3	3	45	40	60
		BC-506B	Biomembranes-I					
DSC	Core (Practical)	BC-507	Techniques in Plant Biotechnology and Molecular Biology-I	2	4 / batch	60	40	60
		BC-508	Diagnostic Biochemistry	2	4 / batch	60	40	60
		BC-509	Biophysical Chemistry	2	4 / batch	60	40	60
AU	Elective Audit Course (Anyone)	AC-501A	NCC	No credit	2	30	100	--
		AC-501B	NSS					
		AC-501C	Sports					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

NCC: National Cadet Corps

NSS: National Service Scheme

Structure of T.Y.B.Sc. (Biochemistry) Curriculum Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	BC-601	Genetic Engineering	3	3	45	40	60
	Core II	BC-602	Plant Biotechnology and Biomembranes	3	3	45	40	60
	Core III	BC-603	Immunology	3	3	45	40	60
	Core IV	BC-604	Enzymology	3	3	45	40	60
SEC	Skill Based	BC-605	Analytical Techniques	3	3	45	40	60
DSE	Elective Course (Anyone)	BC-606A	Toxicology	3	3	45	40	60
		BC-606B	Biomembranes-II					
DSC	Core (Practical)	BC-607	Techniques in Plant Biotechnology and Molecular Biology-II	2	4 / batch	60	40	60
		BC-608	Immunology and Toxicology	2	4 / batch	60	40	60
		BC-609	Analytical Biochemistry and Enzymology	2	4 / batch	60	40	60
AU	Elective Audit Course (Anyone)	AC-601A	Soft Skills	No credit	2	30	100	--
		AC-601B	Yoga					
		AC-601C	Practicing cleanliness					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

Skill Enhancement Course (SEC):

To increase employability of Biochemistry students in industries courses like Biophysical Chemistry and Analytical Techniques have been introduced. These courses will improve common skills required in industry like preparation of solutions, sample isolation, purification and quantification by advanced techniques like chromatography, electrophoresis, spectrophotometry etc. This shall not only increase the potential of students' employability in industries, but also useful in higher studies and research career.

Discipline Specific Elective Course (DSE):

Elective course will give students choice to study the course of their interest. In the 5th semester, students can choose either Fermentation Technology or Biomembranes-I whereas in 6th semester they have choice between Toxicology and Biomembranes-II. Student who has selected Fermentation Technology for the 5th semester, compulsorily must take Toxicology in 6th semester which is same as in case of Biomembranes-I and II.

Audit Course (AU):

The syllabi for audit courses will be common for all courses and shall be available separately.

Equivalence for T.Y. B.Sc. (Biochemistry) is as follows in the table:

Old Syllabus (w.e.f. June 2017) (Semester pattern 60:40) courses	**Equivalent New Syllabus (w.e.f. June 2020) CBCS pattern (Semester pattern 60:40) courses**
BC- 351: Genetics	BC- 501: Genetics
BC- 352: Plant Biochemistry	BC- 502: Plant Biochemistry and Biofertilizers
BC- 353: Clinical Biochemistry-I	BC- 503: Clinical Biochemistry
BC- 354: Metabolism	BC- 504: Metabolism
BC- 355: Biophysical Chemistry	BC- 505: Biophysical Chemistry
BC- 356: Biotechnology	BC-506 A: Fermentation Technology
	BC-506 B: Biomembranes-I
BC- 357: Techniques in Molecular Biology-I	BC-507: Techniques in Plant Biotechnology and Molecular Biology-I
BC- 358: Diagnostic Biochemistry-I	BC- 508: Diagnostic Biochemistry
BC-359: Analytical Biochemistry and Enzymology-I	BC-509: Biophysical Chemistry
BC- 361: Genetic Engineering	BC- 601: Genetic Engineering
BC- 362: Plant and Agro Biotechnology	BC-602: Plant Biotechnology and Biomembranes
BC- 363: Clinical Biochemistry-II	BC- 603: Immunology
BC- 364: Enzymology	BC- 604: Enzymology
BC- 365: Analytical Techniques	BC- 605: Analytical Techniques
BC- 366: Biostatistics and Bioinformatics	BC- 606 A: Toxicology
	BC- 606 B: Biomembranes-II
BC- 367: Techniques in Molecular Biology-II	BC- 607: Techniques in Plant Biotechnology and Molecular Biology-II
BC- 368: Diagnostic Biochemistry-II	BC- 608: Immunology and Toxicology
BC-369: Analytical Biochemistry and Enzymology-II	BC-609: Analytical Biochemistry and Enzymology

Discipline Specific Core (DSC) Course

BC-501: Genetics (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basic concepts of Genetics.
- To study central dogma of genetics

Learning outcomes

After successful completion of this course, students are expected to:

- Understand the importance of Mendel's work.
- Understand structure of chromosome and DNA organization.
- Understand replication, transcription, translation processes.
- Understand fine structure of gene, gene regulation and mutations.

Unit	Title	Topic Particular	Hours
Unit I	**Basic Genetics**	• Mendel's law o Law of dominance o Law of segregation o Law of independent assortment • Incomplete dominance • Test cross, back cross • Concept of multiple alleles o Characters, symbolism e.g. ABO types • Lethal gene	11
Unit II	**Chromosomes and structural organization of prokaryotic & eukaryotic DNA**	• Morphology, structure and types of chromosome • Chromosome number and variation in chromosome number • Structural organization of prokaryotic & eukaryotic DNA • Central dogma	11
Unit III	**DNA replication and transcription in bacteria**	• DNA replication in *E. coli* o Replication origin, unwinding of the strand, Template DNA, RNA primer, polymerization, replication fork, leading strand, lagging strand, Okazaki fragment, • Transcription components o Template, activated precursors, divalent metal ions, RNA polymerase, sigma factor o Transcription process-initiation, elongation, termination • Fine structure of gene o Cistron, muton, recon, intron, promotor, repressor, exon, regulator, operator etc • Gene regulation	12

		○ Operon concept, *lac* operon	
Unit IV	**Prokaryotic Translation and Mutations**	• Activation and transfer of amino acids to tRNA • Translation-initiation, elongation, termination • Post translational modification in eukaryotes • Mutations- definition • Gene mutations ○ Base pair substitutions- transition, transversion and inversion ○ Frameshift mutations- deletion and insertion ○ Missense mutation, nonsense mutations ○ Mutations in termination codons ○ Silent mutations • Mutagens: definition ○ Chemical-base analogues, agents modifying purines and pyrimidines ○ Physical radiations	11

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Discipline Specific Core (DSC) Course

BC-502: Plant Biochemistry and Bio-fertilizers (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of Plant Biochemistry.
- To study the life processes of plants
- To generate awareness about importance of biofertilizers.

