Pt. Ravishankar Shukla University Raipur

CURRICULUM & SYLLABI

(Based on CBCS & LOCF)

M.Sc. Biochemistry

Semester System

Session: 2024-25 & 25-26
(w. e. f. Academic Session 2024)

Approved by:	Board of Studies	Academic Council
Date:	05/09/2024	

Member (BOS) 05/09/24

Chairman (BOS) 05/09/2024

M. Sc. Biochemistry

The Students of M.Sc. Biochemistry program will learn experimentally and theoretically about the chemistry of biological phenomenon of living organisms. The course aims to provide the skills of identifying scientific issues, developing hypothesis based on literature, designing experiments and displaying results for betterment of mankind. To prepare students for the future careers in the concerned/various relevant fields in which a core understanding of the chemistry of life is important. This program would add highly skilled scientific workforce in the area of biomedical research sectors, academic, industry as well as for research laboratories across the country and the globe by following best practices for improving the professionalization and employability of students. This program would provide the practical and technical skills with laboratory-based work and the final year research project would prepare the students for a research or technical position by defining specific and transferable skills. Aim of this program to sensitize and train the students towards research with typical employers include pharmaceutical, biotechnology, food, water and agricultural companies and specialist services, such as toxicological studies and train the students in generic and competency skills so as to be able to work in potential places including scientific and medical publishers and the Intellectual Property Office.

Program Outcome:

On successful completion of this program the graduates shall have:

PO1.	**Knowledge:** A knowledge of contemporary issues related to biochemistry. Ability to demonstrate the fundamental knowledge of molecules of life, molecular techniques, toxicology in the area of biochemistry.
PO2.	**Critical Thinking and Reasoning:** Ability to think critically and apply the same to update scientific knowledge.
PO3.	**Problem Solving:** Ability to identify, formulate and solve professional problems in the area of biochemistry, experimental skill and critical thinking, students will be capable of addressing intricate societal and industrial challenges.
PO4.	**Advanced Analytical and Computational Skills:** Ability to design experiment and interpret the results. An ability to design a system, or process to meet desired need within realistic constraints
PO5.	**Effective Communication:** An ability to communicate effectively in scientific reasoning and data analysis in both written and oral forms.
PO6.	**Social/ Interdisciplinary Interaction:** Ability to function in a multidisciplinary team.
PO7.	**Self-directed and Life-long Learning:** A recognition of the needed for and an ability to engage in lifelong learning in the area of biochemistry.
PO8.	**Effective Citizenship: Leadership and Innovation:** An ability to use the techniques, skills and modern professional tools necessary for professional practice and for research.
PO9.	**Ethics:** An understanding of professional and ethical responsibility in the area of biochemistry.
PO10.	**Further Education or Employment:**
PO11.	**Global Perspective:** The broad education necessary to understand the impact of solutions in a global, economic, environmental and societal context.

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Program Specific Objectives:

PSO1.	Students shall be able to identify, formulate and solve the problems of biological metabolisms, protein biochemistry and molecular biology.
PSO2.	Students shall be able to conduct the experiments in the field of medicine, toxicology and immunology as well as to analyses and interpret the results.
PSO3.	Students shall be able to use the biochemical techniques, bioinformatics tools, biostatistics, skills and modern pathological tools necessary for professional practice and for research.

M. Sc. Biochemistry

Specification of Course	Semester	No. of Courses	Credits
Core	I-IV	22	90
Elective	IV	09	10
Total		31	100
Additional Courses (Qualifying in nature, for Student admitted in School of Studies only)			
Generic Elective	II-III	02	04
Indian Knowledge System/ Skill Enhancement / Value Added Courses	I, III	02	04

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M.Sc. Biochemistry: Program Structure

Semester	Course Nature	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
							CIA	ESE	Total
Semester-I	Core	(BCH-110)	Molecular cell Biology & Genetics	T	5	5	30	70	100
	Core	(BCH-120)	Chemistry of Biomolecules	T	5	5	30	70	100
	Core	(BCH -130)	Microbial Biochemistry and Biostatistics	T	5	5	30	70	100
	Core	(BCH-140)	Biophysical Chemistry and Biochemical Techniques	T	5	5	30	70	100
	Core	(BCH-150)	Lab Course I (Based on paper I & II)	P	4	2	30	70	100
	Core	(BCH-160)	Lab Course I (Based on paper III & IV)	P	4	2	30	70	100
TOTAL						**24**	**180**	**420**	**600**
Semester-II	Core	(BCH-210)	Bioenergetics & Metabolism	T	5	5	30	70	100
	Core	(BCH-220)	Plant Physiology and Biochemistry	T	5	5	30	70	100
	Core	(BCH-230)	Biology of Immune System	T	5	5	30	70	100
	Core	(BCH-240)	Human Physiology	T	5	5	30	70	100
	Core	(BCH-250)	Lab Course I (Based on paper I & II)	P	4	2	30	70	100
	Core	(BCH-260)	Lab Course II (Based on paper III & IV)	P	4	2	30	70	100
	*	(BCH-270)	Internship	P	4	2	-	-	-
TOTAL						**26**	**180**	**420**	**600**
Semester-III	Core	(BCH-310)	Clinical Biochemistry	T	5	5	30	70	100
	Core	(BCH-320)	Secondary Metabolites	T	5	5	30	70	100
	Core	(BCH-330)	Nutritional and Environmental Biochemistry	T	5	5	30	70	100
	Core	(BCH-340)	Enzymology	T	5	5	30	70	100
	Core	(BCH-350)	Lab Course I (Based on paper I & II)	P	4	2	30	70	100
	Core	(BCH-360)	Lab Course II (Based on paper III & IV)	P	4	2	30	70	100
TOTAL						**24**	**180**	**420**	**600**
Semester-IV	Core	(BCH-410)	Genetic Engineering	T	5	5	30	70	100
	Core	(BCH-420)	Nutraceuticals and Functional Foods	T	5	5	30	70	100
	Elective-1 (Select any one)	(BCH-401)	Plant Biotechnology	T	5	5	30	70	100
		(BCH-402)	Infectious Diseases: Molecular basis, Control and Prevention	T			30	70	100
	Elective-2 (Select any one)	(BCH-403)	Life Style Disorders: Cancer and Cardiovascular Diseases	T	5	5	30	70	100
		(BCH-404)	Bioinformatics	T			30	70	100
	Core	(BCH-430)	Lab Course I (Based on paper I & II)	P	6	3	30	70	100
	Core	(BCH-440)	Lab Course II (Based on paper III & IV)	P	6	3	30	70	100
TOTAL						**26**	**180**	**420**	**600**

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* Internship will be 2 credit/60 hours of practical based course. After completion of II Semester examinations internship shall be done by students as guideline provided by University.

Project Work (Elective-3)

			Marks					Credit
			(External)		(Internal)*		Total	
			Max.	Min	Max.	Min		
I	DESSERTATION	P	200		100		300	14
II	SEMINAR BASED ON PROJECTS	P	70		30		100	06
III	VIVA VOCE	P	70		30		100	02
Elective-4 (Select any one)	Methodology, Philosophy and Ethics of Research	T	70		30		100	4
	Can choose paper(s) from MOOC Courses (Swayam Portal)**							
	Total						600	26

**

a) The chosen paper will be other than the papers offered in the current course structure.
b) The paper will be for PG level with a minimum of 12 weeks duration.
c) The list of courses on SWAYAM keeps changing; the departmental committee will finalize the list of MOOC courses for each semester.
d. The paper(s) may be chosen from the Swayam Portal on the recommendation of the Head of the Department or its nominee / Professor in Charge.

1. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Generic Elective Courses (only qualifying in nature) offered by other departments/SoS in Semester II and Semester III.
2. The candidates, who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Skill Enhancement Course/Value Added Course (only qualifying in nature) in Semester I and Semester II.

Project Work

A student of IV semester will have the choice to opt for project work / dissertation in lieu of four theory papers and two lab courses. The project has to be carried out in recognized national laboratories or UGC-recognized universities. No student will be allowed to carry out project work in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur. The valuation of all the projects will be carried out by an external examiner and HOD of Biochemistry / Professor in-charge.

Generic Elective (Any two): For Non- Biochemistry students

(Offered to PG students of other Departments/SoS only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
II	BCH 270	BCH GE-1: Biomolecules	T	2	2	30	70	100
	BCH 280	BCHGE-2: Intermediary Metabolism	T	2	2	30	70	100
III	BCH 370	BCH GE-3: Biochemical Techniques	T	2	2	30	70	100
	BCH 380	BCH GE-4: Nutritional Biochemistry	T	2	2	30	70	100

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Skill Enhancement Elective Course: (Offered to the PG students of SoS in Biochemistry)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	BCH 170	BCH SEC-1: Biostatistics	P	2	2	30	70	100
Course on- INDIAN KNOWLEDGE SYSTEM (IKS)								
I	BCH 180	BCH IKS: Indian Health Sciences	T	2	2	30	70	100
Value Added Courses								
III	BCH 390	BCH VAC -1: Techniques in Bio ethanol Production	P	2	2	30	70	100

Pattern of Question Paper and Evaluation: As per University examination guideline.

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M. Sc. Biochemistry
FIRST SEMESTER (July 2024 – December 2024)
PAPER - I: Molecular cell Biology & Genetics [Credit: 5 and Maximum Marks: 100]

Course Objective: The module is designed to provide introduction the molecular mechanisms of life together with its advancements.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO.1 –Describe the chemical and molecular foundations of cell and the role in biological systems.
CO.2 – Demonstrate the cell cycle, its regulation and development.
CO.3 - Regulation of gene expression in prokaryotes, Operon concept, post transcriptional and post translational modifications, protein as signal.
CO.4- Evaluate the gene regulatory mechanisms in prokaryotic and eukaryotic cell.

Unit-I: asymmetrical organization of lipids, proteins and carbohydrates. Osmosis, ion channels, membrane pumps and electrical properties of membranes. Active transport by ATP-powered pumps: types, properties and mechanisms. Transport of proteins into mitochondria, chloroplast and endoplasmic reticulum. Transport of proteins into and out of nucleus. Transport by vesicle formation: exocytosis, endocytosis and its molecular mechanism.

UNIT-II: Cell signaling: Signaling via G-protein linked and enzyme linked cell surface receptors, MAP kinase pathways. Eukaryotic cell division cycle: different phases and molecular events, regulation and control of cell cycle. Apoptosis. Oncogenes and tumor suppressor genes: viral and cellular Oncogenes, retinoblastoma, E2F and p53 proteins.

Unit-III Linkage, crossing over & its cytological basis. Chromosome mapping- two factor crosses and three factor crosses. Molecular mechanism of crossing over, Recombination within gene or gene conversion. Complementation. Sex determination and sex linkage.

UNIT-IV: Mechanism of replication, enzymes involved replication origin and replication fork, fidelity of replication. RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, elongation, and termination, RNA processing, capping, RNA editing, splicing, and polyadenylation.

UNIT – V: Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyltRNAsynthetase, and translational proof-reading
Gene Expression and Regulation of gene expression in prokaryotes. Induction and repression, positive and negative control. Operon concept, lac operon, Trp operon, Ara operon.

