M.Sc. Biochemistry

SYLLABUS

UNIVERSITY OF KERALA

(2022 Admission Onwards)

Table of Contents

Programme Specific Outcomes (PSO)

- To impart advanced knowledge on various concepts of biochemistry.
- Enable students to achieve capacity for inquisitive enquire in the field of biochemistry.
- To integrate and apply the techniques of Analytical biochemistry, Clinical Biochemistry, Microbiology and Molecular biology.
- To develop skills in students necessary for careers into advanced research.
- To learn the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.
- Enrich the skills and applied knowledge of students towards current industry expectations from biochemists.

Programme Structure

Semester	Course Code	Title of the Course	Instructional Hours/Week			Maximum Marks		
			L	T	P	CA	ESA	Total
I	BC 511	Advanced Techniques in Biochemistry	5	1	0	25	75	100
	BC 512	Physiology	5	1	0	25	75	100
	BC 513	Plant and Microbial Biochemistry	5	1	0	25	75	100
	BC 514	Practical I - Biochemical and Microbial Techniques	0	0	10	25	75	100
II	BC 521	Enzymes	4	1	0	25	75	100
	BC 522	Metabolism	4	1	0	25	75	100
	BC 523	Clinical Biochemistry	3	1	0	25	75	100
	BC 524	Cell Biology and Genetics	4	1	0	25	75	100
	BC 525	Practical II: Enzymology and Clinical Biochemistry	0	0	10	25	75	100
III	BC 531	Molecular Biology	4	1	0	25	75	100
	BC 532	Immunology	4	1	0	25	75	100
	BC 533	Pharmacology and Toxicology	3	1	0	25	75	100
	BC 534	Methods in Research	4	1	0	25	75	100
	BC 535	Practical II: Immunotechniques and Phytochemical analysis	0	0	10	25	75	100
IV	BC 541	Molecular Endocrinology	5	1	0	25	75	100
	BC 542	Biotechnology and Genetic Engineering	5	1	0	25	75	100
	BC 543	Practical IV: Techniques in Molecular Biology	0	0	10	25	75	100
	BC 544	Dissertation	0	0	5	0	60	80
		Presentation and Viva Voce of Dissertation	0	0	0	0	20	
	BC 545	Comprehensive Viva Voce	0	0	0	0	20	20

SEMESTER - I

Course Code	Title of the Course	Instructional Hours/Week			Maximum Marks		
		L	T	P	CA	ESA	Total
BC 511	Advanced Techniques in Biochemistry	5	1	0	25	75	100
BC 512	Physiology	5	1	0	25	75	100
BC 513	Plant and Microbial Biochemistry	5	1	0	25	75	100
BC 514	Practical I - Biochemical and Microbial Techniques	0	0	10	25	75	100

Semester - I	Course Code: BC 511	Number of Hours/Week: 5

ADVANCED TECHNIQUES IN BIOCHEMISTRY

AIM: The purpose of this course is to familiarize students with operation of all biochemical equipment.

OBJECTIVE: The objectives of this course are to train students the principle and applications of basic laboratory equipment and to expose the students to various advanced laboratory techniques in areas of biochemistry.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Obtain knowledge about the principle, applications and basic operational procedures of essential laboratory equipment like bright field and fluorescence microscopy, centrifugation and electrophoresis
- Get an understanding of various chromatographic techniques and its application in the isolation of nucleic acids, proteins, sugars and other bio molecules
- Develop an understanding about the principle and application of immunological techniques
- Understand the different processes employed in tissue histopathologic analysis.
- Attain insights about how genetic material can be amplified by techniques like PCR and analysed to understand the source of biological samples.
- Gain confidence to handle advanced laboratory equipment like atomic force microscopy and advanced spectroscopy.

COURSE CONTENT

Module I: Microscopy

Basic principles, instrumentation and applications of microscopy. Bright field, Phase-contrast, Fluorescence and Confocal Microscopy, Electron Microscope – Scanning and Transmission Electron Microscopy, Atomic Force Microscopy. Histopathology – definition, fixation, decalcification, tissue processing, cutting, staining and analysis.

Module II: Electrophoresis, PCR and Blotting

Electrophoresis: Basic principles, instrumentation and applications of electrophoresis. Factors affecting electrophoresis. Electrophoretic techniques – Agarose gel, SDS-PAGE, Capillary, 2-D and Pulsed field.

PCR and Immunological techniques: DNA amplification by PCR - Conventional, Reverse-Transcriptase, Inverse, Quantitative Real-time, Nested and Multiplex PCR. Primer designing.

Blotting techniques and Immunohistochemistry: Principle, methodology and applications Western, Southern and Northern blotting and Immunohistochemistry.

Module III: Centrifugation & Flow Cytometry

Basic principles, centrifugation units, types of centrifugations and its applications: Differential Centrifugation, Density Gradient Centrifugation and Ultracentrifugation.

Flow cytometry - fluidics, optics and electronics, data analysis and applications.

Module IV: Chromatography

Basic principles, Instrumentation, working and applications of partition chromatography (Paper), adsorption chromatography (TLC, HPTLC, different types of columns), affinity chromatography, ion exchange chromatography, gel filtration chromatography, gas-liquid chromatography (GLC), high pressure liquid chromatography (HPLC).

Module V: Spectroscopy

Principle of spectroscopy, Concept of absorptions, transmission, scattering, phosphorescence, fluorescence, luminescence, diffraction spectra. Principle, instrumentation, working and application of UV, Visible and IR spectroscopy, spectrofluorimetry, flame photometry, atomic absorption spectrometry, luminometry.

NMR and mass spectrometry: Principle, instrumentation, working and application of Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR), Mass spectrometry - GC-MS, HPLC-MS and LC-MS/MS, Matrix-assisted laser desorption/ionization, Time- of Flight Mass spectroscopy (MALDI-TOF MS), X-ray crystallography.

References

1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology. 2010.
2. Prakash Singh Bisen and Anjana Sharma. Introduction to Instrumentation in Life Sciences. 2012.
3. Rhodes G. Crystallography Made Crystal Clear. 2000.
4. U Satyanarayana, Biochemistry, Books and Allied (p) Limited, 2014
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6. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
7. Bancroft, J.D. and Stevens, A.: theory and practice of histological techniques ed.3, Churchill livingstone inc. 1990. Edinburgh. London, Melbourne and New York.

On-line Sources

1. https://microbenotes.com/centrifugation-principle-types-and-applications/

2. https://chem.libretexts.org/Courses/Northeastern_University/10%3A_Spectroscopic_Methods/10.1%3A_Overview_of_Spectroscopy
3. https://books.google.co.in/books?id=BOlzy9W6l6oC&printsec=frontcover&dq=chromatography&hl=en&sa=X&ved=2ahUKEwjE9vzG6J7rAhUCfH0KHXyrDNAQ6AEwAHoECAQQAg#v=onepage&q=chromatography&f=false

FIRST SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTION

BC 511: ADVANCED TECHNIQUES IN BIOCHEMISTRY

Time: 3 hours **Max. Marks: 75**

Part I

Answer **any ten** of the following. **Each** question carries **3** marks

1. How to prepare a stacking gel?
2. How to use 2-D gel electrophoresis for protein identification.
3. Discuss the methodology of IR spectroscopy.
4. How to perform Density-Gradient centrifugation.
5. Write short note on adsorption chromatography.
6. Discuss the principle and applications of flame photometry.
7. Explain the importance of immunohistochemistry in cancer diagnosis.
8. Give note on the principle and applications of HPTLC.
9. Discuss the principle and diagnostic importance of MALDI-TOF.
10. Distinguish between RPM and RCF.
11. Compare and contrast Southern and Northern blotting techniques.
12. What does a luminometer do?

(10 X 3 = 30 Marks)

Part II

Answer **any five** of the following. **Each** question carries **5** marks

13. Discuss the methodology of Quantitative Real-time PCR
14. Give the principle and instrumentation of phase-contrast microscopy.
15. Describe the methodology and applications of Western Blotting technique.
16. Explain the steps involved in the histopathological analysis of a tissue.
17. Discuss the principle and applications of X-ray crystallography.
18. Compare and contrast Agarose gel electrophoresis with SDS-PAGE.
19. Explain the technique of ultra-centrifugation.
20. Give an account on molecular sieve chromatography.

(5 X 5 = 25 Marks)

Part III

Answer **any two** of the following. **Each** question carries **10** marks

21. Describe the principle, methodology and applications of flow cytometry.

22. Give an account on Nuclear Magnetic Resonance (NMR) spectroscopy.

23. Explain the principle, instrumentation and applications of HPLC.

(2 X 10 = 20 Marks)

Semester - I	Course Code: BC 512	Number of Hours/Week: 5

PHYSIOLOGY

AIM: To study the basic anatomy and physiological aspects of organ systems.