Learning outcomes

After successful completion of this course, students are expected to:

- Learn life processes like photosynthesis, photorespiration and energy generation.
- Study various phytohormones, secondary metabolites and their mechanism.
- Understand importance of biofertilizers.

Unit	Title	Topic Particular	Hours
Unit I	**Photosynthesis, Photorespiration and ATP generation**	• Definition of photosynthesis, Ultra structure of chloroplast • Chemistry of Chlorophyll • Mechanism of Photosynthesis o Photosystem I and II o Light (Hill) reaction: Cyclic and non-cyclic photophosphorylation o Dark reaction: C3 and C4 pathways o Kranz anatomy o Significance of photosynthesis o Factors affecting photosynthesis-external and internal • Photorespiration: o Definition o Metabolism of Photorespiration o Significance of photorespiration • Electron transport chain: o Components of ETC o Oxidative phosphorylation o Redox potential and sites of ATP synthesis	12
Unit II	**Phytohormones**	• Definition and types of phytohormones • Mechanism of action, physiological effect and applications of o Auxins o Cytokinins o Gibberellins o Abscisic acid o Ethylene • Seed dormancy and seed germination	11
Unit III	**Secondary Metabolites**	• Introduction and biosynthetic pathway of secondary metabolites	11

		• Classification of Isoprenoid /terpenoids: classification, chemistry, distribution and role of isoprenoids o Nitrogen containing secondary plant products: Classification ▪ Alkaloids: chemistry distribution classification and physiological role ▪ Cyanogenic glycosides and Glucosinolates: chemistry and functions ▪ Non-protein amino acids: chemistry and functions o Plant phenolics: chemistry, biological functions, classification ▪ Chemistry and functions of lignin, flavonoids and tannins	
Unit IV	**Biofertilizers**	• Biological nitrogen fixation o Nitrogen cycle o Symbiotic and asymbiotic nitrogen fixation o Mechanism of nitrogen fixation • Genetic engineering- nitrogenase and hydrogenase gene • Biofertilizers o Symbiotic nitrogen fixer o Asymbiotic nitrogen fixer o Phosphate solubilising bacteria o Organic fertilizers o Benefits and limitations of biofertilizers • Composting –mixed culture composting, vermicomposting	11

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Discipline Specific Core (DSC) Course

BC-503: Clinical Biochemistry (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with Biochemistry of various diseases
- To understand inborn errors of metabolism

Learning outcomes

After successful completion of this course, students are expected to:

- Learn various disorders related to carbohydrate metabolism.
- Study different hemoglobinopathies.
- Understand clinical importance of various enzymes and isoenzymes.
- Learn concept of inborn errors of metabolism.

Unit	Title	Topic Particular	Hours
Unit I	**Disorders related to Carbohydrate metabolism**	• Regulation of blood glucose level o supply of glucose to the blood and removal glucose from blood o Post absorptive state o Postprandial state o Fundamental regulatory mechanism o Hormonal influence on carbohydrate metabolism • Blood sugar level and its clinical significance o Normal values of blood glucose level o Causes of hyperglycemia and hypoglycaemia • Glycosuria: mechanism, types-hyperglycemic glycosuria and renal glycosuria and their subtypes • Diabetes Mellitus: Definition, stages of diabetes mellitus, clinical types and causes, metabolic changes and complications, effect of insulin on carbohydrate, lipid and protein metabolism	12
Unit II	**Hemoglobinopathies**	• Structure and functions of hemoglobin • Abnormal hemoglobins: types based on mutation in structural gene and mutation in regulator gene o Sickle cell anaemia o Methemoglobinemia-Hb-M, Hb-Sabine o High O_2-affinity hemoglobins-Hb-Chesapeake, Hb-Rainier o Hemoglobin interfere in mRNA formation-Hb-Constant spring o Thalassemia	11
Unit III	**Enzymes and**	• General consideration	11

	isoenzymes of clinical importance	• Serum enzymes in heart diseases • Serum enzymes in liver diseases • Serum enzymes in GI tract diseases • Serum enzymes in muscle diseases • Serum enzymes in bone diseases • Isoenzymes: definition, clinical significance of LDH and CPK isoenzymes	
Unit IV	**Inborn Errors of Metabolism**	• Carbohydrate metabolism disorders o Lactose intolerance o Glycogen storage disease o Galactosemia • Protein metabolism disorders o Phenylketonuria o Alkaptonuria o Albinism o Maple syrup urine disease • Lipids metabolism disorders o Gaucher's disease o Nieman Pick's disease o Tay Sachs disease • Nucleic acid metabolism disorders o Lesch Nyhan syndrome o Gout	11

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Discipline Specific Core (DSC) Course

BC-504: Metabolism (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of metabolism
- To comprehend catabolism and anabolism of various metabolites

Learning outcomes

After successful completion of this course, students are expected to:

- Learn various catabolic and anabolic reactions related to carbohydrate and amino acids.
- Study lipid and nucleotide metabolic reactions.
- Understand importance of metabolism in living things.