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Lab Course

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the basic lab requirements and their uses.
CO.2 – Examine various cell organelles through micrograph techniques.
CO.3 – Analyse various nucleic acids through staining techniques.
CO.4 – Examine plolyploidy through onion root with various treatments.
CO.5 – Examine cancer cell by photomicrography.
CO.6 – Analyse various stages of mitosis.
CO.7 – Examine various stages of meiosis cell division.

Exercises:

1. Sub-cellular fractionation and marker enzymes
2. Identification of biomolecules in different tissues by histochemical techniques
3. Preparation of Karyotype of metaphase plate.
4. Preparation of Meiotic plate and determination of phases.
5. Isolation, purification and estimation of RNA
6. Isolation, purification and estimation of DNA
7. Determination of Tm of nucleic acid
8. Fraction of poly (A) RNA
9. Restriction Mapping
10. Restriction Digestion
11. Ligation
12. DNA molecular size determination

Books Recommended:

Molecular Cell Biology H. Lodish, A. Berk, SL Zipursky, P. Matsudaira, D. Baltimore, andJames Darnell.
Essential Cell Biology B. Alberts, D. Bray, K. Hopkin and A. Johnson
Molecular Biology of the Cell B. Alberts, A. Johnson, J. Lewis and M. Raff
Cell and Molecular Biology Gerald Karp : Concepts and experiments
Molecular Biology of the Gene JD Watson et al.
Molecular Biology of the Cell John Wilson, Tim Hunt
Martin Raff, Keith Roberts, Peter Walter
Genes VIII Benjamin Lewin

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M. Sc. Biochemistry
FIRST SEMESTER (July 2024 – December 2024)
PAPER – II: Chemistry of Biomolecules [Credit: 5 and Maximum Marks: 100]

Course Objective: The module is designed to provide introduction & detailed information on the molecules of life.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Understand H-bonding, acids and bases, reaction equilibrium, ionization behavior.
CO2: Illustrate the detailed structure and functions cellular components.
CO3: Understand the structure and biological importance of carbohydrate and lipids.
CO4: Understand the structure and synthesis of protein and nucleic acids.
CO5: Differentiate the role of cell suicide in maintaining the cellular balance.

UNIT – I: Physical Properties and structure of H_2O, H-Bonding, Ionization of water, pH scale, Handerson – Hasselbalch Equation, Buffers, Buffer solution and their action, Ionization behavior of amino acids and proteins. Colloidal Particles and their properties, Donnan membrane Equilibrium and its biological application.

UNIT – II: Carbohydrates – Structure of Monosaccharide, Isomerism of sugars, Reactions of aldehyde and ketone groups, Ring structure and anomeric forms, mutarotation, structure, occurrence and biological importance of monosaccharide, oligosaccharides and polysaccharides e.g., cellulose, chitin, agar, alginic acid, pectins, proteoglycans, sialic acids, glycogen and starch. Bacterial cell wall polysaccharides.

Lipids - Definition and classification. Fatty acid – classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acid, prostaglandins.Triacylglycerols- nomenclature, physical and chemical properties of fats- hydrolysis, saponification value, rancidity of fats, Reichert-Meissel number, reaction of glycerol. Glycerophospholipid, sphingomyelins, glycolipids. Properties and functions of phospholipids and sterols.

UNIT-III: Amino Acids and Proteins – Amino Acids – common structural features, classification and structures of standard amino acids, physical and chemical properties of amino acids. Essential Amino acids. Level of organization of protein – primary, secondary, tertiary structure of protein. Forces stabilizing the tertiary and quaternary structure of protein. Denaturation and renaturation of proteins. Salting in and salting out of proteins. Structure and biological function of fibrous protein, globular proteins (hemoglobin and myoglobin), lipoprotein, metalloprotein, glycoprotein and nucleoproteins.

UNIT – IV: Nucleic Acids Structure of constituents of nucleic acids, purines, pyrimidines, nucleosides and nucleotides. General structural plan of nucleic acids, features of DNA double helix. Denaturation and annealing of DNA, structure and roles of different types of RNA. Central dogma and molecular biology. Biological roles of nucleotides.

UNIT-V Vitamins: Structure and active form of water- and fat-soluble vitamins, Coenzymes, Deficiency diseases and symptoms.

Porphyrins: Porphyrin nucleus and classification of porphyrins. Important Metalloporphyrin's occurring in nature, Detection of porphyrins, Bile pigments-chemical and their physiological significance.

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Lab Course

Course Objective: The module is designed to provide introduction to basics of reagent preparation and quantification of biomolecules.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Apply the knowledge to prepare buffer solution
CO2: Apply the knowledge to prepare normal and molar solution
CO3: Apply the techniques for identification of pKa value CO4: Determine the different properties of solutions
CO4: Determine the proteins content in different sample.

Experiments:

1. Specific tests for sugars, amino acids and lipids
2. Formal titration of amino acids
3. Estimation of proteins using ninhydrin and biuret method
4. Estimation of sugar by anthrone and Folin-Wu method.
5. Saponification value and iodine number of fat.
6. Estimation of ascorbic acid.
7. Achromic point determination using salivary amylase
8. Effect of ions on salivary amylase activity.
9. Enzyme assay and kinetics (ex. Amylase, Protease)

Books Recommended:

Nelson, Cox and Lehninger Principles of Biochemistry
G. Zubay Biochemistry
Stryer Biochemistry
Garrett and Grosham Biochemistry
West, Tood, Mason &Bbruglen Text book of biochemistry
White, Handler & Smith Biochemistry-clinical application
D. Voet and J C Voet Biochemistry

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M. Sc. Biochemistry
FIRST SEMESTER (July 2024 – DEC 2024)
PAPER – III: Microbial Biochemistry and Biostatistics
[Credit: 5 and Maximum Marks: 100]

Course Objectives: The module is designed to provide introduction to the biochemistry of micro-organisms and give a general description of the basic recombinant DNA Techniques.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Explain the structure of bacteria and their microscopic examinations.
CO2: Analyze the types bacterial toxins and the toxicology.
CO3: Apply the use of microbes.
CO4: Explain Data, methods to test hypothesis.
CO5: Apply the scientific research etc.
CO6: Apply the knowledge of biostatistical analysis.

UNIT-I: General characteristics of fungi, classification of fungi, life cycle of selected fungal genus (Aspergillus, Pencillium, Fusarium and Mucor). Algae: Distribution, classification, reproduction, ecology and Economic importance.

UNIT-II: Morphology and ultra-structure of bacteria, morphological types, cell wall of archaebacteria, gram negative, gram positive eubacteria, eukaryotes. Cell membranes – structure, composition and properties. Structure and function of flagella, cilia, pili, gas vesicles.Cyanobacteria, protozoa, mycoplasma and Rickettsia.Gene transfer mechanisms, transformation, transduction, conjugation and transfection. Plasmids F: factors colicins and col factors, plasmids as a vector for gene cloning.

UNIT-III: Viruses: Structure and classification of viruses; morphology and ultra-structure; capsids and their arrangements, types of envelopes, viral genome, their types and structure, virus related agents (viroids, prions). General feature of virus reproductions, early events in virus multiplication, virus restriction and modification of host, virus mRNA. General overview of bacterial viruses, RNA and DNA bacteriophages (MS2, ϕX174, M13, T3, T4). Lysogeny and Lytic phase. General account of plant and animal viruses (TMV, HIV and other oncogenic virus, Hepatitis virus).

UNIT-IV: Introduction to biostatistics. Types of biological data: data on different scales. Frequency distributions.Cumulative frequency distributions. Randomsampling.Parameters and statistics. Measures of central tendency and dispersion: Mean, Median, Mode, Range, Variance and Standard deviation. Coefficient of variation.Distribution: normal & binomial. Probability: Basic laws of probability, addition law, multiplication law. Probability and frequency.

UNIT-V: Statistical errors in hypothesis testing. Testing goodness of fit: Chi-square goodness of fit. Heterogeneity Chi-square.The 2 x 2 contingency table. One sample hypothesis.Two-sample hypothesis.Testing for difference between two means (t-test).Testing for difference between two variances (F-test). The paired sample t-test. Multiple-sample hypothesis (ANOVA): Single factor and two factors ANOVA. Simple linear regression. Regression vs. Correlation.

Scientific Writing: Interpretation and Report Writing. Meaning of Interpretation, Techniques of interpretation, Precaution of interpretation. Significance of Report Writing. Step in Report Writing. Types of Report Writing.Component of a Research Report.

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Lab Course

Course Outcome:

On successful completion of this program the graduates shall have:

CO1: Demonstrate the techniques of pure culture of bacteria or fungi.
CO2: Interpret the motility of the microbes.
CO3: Interpret the biochemical activities of microbes by various tests
CO4: Understand about the impact of antibiotics on microbial survival
CO5: Apply the knowledge of sampling techniques.
CO6: Calculate the measures of central tendencies with the help of online software
CO7: Illustrate various data presentation styles for a good presentation
CO8: Test the significance of data

Experiments:

1. Glassware preparation and sterilization techniques- wet heat- dry heat-
filter types- laminar flow chamber types- CDC- safety levels.
2. Preparation of liquid & solid media, plating, pouring, inoculation and incubation for growth of microorganism
3. Methods of obtaining pure culture of microorganisms (a) streak plate (b) Pour plate, and (c) spread plate methods
4. Microscopic examination of the microorganisms, identification and staining methods
5. Micrometery and camera lucida drawings
6. Study of bacterial growth by turbiditimetry/ spectrophotometry
7. Biomass measurement for fungi
8. Isolation and enumeration of microorganisms from soil by serial dilution agar plating method.
9. Enumeration of viruses by plaque assay technique.
10. Motility of bacteria by hanging drop technique.

Experiments:

1. Exercises for data distribution.
2. Exercises for computation of measures of central tendency.
3. Exercises for computation of measures of variability.
4. Computation of correlation coefficient, r, and regression constants.
5. Data analysis by ANOVA and multiple-range tests.
6. Hypothesis testing by t-test, F-test, and Chi-square test.
7. Review Writing.

Books Recommended:

Campbell RC Statistics for biologists
Zar JH Biostatistical Analysis
Wardlaw AC Practical Statistics for Experimental Biologists
Snedecor GW & Cochran WG Statistical Methods
Sokal RR &Rohlf FJ Introduction to Biostatistics

Books Recommended:

Microbiology L.M. Prescott, J.P. Harley and D.A. Klein
General Microbiology RY Stanier, J L Ingrahamana, ML Wheelis& P. R. Painter
Principles of Microbiology R.M. Atlas
Microbiology Peleczar, Chan & Krieg.
General Virology Luria, Darnell, Baltimore and Campell.
Introduction to Mycology CJ Alexopoulos and CW Mims

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M. Sc. Biochemistry
FIRST SEMESTER (JULY 2024 – DEC 2024)
PAPER- IV: Biophysical Chemistry and Biochemical Techniques
[Credit: 5 and Maximum Marks: 100]

Course Objectives: This module is a general introduction to different types of techniques. It includes the DNA isolation Technique, PCR, RFLP etc.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Apply the principle, methodology and applications of Spectroscopic techniques.
CO2: Apply the principle, methodology and applications of Centrifugation techniques.
CO3: Employ the principle, methodology and applications of Electrophoretic techniques.
CO4: Apply the principle, methodology and applications of Chromatography techniques.
CO5: Interpret the principle, methodology and applications of PCR techniques.
CO6: Outline the principle, methodology and applications of Radioisotope techniques.