OBJECTIVE: To study how foods are digested and absorbed, to help in study physiological and biochemical functions of circulatory, respiratory, renal, muscular, and nervous system of the body.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Understand the digestion and absorption of macro and micro nutrients of food.
- Memorize blood components and how gaseous exchange occur in lungs, respiratory adaptation and the role of hemoglobin.
- Critically analyze and discuss the structure, muscle proteins and molecular events of muscle contraction.
- Comprehend how neuron and synapse transmit nerve impulses and path to brain.
- Appreciate the role of kidney in urine formation and detoxification mechanism occurring in the liver.

COURSE CONTENT

Module I: Digestion, Absorption and Excretion

Digestive secretions - composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids.

Excretory system - structure of nephron. Formation of urine - glomerular filtration, tubular reabsorption of glucose, water and electrolytes, tubular secretion, regulation of water and mineral balance.

Module II: Blood and Circulation

Composition and functions of blood and plasma. Blood groups. Blood coagulation - mechanism, fibrinolysis, anticoagulants. Hemoglobin - structure, abnormal types, anemia. Structure of heart, cardiac cycle, heart sounds, E.C.G (elementary knowledge) vasomotor circulation, coronary circulation, blood pressure, spleen, lymph, normal composition and function of lymph - role of different lymph cells.

Module III: Respiration

Structure of lungs, mechanism and regulation of respiration. Transport of blood gases - O_2 and CO_2. Organization of respiratory system, respiratory membrane, pulmonary ventilation, pulmonary volumes and capacities, alveolar ventilation, surfactants, exchange of gases, transport

of gases, regulation of respiration, hypoxia, cyanosis, hypercapnia, dyspnea, apnea, periodic breathing, artificial respiration.

Module IV: Muscle and Eye

Muscle tissue – voluntary, involuntary and cardiac, Ultra structure-overview, muscle proteins-Myosin and Actin, Tropomyosin, Troponin, Mechanism of muscle contraction –electrical, chemical and mechanical path, Power stroke in contraction, Regulation of Muscle contraction - Ca^{2+}, Ca^{2+} - Na^{+} exchanger, Ca2+ ATPase, Relaxation, Role of NO in muscle relaxation, sources of energy for muscular work.

Eye - Structure and functions of rods and cones, photochemistry of vision, role of vitamin A, light activation of rhodopsin, biochemical reactions (cycle), origin of nerve impulse in vision, Cone vision- cones, mechanism of color vision, light and dark adaptation.

Module V: Nervous System

Nerve and synapse - structures, resting membrane potential, action potential, Transmission of nerve impulses, Molecular mechanisms in synaptic transmission, Acetylcholine as synaptic transmission, other neurotransmitters, Neuron-neuron interaction, Synthesis, storage and release of neurotransmitters, synaptic vesicle proteins, Inhibition of acetylcholine esterase and acetyl choline receptor, Intermediary metabolism in brain, Neuropeptides.

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1. Review of Medical Physiology by William. F. Ganong. McGraw-Hill Medical; 22 edition (2005)
2. Human physiology by C.C. Chatterjee. 11th edition (1985)
3. Rodwell, Victor W., David Allen Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil. Harpers illustrated biochemistry. McGraw-Hill Medical Publishing Division, 2015.
4. Devlin, Thomas M. Textbook of biochemistry: with clinical correlations. John Wiley & Sons, 2011.
5. Hall, John E. Guyton and Hall textbook of medical physiology. Elsevier Health Sciences, 2010.
6. White, A., P. Handler, and E. L. Smith. Principles of Biochemistry. New York, McGraw-Hill 1117 (1954).
7. Sherwood, Lauralee. Human physiology: from cells to systems. Cengage learning, 2015.
8. Essentials of Medical Physiology K. Sembulingam & Prema Sembulingam
9. Biochemistry – U. Satyanarayana, U. Chakrapani, third edition, ISBN 81-87134-80-1

On-line Sources

1. https://fokt.pw/textbookofbiochemistry.pdf

FIRST SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTION

BC 512: PHYSIOLOGY

Time: 3 hours **Max. Marks: 75**

Part I

Answer **any ten** of the following. **Each** question carries **3** marks

1. Does bile salt aid in lipid digestion? Justify your answer
2. Role of NO in muscular contraction.
3. What are neuropeptides?
4. Distinguish between light and dark adaptation of eye
5. Write short note on erythropoiesis.
6. Discuss chloride shift.
7. Draw oxygen dissociation curve and comment on Bohr effect.
8. Give note on muscle proteins.
9. What is glomerular filtration?
10. Distinguish between resting membrane potential and action potential.
11. Proteolytic enzymes in the digestive process.
12. Sources of energy for muscle work.

(10 X 3 = 30 Marks)

Part II

Answer **any five** of the following. **Each** question carries **5** marks

13. Discuss rhodopsin cycle.
14. Draw the structure of nephron and explain the physiology of urine formation.
15. Write shortly on renal regulation of water.
16. Describe a normal ECG curve.
17. Describe the composition and role of lymph in human body.
18. Discuss in detail about the mechanism of muscle contraction
19. Explain the process of nerve impulse transmission.

20. Enumerate the different phases of cardiac cycle. Explain the various events occurring during the different phases of cardiac cycle.

(5 X 5 = 25 Marks)

Part III

Answer **any two** of the following. **Each** question carries **10** marks

21. Explain in detail about the digestion and absorption of lipids
22. Write in detail the gas exchange and gas transport in human physiology
23. Discuss the chemistry, synthesis, storage, release, mechanism of action and inactivation of acetylcholine

(2 X 10 = 20 Marks)

Semester - I	Course Code: BC 513	Number of Hours/Week: 5

PLANT AND MICROBIAL BIOCHEMISTRY

AIM: This course aims to give a thorough knowledge on the plant secondary metabolites, basic biochemical processes and the disease resisting mechanisms in plants. It also aims to impart in depth knowledge of the different types of microbes, nutrient cycles, microbial interactions and bacterial genetics.

OBJECTIVE: The purpose of this course is to give students a brief awareness on the biochemical mechanisms occurring in plants, important secondary metabolites, hormones and phenomena such as photomorphogenesis and senescence. In addition, to impart knowledge of the basic principles of microbiology, nutrient cycles and microbial interactions.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

- Discuss the importance and processes of photosynthesis, photorespiration and electron transport chain in plants.
- Explain the value of secondary metabolites produced in plants.
- Understand the mechanism of plant resistance.
- Discuss the role of plant hormones and how these regulate plant functions.
- Distinguish different groups of microbes, their nutritional requirement and genetic aspects.
- Apply the theoretical knowledge on various microbial techniques to practical purpose.
- Apply the knowledge in microbial nutrition for the culturing of microbes in laboratory.

COURSE CONTENT

Module I: Photosynthesis

Photosynthetic pigments, Structure & biosynthesis of chlorophyll (a and b). Photochemical reaction system, photosynthetic electron transport chain, Cyclic and non-cyclic photophosphorylation, Calvin cycle and its regulation, Hill's equation, Hatch- Slack pathway (C4 pathway), photorespiration, Crassulacean acid metabolism.

Module II: Plant Hormones, Phytochromes and Senescence

Structure and functions of plant hormones - auxins (indole acetic acid), gibberellins, cytokinins, ethylene, abscisic acid and florigen. Photochemical and hormonal control in plants.

Phytochromes - Structure, properties and mechanism of action of phytochromes. Calcium and calmodulin mediated Pfr responses.

Senescence – various levels of senescence, Mechanism of different biochemical changes during senescence.

Module III: Secondary metabolites

Introduction and classification of secondary metabolites. Phenols - Functions, Shikimate Arogenate Pathway, Phenyl Alanine/ Hydroxycinnamate pathway, Phenyl propanoids pathway, Hydroxy cinnamate conjugates, Hydroxycoumarins, hydroxy benzoates, Flavonoids, Lignins, Lignans, Neolignans, Tannins and Quinones. Isoprenoids - Nomenclature, Classification and Occurrence, General pathway for Terpenoid biosynthesis and functions. Alkaloids - Nicotine, Caffeine and Cocaine. Toxic secondary metabolites, secondary metabolites of medicinal importance.

Plant Resistance: Mechanism of plant resistance, phytoalexins, elicitors and pathogen related proteins

Module IV: Introduction to Microbiology

A brief introduction to major groups of microorganisms - Bacteria, Viruses, Fungi, Mycoplasma, Protozoa and Algae (classification not expected). Bacteria- Ultra structure of bacteria, chemical composition of bacterial cell wall. Staining techniques- simple, differential and special staining techniques. Microbial growth- Definition, Growth curve, Physical conditions required for growth, nutritional types of bacteria, bacteriological media and its types. Sterilization and disinfection.

Module V: Nutrient Cycles, Microbial interactions and Bacterial Genetics

Nutrient cycles: Carbon, Sulphur, phosphorus and nitrogen cycles. Nitrogen fixation: Symbiotic and non-symbiotic nitrogen fixation, Nitrogenase complex, NIF genes and NOD genes.

Microbial interactions: Mutualism, co-operation, commensalism, predation, amensalism and competition.

Bacterial genetics: Para sexual process in bacteria and its significance: Transformation, transfection, transduction and conjugation.