Unit	Title	Topic Particular	Hours
Unit I	**Carbohydrate metabolism**	• Glycolysis: steps; balance sheet; bioenergetics; fate of pyruvate • Tricarboxylic acid cycle: oxidation of pyruvate to acetyl Co-A; steps of TCA cycle; balance sheet; bioenergetics • Glyoxylate cycle • HMP pathway: functions of HMP pathway; steps • Glycogenolysis: steps of conversion of glycogen to glucose under the influence of epinephrine and glucagon • Gluconeogenesis: from pyruvate and amino acids • Glycogen biosynthesis	12
Unit II	**Amino acids metabolism**	• Proteolysis: digestion of proteins; enzymes involved in digestion of protein • Transamination: Transamination of L-aspartate, L-alanine, L-leucine, and L-tyrosine; mechanism of the reaction • Oxidative deamination: general reaction; oxidative deamination of glutamate • Transmethylation: mechanism of transmethylation involving methionine as methyl group donor • Decarboxylation: general reaction; decarboxylation of histidine, tryptophan and arginine • Nitrogen excretory products: o Synthetic pathway o Glutamine pathway o Direction excretion o Creatine and creatinine o Urea cycle	11

Unit III	**Lipid metabolism**	• Activation of fatty acids and transportation into mitochondria • β-oxidation of saturated even carbon fatty acids: steps, balance sheet, bioenergetics • β-oxidation of saturated odd carbon fatty acids: steps, fate of propionyl Co-A • β-oxidation of unsaturated fatty acids: fatty acids having one and two double bonds • Biosynthesis of fatty acids: formation of malonyl Co-A; enzymes and functions of fatty acid synthetase complex; steps of fatty acid biosynthesis • Elongation of saturated fatty acid and desaturation of fatty acids	11
Unit IV	**Nucleotides metabolism**	• Biosynthesis of purine ribonucleotides: steps of AMP and GMP biosynthesis • Regulation of purine nucleotide biosynthesis • Biosynthesis of pyrimidine ribonucleotide: steps of UMP and CMP biosynthesis • Regulation of pyrimidine biosynthesis • Biosynthesis of Deoxyribonucleotides: conversion of ribose sugar to 2'deoxyribose sugar • Formation of deoxythymidylic acid: steps • Regulation of deoxyribonucleotide biosynthesis • Degradation of purines • Salvage of purines • Purine nucleotide cycle • Pyrimidine degradation	11

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Skill Enhancement Course (SEC)

BC-505: Biophysical Chemistry (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To study various biophysical processes.
- To study laws of thermodynamics and bioenergetics**.**

Learning outcomes

After successful completion of this course, students are expected to:

- Understand the concept of acid-base and buffers.
- Study various biophysical processes like diffusion, osmosis, viscosity, etc.
- Learn energy rich compounds, bioenergetics and laws of thermodynamics.

Unit	Title	Topic Particular	Hours
Unit I	**Acids and Bases**	• Properties of water in relation to life process o Expansion on freezing o Uniquely high surface tension o Uniquely high heat capacity o High solvent power • Concept of Acid and Base o Arrhenius theory o Lewis acid and base o Lowry-Bronsted Theory • Acid-Base equilibria in water o Law of Mass Action o Ionisation of water o Equilibrium constant and Ionisation constant of water o Concept of pH • Buffers-Concept and definition o Henderson-Hasselbalch equation • Biological buffer systems o Phosphate buffer system o Bicarbonate buffer system	11
Unit II	**Diffusion, Osmosis and Colloidal phenomena**	• Diffusion-definition and types o Fick's laws of diffusion-first and second o Methods of determination of diffusion coefficient o Significance of diffusion coefficient • Osmosis-definition o Osmotic pressure- definition and its measurement o Tonicity-types o Significance of osmosis in biology • Colloids-concept o Classification of colloids-lyophilic and lyophobic colloids	12

		○ Brownian movement ○ Tyndall effect ○ Donnan membrane equilibrium	
Unit III	**Viscosity, Surface tension and Adsorption**	• Viscosity-concept ○ Factors affecting viscosity ○ Measurement of viscosity ▪ Capillary flow ▪ Rotation of a cylinder immersed in solution ▪ Rate of fall of a ball through solution ○ Applications of viscometry ○ Significance of viscosity in biological systems • Surface tension-concept ○ Factors affecting surface tension ○ Measurement of surface tension • Adsorption- concept ○ Kinds of adsorption interactions ○ Characteristics of adsorption ○ Importance of adsorption phenomena	11
Unit IV	**Bioenergetics**	• Energy, Free energy and Energetic coupling • Energy rich compounds ○ ATP, causes of energy richness of ATP ○ Other energy rich compounds • Thermodynamics-definition ○ First and second law of thermodynamics ○ Enthalpy ○ Entropy ○ Standard free energy change ○ Exergonic and endergonic reactions • Redox potential and its measurement	11

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Discipline Specific Elective (DSE) Course

BC-506 A: Fermentation Technology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of Fermentation Technology.
- To explore industrial applications of fermentation**.**

Learning outcomes

After successful completion of this course, students are expected to:

- Learn screening of microbes, their preservation and inoculum development.
- Understand instrumentation, types and working of bioreactors.
- Study the basics of downstream processing.

Unit	Title	Topic Particular	Hours
Unit I	**Basics of Fermentation Technology**	• Fermentation: definition and concept • Characteristic of industrial strain • Screening of industrially important microbes: Primary & Secondary • Fermentation media: Composition, Raw materials, screening of media, antifoam, buffer. • Inoculum –stock, working culture • Inoculum development • Preservation methods for industrially important microbes	11
Unit II	**Bioreactors**	• History of Bioreactors • Parts of Bioreactors and their functions o Materials of construction o Valves o Agitators and its types o Sparger o Port feeders o Baffles • Controlling system • Types of bioreactors o Primary bioreactor o Tower o Air lift o Deep jet • Conventional Bioreactor-common features • Operation of conventional bioreactor	12
Unit III	**Types of fermentation and Downstream processing**	• Types of fermentation o Submerged o Solid state o Batch fermentation o Continuous fermentation: ▪ Chemostat ▪ Turbidostat	11

		• Synchronous culture and its applications.
		• Introduction to downstream processing
		  o Solid-liquid separation
		  o Release of intracellular products by cell disruption
		  o Concentration
		  o Purification by chromatography
		  o Formulation
		  o Drying	

Unit IV	**Industrial Biotechnology**	• Industrial sterilization process -
		  o Concept and need of sterilization
		  o History of sterilization
		  o Types of sterilization:
		  ▪ Batch
		  ▪ Continuous
		  ▪ Filtration
		• Industrial production of –
		  o Enzymes- amylase
		  o Acid- citric acid
		  o Alcohol- ethanol
		  o Antibiotic- penicillin
		• Microbial biomass production
		  o Introduction
		  o Yeast
		  o Economic aspect and Applications
		• Bioconversion
		  o Introduction
		  o Biomining and bioleaching- copper
			11

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Discipline Specific Elective (DSE) Course

BC-506 B: Biomembranes-I (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom with basic concepts of Biomembrane.
- To study various structures of biomembranes.