UNIT-I : Centrifugation: Principle, techniques. Preparative, analytical and ultracentrifuges, sedimentation coefficient and factors affecting sedimentation coefficient.Application of centrifugation.

UNIT-II : Photometry: Basic principles of colorimetry, UV- visible spectrophotometry & IR-spectrophotometry. Spectroflurometry Atomic absorption spectroscopy: Principle, Instrumentation and applications Electrophoresis: Paper electrophoresis, Starch gel, agarose, PAGE-type, 2D-E.

UNIT-III Microscopic techniques: light microscopy, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

Microtomy: types, principle and applications *Lyophilization*: Principle, instrumentation and applications

UNIT-IV: Chromatography: Paper and Thin Layer Chromatography. Gel filtration, Ion exchange chromatography and Affinity chromatography. Gas-liquid chromatography and HPLC.

Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *In situ* localization; FISH and GISH. Radioactivity: GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters

UNIT-V: Molecular techniques: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, separation methods; RNA, DNA and proteins; 1-D and 2-D, isoelectric focusing gels; Molecular cloning of DNA and RNA fragments in bacterial systems; Expression of recombinant DNA; DNA sequencing. Gene expression; mRNA, cDNA using PCR and qRT-PCR. Micro array based techniques. Molecular Markers for diversity analysis: RFLP, RAPD, AFLP, VNTR, SSR, ISSR, SNP, DArT.

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Lab Course

Course Objective: This module is a general introduction to different types of techniques involved in quantification of some biomolecules like glucose, vitamins, hemoglobin, chlorophyll and lipids.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Apply the estimation techniques for different blood components
CO2: Illustrate the technique of hemoglobin level determination
CO3: Analyze various enzymes related to organ disorders
CO4: Illustrate the techniques of paper chromatography
CO5: Analyze plant pigments by calorimetric method.

Exercise:

A. Verification of Beers Law
B. Determination of absorption maxima
C. Quantitative determination, Enzyme kinetics
D. Amino acid and carbohydrate separation by paper and TLC
E. Ion exchange and gel filtration chromatography
F. SDS Polyacralamide Gel Electrophoresis DNA electrophoresis
G. Isoenzymes
H. Separation of sub-cellular organelles by differential centrifugation.
I. Isolation of DNA and Agarose gel Electrophoresis
J. Isolation of RNA and Electrophoresis of RNA on denaturing gels.
K. Isolation of Protein and SDS-PAGE

Books Recommended:

1. K Wilson and John Walker Practical Biochemistry: Principles & Techniques
2. RF Boyer Biochemistry Laboratory: Modern Theory & Techniques
3. S Carson, H Miller and D Scott Molecular Biology Techniques: A Classroom Laboratory Manual
4. TC Ford and J. M. Graham An Introduction to Centrifugation
5. R Baserga and D Malamud Autoradiography: techniques and application
6. T Chard An Introduction to Radioimmunoassay and Related Techniques , Volume 6
7. MD Bruch NMR Spectroscopy Techniques

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M. Sc. Biochemistry

SECOND SEMESTER (JAN 2025– JUN 2025)

PAPER – I: Bioenergetics & Metabolism [Credit: 5 and Maximum Marks: 100]

Course Objective: This module is a general introduction to the metabolism of biomolecules (Carbohydrates, Lipids and the basic energetics).

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the fundamentals of thermodynamics in biochemical processes.
CO.2 – Acquire the knowledge of energy production in living systems by the degradation of fatty acids.
CO.3 – Explain the various pathways of fatty acid synthesis in living systems.
CO.4 – Describe the energy generated from the carbohydrate metabolism.
CO.5 – Explain the mechanism of the machinery system involved in carbohydrate metabolism.

UNIT-I: Introduction to Metabolism

General features of metabolism, experimental approaches to study metabolism: Use of intact organism, bacterial mutants, tissue slices, stable and radioactive Isotopes.

Carbohydrate Metabolism:

Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentations. Entry of fructose, galactose, mannose etc. Reactions and energetic of TCA Cycle. Gluconeogenesis, glycogenesis and glycogenolysis. Reaction and Physiological significance of pentose phosphate pathway. Regulation of Glycolysis and TCA cycle Photosynthesis a brief review.

UNIT-II: Electron Transport Chain and Oxidative Phosphorylation- Structure of mitochondria, sequence of electron carriers, sites of ATP production, inhibitors of electron transport chain. Hypothesis of mitochondrial Oxidative phosphorylation. Transport of reducing potentials into mitochondria.

UNIT-III: Lipid Metabolism : Introduction, hydrolysis of triacylglycerols, transport of fatty acids into Mitochondria, B oxidation saturated fatty acids, ATP yield from fatty acid Oxidation. Biosynthesis of saturated and unsaturated fatty acids. Metabolism of Ketone bodies, oxidation of unsaturated and odd chain fatty acids. Biosynthesis of triglycerides and important phospholipids, glycolipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism.

UNIT-IV: Amino acid Metabolism: General reactions of amino acid metabolism: transamination, oxidative Deamination and decarboxylation. Urea cycle. Degradation and biosynthesis of Amino acids. Glycogenic and ketogenic amino acids.

UNIT-IV: Nucleotide Metabolism : Sources of the atoms in the purine and pyrimidine molecules. Biosynthesis and Degradation of purines and pyrimidines biosynthesis.

Porphyrin Metabolism: Biosynthesis and degradation of porphyrins. Production of bile pigments.
Inborn Errors associated with metabolism.

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Lab Course

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 Explain biochemical parameter of biological sample.
CO.2- Explain fermentation process by microorganism.
CO.3- Explain enzyme assay of salivary enzyme.
CO.4- Apply the various techniques for isolation of lipids.
CO.5- Practice the biochemical parameters in biological system.
CO.6- Practice the estimation of plasma sugar.
CO.7- Demonstrate the cholesterol level from known sources.

Experiments:

1. Protein estimation by Lowry, Bradford and Spectrophotometric method
2. Estimation blood cholesterol
3. Estimation of sugar by Nelson- Somagy and Benedict's reagent
4. Isolation and estimation of lipid from seeds and egg.
5. Estimation of inorganic and total phosphorus by Fiske-SubbaRao method
6. Assay of phosphatases in blood and seeds
7. Urease estimation in plant tissues

Books Recommended:

Principles of Biochemistry Nelson, Cox and Lehninger
Biochemistry G. Zubay
Biochemistry Stryer
Biochemistry Garrett and Grosham
Text book of biochemistry West, Tood, Mason &Bbruglen
Biochemistry White,Handler& Smith
Biochemistry with clinical application D. Voet and J C Voet
Enzymes Dixon and Webb
Fundamentals of Enzymology Price and Steven
Practical biochemistry Plummer
Enzyme biotechnology G. Tripathi
Enzyme Reaction Mechanism Walsh
Enzyme catalysis and regulation Hammes

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M. Sc. Biochemistry
SECOND SEMESTER (JAN 2025 – JUN 2025)
PAPER- II: Plant Physiology and Biochemistry [Credit: 5 and Maximum Marks: 100]

Course Objective: The module is designed to provide introduction & detailed information on the basics of plant biochemistry and latest development in plant biotechnology.

Course Outcome:
On successful completion of the course, the student shall be able to:
CO1: Differentiate between photosynthesis and respiration in a plant cell.
CO2: Acquire the knowledge about nitrogen fixation and plant hormones.
CO3: Understand the plant stress management.

UNIT- I Solute transport and photo assimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

UNIT-II Nitrogen metabolism: assimilation of nitrate,structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation. Biological nitrogen fixation by free living and in symbiotic association; structure and function of the enzyme nitrogenase.

UNIT-III Photosynthesis – Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – C3 and C4 pathway of carbon reduction and its regulation, Photorespiration.

UNIT-IV Phytohormones: Structure, biosynthesis, molecular mechanisms of Auxin, Gibberellins, Cytokinin, Abscisic acid and Ethylene, Brassinosteroids.
Senescence and Programmed cell death: Senescence; Metabolism and regulation of pigment and nucleic acid, PGR regulation, SAG. PCD; Formation of TE and mobilization of cereal endosperm.

Unit-V Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Antioxidative defense system in plants – reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defense mechanism.

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Lab Course

Course Objective: The module is designed to provide an experimental background on analysis of plant metabolites and learn the basic plant tissue culture techniques.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Estimate the chlorophyll contents in various leaf sources.

CO2: Analyze the various metabolites present in plant.

Exercise:

1. Spectrophotometric determination of chlorophyll-a, chlorophyll-b and total chlorophyll in young, mature and senescent leaves.
2. Kinetin estimation by cucumber cotyledons expansion bioassay.
3. Auxin bioassay using wheat coleoptiles.
4. GA bioassay by inducing *de-novo* synthesis of Amylase in de-embryonated seeds of wheat.
5. Estimation of mono, di and total phenols in the young and aged leaves.
6. Estimation of Guaiacol peroxidase activity in fresh and aged seeds.
7. Determination of Superoxide dismutase levels in the healthy and deteriorated seeds.
8. Estimation of metal toxicity induced changes in the AOS levels in leaf tissues.
9. Determination of Nitrate reductase activity in leaf tissues.
10. Separation of isozymes of SOD and GPX.

Books Recommended:

Fosket DF Plant Growth & Development
Foyer CH Photosynthesis
Bacon KE Photosynthesis: Photobiochem. &Photobiophysics
Leopold AC &Kriedemann PE Plant Growth & Development
Moore TC Biochemistry & Physiology of Hormones
L Taiz& E Zeiger Plant Physiology
BB Buchanan, W Gruissem& Biochemistry and Molecular Biology of Plants
RL Jones MB Wilkins Advanced Plant Physiology
JA Hopkins Introduction to Plant Physiology
FB Salisburry& CW Ross Plant Physiology
Hans-Walter Heldt Plant Biochemistry & Molecular Biology

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M. Sc. Biochemistry
SECOND SEMESTER (JAN 2025 – JUN 2025)
PAPER – III: Biology of Immune System [Credit: 5 and Maximum Marks: 100]

Course Objective: The module is designed to provide introduction & detailed information on the principles of body's defense mechanism.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Differentiate between innate and adaptive immunity and also between humoral and cell mediated immunity.
CO2: Explain the primary and secondary responses and their relevance to immunizations.
CO3: Identify the role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses.
CO4: Apply immunochemical techniques used in pathological laboratories.
CO5: Discriminate the nature of antigens and antibodies.

UNIT-I Innate immune mechanism and characteristics of adaptive immune response. Cells of immune system: Hematopoisis and differentiation, mononuclear cells and granulocytes. Antigen presenting cells. Primary and Secondary lymphoid organs and tissues. Ontogeny and phylogeny of lymphocytes. Lymphocyte traffic.

UNIT-II Antigens: nature of antigens, factor affecting immunogenicity, Haptens and super antigens. Antigenic determinants. Recognition of antigens by T and B cell. Antigen processing. Role of MHC molecules in antigen presentation and co-stimulatory signals .Antigen and antibody interaction.

UNIT-III: Antigen receptor molecules: B-cell receptor complex, Immunoglobulin- structure, types and function. T-cell receptor complex. Clonal selection theory- concept of antigen specific receptor. Organization and expression of immunoglobulin genes. Generation of antibody diversity. Light and heavy chain gene recombination. Recombination Signal Sequences. Heavy chain constant region genes. Class switching. T-cell receptor diversity.