References

1. Dey, Prakash M., and Jeffrey B. Harborne, eds. Plant biochemistry. Academic Press, 1997.
2. Bonner, James, and Joseph E. Varner, eds. Plant biochemistry. Elsevier, 2012.
3. Salisbury, Frank B., and Cleon W. Ross. "Plant physiology. 4th." Edn. Belmont, CA. Wadsworth (1992).
4. Lea, Peter J., and Richard C. Leegood. Plant biochemistry and molecular biology. John Wiley & Sons, 1993.
5. Heldt, Hans-Walter, and Fiona Heldt. "Plant biochemistry and molecular biology." Oxford University Press, (1997).

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2. https://books.google.co.in/books?id=radCAAAAQBAJ&printsec=frontcover&dq=plant+diseases&hl=en&sa=X&ved=2ahUKEwicobz-4p7rAhXIcn0KHY6PC8cQ6AEwAXoECAUQAg#v=onepage&q=plant%20diseases&f=false
3. https://books.google.co.in/books?id=AVTtCAAAQBAJ&printsec=frontcover&dq=plant+hormones&hl=en&sa=X&ved=2ahUKEwivvqKs457rAhUbb30KHQ4aBREQ6AEwAnoECAQQAg#v=onepage&q=plant%20hormones&f=false

FIRST SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTION

BC 513: PLANT AND MICROBIAL BIOCHEMISTRY

Time: 3 hours **Max. Marks: 75**

Part I

Answer **any ten** of the following. **Each** question carries **3** marks

1. Give note on photosynthetic pigments
2. What do you know about CAM?
3. Differentiate between cyclic and noncyclic photophosphorylation
4. Give the structure and functions of auxin
5. What are the functions of gibberellins?
6. Comment on alkaloids
7. Discuss the secondary metabolites of medicinal importance
8. Write short note on phytoalexins
9. Why agar is used as solidifying agent in culture media?
10. Distinguish between sterilization and disinfection
11. Discuss mutualism and commensalism with suitable examples
12. Draw phosphorous cycle and explain its importance

(10 X 3 = 30 Marks)

Part II

Answer **any five** of the following. **Each** question carries **5** marks

13. Write short note on C4 pathway
14. Give an account of senescence
15. Explain the general pathway for terpenoid biosynthesis
16. Discuss the nutritional types of bacteria
17. Give note on growth curve
18. How will you differentiate bacteria by gram staining?
19. Briefly explain symbiotic nitrogen fixation

20. Write note on transduction

(5 X 5 = 25 Marks)

Part III

Answer **any two** of the following. **Each** question carries **10** marks

21. Explain Calvin cycle and its regulation
22. Describe the structure, properties and mechanism of action of phytochromes
23. With the help of a neat diagram explain the ultrastructure of bacteria

(2 X 10 = 20 Marks)

Semester - I	Course Code: BC 514	Number of Hours/Week: 10

PRACTICAL I: BIOCHEMICAL AND MICROBIAL TECHNIQUES

Aim: To give hands on training in basic instruments used for routine biochemical experiments and to impart basic practical skills of microbiology.

Objective: This lab helps students to familiarize the basic techniques and instrumentation for various biochemical analysis and to provide hands own training in basic techniques of microbiology and microbial biochemistry.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

- Separate molecules using chromatographic and electrophoretic techniques
- Conduct sterilization techniques and prepare microbial culture media
- Differentiate bacteria using different staining techniques
- Isolate pure culture and identify the organism using biochemical techniques
- Determine the quality of milk and water

COURSE CONTENT

I. Biochemical Techniques:

a) Dialysis - Separation of macromolecules from small molecules, Concentration of protein solution.

b) Paper chromatography - Separation of sugars by ascending or descending chromatography, Separation of amino acids by paper chromatography.

c) Thin layer chromatography - Separation of sugars on thin layer of silica gel, Separation of lipids on silica gel.

d) Electrophoresis - Separation of proteins by Polyacrylamide Gel Electrophoresis.

II. Microbial Techniques

a) Sterilization techniques – Physical and chemical agents of sterilization.

b) Preparation of media – liquid and solid media (Plate, Slant and Tube preparation).

c) Staining techniques- simple, differential and special staining.

d) Motility test - Hanging drop method.

e) Pure culture techniques - streak plate, pour plate and spread plate

f) Biochemical tests for identification -IMViC reactions, Catalase, Oxidase, Urease, Carbohydrate fermentation.

g) Detection of enzyme activity - Amylase, Caseinase, Phosphatase.

h) Test for the quality of milk, Water analysis by MPN method

Practical Examination Scheme

Biochemical & Microbial Techniques

Duration: 6 hrs **Maximum: 75 Marks**

I. Biochemical Techniques: 30 marks

Thin layer/Paper chromatography/PAGE:

i. Procedure - 5 marks
ii. Instrument Setting - 5 marks
iii. Chromatogram development/ running the gel- 5 marks
iv. Final result- 15 marks

II. Microbial Techniques: 35 marks

a) Staining techniques- 20 marks:
   i. Procedure- 5 marks
   ii. Preparation of smear and staining-5 marks
   iii. Final result- 10 marks
b) Biochemical tests- IMViC reactions, Catalase, oxidase, urease, carbohydrate fermentation/Detection of enzyme activity- Amylase/ Caseinase- 15 marks
   i. Procedure 5 marks
   ii. Steps- 5 marks
   iii. Observation- 5 marks.

III. Spot test/ practical based short answer type questions (10 numbers) - 10 marks (Answer in a word or sentence)

SEMESTER - II

Course Code	Title of the Course	Instructional Hours/Week			Maximum Marks		
		L	T	P	CA	ESA	Total
BC 521	Enzymes	4	1	0	25	75	100
BC 522	Metabolism	4	1	0	25	75	100
BC 523	Clinical Biochemistry	3	1	0	25	75	100
BC 524	Cell Biology and Genetics	4	1	0	25	75	100
BC 525	Practical II: Enzymology and Clinical Biochemistry	0	0	10	25	75	100

Semester - II	Course Code: BC 521	Number of Hours/Week: 4

ENZYMES

AIM: The course aims to provide an advanced understanding of the core principles and applications of enzymes.

OBJECTIVE: This course enables students to acquire specialized knowledge and understanding of the selected aspects of enzymes related to classification, purification, kinetics, mechanism, regulation and applications which are essential for laboratory work and research project.

COURSEOUTCOME

After the completion of this course, the student will be able to:

- Describe nomenclature and classification of enzymes and coenzymes.
- Predict possible catalytic mechanism of a given reaction type.
- Apply knowledge on enzyme kinetics for laboratory and research purpose.
- Predict the type of enzyme inhibition from kinetic data.
- Apply the knowledge on isolation and purification of enzymes for practical purpose
- Describe the major applications of enzymes in industry and medicine.

COURSE CONTENT

Module I: Introduction to enzymes and coenzymes

General introduction, Nomenclature and classification of enzymes (Class and subclass with one example). Energy of activation and its significance. Enzyme specificity, measurement and expression of enzyme activity - Definition of Unit, international unit (IU), katal. Coenzymes-classification - vitamin and nonvitamin coenzymes. Structure and coenzyme function of CoA, TPP, PLP, NAD/NADP, FAD, FMN, Biotin, folic acid, Vitamin B12 coenzymes.

Module II: Mechanism of enzyme action

Active site - determination of active site amino acids - chemical probe, affinity label, and site-directed mutagenesis, Investigation of 3-D structure of active site. Mechanism of enzyme action - general acid-base catalysis, covalent catalysis, proximity and orientation effects, role of metal ion in enzyme catalysis, mechanism of serine proteases - chymotrypsin, lysozyme, and ribonuclease.

Module III: Enzyme kinetics

Order of reaction, progress curve for enzyme catalyzed reactions. Study of the factors affecting the velocity of enzyme catalyzed reaction - enzyme concentration, temperature, pH, inhibitors and activators (explanation with graphical representation), Michaelis-Menten equation; Km and Vmax values and their significance, Lineweaver-Burk plot and its physiological significance, Eadie-

Hofstee plot. Bi-substrate reactions, mechanism of bi-substrate reactions-random, ordered and ping pong mechanisms.

Module IV: Enzyme inhibition and regulation

Enzyme inhibition – competitive, non-competitive, uncompetitive and mixed. Allosteric and feedback inhibition with examples, suicide inhibition. Dose-response curves of enzyme inhibition. Regulation of enzyme activity-covalently modified regulated enzymes, allosteric enzymes, MWC and KNF models Hill' equation coefficient, Feedback regulation. Multienzyme complex-Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthase complex. Isoenzymes-lactate dehydrogenase and creatine phosphokinase.

Module V: Enzyme Technology

Isolation and purification of enzymes and criteria of purity- specific activity. Industrial uses of enzymes-sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production. Immobilization of enzymes and their applications. Designer enzymes - Abzymes, Ribozymes. Serum enzymes in health and disease-diagnostic and therapeutic applications.