Learning outcomes

After successful completion of this course, students are expected to:

- Explain the various structure of cell membranes.
- Study the composition of various cell membranes, models of membranes
- Learn specialized features and asymmetry of biomembranes

Unit	Title	Topic Particular	Hours
Unit I	**Introduction to Biomembrane**	• Introduction, definition • A historical perspective of different models of membranes • Membrane characteristics with experimental basis of the model (Langmuir trough experiment, freeze fracture technique, X- ray diffraction) • Biomedical importance of membrane Compartmentalization of body's internal water by membranes • Ionic composition of intracellular and extracellular fluids • Factors affecting physical properties of membrane	11
Unit II	**Composition of Biomembranes**	• Lipids-introduction, types and role • Proteins • Integral • Peripheral& • Lipid anchored • Carbohydrates-types and functions. • Hydropathy plots & membrane Topology. • Composition variation between membranes (Prokaryotic / Eukaryotic / neuronal, Membranes / Sub cellular compartments). • Details of fluid mosaic model.	11
Unit III	**Model Membrane Systems**	• Synthesis and drug targeting tool o Monolayers o Planar bilayer o Liposomes • Isolation & purification of membrane and membrane proteins- o use of detergents,	11

		○ density gradient centrifugation etc. for purification of membrane proteins-role and its applications, • Criteria of membrane purification • Enzyme markers.	
Unit IV	**Membrane Structures and asymmetry**	• Polymorphic structures of amphiphilic molecules like soaps, detergents, lipids in aqueous solutions • Micelles & Bilayers-introduction, formation. • Thermodynamic forces and other factors affecting the formation of different structures. • Critical packing parameter. • Asymmetric nature of membrane • Macro and micro domains in membranes • Specialized features of plasma membrane: ○ Lipid rafts ○ Caveolae ○ Tight Junctions. • Membrane Skeleton ○ Role in maintaining cell structure ○ Membrane asymmetry. • RBC membrane- as a model.	12

References

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- Murray R., Bender D., Botham K. (2012), Harper's Illustrated Biochemistry, 29th edition, McGraw Hill Education.
- Voet D., Voet J.G. (2004), Biochemistry, John Wiley &Sons, Inc.
- Darnell J., Lodish H., Baltimore D. (2008), Molecular Cell Biology, Scientific American Books.
- Gupta M. L., Jangir M. L. (2002), Cell Biology – Fundamentals and Applications, Agrobios.
- Alberts B., Johnson A., Lewis J. (2008), Molecular Biology of the Cell, 5th edition, Garland Publishing.

Discipline Specific Core (DSC) Course

BC-507: Techniques in Plant Biotechnology and Molecular Biology-I (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom with Techniques in Molecular Biology.
- To study techniques in Plant Biotechnology.

Learning outcomes

After successful completion of this course, students are expected to:

- Isolate DNA and estimate DNA, RNA, secondary metabolite and chlorophyll pigments.
- Produce alcohol, citric acid, amylase and vermicompost.
- Screen phosphate solubilizing bacteria**.**

Sr. No.	Topic Particular	Hours
1	Isolation of DNA from suitable sample	04
2	Estimation of DNA by DPA method	04
3	Estimation of RNA by orcinol method	04
4	Estimation of chlorophyll pigments by spectrophotometric method	04
5	Estimation of any one secondary metabolite	04
6	Production of alcohol	04
7	Production of citric acid	04
8	Production of amylase	04
9	Preparation of manure by vermicomposting process	04
10	Determination of activity of Phosphate solubilizing bacteria	04
11	Separation of plant pigments by chromatography.	04
12	Isolation of nitrogen fixing bacteria from root nodules.	04
13	Isolation of nitrogen fixing bacteria from soil sample.	04
14	Demonstration of working of fermenter.	04
15	Solve the problems based on Mendel's experiments.	04

References

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- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.

***Mandatory to perform any 10 practicals from above.**

Discipline Specific Core (DSC) Course

BC-508: Diagnostic Biochemistry (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom with various pathological tests.
- To generate awareness about clinical significance of the tests.

Learning outcomes

After successful completion of this course, students are expected to:

- Estimate various clinically important components with their clinical significance.
- Estimate various clinically important enzymes and their clinical significance.
- Correlate results obtained clinically.

Sr. No.	Topic Particular	Hours
1	Estimation of blood glucose in serum by GOD/POD method.	04
2	Estimation of reducing sugar in urine	04
3	Hb estimation by using haematometer its significance	04
4	Serum bilirubin estimation.	04
5	SGOT estimation by 2, 4 DNPH method.	04
6	SGPT estimation by 2, 4 DNPH method.	04
7	Serum alkaline phosphatase estimation by colorimetric method.	04
8	Serum acid phosphatase estimation by colorimetric method.	04
9	Estimation of cholesterol by colorimetric method.	04
10	Estimation of serum uric acid from the given sample.	04
11	Estimation of serum urea from the given sample.	04
12	Estimation of serum creatinine from the given sample.	04
13	Detection of abnormal constituents of urine: - Sugar, protein, ketone bodies and bile pigments	04
14	Estimation of proteins by Biuret method and albumins by Dumas method	04
15	Estimation of serum bilirubin.	04

References

- Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi.
- Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers.
- Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai
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- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.

***Mandatory to perform any 10 practicals from the above.**

BC-509 : Biophysical Chemistry (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with practical applications of biophysical chemistry.
- To give practical experience of biophysical processes.

Learning outcomes

After successful completion of this course, students are expected to:

- Prepare buffers of desirable pH and molarity.
- Determine viscosity and surface tension of the sample.
- Practical experience of the processes like diffusion and osmosis.