UNIT-IV Cell mediated and Humoral immune response and its regulation. Cytokines and interleukins-structure and function. Hypersensitive reactions and their types. Immunodeficiency disorders. Autoimmunity. Major Histocompatibility Complex- types, structural organization, function and distribution. Transplantation and Rejection. Complements in immune function.

UNIT-V Immune response to infectious diseases: viral, bacterial and protozoal. Cancer and immune system. Nutrition and Immune response. Principles of vaccination. Immunization practices. Passive immunization (immunotherapy). Role of vaccine in prevention of diseases: vaccines against important viral, bacterial, protozoan and parasitic diseases. DNA vaccines; Antiviral, antibacterial agents.

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Lab Course

Course Objective: The module is designed to provide introduction & detailed information on some basic immunodiagnostic techniques and quantification of blood proteins.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Apply the techniques to test various clinical conditions.
CO2: Perform immunological techniques
CO3: Analyze the different blood cell counting.
CO4: Perform qualitative and quantitative test for proteins

Experiments:

1. Identification of cells of immune system
2. Separation of mononuclear cells by Ficoll-Hypaque
3. Identification of Lymphocytes and their subsets
4. Lymphoid organs and their microscopic organization
5. Isolation and purification of Antigens
6. Purification of IgG from serum
7. Estimation of Levels of gamma globulins and A/G ratio in blood
8. Antigen antibody interaction

Books Recommended:

Kuby's Immunology R.A. Goldsby, T. J Kindt and B. A. Osborne
Immunology Roitt, Brostoff and Male
Fundamentals of Immunology William Paul
Immunology Tizard
Immunology Abbas et al

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M. Sc. Biochemistry
SECOND SEMESTER (January 2025– June 2025)
PAPER- IV: Human Physiology

Course Objective: The module is designed to provide introduction & detailed information on the Human physiology

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Explain mechanism of signal transduction by steroid and polypeptidehormones and the role of second messengers in signal transduction..

CO2: Explain the The process of gaseousexchange in tissues and lungs, respiratory adaption to high altitude and the difference between hemoglobin and myoglobin.

CO3: Identify the role of steroids in muscle building and the use of hormones in cattle and poultryindustry. Students will gain awareness on muscular dystrophies

CO4: Expalin role of kidneyin erythropoiesis.

Course Content:

Unit-I: Neurotransmission: Types of neurons, generalized structure of multipolar neuron. Resting membrane potential, Action potential, Transmission of nerve impulse along an axon and across a synapse. Neurotransmitters and inhibitors of neurotransmission.

UNIT-II: Muscle: Types of muscles and their structure. Ultra structure of skeletal muscle.Contractile andregulatory proteins of muscle.Sliding filament model of skeletal muscle contraction. Bone: Composition and structure of long bone, growth and remodelling of long bone. Factors affecting its growth.

Unit-II: Excretory system: Structure of the nephron, formation of urine – Glomerular filtration, tubularreabsorption and secretions.

Body fluids: Blood volume, composition and functions, RBC, WBC and platelets, theirstructure and functions. Mechanism of blood coagulation.Biochemical events in transport ofCO_2 and O_2 in blood.Cerebrospinal fluid, lymph and its function. Blood brain barrier.

Unit-III: Heart and lungs –Structure and function of cardiac tissue and lungs Acid-base balance: Maintenance of normal pH of the body fluids. Blood buffers. Role of lungs
and kidney in acid base balance. GIT and Liver: Structure and function of gastrointestinal tract, Structure of a lobule, functions– metabolic, storage and detoxification.

Unit-IV: Endocrine system: Endocrine organs, classification of hormones. Dynamic balance and regulation of hormone secretions. Functions of the hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. General mechanism of hormone action. Concept of messengers eg: cAMP, DAG, IP3.

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Lab Course

Course level learning outcomes:

The learning outcomes include: Qualitative and quantitative analysis of biological molecules and their estimation using multiple methods

1. Practical content
2. Preparation of blood smear and differential leucocyte count.
3. RBC and WBC counting, Calculation of blood Indices.
4. Estimation of hemoglobin
5. Colorimetric estimation of Protein by Lowry's method.
6. Estimation of Uric acid.
7. Urea by DAMO method.
8. Creatinine by Jaffe's method.
9. Phosphorous by Fiske and Subbarow's method.
10. Iron by Wong's method.
11. Qualitative analysis of urine - detection of urea, uric acid and creatinine.

Suggested Readings:

1. Human Physiology, Vol. I & II, - C. C. Chatterjee – Medical Allied Agency – Calcutta.
2. Concise Medical Physiology – Choudhary – New Central Book Agency – Calcutta.
3. TextBook of Medical Physiology – Guyton – Prism Books Pvt. Ltd. – Bangalore.
4. Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice HallInternational Inc.
5. Textbook of medical physiology: A. C. Gyton, and J. E HallSaunders Elsevier
6. Publications, A division of Reed Elsevier India Pvt .Ltd.New Delhi ISBN 81-8147-084-2
7. Human physiology: Chatterjee, Medical Allied Agency.

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M. Sc. Biochemistry
THIRD SEMESTER (JULY 2025 – DEC 2025)
PAPER - I: Clinical Biochemistry [Credit: 5 and Maximum Marks: 100]

Course Objective: The module is designed to provide introduction & detailed information on the basics of pathological conditions arising in body and the basic concepts of hormones and their functions.
Course Outcome:
On successful completion of the course, the student shall be able to
CO1: Explain about the normal constituents of urine, blood and their significance inmaintaining good health.
CO2: Explain the mechanisms of causation of diseases of liver, kidney and of Cancer will be explained.
CO3: Identify the variations in the levels of trigycerides andlipoproteins and their relationship with various diseases.
CO4: Expalin the role of enzymes in diagnosis of various diseases.

UNIT-I: Urine: Normal composition of urine – volume, pH, colour, specific gravity. Constituents-urea,uric acid, creatinine, pigment. Abnormal constituents – glucose, albumin, ketone bodies,variations in urea, creatinine, pigments and their clinical significance in brief.
Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance.

Unit-II: Blood: Normal constituents of blood and their variation in pathological conditions - urea, uricacid, creatinine, glucose, bilirubin, total protein, albumin/globulin ratio. Lipid profile –cholesterol, triglycerides, lipoproteins - HDL and LDL.
Blood Clotting – Disturbances in blood clotting mechanisms – haemorrhagic disorders –haemophilia, von Willebrand's disease, purpura, Rendu-Osler-Werber disease, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation, acquired prothrombincomplex disorders, circulating anticoagulants.

Unit- III: Diagnostic Enzymes – Enzymes in health and diseases. Biochemical diagnosis of diseases byenzyme assays – SGOT, SGPT, alkaline phosphatase, CPK, cholinesterase, LDHDisorders of liver and kidney – Jaundice, fatty liver, normal and abnormal functions of liverand kidney. Inulin and urea clearance.

UNIT-IV: Electrolytes and acid-base balance – Electrolytes, reabsorption of electrolytes, acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, regulation of sodium and water balance, renin-angiotensin system, clinical investigation of sodium, potassium, chloride;
Unit-V: Biochemistry of Cancer, Cellular differentiation in cancer, carcinogens and cancer therapy
Inborn errors of metabolism: Sickle cell anaemia, phenyl ketonuria, Neimann – Pick diseaseand Gaucher's disease.

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Lab Course

Course Objective: The module is designed to provide introduction & detailed information on some basic diagnostic techniques.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO1: Analyze the protein content in normal and diseased samples
CO2: Analyze the sugar content in normal and diseased samples
CO3: Analyze the various metabolites present in human.
CO. 4- Demonstrate glucose tolerance test.
CO. 5- Illustrate various important ions of different samples.
CO. 6- Illustrate thyroid hormones in blood sample.

1. Assay of Alkaline and Acid Phosphates
2. Estimation of blood glucose by GOD and POD method
3. Various types of glucose tolerance tests.
4. Estimation of SGOT, SGPT, LDH and CPK, Serum Amylase enzymes
5. Estimation of HDL- cholesterol, LDL- cholesterol.
6. Estimation of uric acid and creatinine in plasma.
7. Estimation of urine and blood billurubin.
8. Histological / Histochemical / Cytological study of Endocrine gland
9. Qualitative and quantitative analysis of urine : proteins, Bence-Jones proteins, Cl- , Ca+2

10Qualitative analysis of abnormal constituents in urine - glucose, albumin, bilepigments,bile salts and ketone bodies.

11. Experiments on blood

(a) Estimation of haemoglobin by cyanmethemoglobin method
(b) Determination of A/G ratio in serum

12. Gel Electrophoresis of serum proteins

Suggested Readings:

1. Harper's Biochemistry: R.K.Murray, D.K.Granner, P.A. Mayes and V.W.Rodwell.
2. Clinical Laboratory Science Review: Robert R. Harr
3. Fundamentals of Clinical Chemistry: C.A. Burtis, E.R. AshwoodTietzvb
4. Notes on Clinical Chemistry- Principles of Internal Medicines: Whitby, Smith, Beckett, Walker, Harrison
5. Concise Medical Physiology – Choudhary – New Central Book Agency – Calcutta.
6. TextBook of Medical Physiology – Guyton – Prism Books Pvt. Ltd. – Bangalore.
7. Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice HallInternational Inc.
8. Textbook of medical physiology: A. C. Gyton, and J. E HallSaunders ElsevierPublications, A division of Reed Elsevier India Pvt .Ltd.New Delhi ISBN 81-8147-084-2
9. T.M. Delvin (editor), Text book of biochemistry with clinical correlation, (1982), JohnWiley & Sons Inc. USA.

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M. Sc. Biochemistry
THIRD SEMESTER (JULY 2025 – DEC 2025)
PAPER – II: Secondary Metabolites [Credit: 4 and Maximum Marks: 100]

Course Outcome:
On successful completion of the course, the student shall be able to
CO-1: Explain Food crops Medicinal: Plant secondary metabolites.
CO-2 : Understand Knowledge of extraction, isolation, characterization and elicitation of bioactive metabolites.
CO-3: Analyze Nutraceuticals and functional foods.
CO-4: Explain Plant-based biofuels.

Unit-I: Introduction to secondary metabolites: Definition and systematic of secondary metabolites. Major classes of secondary metabolites i.e. alkaloids, terpenoids/ or isoprenoids, flavonoids and phenolics. Significance of secondary metabolites in plant's life. Roles in chemical defense system, taxonomical and ecological functions. Pharmacological and biological properties of secondary metabolites. Industrial and commercial significance of secondary metabolites

Unit-II: Biosynthesis and regulation of secondary metabolites: Biosynthesis of alkaloids derived from Shikimic acid pathway. Biosynthesis of isoprenoids via 3C-methyl-D-erythritol-4-phosphate (MEP) pathway. Biochemical pathways of flavonoids and polyphenol (lignin) biosynthesis. Integration of secondary metabolism with primary metabolic pathways.

Unit-III: Regulation: Genetic, developmental, seasonal and geographical factors, roles of precursor feeding, metabolic channeling and compartmentalization. Cross-talk/exchange of intermediates between biochemical pathways. Use of specific enzyme inhibitors in regulation

Unit-IV: Production of secondary metabolites: Methods of production of secondary metabolites: Tissue, organ and hairy root cultures. Roles of Endophytes in production of secondary metabolites. Production of secondary metabolites in bioreactors. Effects of precursors, co-factors and elicitors on production. Production of Taxol, Camptothecin, Berberine and rubber.