References

1. Dixon, M., and E. C. Webb. "Enzyme inhibition and activation." Enzymes 3 (1979): 126-136.
2. Palmer, T. Understanding Enzymes, 4th ed., Prentice Hall/Ellis Horwood, London (1995).
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4. Bugg, T. D. H. (2012) Introduction to Enzyme and Coenzyme Chemistry, Third Edition, John Wiley & Sons Ltd, Chichester, UK.
5. Donald Voet and Judith Voet, Fundamentals of Biochemistry, 4nd edition; 2006
6. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology. John Wiley & Sons, 2012.

SECOND SEMESTER M.SC. BIOCHEMISTRY EXAMINATION

MODEL QUESTIONS

BC 521: ENZYMES

Time:3hrs. **Max marks:75**

PART-1

Answer any 10 of the following. Each question carries 3 marks.

1. Mention the classification of coenzymes
2. Derive Michaelis-Menten equation
3. Make a note on designer enzymes
4. Make a brief note on coenzyme functions of biotin
5. What is Km? How it is determined
6. What is suicide inhibition? Illustrate with examples
7. With the help of Lineweaver -Burk plot explain what happens to Km and Vmax during competitive inhibition.
8. Explain the mechanism of action of ribonuclease
9. Give the structure of any three coenzymes.
10. Write briefly on acid -base catalysis.
11. Give the features of active site.
12. Explain allosteric inhibition.

(3 X 10=30 marks)

PART-II

Answer any 5 of the following. Each question carries 5 marks.

13. Explain general features of enzymes
14. Explain acid -base catalysis and covalent catalysis
15. Derive Lineweaver- Burk equation and explain its applications
16. Explain bi substrate reactions with suitable examples
17. Explain isoenzymes of lactate dehydrogenase and creative phosphokinase
18. Write the structures and functions of CoA, TPP, PLP, NAD and FAD

19. Explain the methods of enzyme immobilization and write its applications

20. Discuss on isolation and purification of enzymes

(5 X 5=25 marks)

PART-III

Answer any two of the following. Each question carries 10 marks

21. Discuss the classification and nomenclature of enzymes with suitable examples

22. Explain different types of enzyme inhibition

23. Describe diagnostic and therapeutic applications of enzymes

(2 X 10=20 marks)

Semester - II	Course Code: BC 522	Number of Hours/Week: 4

METABOLISM

AIM: This course is aimed at providing an insight into various metabolic pathways operating in living cells with special stress on carbohydrate, lipids, amino acids and nucleic acid metabolism and the biochemical processes involved in bioenergetics.

OBJECTIVE: The main objective is to make students familiar with metabolism of carbohydrates, lipids, amino acids and nucleic acids and the biochemical processes involved in bioenergetics.

COURSEOUTCOME

After completion of the course, students shall be capable of**:**

- Explain the metabolism of carbohydrates
- Compare and contrast aspects of lipid metabolism
- Discuss the important biochemical steps in the metabolism of amino acids
- Discuss the important biochemical steps in the metabolism of nucleic acids
- Illustrate the structure of mitochondria and how energy production occur in the organelle
- Comprehend the role of oxidative phosphorylation in bioenergetics and ATP generation.

COURSE CONTENT

Module I: Metabolism of Carbohydrates

Overview of glycolysis, gluconeogenesis, citric acid cycle, galactose and fructose metabolism. Detailed study of regulatory mechanism and energetics. Importance of pyruvate dehydrogenase. Cori and glyoxylate cycle. HMP shunt. Biosynthesis and degradation of Glycogen starch and sucrose. Role of UDP sugars in carbohydrate metabolism. Metabolism of mucopolysaccharides, Hyaluronic acid, chondroitin sulfate, dermatan sulfate, heparin and keratin.

Module II: Metabolism of lipids

Biological regulation and significance of fatty acid metabolism. Metabolism of ketone bodies - Formation, utilization, excretion and clinical significance. Metabolism of triglycerides, phospholipids and sphingolipids. Fatty acid derivatives: eicosanoids, their function and metabolism. Lipoprotein metabolism and its regulation. Lipid peroxidation. Cholesterol - Biosynthesis, regulation, transport and excretion. HMG CoA reductase regulation. Biosynthesis of cholesterol derivatives; overview- bile acids, vitamin D and steroid hormones.

Module III: Metabolism of Amino acids

Amino Acid Metabolism: Overview of biosynthesis of nonessential amino acids. Metabolic fate of amino groups- transamination, decarboxylation and deamination. Nitrogen excretion- ammonia formation and the urea cycle. Catabolism of amino acid carbon skeleton- glucogenic and ketogenic

amino acids. Amino Acid Derivatives: Conversion of amino acids to specialized products (bioactive amines): Histamine, Serotonin, epinephrine and nor-epinephrine. Nitric oxide synthesis and function.

Module IV: Metabolism of Nucleic acids

Nucleotide biosynthesis - de novo and salvage pathways for biosynthesis of purine and pyrimidine. Mechanism of feedback regulation. Biosynthesis of dNTPs. Mechanism of purine and pyrimidine catabolism, uric acid, xanthine oxidase inhibitors.

Module V: Bioenergetics

Laws of thermodynamics-Role of high energy phosphates in energy transfer, concept of free energy. Biological oxidation, redox potential, coupled reactions. Enzymes involved in oxidation and reduction-oxidases, dehydrogenases, hydroperoxides, oxygenases. Electron Transport Chain: Structure of Mitochondria, Components and different complexes in detail. Inhibitors of electron transport chain. Microsomal ETC. Oxidative phosphorylation: Sites of ATP production, Hypothesis of mitochondrial oxidative Phosphorylation-Chemiosmotic theory, P/O ratio, Inhibitors and Uncouplers, Transport of reducing potentials into mitochondria-Malate aspartate and Glycerol-3-phosphate shuttle. Brief description of ETRC in microorganism.

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1. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry: a short course. Macmillan, 2011.
2. Cox, Michael M. Lehninger, Principles of Biochemistry. Freeman, 2013.
3. Garrett, Reginald, and Charles Grisham. Biochemistry. Nelson Education, 2012.
4. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of biochemistry." New York: John Wiley & Sons 2008.
5. Zubay, Geoffrey L., William W. Parson, and Dennis E. Vance. Principles of biochemistry: student study art notebook. Wm. C. Brown, 1995

SECOND SEMESTER MSC BIOCHEMISTRY EXAMINATION

MODEL QUESTIONS

BC 522: METABOLISM

Time: 3hrs. **Max marks:75**

PART - 1

Write notes on any 10 of the following. Each question carries 3 marks.

1. How is glucose converted to ethyl alcohol in alcoholic fermentation?
2. Describe the TCA cycle. What are the regulatory sites of this pathway?
3. Discuss on the role of epinephrine in glycogenolysis.
4. Explain in detail the role of UDP sugars in carbohydrate metabolism.
5. Explain lipoprotein metabolism.
6. Explain glycolysis.
7. What is P:O ratio?
8. Trace the pathway leading to sphingomyelin biosynthesis.
9. How pyrimidines are catabolized?
10. Discuss degradation of amino acids.
11. What is the mechanism of coupling in oxidative phosphorylation?
12. What is the ATP yield from complete oxidation of glucose? Explain.

(10x3=30 Marks)

PART - II

Answer any 5 of the following. Each question carries 5 marks.

13. What are the reactions of glyoxylate cycle? Write its significance.
14. Write the reactions of HMP pathway? Write its significance?
15. Write briefly on gluconeogenesis from amino acids.
16. Write a short note on formation of polyenoic acids.
17. Write briefly on oxidation of unsaturated fatty acids.
18. What are essential amino acids? Mention it's significance.
19. How are Purines catabolized?

20. Describe about bifunctional role of F1F0 ATP synthase.

(5x5=25 Marks)

PART - III

Answer any two of the following. Each question carries 10 marks

21. Write an essay on ETC and oxidative Phosphorylation?

22. Describe Glycogen metabolism and its regulation

23. Explain Urea Cycle and its regulation

(2x10=20 Marks)

Semester - II	Course Code: BC 523	Number of Hours/Week: 3

CLINICAL BIOCHEMISTRY

AIM: To familiarize the biochemical tests important in clinical investigations, and to introduce the various methods of specimen collections and the automation in the clinical laboratory.

OBJECTIVE: Discuss the biological sample collection and its processing, diagnostic and prognostic importance of various biochemical parameters and impart knowledge in clinical laboratory automation.

COURSE OUTCOME

After the completion of this course, the student will be able to:

- Gain detailed knowledge on the biological sample collection and its interpretation.
- Explain the automation in the clinical laboratory.
- Understand the importance of enzymes in diagnosis of diseases.
- Understand the etiology of diseases that occur due to improper digestion and absorption of foods.
- Acquire clinical knowledge on physiological organs and its related disorders.
- Obtain in depth idea on oncologic aspects and anti-oxidants.

COURSE CONTENT

Module I: Specimen collection and automation

Specimen collection and processing: Blood collection methods, anticoagulants. Cerebrospinal fluid (CSF): Composition and collection, gross examination, cell counts, chemical examination and bacteriologic examination. Amniotic fluid: Origin, collection, composition and routine analysis of amniotic fluid. Collection and examination of Synovial fluid, Pleural fluid, Pericardial fluid and Peritoneal fluid. Collection of urine: Timed urine specimens, urine preservatives.