Sr. No.	Topic Particular	Hours
1	Preparation of phosphate buffer of suitable pH and molarity.	04
2	Determination of viscosity of suitable liquid by viscometer.	04
	Measurement of surface tension of the given sample.	04
3	Estimation of λ_{max} and extinction coefficient of a given chromophore.	04
4	Purification of protein by salt precipitation and solvent fractionation procedure.	04
5	Quantitative estimation of protein by Lowery's method.	04
6	Determination of diffusion of the sugar across a semipermeable membrane.	04
7	Study of osmosis by potato osmometer.	04
8	To study cell membrane permeability using beetroot.	04
9	To study the effect of temperature on permeability of beetroot membrane.	04
10	Preparation of RBC ghost cells and to study the effect of different solutes on permeability of RBC membrane.	04
11	To study the effect of pH on permeability of beetroot membrane.	04
12	Purification and estimation of casein from milk.	04
13	Demo calculation of the isoelectric point of a protein.	04
14	Separation of carbohydrates by paper chromatography.	04
15	Preparation of lactalbumin from milk.	04

References

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
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***Mandatory to perform any 10 practicals from above.**

Discipline Specific Core (DSC) Course

BC-601: Genetic Engineering (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To introduce students to the genetic engineering field.
- To make students aware about various genetic engineering techniques**.**

Learning outcomes

After successful completion of this course, students are expected to:

- Learn role of enzymes and vectors involved in gene transfer.
- Study various gene transfer methods.
- Study gene library preparation.
- Understand the basic principles of DNA sequencing and PCR.

Unit	Title	Topic Particular	Hours
Unit I	**Introduction to Genetic Engineering**	• Concepts of Genetic engineering • Enzymes involved in genetic engineering- restriction endonucleases, DNA ligases, Alkaline phosphatases, DNA modifying enzymes • Prokaryotic and eukaryotic cells as hosts	11
Unit II	**Vectors and methods of gene transfer**	• Vectors- Plasmids, Bacteriophages, Cosmids, Artificial chromosome vectors, Shuttle vectors • Construction of rDNA- palindromes and staggered cleavage adding poly dA and poly dT tails, blunt end ligation • Methods of gene transfer- transformation, conjugation, Electroporation, Liposome mediated gene transfer, transduction, direct transfer of DNA, particle bombardment, microinjection, polyethylene glycol mediated gene transfer	12
Unit III	**Gene Libraries**	• Concept of gene libraries • Creation of human gene library, Use of long chain PCR for gene library construction • cDNA libraries- cDNA synthesis, construction of cDNA libraries, RT-PCR for cDNA libraries • Screening Strategies- screening by DNA hybridization, DNA probes, colony hybridization, PCR, immunological assay, protein function	11
Unit IV	**Techniques in Genetic Engineering**	• DNA Sequencing: Technique, applications, limitations of o Maxam Gilbert technique o Sanger's Dideoxynucleotide method o Pyrosequencing o DNA chip • Polymerase Chain Reaction: principle, technique,	11

		applications of PCR in various fields	

References

- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
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Discipline Specific Core (DSC) Course

BC-602: Plant Biotechnology and Biomembranes (Theory)

Total Hours: 45 **Credits: 3**

Course objective

- To accustom students with plant tissue culture techniques.
- To study the role of membranes in biological systems

Learning outcomes

After successful completion of this course, students are expected to:

- Learn various plant tissue culture techniques.
- Understand Agrobacterium mediated gene transfer.
- Explain mechanism of membrane transport and cell signaling.

Unit	Title	Topic Particular	Hours
Unit I	**Plant Tissue Culture**	• Introduction to PTC • Culture media composition • Terms used in PTC • Basic technique of plant tissue culture • Applications of PTC • Types of cultures-Callus culture, Cell culture • Protoplast isolation, fusion and culture	10
Unit II	**Micropropagation and Genetic Engineering of Plants**	• Micropropagation: o Definition and technique o Multiplication by axillary buds and apical shoots- meristem, shoot tip cultures and bud cultures o Organogenesis-direct and indirect o Somatic embryogenesis-direct and indirect o Factors affecting o Applications and disadvantages • Agrobacterium mediated gene transfer o Organisation of Ti plasmid o T-DNA transfer and integration o Ti plasmid derived vector systems o Plant transformation techniques using Agrobacterium o Advantages and limitation of Agrobacterium mediated gene transfer	12
Unit III	**Membrane transport and Special molecules of Transport**	• Principles and mechanism of o Osmo-regulation o Diffusion- types • Features of uniport, symport and antiport transport systems • Role of proteins in the process like exocytosis, endocytosis- phagocytosis and pinocytosis,	12

		receptor mediated endocytosis (cholesterol transport), and ATP, ADP- exchanger. **Special molecules of Transport:** • ATPases and its types (Sodium- Potassium pump, ABC, P type, V type ATPases). Sodium, proton Potassium and chloride dependent processes. • Phosphotransferase system • Group translocation	
Unit IV	**Membrane receptors and drug targets**	• Cell signaling definition and its types • Membrane receptors o Structure and functions o Types-enzyme linked; ion-channel linked, & G-protein linked receptors with example; o Methods to study membrane receptors o Purification of adrenergic and cholinergic receptors o Second messengers-Introduction, definition, examples and their roles. • Penetrating the defenses: o How antimicrobial agents reach their targets, o cellular permeability barrier to drug penetration, o some examples of modes of penetration of antimicrobial agents	11

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- Gupta P. K. (2005), Elements of Biotechnology, Rastogi Publication Meerut.
- Ignacimuthu S. (1997), Applied plant biotechnology, Science Publishers, U.S.
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- Jain V. K. (1983), Fundamentals of Plant Physiology, 3rd edition, S. Chan and company ltd, New Delhi
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- Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai.

Discipline Specific Core (DSC) Course

BC-603: Immunology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of immunology
- To comprehend various immunochemical tests

Learning outcomes

After successful completion of this course, students are expected to:

- Explore cells and organs of immune system.
- Learn immunity and immune response.
- Study concept of antigen and antibody.
- Understand the importance of immunochemistry in diagnosis.