Unit-V: Metabolic Engineering of secondary metabolic pathways: Cloning and characterization of enzymes of the Shikimate and MEP pathways. Functional genomics approaches for improvement of secondary metabolite production. Metabolic engineering of *Escherichia coli* and yeast for the production of flavonoids, terpenoids and alkaloids.

Lab Course:
1. Isolation of essential oil and determination of the oil yield.
2. Qualitative test for determination of terpenoids, alkaloids, flavonoids and saponins.
3. Quantitative test for determination of terpenoids, alkaloids, saponins and phenolics.
4. Determination of antimicrobial activity of the plant extracts.
5. Demonstration of hairy root culture for production of secondary metabolites
6. RNA extraction and gene expression of key enzymes of Biosynthesis of alkaloid; *Strictosidine Synthsae [STR1], Strictosidine glucosidase (SG), Acetylajmalan Esterase (AAE) etc.*

Recommended Books:
David S. Seigler Plant Secondary Metabolism,
Alan Crozier Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet
Y. M. Shukla Plant Secondary Metabolites
R. Verpoorte, A. W. Alfermann Metabolic Engineering of Plant Secondary Metabolism.
Herbert, R.B. The Biosynthesis of Secondary Metabolites
Fett-Neto, Arthur Germano (Ed.) Biotechnology of Plant Secondary Metabolism Methods and Protocols
Keller, Nancy P., Turner, Fungal Secondary Metabolism
Bell, E.A., Charlwood, B.V. (Eds.) Secondary Plant Products
Petroski, Richard J., McCormick, Secondary-Metabolite Biosynthesis and Metabolism

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M. Sc. Biochemistry
THIRD SEMESTER (July 2025 – December 2025)
PAPER- III: Nutritional and Environmental Biochemistry
[Credit: 5 and Maximum Marks: 100]

Course Objectives: 1. The module is designed to provide information on organic and inorganic content of food stuffs, food preservation techniques and some knowledge on various nutritional disorders.
2. This module will be helpful to develop understanding of Human-environment interactions and consequences of disturbance of the environment.

Course Outcome:
On successful completion of the course, the student shall be able to:
CO1: Explain the basic components of food stuff and balance diet.
CO2: Summarize the dietary component and body electrolytes.
CO3: Recognize the food vitamins and minerals with nutritional disorder.
CO4: Distinguish the effect of toxic substances on environment.
CO5: Interpret the effect of toxic chemicals on body parts and their cure.

UNIT-I Composition of balanced vegetarian and non-vegetarian diets; recommended dietary allowance (RDA) for different categories of the human beings. Food preservation standards, food adulterations and precautions, government regulations on preservation and quality of food. Food processing and loss of nutrients during processing and cooking. Basal metabolism and methods of measuring basal metabolic rate (BMR); energy requirements during growth, pregnancy, lactation and various physical activities.

Unit-II: Minerals - sources, requirement, physiological function, deficiency and toxicity of calcium, sodium, potassium, iron, magnesium, chromium. Cobalt, copper, manganese, molybdenum, selenium, iodine and zinc. Vitamins - definition and types of vitamins, sources, requirement, biological functions, deficiency symptoms of thiamine, riboflavin, niacin, pyridoxine, panthothenic acid, folic acid, biotin, cyanocobalamine, vitamins C, A, D, E and K. Hypervitaminosis.

Basal metabolism and methods of measuring basal metabolic rate (BMR); energy requirements during growth, pregnancy, lactation and various physical activities.

UNIT- III Nutritional aspects of the carbohydrates, lipids and protein: nutritive value, requirements, and functions. Nutritional aspects of the vitamins and minerals: requirement and functions Malnutrition, its implications, relationship with dietary habits and prevention. Disorders related to the nutrition: Protein energy malnutrition, Starvation, Obesity.

UNIT- IV
Environmental Pollution: Types, Outdoor and indoor Air pollution, sources, structure and control strategies. Water and Soil Pollution.Eco–toxicology and its environmental significance.Xenobiotic metabolism, Phase I reaction – oxidation – reduction, hydrolysis and hydration. Phase II reaction – conjugation and methylation.

UNIT- V
Pesticide toxicity – insecticides, fungicides, herbicides and biopesticides.Toxicology of food additives.Metal toxicity – arsenic, mercury, lead and cadmium. Toxicity testing – Test control, genetic toxicity testing. Occupational toxicology: Occupational hazards and their assessment.
Bioremediation: Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, In situ and Ex-situ technologies, Phytoremediation.

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Lab Course

Course Objectives: The module is designed to provide detailed techniques about estimation of vitamins and minerals in food products and also to analyze the microbial content of domestic and industrial effluents.

Course Outcome: On successful completion of the course, the student shall be able to:

CO1: Analyze the contents of mineral and vitamin in food samples.
CO2: Analyze the chemical and microbial contents in various effluents.
CO3: Demonstrate TLC for different food components.
CO4: Analyze the adulterants present in food samples.

Exercises:

1. Separation and purification of sub-cellular organelles and assay of marker enzymes.
2. Protein fractionation - salt, solvent and isoelectric precipitation.
3. Identification and assay of certain toxicants.
4. Effect of various toxicants on serum enzymes and proteins
5. Effect of various toxicants on liver and kidney metabolism
6. Estimation of carbohydrate, protein and fat in food materials.
7. Titrimetric method of ascorbic acid estimation in fruit.
8. Separation of casein protein from milk

Books Recommended:

LG Corkerhem and BSS Shane Basic Environmental Toxicology
T Shibamato& L F Bzeidanes Introduction to Food Technology
M. Stipanuk Biochemical, Phys. & Mol. Aspects of Human Nutrition
Tom Brody Nutritional Biochemistry
DA Bender Nutritional Biochemistry of the Vitamins
R.L. Pike and M.L. Brown Nutrition: An integrated approach -
G.P. Talwar Text book of Biochemistry and Human Biology
DWS Wong Mechanism and theory in food chemistry
M.S. Banji N P. Rao& V. Reddy Text book of Human Nutrition
Linten Nutritional Biochemistry and Metabolism

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M. Sc. Biochemistry
THIRD SEMESTER (July 2025 – December 2025)
PAPER - IV: Enzymology [Credit: 5 and Maximum Marks: 100]

Course Objectives: The module is designed to provide introduction & detailed information on structure, biosynthesis and engineering of proteins.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Explain the enzyme classification.
CO2: Interpret the mechanisms of enzyme actions.
CO3: Acquire knowledge of allosteric enzymes and their kinetics.
CO4: Analyze the thermodynamics of enzyme substrate reactions.
CO5: Outline the knowledge of enzyme action, isolation and purification techniques.

UNIT-I Fibrous and globular proteins, Protein tertiary structure and enzymes, Active site, Transition state analogue. Nomenclature and classification of enzymes. Isolation and purification of enzymes. General properties and effects of pH, substrate and temperature on enzyme catalyzed reactions.

UNIT-II: Kinetics of catalyzed reaction: Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, Concept of convergent and divergent evolution of enzyme. Methods of examining enzyme – substrate complexes

UNIT-III Enzyme Turnover and methods employed to measure turnover of enzymes, significance of enzyme turnover.

Protein – ligand binding, including measurement, analysis of binding isotherms, cooperativity phenomenon, Hill and Scatchard plots. Multi enzyme system: occurrence , isolation & their properties , mechanism of action & regulation; Pyruvate dehydrogenase complex, fatty acid synthetase complexes. Mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymease

UNIT-IV General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, symmetrical and sequential modes for action of allosteric enzymes and their significance.Water soluble enzymes and their coenzymes. Metalloenzymes. Immobilized enzymes and their industrial applications.

UNIT-V Enzymes of Industrial Importance; their source, characteristic properties, functions and uses. Enzymes used in leather, paper, and textile industries. Enzymes in baking, brewing, Alcohol products; enzymes in detergents, starch and animal feeds. Amylases, cellulases, catalase, pectinase, lipase, protease, xylanase, laccase, beta glucanase.

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Lab Course

Course Objective: This module is a general introduction to different analytical techniques involved in assessment of some specific enzymes of our body.

Course Outcome:

On successful completion of the course, the student shall be able to:

CO1: Illustrate the kinetics of a specific enzyme involved in a metabolic activity of human body
CO2: Identify the optimum pH and temperature of an enzyme
CO3: Interpret the enzyme inhibition by various factors
CO4: Illustrate the enzymatic activity

Exercise:

1. Estimation of enzymes
2. Separation, purification of sub-cellular organelles & assay of marker enzymes.
3. Methods of purification of an enzyme - ion-exchange, gel filtration
4. Test of homogeneity by SDS-PAG E
5. Kinetics of an enzymatic reaction
6. Effect of various toxicants on serum enzymes and proteins
7. Enzyme modeling: Validation Criteria by WHATIF, Verify3d, PROSA and DOPE score
8. Verification of Ramachandran Plot: Estimation of interaction energy per residue by PROSA and Verify3D.
9. Enzyme packing quality: Assessed by WHATIF.

Books Recommended:

Brandon and Tooze Introduction to Protein Structure
Campell Discovering Genomics, Proteomics and Bioinformatics,
Dan Gusfield Algorithms on Strings Trees and Sequences
Lesk, A.M Introduction to Protein Architecture
Mcpherson, A. Introduction of Molecular Crystallography
Pennington Proteomics from Protein Sequence to Function
Durbin, Eddy, Anders & Graeme Biological Seq. Analysis: Probabilistic Models of Proteins & Nucleic Acids
S.A. Bbernhard The structure and function of enzymes
J. Palmer Enzymes: biochemistry, Biotechnology, Clinical chemistry

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M. Sc. Biochemistry
FOURTH SEMESTER (JANUARY 2026 – JUNE 2026)
PAPER – I: Genetic Engineering [Credit: 5 and Maximum Marks: 100]

Course Objective: This module is a general introduction of both the principles and application of molecular and genetic engineering. The module aims to understand the mechanisms of living, from the molecular basis of cell function to the integrated behavior of the whole body.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Compute the basic steps of genetic engineering according to the species.
CO.2 – Modify the DNA recombinant molecules according to the target cell.
CO.3 – Apply the knowledge of DNA sequencing while genetic engineering.
CO.4 – Convert the genetic information into cDNA library and genomic library that would be beneficial for the preparation of transgenic organisms.
CO.5 – Choose the appropriate gene delivery system for the target cell.

UNIT- I Milestones of genetic engineering: isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation of clones, cloning and patenting of life forms, genetic engineering guide lines. Molecular tools and their applications: restriction enzymes, modification enzymes. Molecular techniques: gel electrophoresis, polymerase chain reaction, DNA sequencing, DNA microarray.

UNIT-II Gene cloning vectors: plasmids and transformation, bacteriophages and in vitro packaging, cosmids, artificial chromosomes. Genomic library: strategies of genomic DNA library construction, transformation, construction of eukaryotic genomic library, screening methods. cDNA library: isolation and purification of mRNA, first strand synthesis, second strand synthesis, cDNA library construction.

UNIT-III: Study of gene regulation: reporter assays Expression strategies for heterologous genes: vector engineering and codon optimization, host engineering, in vitro transcription and translation.