Basic concepts and definitions of automation in the clinical laboratory. Multifunction Workstations (Automated Specimen Processing), Total Laboratory Automation Systems. Post assay processing, Signal processing, Data handling and Process control, Instrument clusters, Microtiter plate systems, Automated pipetting stations.

Module II: Clinical enzymology

Principles of diagnostic enzymology, Factors affecting enzyme levels in blood. Principle, assay, and clinical significance of transaminases, creatine kinase, lactate, Dehydrogenase, phosphatases, 5'nucleotidase, gamma –glutamyl transferase, amylase, lipase, trypsin, chymotrypsin, choline

esterase, glutamate dehydrogenase and glucose -6-phosphate dehydrogenase. Enzyme pattern in diseases: Myocardial infarction, hepatobiliary diseases.

Module III: Diseases related to digestion and absorption of foods

Gastritis and gastric atrophy (hyperacidity), Achlorhydria (hypochlorhydria), Ulcers - Peptic ulcer, Zollinger –Ellison syndrome, Meckel's diverticulum. Pancreatitis, Lactose intolerance, Monosaccharide malabsorption, Disaccharidase deficiency, Steatorrhea, Chyluria, Cholelithiasis, Sprue, Porphyrias.

Module IV: Organ function tests and related disorders

Liver function test and related disorders: Jaundice, cirrhosis, hepatitis, fatty liver and gall stones. Renal function test and related disorder: Acute renal failure. glomerular disease, tubular diseases, analysis of urinary calculi. Gastric and pancreatic function test. Hyper and hypo lipoproteinemias and diagnostic test for lipoprotein disorders. Atherosclerosis, Diabetes, Cancer, Inflammatory arthritis, Obesity – Risk factors, Molecular pathogenesis, Biochemical and clinical features, diagnosis, treatment.

Module V: Free radicals in diseases and diagnosis of cancer

Free radicals in diseases: Introduction, Types of free radicals. Free radical induced lipid peroxidation and antioxidants (Enzymic – SOD, Glutathione peroxidase, Glutathione reductase; Non Enzymic-Ascorbic acid, Tocopherol, Reduced Glutathione).

Molecular diagnosis of Cancer: PCR and RFLP based methods. Tumor Markers such as CA125, CEA, AFP, HCG, Triple (ER/PR/HER2) negative breast cancer markers, BRAC genes.

References

1. Praful B. Godkar, Darshan P. Godkar. Textbook of Medical Laboratory Technology (2nd Edition) Bhalani Publishing House, 2003.
2. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.
3. Chatterjea MN, Shinde Rana. Textbook of Medical Biochemistry. Jaypee Brothers Medical Publishers, 2012.
4. Devlin, Thomas M. Textbook of Biochemistry: With Clinical Correlations. Hoboken, NJ: John Wiley & Sons, 2011.
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7. Zubay, Geoffrey L., William W. Parson, and Dennis E. Vance. Principles of biochemistry: student study art notebook. Wm. C. Brown, 1995

On-line Sources

1. https://www.researchgate.net/publication/314089643_Automation_in_the_Clinical_Laboratory

SECOND SEMESTER M.SC. BIOCHEMISTRY EXAMINATION

MODEL QUESTIONS

BC 523: CLINICAL BIOCHEMISTRY

Time:3hrs. **Max marks:75**

PART- I

Write notes on any 10 of the following. Each question carries 3 marks.

1. What are reactive oxygen species and name any two diseases associated with ROS.
2. Write short note on Van den Bergh test.
3. Discuss on the role of anticoagulants in blood sample collection.
4. Write briefly on collection and examination of synovial fluid.
5. What is the significance of amniocentesis?
6. Write short note on preservatives of urine sample.
7. What are non-enzymic antioxidants? Give examples?
8. Explain the principle of diagnostic enzymology.
9. Write short note on obesity.
10. Discuss on analysis of urinary calculi
11. What is hyper lipoproteinemia?
12. Comment on tumour markers.

(10x3=30 Marks)

PART-II

Answer any 5 of the following. Each question carries 5 marks.

13. Classify jaundice. How do you investigate a case of jaundice?
14. How creatinine clearance test is done? What is its diagnostic significance?
15. Write briefly on automation
16. Write a short note on free radical scavenger mechanism.
17. Discuss the free radical induced lipid peroxidation.
18. What are tumor markers? Describe with examples.

19. Explain atherosclerosis.

20. Explain pancreatic function test.

(5x5=25 Marks)

PART-III

Answer any two of the following. Each question carries 10 marks

21. Write an essay on Gastric Function Tests.

22. Describe the composition, collection and examination of Cerebrospinal fluid (CSF).

23. Explain automated specimen processing in clinical laboratory.

(2x10=20 Marks)

Semester - II	Course Code: BC 524	Number of Hours/Week: 4

CELL BIOLOGY AND GENETICS

AIM: To impart knowledge on molecular mechanisms which are the foundations of biological processes in cells and organisms, with an emphasis on eukaryotic cells. The aim of the Genetics is to harness advances in genetics, genome biology and genome technologies to improve the understanding and management of genetic disorders.

OBJECTIVE: The major objective is to make students aware of the fundamental features of prokaryotic and eukaryotic cells, the structure, composition and role of eukaryotic cell membranes, components of the extracellular matrix, different types of cell-cell junctions, specific processes and proteins involved in membrane transport, the major stages of the cell cycle and apoptosis and its regulation, protein sorting, intercellular chemical messengers, receptor subclasses and their possible uses in cell signaling. It also deals with human genetics, chromosome banding and karyotyping.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Characterize structure, function and models of plasma membrane.
- Define processes occurring in cells like membrane transport and the mechanisms involved
- Describe major stages of important cellular processes like cell cycle and apoptosis
- Illustrate cell-cell interactions and molecular players involved.
- Discuss receptor mechanisms and role played by receptors.
- Elucidate protein sorting and roles played by vesicles, lysosomes, Golgi apparatus and endoplasmic reticulum
- Explain the nature of inheritance and how it results in phenotype
- Understand genetic testing and genetic counseling, linkage and genetic mapping, population genetics.

COURSE CONTENT

Module1: Plasma membrane and Transport

Structure and function of plasma membrane, different models, membrane proteins, membrane lipids and membrane fluidity. Transport across cell membrane, passive transport, active transport - primary (P-type, F-type, V-type ATPases, ABC transporters) and secondary, co-transport-symport and antiport. Ion channels, Aquaporins, Regulation of cell volume, Internalization of macromolecules - Endocytosis, pinocytosis, phagocytosis and exocytosis. Receptor mediated endocytosis, coated pits, clathrins.

Module II: Cell Cycle and Cancer

Cell division- Phases of eukaryotic cell cycle, check points —cyclins, maturation promoting factor (MPF), Cyclin dependent kinases, growth factors, inhibition of cell cycle progression.

Programmed cell death, Caspases. Intrinsic and Extrinsic pathways. Pro and anti-apoptotic pathways and cell survival, necrosis, autophagy. Cancer – Development and causes of cancer, metastasis, tumour viruses, oncogenes, tumour suppressor genes, Biomarkers – CEA, PSA, p53, Ras, c-myc

Module III: Protein Sorting and Targeting

Overall pathway of synthesis of nuclear coded, secretory, lysosomal and membrane proteins. Import across ER – Signal hypothesis, post translational modifications of secretory/membrane proteins in ER, sorting of lysosomal proteins, Mannose - 6 - Phosphate receptors, synthesis, trafficking and localization of mitochondrial proteins. Protein traffic into and out of nucleus. Exosomes.

Module IV: Extracellular matrix & Cell signaling

Extracellular matrix & Cell signaling - Overview of extracellular matrix components – Glycoproteins, proteoglycans, fibronectin, laminin. Cell matrix interaction, integrin, Cell interaction, cadherin, selectins, IgSF, cadherin, adherence junctions, desmosomes and Cytoskeleton- Components. Signaling molecules, receptors and their functions- G-protein coupled receptors, Cyclin AMP, Cyclic GMP, IP3, Calcium. Receptor protein tyrosine kinases- Ras & Raf, MAP kinase pathway, JAK/STAT pathway, non-receptor protein tyrosine kinase, Growth factors, NFkB, wnt signaling, Notch pathway, Toll Like receptor. Intracellular receptors (Nitric oxide and nuclear receptor).

Module V: Genetics

Multiple alleles, linkage, chromosome mapping, crossing over, three-point cross, pleiotropism, tetrad and pedigree analysis. Human disorders follow Mendelian patterns of inheritance, Genetics counselling, Genome imprinting, VNTRs, Paternity test. Population genetics - gene pool, gene frequency, Hardy-Weinberg law, non-random mating, factors influencing, heritability, polymorphism. Chromosome banding and karyotyping.