Unit	Title	Topic Particular	Hours
Unit I	**Cells and organs of immune system**	• Hematopoiesis • Cells of immune system o Lymphoid cells- T-cells, B-cells, Natural killer cells, dendritic cells o Granulocytes- Neutrophils, Eosinophils, Basophils, Monocytes, Macrophages, Mast cells • Organs of immune system o Primary lymphoid organs ▪ Thymus ▪ Bone marrow ▪ Lymphatic system o Secondary lymphoid organs ▪ Lymph nodes ▪ Spleen ▪ MALT and GALT	12
Unit II	**Immunity and Immune response**	• Immunity- definition and types • Innate immunity o Factors influencing innate immunity o Mechanism of innate immunity o Cellular factor in innate immunity • Adaptive/ acquired immunity o Active and passive immunity • Immune response o Humoral immune response ▪ Primary and secondary immune response ▪ Antibody production ▪ Factors affecting antibody production o Cell mediated immune response	11
Unit III	**Antigen and**	• Antigen-	11

	Antibody	○ Definition ○ Basic terms- hapten, adjuvants, epitopes ○ Antigenicity and immunogenicity ○ Determinants of an antigenicity • Basic structure of antibody ○ Classes of antibodies ▪ IgG, IgA, IgM, IgD, IgE- structure and functions ○ Antigenic determinants on immunoglobulins ▪ Isotype, Allotype and Idiotype	
Unit IV	**Immunochemistry**	• General features of antigen-antibody reactions • Precipitation reaction- mechanism and applications ○ Flocculation reaction ○ Single diffusion ○ Double diffusion ○ Radial immunodiffusion ○ Immunoelectrophoresis ○ Crossover immunoelectrophoresis ○ Rocket immunoelectrophoresis • Agglutination reaction ○ Slide and tube agglutination ○ Coombs test and passive agglutination • Immunofluorescence • Radioimmunoassay • ELISA- types	11

References

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Discipline Specific Core (DSC) Course

BC-604: Enzymology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of enzymology.
- To understand applications enzyme in various fields.

Learning outcomes

After successful completion of this course, students are expected to:

- Understand classification and specificity of enzymes.
- Learn mechanism of enzyme action and enzyme kinetics.
- Study activation and deactivation of regulatory enzymes.
- Explore various industrial applications of enzymes.

Unit	Title	Topic Particular	Hours
Unit I	**Basic concepts in enzymology**	• Definition of enzyme • Terminologies - intracellular enzymes, extracellular enzymes, holoenzymes, apoenzymes, prosthetic group, cofactor, coenzymes, isoenzymes, katal, international unit, turnover number and active site. • Nomenclature and classification (IUB) of enzymes • Factors affecting enzyme activity - effect of substrate concentration, enzyme concentration, product concentration, pH, temperature, activators, time, light and radiation. • Specificity of enzyme action - absolute specificity, group specificity, optical specificity and geometrical specificity. • Active site - definition and salient features of active site.	11
Unit II	**Enzyme Kinetics and Inhibition**	• Mechanism of enzyme action – lowering of activation energy, lock and key model, induced fit model. • Michaelis Menten Equation: derivation, Km Vmax • Transformation of Michaelis –Menten equation: Lineweaver-Burk plot, Eadie-Hofstee plot • Inhibition: Reversible inhibition- competitive, non-competitive and uncompetitive inhibition with examples. • Factors contributing to the catalytic efficiency of enzymes: proximity and orientation of the substrate, covalent catalysis, acid-base catalysis, factor of strain in enzyme catalysis	12
Unit III	**Regulatory enzymes**	• Allosteric enzymes: definition, feedback inhibition, positive and negative modulator,	11

		heterotropic and homotropic control, mechanism of regulatory activity of allosteric enzymes-sequential and symmetry model, kinetics of allosteric enzymes, aspartate transcarbamoylase-kinetics and inhibition • Covalently modulated enzymes: definition, explanation with example of glycogen phosphorylase enzyme • Covalent activation of zymogen: pepsinogen, trypsinogen, chymotrypsinogen • Classes of proteolytic enzymes: serine, aspartate, cysteine and metalloproteases	
Unit IV	**Applications of enzymes**	• Enzyme Immobilization: methods • Applications of immobilized enzymes and cells o Manufacture of commercial products o Analytical applications o Therapeutic applications • Enzyme based biosensors and their applications • Other applications of enzymes	11

References

- Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York.
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
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- Powar C. B. (2010), Cell Biology, Himalaya Publishing House, Mumbai
- Powar C. B., Chatwal G. R. (2011), Biochemistry, Himalaya Publishing House, Mumbai

Skill Enhancement Course (SEC)

BC-605: Analytical Techniques (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of various analytical techniques.
- To explore applications of analytical techniques.

Learning outcomes

After successful completion of this course, students are expected to:

- Study concept, principle, and applications of various spectrophotometry.
- Learn principles and applications of various chromatography and electrophoretic techniques.
- Understand concept of centrifugation and radioactivity and its applications.

Unit	Title	Topic Particular	Hours
Unit I	**Spectrophotometry**	• Concept of electromagnetic radiations, electromagnetic spectrum • Laws of absorption- Lambert and Beer Law • Chromophore concept-auxochrome, various chromic shifts • Instrumentation for UV-Visible and infra-red spectrophotometry o Applications of UV-Vis spectrophotometry o Theory and applications of infra-red spectroscopy • Spectrofluorimetry o Fluorescence and phosphorescence o Theory and instrumentation of fluorimetry o Advantages, disadvantages and applications • Flame spectrophotometry-concept o Instrumentation for emission flame photometry and atomic absorption spectrophotometry o Applications of both	11
Unit II	**Chromatography**	• Concept of distribution coefficient • Modes of chromatography • Classification of chromatography • Principle and applications of- o Paper chromatography o Thin layer chromatography o Gel filtration chromatography o Ion exchange chromatography o Affinity chromatography o Gas liquid chromatography o Liquid-liquid chromatography	12

Unit III	**Electrophoresis**	• Principle of electrophoresis • Migration of an ion in an electric field • Factors affecting electrophoretic mobility • Principle and applications of- o Paper electrophoresis o Agarose gel electrophoresis o Polyacrylamide gel electrophoresis o SDS-Polyacrylamide gel electrophoresis o Isoelectric focusing o Capillary electrophoresis o Immunoelectrophoresis	11
Unit IV	**Centrifugation and Radioactivity**	• Basic principles of centrifugation • Instrumentation for centrifugation: low speed, high speed and ultracentrifuges • Applications of centrifugation: preparative techniques, analytical measurements • Radioactivity: introduction, isotopes in Biochemistry, units of radioactivity • Detection and measurement of radioactivity: Liquid Scintillation Counting, Geiger Muller Counting • Applications of radioisotopes • Radioisotopes and safety	11

References

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- Holmes D. J., Peck H. (1983), Analytical biochemistry, academic press, New York.
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- Roy R.N. (2001), A Textbook of Biophysics, New Central Book agency (P) Ltd.