UNIT-IV Processing of recombinant proteins: recombinant proteins purification, refolding, characterization and stabilization Site directed mutagenesis, protein engineering Gene knockout technique

UNIT-V Plant transformation technology: basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes. Vector-less or direct DNA transfer: particle bombardment, electroporation, microinjection. Application of plant transformation for productivity and performance, herbicide resistance, insect resistance, virus resistance, long shelf-life of fruits

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Lab Course

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate isolation of nucleic acid from microorganisms.
CO. 2- Demonstrate digestion reaction in nucleic acids of various samples.
CO. 3- Illustrate PCR methods.
CO. 4- Sketch Complementation by various techniques.
CO. 5- Illustrate hyper expression of poly histidine-tagged recombinant protein and purification.

Exercises:

1. Bacterial culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Quantitation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/phagemid vectors.
8. Isolation of RNA.
9. Synthesis of cDNA.
10. RAPD analysis by PCR.

Books Recommended:

1. Genes VIII Benjamin Lewin
2. An Introduction to Genetic Engineering DST Nicholl
3. Principles of Gene Manipulation and Genomics SB Primrose and Richard
4. Gene Cloning and Manipulation CJ Howe
5. Genetic Engineering (Genetics and Evolution) R Hodge
6. Introduction to Biotechnology & AJ Nair
7. Genetic Engineering
8. Genetic Engineering A Kumar & N Garg
9. Biotechnology & Genetic Engineering L Yount
10. DNA Microarrays & Gene Expression: from P Baldi& G Wesley

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M. Sc. Biochemistry
FOURTH SEMESTER (January 2026 – June 2026)
PAPER- II: Nutraceutical Biochemistry and Functional Foods
[Credit: 5 and Maximum Marks: 100]

Course Objectives:
i) Provide basic knowledge on nutraceuticals/bioactive compounds (e.g. carotenoids, glucosinolates, and polyphenols);
ii) Familiarize students with the scientific evidence about the role of diet and dietary components in the modulation of risk factors associated with chronic diseases (e.g cardiovascular diseases) and human health;
iii) Enable students to understand the concept of functional foods and their role in the human health and well-being.

Course outcomes:
On successful completion of the course, the student shall be able to:
CO1: Basic knowledge on the nutraceuticals in the context of the human well-being.
CO2: Equipped with knowledge necessary to understand the diet-health relationships and the importance of human evidence-based nutrition.
CO3: Learn the regulatory aspects of functional foods and the requirements for safety and efficacy assessment of nutraceutical and functional food.
CO4: Perspectives about the application of biotechnology for improving the formulation of potential functional ingredients/foods will be mastered.

Unit-I: Introduction to Nutraceuticals as Science:
Historical perspective, classification, scope and future prospects. Scrutinising the term 'nutraceutical', Regulation of various countries. Medicinal Plants: Ethnomedicine in India, Applied aspects of the Nutraceutical Science. Sources of Nutraceuticals. Relation of Nutraceutical Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition

Unit-II: Properties, structure and functions of various Nutraceuticals:
Glucosamine, Octacosanol, Lycopene, Falvanoids, Carnitine, Melatonin and Ornithine alpha, ketoglutarate.Use of proanthocyanidins, grape products, flaxseed oil as Nutraceuticals. Nutraceutical Industry and Market Information, New technologies in development of Nutraceuticals and functional foods Functional Foods, Scope of Genetic engineering, Nutritional Genomics

Unit-III: Food as remedies
Nutraceuticals bridging the gap between food and drug, Special Dietary Needs, Disease and Nutrition; Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers etc. Brief idea about some Nutraceutical rich supplements e.g. Bee pollen, Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina etc.

Unit-IV: Anti-nutritional Factors present in Foods
Types of inhibitors present in various foods and how they can be inactivated. General idea about role of Probiotics and Prebiotics as nutraceuticals.

UNIT-V: Recent advances in techniques & feeding of substrates. Methods of analysis of effect of nutaceuticals on animals; through animal cell culture and mouse (Murine) model. Assessment of nutritional status and Recommended Daily allowances.

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Lab Course

Course outcomes:

On successful completion of the course, the student shall be able to:

CO1: Student will be skilled with basic Research on bioactive compounds.

Experiments:

Identification using characteristic features of nutracuetically important plants like; *Phyllanthusemblica, Curcuma longa, Zinziberofficinalis*, Solanaceae (*Withaniasomnifera), Aloe vera*, Lilliaceae (*Aliumsativum*), Lamiaceae (*Ocimum sanctum*), Apiaceae (*Coriandrumsps*) and Liliaceae (*Asparagus sps.*), *Centellaasiatica.*

Study of following Parasites/ Vectors/ pests: Identification, Habits and control measures (museum Specimens / slides): *Entamoebahistolytica, Taeniasps, Ascarislumbricoides, Ancylostomadueodenaei, Trichinellaspiralis, Trichuratrichuris,* Mosquito (*Culex and Anopheles*), House fly, Green bottle fly, Head Louse, Cockroach (*Periplanata&Blatta*), bed bug, *Mus*sps. (Mouse) and *Rattus*sps. (House rat)

Reactions of mono, di and polysaccharides and their identification in unknown mixtures

Determination of Acid value, Saponification and Iodine number of natural fats & oils.

Estimation of proteins with Bradford's and other methods.

Extraction and estimation of total sugars from food products (dairy product, fruit juices, bread).

TLC separation of Plant pigments – Curcumin and carotene.

To isolate DNA and RNA from given plant/ animal material and estimate DNA by Diphenylamine (DPA) method and RNA by Orcinol reagent

Extraction, purification and evaluation of activity of any one digestive enzyme (e.g. Beta amylase from sweet potato)

Estimation of ascorbic acid from lemon &amla juice by titration method

Estimation of total Nitrogen of foods by Kjeldahl and Micro Kjeldahl methods.

Chromatography: Paper, TLC, adsorption, ion exchange, gel filtration, affinity, GC & HPLC.

Separation of Milk proteins on Native and SDS gels.

Books Recommended:

1. Stryer E.A., Biochemistry
2. Zubay, Geoffrey L. Biochemistry,
3. Greenberg David M. Metabolic Pathways, Vol 3 Todd and others, Clinical Diagnosis and Management, 17th Ed,
4. Gopalan C., et al Dietary Allowances for Indians, NIH, Hyderabad.
5. Anita F.P. Clinical Dietetics and Nutrition, 4th Ed, 1997,
6. Devlin, T.M. Text Book of Biochemistry with Clinical Correlation,
7. Mahan, L.K. &Ecott- Stump, S. [Ed.] Krause's Food, Nutrition and Diet Therapy
8. Lehninger Nutrition Concepts & Controversies,
9. W. Jeffrey, Hursts Methods of Analysis for Functional Foods and Nutraceuticals

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M. Sc. Biochemistry
FOURTH SEMESTER (January 2026 – June 2026)
SPECIAL PAPER – III (A): Plant Biotechnology
[Credit: 5 and Maximum Marks: 100]

Course Objective: This module will help to understand production of plats in the lab, production of high quality seeds, plants and plant products, engineering with plant genome.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Requirement and essentials of a plant tissue culture laboratory.
CO.2 –Skilled with plant tissue culture laboratory.
CO.3 – Socially aware with hybrid and indigenous verity and quality of plant based foods.
CO.4 – understand research area and research possibility towards plant science.
CO.5 – Apply plant tissue culture and its importance in various fields for development of new crops.

UNIT- I Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids. Tissue culture media (composition and preparation). Initiation and maintenance of callus and suspension culture; single cell clones. Organogenesis; somatic embryogenesis; transfer & establishment of plants in soil. Shoot tip culture: Rapid clonal propagation and production of virus free plant.

UNIT-II Embryo culture and embryo rescue. Anther, pollen and ovary culture for production of haploid plants & homozygous lines. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Germplasm conservation: Cryopreservation & slow growth cultures. Chloroplast Transformation: Advantages, vectors, success; tobacco & potato.

UNIT-III Plant transformation technology: Basis of tumor formation, Mechanism of DNA transfer, Features of Ti and Ri plasmids, role of virulence genes, use of Ti and Ri as vectors, binary vectors, markers, use of reporter genes, 35S and other promoters, use of scaffold attachment regions, multiple gene transfers, particle bombardment, electroporation, microinjection. Applications of plant transformation for productivity and performance: herbicide resistance, insect resistance, Bt genes, Non–Bt like protease inhibitors & amylase inhibitors, virus resistance, nucleocapsid gene, disease resistance, PR (Pathogenesis Related) proteins, nematode resistance, abiotic stress, male sterile lines.

UNIT-IV Metabolic Engineering and Industrial Products: plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines.

UNIT-V: Molecular Markers– RFLP maps, linkage analysis, RAPD markers, STS (Sequence Tagged Strands), microsatellites, SCAR (Sequence characterized amplified regions), SSCP (Single strand conformational polymorphism), AFLP, map based cloning, molecular marker assisted selection.

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Lab Course

Course Objective: This module will help to understand production of plats in the lab, production of high quality seeds, plants and plant products, engineering with plant genome.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Skilled with plant tissue culture laboratory.

Experiments:

1. Preparation of culture media.
2. To perform meristem/ bud culture, shoot multiplication & rooting phenomenon.
3. To study organogenesis.
4. To perform somatic embryogenesis.
5. To study the process of plantlet acclimatization.
6. To perform embryo culture.
7. To study the process of another culture development.
8. Study of molecular markers.
9. Extraction of DNA from plant cultures.
10. Estimation & separation of DNA: Agarose gel electrophoresis & spectrophotometer.

Books Recommended:

Razdan MK Introduction to Plant Tissue Culture
Vasil IK Plant Cell and Tissue Culture
Bhojwani SS and Razdan MK Plant Tissue Culture
Singh BD Biotechnology: Expanding Horizons
RH Smith Plant Tissue Culture Techniques and Experiments
L Kyte and J Kleyn Plants from Test Tubes: An Introduction to Micropropagation
M Smith Plant Propagator's Bible
MR AhujaMicropropagation of Woody Plants
YPS Bajaj Trees III
YPS Bajaj Trees IV

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M. Sc. Biochemistry
FOURTH SEMESTER (January 2026 – June 2026)
[Credit: 5 and Maximum Marks: 100]
Special Paper: PAPER- III (B): Infectious Diseases: Molecular Basis, Spread, Control and Prevention

Course Objectives:
The objective is to offer detailed knowledge about the mechanisms of disease, cause, transmission, detection, treatment and prevention.

Course Learning Outcomes:
1. Students will gain overall knowledge about the mechanisms of disease cause, transmission, detection, treatment and prevention.
2. Students will develop the ability to relate to any existing or emerging infection as well as will learn about drug resistance and its mechanisms.
3. The students will have the know-how to research and develop new tools for their management.

Contents:
Unit I: Overview of infectious diseases, infectious agents - Bacteria, Viruses, protozoa and fungi, pathogenicity and virulence; Facultative / obligate intracellular pathogens. Emerging and re-emerging infectious diseases and pathogens including X-MDR M. tuberculosis, MRSA, SARS virus, Bird flu, prions, AIDS, Dengue Hemorrhagic Fever, and Chlamydiae, opportunistic fungal pathogens.