References

1. Lodish, Harvey. Molecular cell biology.Macmillan, 2008.
2. Berk, Arnold, and S. Lawrence Zipursky. Molecular cell biology. Vol. 4. New York: WH Freeman, 2000.
3. Karp, Gerald, and Nancy L. Pruitt. Cell and molecular biology: concepts and experiments. J. Wiley, 2002.
4. Cooper, G. M., and R. Hausman. "The Cell-A Molecular Approach, 2000."Sunderland (MA):

Sinauer Associates, Inc, 2000.

5. Pollard, Thomas D., William C. Earnshaw, and Jennifer Lippincott-Schwartz. Cell biology. Elsevier Health Sciences, 2007.
6. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Essential cell biology. Garland Science, 2013.
7. Lewin, Benjamin, Jocelyn E. Krebs, Elliott S. Goldstein, and Stephen T. Kilpatrick. Lewin's Genes XI.Jones& Bartlett Publishers, 2014.
8. Snustad, D. P., and M. J. Simmons. Principles of genetics.6th edition. John Wiley & Sons, Hoboken (2012).
9. Guttman, Burton. Genetics: The Code of Life. The Rosen Publishing Group, Molecular Genetics: Klug and Cummings (2011).

SECOND SEMESTER M.SC. BIOCHEMISTRY EXAMINATION

MODEL QUESTIONS

BC 524: CELL BIOLOGY AND GENETICS

Time: 3hrs. **Max marks: 75**

PART - I

Write notes on any 10 of the following. Each question carries 3 marks.

1. Describe three classes of membrane proteins
2. Discuss about passive transport
3. Illustrate cell cycle and its regulation
4. Write note on growth factors.
5. Explain NF-KB signaling pathway
6. Discuss any two G protein coupled receptors
7. Give an account of signal hypothesis
8. What is three-point cross.
9. Differentiate between linkage and crossing over
10. Name any two intracellular receptors.
11. Define Polymorphism. What are the factors influenced the population genetics?
12. What is the role of second messengers in cell signaling?

(10x3=30 marks)

PART - II

Answer any 5 of the following. Each question carries 5 marks.

13. What is the role of CDKs and cyclins in controlling cell cycle?
14. How does transport of macromolecules occur through the membrane?
15. Discuss about G protein coupled receptors.

16. Write a note on cyclic AMP and Cyclic GMP

17. Explain Hardy Weinberg law and Hardy Weinberg equilibrium.

18. What is the chemical nature of microfilaments? What are their functions?

19. Explain the process of endocytosis.

20. Discuss about tyrosine kinase

(5x5=25 marks)

PART-III

Answer any two of the following. Each question carries 10 marks

21. Describe fluid mosaic model of bio membranes?

22. Explain about Cell cycle checkpoints

23. Write in detail about protein targeting.

(2x10=20 marks)

Semester - II	Course Code: BC 525	Number of Hours/Week: 10

PRACTICAL II: ENZYMOLOGY AND CLINICAL BIOCHEMISTRY

AIM: To enable students to quantitate the biochemical parameters of organ function and to determine the activity of various enzymes and their kinetics.

OBJECTIVE: This lab course helps students to diagnose various derangements in metabolism/organ function. To practice the optimization of conditions for enzymes isolation, assay and its kinetics.

COURSE OUTCOME

After the completion of the course the student will be able to:

- Trained on handling and isolation of enzymes from biological sample.
- Assay enzymes and express the activity in different units.
- To determine the kinetic parameters of any enzyme.
- To determine the optimum pH, temperature, effect of activator/inhibitors on enzyme
- Activity.
- Perform liver function test.
- Estimate cardiac markers.
- Analyze biochemical markers of diabetes.

COURSE CONTENT

1. **Determination of enzymatic activity in biological tissues - Serum/plasma, liver and plant extracts (Any five)**
    - β - hexosaminidase
    - Amylase
    - Trypsin
    - Urease
2. **Enzyme Kinetics (amylase, trypsin, urease, yeast fructfuranosidase) - any one**
    - Progress curve of enzyme action

- Effect of substrate concentration on enzymatic activity
- Effect of pH on enzymatic activity
- Effect of enzyme concentration on enzymatic activity
- Effect of temperature on velocity of enzyme catalysed reaction
- Effect of activators/electrolytes on velocity of enzyme catalysed reaction

3. Preparation and purification of any of the following enzymes

- LDH from rabbit muscle
- Urease from red gram
- β - amylase from sweet potato

4. Blood analysis

A. Liver Function Tests

Acid and alkaline phosphatase, ALT, AST, Bilirubin, Protein, Albumin, A/G ratio

B. Kidney Function Tests

Urea, Uric acid, Creatinine

C. Cardiac Markers

Lipid profile (Cholesterol, Triglyceride, HDL-C, LDL-C), LDH, CRP, CPK

D. Biochemical markers of Diabetes Mellitus

Blood glucose (RBS, FBS, PPBS), Glycosylated Hb, Glucose Tolerance Test.

Practical Examination Scheme

Practical II – BC 525: Enzymology and Clinical Biochemistry

Duration: 6 hrs **Maximum: 75 Marks**

I. Enzymology: 35 Marks

Determination of enzyme activity/ Enzyme kinetics

- Principle and Procedure - 5 marks
- Isolation of enzymes - 10 marks
- Tabulation – 5 marks
- Graph – 5 marks
- Final Result – 10 marks

II. Blood Analysis: 30 marks (Blood/Liver/Kidney function tests)

- Principle and Procedure – 5 marks
- Tabulation – 5 marks
- Graph – 5 marks
- Calculation – 5 marks
- Final Result – 10 marks

III. Spot test/ practical based short answer type questions (Answer in a word or sentence) (10 numbers) **- 10**

SEMESTER - III

Course Code	Title of the Course	Instructional Hours/Week			Maximum Marks		
		L	T	P	CA	ESA	Total
BC 531	Molecular Biology	4	1	0	25	75	100
BC 532	Immunology	4	1	0	25	75	100
BC 533	Pharmacology and Toxicology	3	1	0	25	75	100
BC 534	Methods in Research	4	1	0	25	75	100
BC 535	Practical II: Immunotechniques and Phytochemical analysis	0	0	10	25	75	100

Semester - III	Course Code: BC 531	Number of Hours/Week: 4

MOLECULAR BIOLOGY

AIM: The aim of this course is to provide students with an advanced knowledge of molecular biology so as to appreciate and understand molecular mechanisms involved in storage, transmission and expression of genetic information

OBJECTIVES: This course is designed to engage the students in the finer details of molecular events in the nucleus associated with genetic information processing and their regulation.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Describe cellular processes like DNA synthesis, RNA synthesis and protein synthesis and how they relate to each other,
- Discuss the Central dogma of molecular biology and its importance,
- Define gene expression and how a stimulus can affect the expression of a gene.
- Describe different regulatory mechanisms of gene expression.
- Describe how RNA functions as genetic material in some organisms.
- Explain how misfolded proteins cause diseases in the body.
- Discuss the applications of molecular biology in the modern world like PCR, RNA interference, CRISPR-Cas9.

COURSE CONTENT

Module I: Overview of DNA

Introduction to genetic material - DNA/ RNA as genetic material in bacteria, bacteriophage, virus, viroids and prions; The structure and topology of DNA and RNA molecules; Central dogma of molecular biology; Genes – structure of genes, gene families, gene expression, gene promoters, introns, exons, pseudogenes, gene cluster; DNA supercoiling; Complexity of genome – DNA denaturation, microbial genomes, eukaryotic genome, higher order chromatin structure, animal chromosomes, organelle genomes.

Module II: DNA Replication

DNA replication hypothesis; Semi-conservative replication mechanism; Overview of three stages of replication; Replication patterns; Topoisomerases; Detailed mechanism of replication in- phage T4, bacteria, nucleus and mitochondria; Proof reading mechanism in DNA replication; Termination of circular and linear replications; Regulation of replication- cellular control-methylation licensing factor, DNA mutation, DNA damage, DNA repair, Role of telomerase in replication of chromosome termini.

Module III: Transcription

Transcription of the genetic code – Promoter structure, RNA polymerases- transcription factors, consensus sequences. Detailed overview of the different stages of initiation, elongation and termination in eukaryotes; Detailed mechanism of synthesis and processing of mRNA, rRNA and tRNA; RNA processing in eukaryotic cells; RNA Splicing- spliceosome machinery, Alternative splicing- trans splicing exon shuffling, RNA editing, role of ribozymes.

Module IV: Genetic code and Translation

Overview of genetic code- codon, anticodon interactions, Wobble rules; Translation machinery – ribosomes tRNA, amino acyl tRNA synthetase – classification, proofreading activity of amino acyl tRNA synthetase; Detailed mechanism of Eukaryotic translation – initiation, elongation and termination; mRNA surveillance, Post translational modifications.

Module V: Regulation of Transcription and translation

σ factor, RNA polymerase switching, operon, enhancer, promoters, co-activators, riboswitches, Role of transcription factors in regulating gene expression, Regulation of Translation: repressor proteins, activator proteins; Global regulation of translation in mammalian cells ,Translation in virus infected cells; prion, Regulating gene expression – RNA interference, mechanism and applications; microRNA – its role in translational regulation and cancer; Manipulating cellular mRNA translation - Crispr-Cas technology.