Discipline Specific Elective (DSE) Course

BC-606 A: Toxicology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basic concepts of toxicology.
- To study biotransformation of toxicants.

Learning outcomes

After successful completion of this course, students are expected to:

- Learn basic concepts of toxicants, toxicity and dose-response relationship.
- Study metabolism and mode of action of toxicants.
- Understand biotransformation and bioaccumulation of toxicants.

Unit	Title	Topic Particular	Hours
Unit I	**Basic Concepts of Toxicology**	• Toxicology: Definition, history, scope, basic divisions and goals of toxicology • Toxicants and toxicity: o Definition and concept o Factors that influence toxicity o Toxicity of chemical mixtures • Dose: o Definition o Selection of dose o Effect and response of dose • Dose-response relationship: o Graded/quantitative response o Quantal/quantum response • Statistical concept of toxicity: o Concentration-response relationship/ Threshold limits o Criteria for effects and LD_{50}	11
Unit II	**Absorption, Translocation and Excretion of Xenobiotics**	• Membrane permeability and mechanism of chemical transfer • Absorption of Xenobiotics: o Gastro-intestinal tract o Skin, Lungs o Parenteral administration • Translocation of Xenobiotics: o Membrane Barriers o Binding of xenobiotics to plasma proteins o Storage depots: Body fats, brain tissue, erythrocytes and other storage depots • Excretion of Xenobiotics: o Renal excretion, Biliary excretion o Gastro-intestinal tract o Expired air o Sweat, Saliva o Milk, Vaginal secretion	12
Unit III	**Mode of Action of**	• Effect of toxicants on structural proteins,	11

	Toxicants	enzymes, carriers, coenzymes, nucleic acids and lipids • Receptor Concept: o Definition, location and chemical nature o Categories of receptors o Mechanism of action of receptors o Factors affecting functions of receptors o Concept of agonism and antagonism o Role of receptors in toxicology • Mechanism of action of commonly used toxicants: o Metals o Pesticides o Environmental carcinogens o Teratogens o Ionizing and non-ionizing radiations	
Unit IV	**Biotransformation of Toxicants**	• Biotransformation: Definition, sites, principal objectives • Mechanism of biotransformation • Phase I reactions: o Oxidation o Reduction o Hydrolysis • Phase II reactions: conjugation reactions • Factors affecting biotransformation • Biotransformation of DDT • Bioactivation • Antidotes/antagonists: o Definition and classification o Mechanism of antidotal therapy o Antidotal procedures	11

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- Klaassen C. D. (2008), Casarett and Doull's Toxicology- The Basic Science of Poisons, 7th edition, The McGraw Hill Companies Inc.
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- Ung-Mu Lee, Sam Kacew, Hyung Sik Kim (2017) Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment, 7th edition, CRC Press.
- Lipmann M. (2009), Environmental toxicants – Human Exposure and Their Health Effects, 3rd edition, Wiley Interscience.
- Duffus J. H. and Worth H. (1996) Fundamental Toxicology for Chemists, Royal Soc. Chem.
- Pandey K., Shukla J. P., Trivedi S. P. (2005) Fundamentals of Toxicology, New Central Book Agency, Kolkata
- Subramanian M. A. (2010), Toxicology, Principles and Methods, 2nd revised edition, MJP Publisher, Chennai.
- Sharma P. D. (2003), Toxicology, 2nd edition, Rastogi Publication, Meerut.

Discipline Specific Elective (DSE) Course

BC-606 B : Biomembranes-II (Theory)

Total Hours: 45 **Credits: 3**

Course objective

- To accustom with basic concepts of Biomembrane.
- To study the role biomembranes in transport**.**

Learning outcomes

After successful completion of this course, students are expected to:

- Explain different transport system in cells
- Understand drug transport and role of different cells in transport
- Learn different techniques to study cell membranes

Unit	Title	Topic Particular	Hours
Unit I	**Membrane Dynamics**	• Diffusion-Introduction o Lateral diffusion o Transverse / Flip Flop diffusion o Rotational motion of lipids and proteins • Techniques used to study different motion of molecules in membranes: o FRAP o FRET • Translational diffusion coefficient. • Phase Transition studies of lipid bilayer. • Transition temperature. • Membrane fluidity-concept, introduction. • Factors affecting membrane fluidity: o Composition, Temperature, salt /water stress, o Anesthetics, Age, pH, Nutrition etc. • Homeoviscous adaptation • Membrane fusion	11
Unit II	**Membrane transport**	• Study of different transport systems-their structure, thermodynamics (free energy change involved, electro chemical potential, membrane potential, Nerst equation). • Diffusion: Simple diffusion, Facilitated diffusion • Transport systems: o Passive transport (Glucose, anion transporter) o Active transport (P type ATPases V type ATPases, F type ATPases, Na+ / H+ symport systems). o ABC family of transporters. ▪ Transport processes driven by light (Bacteriorhodopsin, halorhodopsin) • Specialized membrane Pores:	12