Unit II: Bacterial disease, epidemiology, signs and symptoms, causative agent, history, infection and pathogenicity, Diagnostics, Therapeutics and vaccines. Drug resistance, mechanisms, Multidrug efflux pumps, extended spectrum β-lactamases (ESBL) and implications on public health, molecular mechanisms for Tuberculosis, Typhoid, Cholera

Unit III: Viral diseases, epidemiology, signs and symptoms, causative agent, history, infection and pathogenesis, Detection, Drugs and inhibitors, Vaccines, molecular mechanisms for AIDS, hepatitis, influenza, dengue, polio, herpes.

Unit IV: Parasitic diseases epidemiology, signs and symptoms, causative agents, history, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development, molecular mechanisms for Malaria.

Unit V: Coronavirus Disease (COVID-19), Fungal Infections, Analysis of Infectious Diseases Infection, Antimicrobials/Antibiotics/Antibacterial, Neuro Infectious Diseases.

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Lab Course

Course level learning outcomes:

Students will acquire the knowledge to isolate bacteria from water/sewage samples, to stain bacteria, fungi, acid fast bacilli and to perform important diagnostic tests for infectious diseases such as WIDAL test. Students will be exposed to permanent slides of pathogens in order to get hands-on training to know nature of various pathogens causing diseases.

Practical content

1. Grams staining for bacteria
2. Isolation and culture of bacteria from water/sewage samples.
3. Demonstration of various media for bacterial culture
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage samples
5. WIDAL test
6. Acid fast staining
7. Permanent slides of pathogens: Mycobacterium tuberculosis, Leishmania, Plasmodiumfalciparum
8. Fungal staining
9. Case Study

Suggested readings

1. Klein's Microbiology (2008) 7th Ed., Prescott, Harley, Willey, J.M., Sherwood, L.M.,Woolverton, C.J. McGraw Hill International Edition (New York) ISBN: 978-007-126727.
2. Principles and practices of Infectious diseases, 7th edition, Mandell, Douglas andBennett. S, Volume, 2. Churchill Livingstone Elsevier. ISBN: 978-0-443-06839-3
3. Sherris Medical Microbiology: An Introduction to Infectious Diseases. (2010).Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill. ISBN-13: 978-0071604024 ISBN-10: 0071604022
4. Medical Microbiology. (2012). Patrick R. Murray, Ken S. Rosenthal, Michael A.Pfaller, Elsevier Health Sciences. ISBN: 978-0-323-08692-9.
5. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds.American Society for Microbiology Press, Washington, DC USA. 2002

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M. Sc. Biochemistry
FOURTH SEMESTER (January 2026 – June 2026)
[Credit: 5 and Maximum Marks: 100]
Special Paper: PAPER- IV (A): Life style Disorders: Cancer and Cardiovascular Diseases

Course Objectives:
The objective is to provide knowledge about common life style disorders with detailed insight in to two major killers: Cancer and Cardiovascular diseases.

Course Learning Outcomes:
1. Students will learn about the various life styles associated disorders.
2. Students will gain detailed insight into Cancer and Cardiovascular diseases with regards to the molecular mechanisms, causes, symptoms, stages, diagnosis and treatments.
3. Students will learn about alternative medicines; current research status, various ethical, social and regulatory issues.

Contents:

Unit I: Introduction: Life style associated disorders like obesity, diabetes, chronic obstructive pulmonary diseases (COPD), cancer and cardiovascular diseases (CVDs); Causes, symptoms, complications, diagnosis, intervention and management of disease; Two major killers: Cancer and Cardiovascular diseases

Unit II: Cancer: History of cancer; Characteristics of normal and transformed cells; Hallmarks of cancer; Causes and symptoms; Pathophysiology; Stages of cancer; Molecular basis of neoplastic growth and metastasis, Key oncogenic pathways; Proto-oncogenesis and Tumor suppressor genes; Cancer causing mutations; Tumor viruses, Overview of important techniques related to cancer research.

Unit III: Cardiovascular diseases: Definition; The origin of cardiovascular diseases (electrical, structural and circulatory) and types of CVDs; Defining the broad spectrum of ailments; Understanding the underlying factors; Stages of CVDs; Molecular basis of CVDs like hypertension, coronary heart (artery) disease, cerebrovascular disease, cardiomyopathy, cardiac hypertrophy, atherosclerosis, myocardial infarction.

Unit IV: Diagnosis and Treatment strategies : Biochemical analysis of cancer and screening methods; Current treatment modalities and their disadvantages, major side effects; Molecular approaches to cancer treatment; Factors affecting prognosis of cancer; Challenges of treatment and disease control strategies. Diagnosis and biomarkers for CVDs; Treatment strategies and management of the condition; Drugs and their discovery; Model systems and animals for CVDs.

Unit V: Behavioral and Mental disorders: Definition; concepts of normality and abnormality; clinical criteria of abnormality; Signs and symptoms: Disorders of consciousness, attention, motor behavior, orientation, experience of self, speech, thought, perception, emotion, and memory.
Psychological theories: Psychodynamic; behavioral; cognitive; humanistic; interpersonal theories/models of principal clinical disorders and problems, viz. anxiety, obsessive-compulsive, somatoform, dissociative, adjustment, substance use, personality, suicide, mood disorders, and culture-specific disorders.

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Lab course

1. Case Studies
2. Power point presentations; discussion of research articles and reviews on it.
3. Identification of modifiable behavioral risk factor in case study.
4. Identification of Nonmodifiable behavioral risk factors in different life style disorder.
5. Students may be given short term project work (05 to 15 Days) to analyze risk factors for a life style disorder through case studies.

Suggested Readings:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Introduction to Human Physiology (2012) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541
3. 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.
4. The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M.Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.
5. Life style disorders, National health portal of India (https://www.nhp.gov.in/lifestyledisorder_mtl)

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M. Sc. Biochemistry
FOURTH SEMESTER (January 2025 – June 2025)
Special Paper: PAPER- IV (B): Bioinformatics
[Credit: 5 and Maximum Marks: 100]

Course Objectives: The module is designed to provide introduction & detailed information on storing, retrieving, analyzing biological data in silico.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO1: Discuss the various databases and GenBank used in storing biological data.
CO2: Identify the basic concepts of sequence similarity by BLAST and FASTA algorithms.
CO3: Explain the phylogenetic analysis and various genome projects.
CO4: Apply the techniques for the protein structure prediction.
CO5: Summarize the cheminformatics and medicinal chemistry.

Unit I Introduction to bioinformatics

Bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pub med, PDB) and software (RASMOL, Ligand Explorer).

Unit II: Data generation

Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.

Unit II Biological Database and its Types

Introduction to data types and Source.Population and sample. Classification and Presentation of Data.Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDB sum)

Unit III Data storage and retrieval and Interoperability

Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt). Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.Data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON and OMG/LIFESCIENCE.

Unit IV Gene Expression and Representation of patterns and relationship

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes).Genetic variability and connections to clinical data.

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Lab Course

Course Objectives: The module is designed to provide a detailed knowledge of online databases available and functioning of all the software to study the bio molecules of life.

Course Outcomes (COs):
On successful completion of the course, the student shall be able to:
CO1: Demonstrate the use of databases.
CO2: Demonstrate the gene and protein sequence retrieval techniques.
CO3: Produce novel DNA and protein structures to be used in therapeutics.
CO4: Perform phylogenetic studies to establish the relationship between two genomes.

Exercises:
01. Retrieval of sequences from NCBI, EBI and EMBL databases.
02. Retrieval of sequences from NBRF-PIR, SWISSPROT and P databases.
03. Transition and Translation of sequences.
04. Retrieval of genome from genome databases.
05. Exploring DIP and PPI.
06. Exploring BIND and PIM.
07. Exploring MINT and GRID.
08. Analysis of phylogenetic tree
09. Exploring PDB file.
10. Analysis of active site by pymol

Books Recommended:
BAXEVANIS, AD & OUELLETTE, BFF : Bioinformatics: a practical guide to the analysis of genes and proteins. 2nd Ed.. 2002.
BAXEVANIS, AD, DAVISON, DB, PAGE: Current protocols in bioinformatics. 2004.
RDM & PETSKO, GA ORENGO, C, JONES, D & : Bioinformatics: genes, proteins and computers. 2003
THORNTON, J Ingvar Eidhammer, IngeJonassen, : Protein Bioinformatics. 2003
William R Taylor HIGGINS, D & TAYLOR, W : Bioinformatics: sequence, structure, and databank. 2000.
David Mount: Bioinformatics: sequence and genome analysis. 2004

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M. Sc. Biochemistry
FOURTH SEMESTER (January 2026 – June 2026)
PAPER (along with Project work): Methodology, Philosophy and Ethics of Research
[Credit: 4 and Maximum Marks: 100]

Course Outcome:

On successful completion of the course, the student shall be able to:

1. Understand, analyse the problem.
2. Apply Scientific process know the cause of the problem.
3. Apply different mathematical tools to correlate factors responsible for the problem.
4. Apply knowledge of bioethics in research.

Unit-I- Foundations of Research: Definition, purpose - Relevance and scope, Motivation and objectives – Research methods vs Methodology. Types of research- pure versus applied, incremental versus innovative; multidisciplinary research.

Unit-II- Research Process and Design: Steps involved in research process; Identifying and defining research problems; Importance of literature review in defining a problem, Formulation of research objectives; Hypothesis, Research design- Meaning and need- induction - deduction. Features of good design- important concepts and different types; basic principles of experimental design.

Unit-III- Data Collection and Analysis : Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies – Measures of central tendency, standard deviation and standard error, ANOVA, Correlation, T test, Data Analysis with Statistical Packages, Generalisation and interpretation of results.

Unit-IV- Scientific Reporting: Types of scientific reports – journal articles – Presentation at conferences- Thesis and dissertations – Books. Structure and components of scientific reports – Layout, Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication. Publication of scientific reports, Impact factor of Journals, h-index, i10-Index, g-index.

Unit-V- Application of Results and Research Ethics: Commercialization – Copyright and Copy left – royalty - Intellectual property rights and patent law – Ethical issues - Ethics in human and animal experimentation. Guidelines for using animals in biological research- The Prevention of Cruelty to Animals Act, India. Scientific misconduct such as Fabrication, Falsification, Plagiarism and Self-Plagiarism; software for checking plagiarism. Conflicts of interests; Citation and acknowledgement - Reproducibility and accountability.

Text Books Recommended –

- Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research methodology, RBSA Publishers.
- Kothari, C.R.,1990. Research Methodology: Methods and Techniques. New Age International. 418p.
- Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p
- Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
- Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

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Generic Elective Courses

M. Sc. Biochemistry

SECOND SEMESTER (January 2025 – June 2025)

Generic Elective – I (BCH GE-1): Introductory Biochemistry and Biomolecules

[Credit: 2 and Maximum Marks: 100]

Course Outcomes (CO)

After completion of the course, the students would be able:

- Students will be exposed to the history of Biochemistry and key contributions of scientists such as Achary Nagarjun, Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, Har Gobind Khorana, Watson and Crick and Venky Ramakrishnan.
- Understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA and their importance in biological systems.
- Understand the methods of determination of amino acid and nucleotide sequence of proteins and DNA respectively.
- They will understand the methods of estimation of DNA & RNA.