References:

1. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry: a short course. Macmillan, 8th edition 2015.
2. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 7th edition, 2017.
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10. Harry F Baker, Rosalind M Ridley (Eds), Prion Diseases, Springer, 1996.
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THIRD SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTIONS

BC 531- MOLECULAR BIOLOGY

Time: 3 hours **Max. Marks: 75**

Part I

Answer any ten of the following. Each question carries 3 marks

1. Pseudogenes
2. DNA supercoiling
3. DNA repair
4. Wobble rule.
5. Enhancers
6. Repressor proteins
7. Role of ribozymes
8. Microbial genomes
9. DNA denaturation
10. RNA processing in eukaryotic cells
11. Genetic code
12. SOS response

(10 X 3 = 30 Marks)

Part II

Answer any five of the following. Each question carries 5 marks

13. General features of promoters?
14. Explain RNA polymerase?
15. Write down the semi conservative replication?
16. Explain post transcriptional modification?
17. Explain alternative splicing?
18. Difference between eukaryotic and prokaryotic transcription?

19. Describe lac operon?

20. Give an account on micro-RNA and its role?

(5 X 5 = 25 Marks)

Part III

Answer any two of the following. Each question carries 10 marks

21. Write notes on eukaryotic translation?

22. What are protein synthesis inhibitors explain?

23. Describe in detail the eukaryotic replication?

(2 X 10 = 20 Marks)

Semester - III	Course Code: BC 532	Number of Hours/Week: 4

IMMUNOLOGY

AIM: To study the immunity or mechanism that normally protects individuals from infection and how to eliminate foreign substances.

OBJECTIVE: To know the organs, cells and molecules responsible for immunity. To give clear understanding of cellular and molecular events that occurs after an organism encounters microbes and other foreign macromolecules. To correlate serological reactions used in the diagnostic laboratory to detect interactions between antigens and antibodies.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Understand the basics of immune system and the various cells and organs involved.
- Understand the concept of antigen-antibody interaction and their molecular aspects.
- Distinguish the various components of innate immunity and their mechanism of action.
- Evaluation of the role of B-lymphocytes in humoral immune response at the molecular level.
- Evaluation of the role of T-lymphocytes and Antigen-presenting cells in cell mediated immune response.
- Correlate serological reactions used in the diagnostic laboratory to detect interactions between antigens and antibodies.
- Justify reasons for vaccination, immunization and immunotherapy.
- Discuss the different immunodeficiency disorders that affect humans.
- Explain monoclonal antibody production.

COURSE CONTENT

Module I: Overview of the Immune system

Introduction, Historical perspective, Haematopoiesis, Cells of immune system, Organs of the immune system – anatomy and functions of lymphoid tissues – Bone marrow, thymus, lymph node and lymphatic system, spleen, cutaneous immune system and mucosal immune system. Immunity- Types and general features. Innate immunity- Barriers of innate immunity (anatomic, physiologic, phagocytic and inflammatory barriers – Lipid mediators, Cytokines, Complement system- classical, alternative and lectin pathway). Antigens, factors that influence immunogenicity, epitopes and haptens.

Module II: Humoral Immunity

Antibody - structure, properties, different classes and biological functions, allotypes, isotypes, and idiotypes. Humoral immunity - B cell receptor, B cell development, Activation, Differentiation - generation of plasma cells and memory B cells. Clonal selection hypothesis. Genetic basis of antibody diversity.

Module III: Cell mediated Immunity

Major histocompatibility gene complex (MHC) - organization, structure and cellular distribution of HLA antigens, Antigen processing and presentation – endogenous and exogeneous pathways. Cell-mediated immunity: T cell development, structural organization of T cell-receptors, T-cell maturation, Activation, Differentiation, Proliferation, B cell – T cell interaction, The germinal centre reactions, Class switch recombination, generation of CD4+and CD8+ cell responses, secondary immune responses, regulation of the adaptive immune response.

Module IV: Immunological techniques

Antigen – antibody interactions - Affinity, avidity, cross reactivity, precipitation, agglutination reactions, complement fixation, Immunodiffusion, Immuno electrophoresis, Immunofluorescence HLA typing, leukocyte migration inhibition technique, delayed hypersensitivity techniques, Radioimmunoassay (RIA), ELISA (indirect, direct, sandwich, chemiluminescence, ELISPOT assay), Western blotting and Hybridoma technology.

Module V: Clinical Immunology

Hypersensitivity - types and mechanism of hypersensitive reaction. Autoimmunity- mechanism of induction of organ specific (Hashimoto’s thyroiditis, autoimmune anaemias, Good Pasteur syndrome, IDDM) and systemic (SLE, multiple sclerosis, rheumatoid arthritis) autoimmune diseases. Transplantation immunology-types of graft, immunological basis of graft rejection, tissue typing. Immunodeficiency diseases-specific impaired function in lymphoid lineage (SCID, Waldenstorm, agammaglobulinemia, Di George syndrome, common variable immunodeficiency) myeloid lineage (CGD, congenital neutropenia, Chediak - Higashi syndrome and leucocyte adhesion deficiency, AIDS). Vaccination and immunization

References:

1. Immunology. David Male, et al. Elsevier publications. 2020, 9th Edition. ISBN: 9780702078446.
2. Kuby Immunology. Jenni Punt, et al. Macmillan publications. 2019, 8th Edition. ISBN: 9781464189784.
3. How the Immune System Works. Lauren M. Sompayrac. Wiley Blackwell publications. 2019, 6th Edition. ISBN-10:111954212X.
4. Roitt’s Essential Immunology. Peter J Delves, et al. Wiley Blackwell publications. 2017, 13th edition. ISBN-10: 1118415779.

THIRD SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTIONS

BC 532- IMMUNOLOGY

Time: 3 hours **Max. Marks: 75**

Part I

Answer any ten of the following. Each question carries 3 marks

1. Systemic autoimmune diseases
2. Passive acquired immunity
3. Haptens
4. Phagocytic cells
5. Acute phase proteins
6. Antigen processing
7. Agglutination reactions
8. Delayed hypersensitivity techniques
9. Flow cytometry
10. Rheumatoid arthritis
11. Western blotting
12. Cytokines

(10 X 3 = 30 Marks)

Part II

Answer any five of the following. Each question carries 5 marks

13. General functions of lymphoid tissues?
14. Differentiate NK cells and dendritic cells?
15. Write down the factors that influence immunogenicity?
16. Explain Immunoglobulin superfamily?
17. Explain initiation of the inflammatory response?
18. Difference between Endogenous and exogenous pathways?
19. Describe B-Cell maturation?

20. Give an account on Immunoelectrophoreis?

(5 X 5 = 25 Marks)

Part III

Answer any two of the following. Each question carries 10 marks

21. Write notes on mechanism of cell-mediated immunity?
22. What are isotypes and subtypes of immunoglobulins, explain?
23. Describe the Immunotherapy?

(2 X 10 = 20 Marks)

Semester - III	Course Code: BC 533	Number of Hours/Week: 3

PHARMACOLOGY AND TOXICOLOGY

AIM: This course is designed to provide detailed understanding of the pharmacological aspects of therapeutics and their diverse modes of drug action.

OBJECTIVE: This course gives the students basic understandings of various phases of pharmacology include pharmaceutics phase, pharmacokinetic phase, pharmacodynamic phase and pharmacogenetics. This course gives an idea of how to design a drug, drugs mode of action, absorption, distribution and elimination. Mechanisms of action of some important pharmaceuticals are also will be explained in this course.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Define a drug and to know its nature, classification, dose-response and how to design/develop drugs.
- Express various drug targets like receptors, enzymes, hormones etc and drug-receptor interaction with theories.
- Critically evaluate what drug does to the body by drug-protein interactions.
- Analyse and come to know what the body does to a drug through absorption, distribution, metabolism and excretion of drugs by the body.
- Comprehend the concept of pharmacogenomics and its applications.
- Illustrate the diverse modes of drug action of common diseases.

COURSE CONTENT

Module I: General Pharmacology

Introduction to pharmacology, sources of drugs, Classification of drugs based on sources, dosage forms, route of administration, site of action of drugs. Mechanism of action, concept of receptors, combined effect of drugs, factors modifying drug action. Dose response curve- ED50 and LD50.

Module II: Pharmacokinetics

Absorption and distribution of drugs, importance of drug – protein interaction. Drug metabolism: chemical pathway of drug metabolism, phase I and phase II reactions, role of cytochrome P450, non- microsomal reactions of drug metabolism, drug metabolizing enzymes. Drug elimination of liver and kidney.

Module III: **Therapeutics**

Biochemical mode of action of antibiotics- penicillin and chloramphenicol, actions of alkaloids, antiviral and antimalarial substances. Biochemical mechanism of drug resistance- sulphonamides. Drug potency and drug efficacy. General principles of chemotherapy: chemotherapy of parasitic infections, fungal infections, viral diseases. Introduction to immunomodulators and chemotherapy of cancer.