		○ Porins in Gram negative bacterial membranes (*E.coli* OmpF, OmpC, LamB) ○ Pore forming toxins (colicins, α hemolysin, anthrax toxin protective antigen) and Aquaporins. • Ion channels: Voltage gated ion channels (Na^+ / K^+ voltage gated ion channel), Ligand gated ion channels (Acetyl choline / IP3 / cGMP gated ion channel), Leaky channels. • Ionophores: Carriers and channel forming (valinomycin, gramicidin).	
Unit III	**Signal Transduction**	• Cell signaling-definition, Types: endocrine, paracrine and autocrine • Hormones-Introduction • Classification of hormones based on solubility & location of their receptors- ○ Lipophilic hormones hormones with intracellular receptors, ○ Lipophilic & ○ Hyrdophilic hormones with cell surface receptors; • Cell surface receptors-Introduction. • Types of receptors with examples ○ Enzyme linked ○ Ion-channel linked, & ○ G-protein linked receptors • Second messengers-Introduction, definition, examples and their roles.	11
Unit IV	**Penetrating the defenses**	• How antimicrobial agents reach their targets, • Cellular permeability barrier to drug penetration, • some examples of modes of penetration of antimicrobial agents, • The exploitation of transport systems in the design of new antimicrobial agents.	11
References	• Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York. • Murray R., Bender D., Botham K. (2012), Harper's Illustrated Biochemistry, 29th edition, McGraw Hill Education. • Voet D., Voet J.G. (2004), Biochemistry, John Wiley &Sons, Inc. • Darnell J., Lodish H., Baltimore D. (2008), Molecular Cell Biology, Scientific American Books. • Gupta M. L., Jangir M. L. (2002), Cell Biology – Fundamentals and Applications, Agrobios. • Alberts B., Johnson A., Lewis J. (2008), Molecular Biology of the Cell, 5th edition, Garland Publishing.		

Discipline Specific Core (DSC) Course

BC-607 : Techniques in Plant Biotechnology and Molecular Biology-II (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with Techniques in Molecular Biology.
- To study Techniques in Plant Biotechnology**.**

Learning outcomes

After successful completion of this course, students are expected to:

- Prepare MS media and will have knowledge about macro and micro elements.
- Perform various plant tissue culture techniques.
- Separate DNA fragments by agarose gel electrophoresis.
- Perform restriction digestion and PCR.

Sr. No.	Topic Particular	Hours
1	Preparation of MS media for PTC.	04
2	Development of somatic embryo from suitable tissue.	04
3	Development of seedling by aseptic germination of available seed.	04
4	Development of shoots by shoot tip culture method.	04
5	Development of callus from suitable tissue.	04
6	Isolation of protoplast.	04
7	DNA digestion using restriction endonucleases.	04
8	Separation of fragments produced by restriction endonucleases digestion by agarose gel electrophoresis	04
9	Amplification of DNA fragment using PCR.	04
10	Separation of fragments produced by PCR by agarose gel electrophoresis	04
11	Isolation of plasmid from micro-organism.	04
12	To study cell membrane permeability using potato.	04
13	Determine the DNA sequence using Sanger's Dideoxy method.	04
14	Perform BLAST of the given DNA sequence.	04
15	Demonstration of Southern blotting.	04

References

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.

***Mandatory to perform any 10 practicals from the above.**

Discipline Specific Core (DSC) Course

BC-608 : Immunology and Toxicology (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with immunological methods
- To make students aware about toxicological methods**.**

Learning outcomes

After successful completion of this course, students are expected to:

- Differentially count WBCs.
- Know the importance of cross matching of donor's and recipient's blood.
- Perform various immunological Ag-Ab tests.
- Determine LC_{50} value, effect of temperature and pH on toxicity of pollutant**.**

Sr. No.	Topic Particular	Hours
1	Differential counting of WBCs	04
2	Blood group detection and cross matching	04
3	Ag-Ab reaction by Ouchterlony double diffusion method	04
4	Radial immunodiffusion	04
5	Demonstration of ELISA and its significance.	04
6	Widal agglutination test (slide test method).	04
7	Determination of LC_{50} value of a pollutant by using suitable test animal.	04
8	Determination of the effect of temperature on the toxicity of a pollutant.	04
9	Determination of the effect of pH on the toxicity of a pollutant.	04
10	Qualitative evaluation of pesticide residues in vegetable samples.	04
11	Demonstration of immunoelectrophoresis.	04
12	Perform VDRL test.	04
13	Determine the relative amount of antigen/antibody in serum sample using precipitin ring test.	04
14	Determination of combined toxicity of pollutants on suitable organism.	04
15	Qualitative evaluation of pesticide residues in the fruit/food sample.	04

References

- Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi.
- Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers.
- Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai
- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, McGraw Hill Education.
- Subramanian M. A. (2010), Toxicology, Principles and Methods, 2nd revised edition, MJP Publisher, Chennai.

***Mandatory to perform any 10 practicals from above.**

Discipline Specific Core (DSC) Course

BC-609 : Analytical Biochemistry and Enzymology (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with various analytical techniques.
- To study enzyme kinetics practically.

Learning outcomes

After successful completion of this course, students are expected to:

- Perform enzymology related practical.
- Perform separation of mixture using chromatography and electrophoresis.
- Immobilize enzyme/yeast cell and can explore it.

Sr. No.	Topic Particular	Hours
1	Estimation of maltose by DNSA method.	04
2	To determine the effect of enzyme-amylase concentration on the rate of reaction.	04
3	To determine the effect of substrate concentration on the activity of amylase and determine Km and Vmax of the reaction.	04
4	To determine the effect of pH on activity of amylase.	04
5	To determine the effect of temperature on activity of amylase.	04
6	Immobilization of suitable enzyme/yeast cells.	04
7	Separation of amino acids using Paper layer chromatography.	04
8	Separation of amino acids using Thin layer chromatography.	04
9	Separation of amino acids using paper electrophoresis.	04
10	Separation of protein by SDS-PAGE.	04
11	Separation of proteins by native PAGE.	04
12	Partial purification of suitable enzyme.	04
13	Study the inhibition of suitable enzyme.	04
14	Estimation of suitable enzyme activity.	04
15	Demonstration of Ion exchange chromatography	04

References

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.

***Mandatory to perform any 10 practicals from the above.**

Skills acquired and Job prospects for the Biochemistry students

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students the way several lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunities in all sectors.

After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

- Laboratory safety practices as well as aseptic techniques
- Accurate weighing and reagent preparation
- Skillful handling of basic and advanced instruments
- Calibration of basic instruments like pH meter, micropipettes etc
    - Advanced techniques like; Chromatography, Electrophoresis
    - Spectrometry, Polymerase Chain Reaction (PCR)
    - Plant Tissue Culture, Animal Tissue Culture
- Collection, organization and presentation of data
- Analysis, Logical thinking and, interpretation of results

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas which include;

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation skill

Job Opportunities:

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public (Government) sectors.

Private Sector:

Biochemist can work in quality control, quality assurance and R & D divisions of companies like-Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sector:

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, Research Scientist etc.

Opportunities in higher studies

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

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