Unit-1 General understanding of Biochemical

Molecular Logic of Life. Definition of Biochemicals. Experiments and discoveries of Acharya Nagarjuna. Famous Indian Biochemists and their inventions/ Discoveries. Importance of Yog, Pranayam, food and healthy lifestyle for balance of biochemical (kaf, vat, pitta) of our body and role in maintaining good mental and physical health. Biochemical basis of Lifestyle disorders.

Unit-2 Structure and functions of Carbohydrates and lipids:

Definition, classification, biological importance. Monosaccharides: Disaccharides: Polysaccharides: Partial structure, occurrence and importance of starch, glycogen, inulin, cellulose, chitine. heparin, hyaluronic acid.

Unit-3 Lipids: Classification and biological role. Fatty acids – Nomenclature of saturated and unsaturated fatty acids. Phosphoglycerides: function of lecithin, cephalins, phosphotidylinosital, plasmalogens, and cardiolipin, importance of sphingomyelin, gangliosides and cerebrosides.

Unit-4 Structure and functions of Amino acids and Proteins: General Structure, classification of amino acids based on R Group. Amino acids D & L notation. **Proteins:** Peptides, Primary Structure of proteins, N- and C- terminal amino acids, Secondary Structure – α Helix. β-sheet, β-bend. Tertiary and quaternary structure, denaturation and renaturation of proteins.

Unit-5 Structure and functions of Nucleic acids: Composition of DNA and RNA. Nucleosides and nucleotides. Chargaff's rule. Primary and secondary structure of DNA, Watson and Crick model of DNA. Melting of DNA (Tm).

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Generic Elective Courses
M. Sc. Biochemistry
SECOND SEMESTER (January 2025 – June 2025)
Generic Elective – II (BCH GE-2): Intermediary Metabolism
[Credit: 2 and Maximum Marks: 100]

Course Outcomes (CO)

After completion of the course, the students would be able:

- Describe the fundamentals of thermodynamics in biochemical processes.
- Acquire the knowledge of energy production in living systems by the degradation of fatty acids.
- Explain the various pathways of fatty acid synthesis in living systems.
- Explain the mechanism of the machinery system involved in carbohydrate metabolism.
- Describe breakdown and synthesis of Amino acids and nucleotides in humans and recognize its relevance with respect to nutrition and human diseases.

Unit-1 Function and Importance of Carbohydrate Metabolism:
glycolysis. Alcoholic and lactic acid fermentations. TCA Cycle. Gluconeogenesis, glycogenesis and glycogenolysis. Physiological significance of pentose phosphate pathway. Regulation of Glycolysis and TCA cycle.

Unit-2 Function and Importance of ATP Production:
Structure of mitochondria, Mechanism of ATP Production, Effect of cyanide. Hypothesis of mitochondrial Oxidative phosphorylation. Function and importance of ETC.

Unit-3 Function and Importance of Lipid Metabolism
Introduction, hydrolysis of triacylglycerols, transport of fatty acids into Mitochondria, β oxidation saturated fatty acids, ATP yield from fatty acid Oxidation. Function and Importance of Biosynthesis of saturated and unsaturated fatty acids. Function and Importance of Metabolism of Ketone bodies.

Unit-4 Function and Importance of Amino acid Metabolism
Function and Importance of of amino acid metabolism. Transport of amino group in blood. Urea cycle. Glycogenic and ketogenic amino acids. Inborn errors associated amino acid metabolism.

Unit-5 Function and Importance of Nucleotide Metabolism
Sources of the atoms in the purine and pyrimidine molecules. Function and Importance of Biosynthesis and Degradation of purines and pyrimidines. Inborn errors associated nucleotide metabolism.

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Generic Elective Courses
M. Sc. Biochemistry
THIRD SEMESTER (January 2025 – June 2025)
Generic Elective – III (BCH GE-3): Bioanalytical Techniques
[Credit: 2 and Maximum Marks: 100]

Course Outcomes (CO)

After completion of the course, the students would be able:

- Examine different components present in the extract of radish leaves by using chromatography technique.
- Analysis independently of various biomolecules in the laboratory.
- Demonstrate the effect of inorganic compound and its percent purities in various types of samples.
- Analyze characteristics of UV absorption spectra of by different methods in samples in different biomolecules.

Unit-1 Spectroscopy - Concepts of spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry. Visible and UV spectroscopy.

Unit-2 Electrophoretic techniques – Principles of electrophoretic separation. Types of electrophoresis including paper and gel. SDS PAGE.

Unit-3 Chromatography – Principles and applications of paper, thin layer, ion exchange, affinity, gel permeation, adsorption and partition chromatography. HPLC and FPLC.

Unit-4 Centrifugation – Principle of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical, ultra-centrifugation, determination of molecular weights and other applications.

Unit-5 Microscopy – Bright field, Dark field, Phase contrast and Fluorescence microscopy Transmission and scanning microscopy, freeze fracture techniques,
Immunological Techniques: Immuno diffusion, immune electrophoresis, radioimmunoassay, ELISA, Immuno fluorescence.

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Generic Elective Courses

M. Sc. Biochemistry
THIRD SEMESTER (July 2025 – DEC. 2025)
Generic Elective – IV (BCH GE-4): Nutritional and Environmental Biochemistry
[Credit: 2 and Maximum Marks: 100]

Course Outcomes (CO)

After completion of the course, the students would be able:

- Explain the basic components of food stuff and balance diet.
- Analyze the food vitamins and minerals with nutritional disorder.
- Analyze the effect of toxic substances on environment.
- Interpret the effect of toxic chemicals on body parts and their cure.

Unit-1 Composition of balanced vegetarian and non-vegetarian diets; recommended dietary allowance (RDA) for different categories of the human beings. Food preservation standards, food adulterations and precautions, Food processing and loss of nutrients during processing and cooking.

Unit-2 BMR : Basal metabolism and methods of measuring basal metabolic rate (BMR); energy requirements during growth, pregnancy, lactation and various physical activities.
Disorders related to the nutrition: Protein energy malnutrition, Starvation, Obesity.

Unit-3. Nutritional aspects of Food: carbohydrates, lipids and protein: nutritive value, requirements, and functions.
Nutritional aspects of the vitamins and minerals: requirement and functions Malnutrition, its implications, relationship with dietary habits and prevention.

Unit-4 Environmental Pollution: Types, Outdoor and indoor Air pollution, sources, structure and control strategies. Water and Soil Pollution.Eco–toxicology and its environmental significance. Xenobiotic metabolism and role of liver.

Unit-5 Pesticide toxicity – insecticides, fungicides, herbicides and biopesticides. Toxicology of food additives.Metal toxicity –lead and cadmium. Occupational toxicology: Occupational hazards and their assessment.

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Course on Indian Knowledge System

M. Sc. Biochemistry

I SEMESTER (July 2024 – DEC. 2024)

Course on Indian Knowledge System (Theory Based) -1

(BCH IKS-1): Indian Health Sciences

[Credit: 2 and Maximum Marks: 100]

Course Outcomes (CO)

After completion of the course, the students would be able to:

1. Understand Base of Indian therapeutic system.
2. Understand basics of Ayurveda.
3. Understand holistic approach to maintain mental and physical health.

Unit-I - Vedic foundations of Ayurveda. Ayurveda is concerned both with maintenance of good health and treatment of diseases. Basic concepts of Ayurveda. The three Gunas and Three Doshas, Pancha-mahabhuta and Sapta- dhatu.

Unit-II- The importance of Agni (digestion). Six Rasas and their relation to Doshas. Ayurvedic view of the cause of diseases. Dinacharya or daily regimen for the maintenance of good health. Ritucharya or seasonal regimen. Important Texts of Ayurveda.

Unit-III- Selected extracts from Astāngahrdaya (selections from Sūtrasthāna) and Suśruta-Samhitā (sections on plastic surgery, cataract surgery and anal fistula).

Unit-IV- The large pharmacopeia of Ayurveda. Charaka and Sushruta on the qualities of a Vaidya. The whole world is a teacher of the good Vaidya. Charaka's description of a hospital.

Unit-V Hospitals in ancient and medieval India. How Ayurveda continued to flourish till 18/19th centuries. Surgical practices, inoculation. Current revival of Ayurveda and Yoga.

Suggested reading:

1. Ayurveda: The Science of Self Healing by Dr.Vasant Lad
2. Astāngahrdaya, Vol. I, Sūtrasthāna and Śarīrasthāna, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.

Online resources:

1. https://vikaspedia.in/health/ayush/ayurveda-1/ayurveda-basics
2. https://www.gersonayurveda.com/ayurvedic-principles
3. https://www.banyanbotanicals.com/info/ayurvedic-living/living-ayurveda/health-guides/digestion/the-importance-of-agni/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2816487/

Member (BOS) Chairman (BOS)

Value Added Course

M. Sc. Biochemistry
III SEMESTER (July 2024 – DEC. 2024)
Value Added Course (Theory Based) -1
(BCH VAC-1): Techniques in Bioethanol Production
[Credit: 2 and Maximum Marks: 100]

Utility and expected outcome of the Course-

1. This course will provide skilled human resource for biofuel production industry.

2. This course will provide enhance probability of employment to PG students as skilled work force for biorefineries.

Content of the Course

Students will have to give laboratory based study under following points.

1. Design of a System for Lab-scale Production of Ethanol.

2. Bioethanol production from Sugarcane waste, rice waste, paddy and other agricultural and domestics wastes in lab. (Carefully observation and maintenance of fermentation condition in experiment).

3.Troubleshooting during experiments (Maintenance of PH, Temperature, Alcohol concentration etc during fermentation).

4. Estimation of ethanol content by chemical/ spectrophotometric method.

5. Comparison of ethanol production from different sources.

5. Suggestion to improve ethanol production.

6. Report writing.

7. Discussion with Case study.

Member (BOS) Chairman (BOS)

M. Sc. Biochemistry

THIRD SEMESTER (July 2025 – DEC. 2025)

Skill Enhancement Elective Course (Practical Based) -1

(BCH SEE-1): Biostatistics

[Credit: 2 and Maximum Marks: 100]

Course Outcomes (CO)

After completion of the course, the students would be able:

- Understand hands-on practical training to plan biological experiments with requisite sample size.
- Perform proper statistical analysis of the data using mean, median, mode, variance and standard deviations. Students will be able to apply the
- Apply use of ANOVA, AMOVA and student t-test.
- Formulate a hypothesis, relevance to type of sample collected and sample size.

Course content.

Course Supervisor/Professor will give/Allot a small in-house/Campus based research topic/problem/project, in which student practically find out results and interpret it statistically. Student will cover following points in their practical/project report.

1. Estimation of population means and variance in simple random sampling.
2. Collection of data - Random sampling method; Stratified sampling method; Cluster sampling method
3. Cluster Sampling- Equal and unequal cluster sizes. Double sampling using regression and ratio estimates and double sampling for stratification.
4. Data representation - Frequency and relative frequency distribution table, Plotting of biological data in a representative graphical format.
5. Data analysis - Calculating Mean, median, mode, variance, standard deviation and standard error for a given data set. Standard t-test for grouped samples.
6. Chi square goodness of fit test. Regression analysis and calculating regression coefficient
7. Learning to analyze data using SPSS software

Suggested Readings:

1. Principles of Biostatistics, M. Pagano and K. Gauvreau (2000); Duxbury Thomas learnings.
2. Analysis of Biological Data, M. Whitlock and D. Schluter (2009); Roberts and company publishers.

Member (BOS)

Chairman (BOS)