Module IV: Screening for pharmacological activity

Screening of analgesic, anti-inflammatory and antipyretic agents, gastrointestinal drugs, antiulcer and laxatives, antioxidants, anticancer and anti-fertility agents. Drugs for metabolic disorders like antidiabetic, anti-hyperlipidemic, anti-obesity and hepatoprotective agents.

Module V: **Clinical Toxicology**:

Definition, classification of toxicity – occupational, environmental and pharmaceutical. Types of toxins and their mechanism of action. Factors affecting toxicity- Drug tolerance, intolerance, addiction, allergy, hypersensitivity, antagonism and synergism. Methods of detection. Drug abuses and their biological effects. Rational prescription of drugs. Toxicity of anticancer drugs. Clinical symptoms of toxicity and marker parameters.

References:

1. F S K Barar, Essentials of Pharmacotherapeutics, S. Chand Limited, 2000.
2. J. Lippincot co,pharmaceutical chemistry, Philadelphia.
3. Bertram Katzung, Anthony Trevor, Basic and Clinical Pharmacology, McGraw Hill Professional, 2014.
4. Golan, David E., Armen H. Tashjian, and Ehrin J. Armstrong, eds. Principles of pharmacology: the pathophysiologic basis of drug therapy. Lippincott Williams & Wilkins, 2011.
5. Klaassen, Curtis D., ed. Casarett and Doull's toxicology: the basic science of poisons. McGraw-Hill, 2013.
6. Screening methods in pharmacology. Robert A Turner, academic press, New York. 7. Goodman & Gilman. The pharmacological basis of therapeutics, Pentagon press.

THIRD SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTIONS

BC 533- PHARMACOLOGY AND TOXICOLOGY

Time: 3 hours **Max. Marks: 75**

Part I

Answer any ten of the following. Each question carries 3 marks

1. Chemical pathway of drug metabolism
2. Drug metabolizing enzymes
3. Penicillin
4. Antioxidants
5. Hepatoprotective agents
6. Drug tolerance
7. Toxicity of anticancer drugs
8. Immunomodulators
9. Gastrointestinal drugs
10. Drug addiction
11. Anti-fertility agents
12. Mode of action of alkaloids

(10 X 3 = 30 Marks)

Part II

Answer any five of the following. Each question carries 5 marks

13. General principles of chemotherapy?
14. Differentiate Analgesic and antipyretic drugs?
15. Write down the factors that influence immunogenicity?
16. Explain the different types of toxins?
17. Explain biochemical mechanism of drug resistance?
18. Difference role of cytochrome P450 in drug metabolism?

19. Describe Dose response curve?

20. Give an account on drug elimination of liver and kidney?

(5 X 5 = 25 Marks)

Part III

Answer any two of the following. Each question carries 10 marks

21. Write notes on Classification of drugs based on sources?

22. What is classification of toxicity?

23. Describe the mode of action of antibiotics?

(2 X 10 = 20 Marks)

Semester - III	Course Code: BC 534	Number of Hours/Week: 4

METHODS IN RESEARCH

AIM: The course is designed to introduce students to the fundamentals of scientific aptitude, analytical skills in research, ethical considerations, and plagiarism.

OBJECTIVES: To develop awareness of the various areas of research in Biochemistry and analytical skills.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Define the purpose and scope of research methodology.
- Develop an understanding on various kinds of research, objectives of doing research, research process, research designs, sampling and to explore research methodology seen in literature.
- Propose a research design and identify different methods to conduct a research project.
- Nurture analytical skills and awareness on various aspects of research in biochemistry.
- Gain knowledge in statistical techniques used in data analysis.
- Understand the ethics in research involving human samples, embryo and stem cell research and to identify plagiarism and data fabrication.

COURSE CONTENT

Module I: Introduction to intellectual property

IPR policy of Government of India, Indian & International Patent laws, Types of patents. Indian Patent Act 1970; Recent Amendments; Protection of New GMOs; Financial assistance for patenting-introduction to existing schemes. Procedure for patent application, international harmonization of patent laws, Patenting of life forms -plant, animals, microbes, gene, process and products.

Module II: Research methodology and Scientific Writing

Types of research - Formulation of hypothesis. Designing a research work -experimental design. Characteristic logical format for writing thesis and papers - Essential features of abstract, Introduction, Review of literature, Materials and methods, results and discussion, Effective illustration, Tables and figures, reference style- Harvard and Vancouver system. Citation and Acknowledgement, ISBN & ISSN. Peer review. Impact factor and H- index of journals. Presentation tools: oral and poster, Microsoft PowerPoint and PDF slides.

Module III: Biostatistics

Introduction to Biostatistics. Concept of sampling and sampling methods. Classification and tabulation of data. Diagrammatic and graphical representation of data. Measure of central tendencies- Mean, median, mode, geometric mean and harmonic mean. Variance - Coefficient of variation. Statistics of Dispersion-range, quartile deviation, mean deviation, standard deviation and standard error. Simple correlation and regression, Software packages for statistical analysis-MS Excel. Probability and law of probability; Probability distributions (binomial, Poisson and normal); Tests of statistical significance (t –Test, chi-square test); Analysis of variance-one way and two- w a y ANOVA (Notice: -The students are expected to understand the concepts and solve relevant problems. No derivations and proofs are expected).

Module IV: Bioethics involving research on animals and human

Research involving animals: outline of the controversy. Ethical issues raised by animal research - pain, distress and suffering. Methods of euthanasia. CPCSEA and prevention of animal cruelty. Bioethics involving research with humans: Research on human subjects and samples. Importance of informed consent. Privacy, ethics and legal issues. Ethical issues involving human embryo and stem cell research.

Module V: Ethics in Research

Research output- Honesty and integrity of a good researcher. Ethical issues- Plagiarism, fabrication and falsification. Misrepresentation of information. Proper interpretation of results and proper scientific presentation. Software to check plagiarism in publications. Legal implications of plagiarism and research fabrication.

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1. Research Methodology: Methods and Techniques. C.R. Kothari, New Age International, 2004.
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2. https://study.sagepub.com/kumar5e
3. https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=51427&printable=1

THIRD SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTIONS

BC 534- METHODS IN RESEARCH

Time: 3 hours **Max. Marks: 75**

Part I

Answer any ten of the following. Each question carries 3 marks

1. Types of patents
2. Procedure for patent application
3. Essential features of an abstract
4. Harvard and Vancouver system
5. Formulation of research objectives
6. Graphical representation of data.
7. Plagiarism
8. Standard deviation
9. Importance of literature review
10. Mean and median
11. Chi-square test
12. Software to check plagiarism in publications

(10 X 3 = 30 Marks)

Part II

Answer any five of the following. Each question carries 5 marks

13. General Ethical issues involving human embryo and stem cell research?
14. Comment on International Patent laws
15. Describe how to write a scientific paper
16. Explain Probability and law of probability?
17. Bioethics involving research with humans.
18. Explain ANOVA?
19. Major ethical issues related to plagiarism.
20. Give an account on Ethical issues raised by animal research?

(5 X 5 = 25 Marks)

Part III

Answer any two of the following. Each question carries 10 marks

21. Write notes on Simple correlation and regression?
22. Characteristic logical format for writing thesis.
23. Explain bioethics involving research with humans

(2x10=20 Marks)

Semester - III	Course Code: BC 535	Number of Hours/Week: 10

PRACTICAL III: IMMUNOTECHNIQUES AND PHYTOCHEMICAL ANALYSIS

AIM: The course is designed to provide students with hands on training in immunological techniques and phytochemical analysis for application from a researcher's point of view.

OBJECTIVE: The course provides detailed protocols, experimental design and application-oriented training of the routine techniques in immunology and phytochemistry. Emphasis is given in encouraging self-exploration and analytical thinking in approaching biological samples of investigation and data derivation.

COURSE OUTCOME

This lab course is designed and delivered to train the learner to techniques routinely employed in immunology and phytochemistry. After the completion of this course, the student will be able to:

- Perform various immunological techniques like immunodiffusion, immunoelectrophoresis and ELISA.
- Develop an analytical thinking on how to test a biological sample and derive data.
- Comprehend classical and modern techniques to isolate phytochemicals from plants
- Would have acquired practical laboratory experience to expand understanding of biological processes and build a career.

COURSE CONTENT

I. IMMUNOTECHNIQUES

A. Blood film preparation and identification of cells

B. Demonstration of immune reaction

1. Blood group
2. Widal test
3. Pregnancy test
4. Coomb's test
5. ELISA

C. Antigen antibody reaction

6. Immuno diffusion
7. Immunoelectrophoresis
8. Immunoblotting
9. Immunostaining
10. Immunofluorescent
11. Production of antibodies

D. Purification of immunoglobulins

II. PHYTOCHEMICAL ANALYSIS

1. Preparation of extracts:

Preparation of extracts of crude drugs/herbs by successive solvent extraction method to record the percentage yield and for subjecting them to phytochemical screening

2. Preliminary phytochemical screening

a. Cold and hot extraction methods
b. Qualitative chemical examination - Detection of phytoconstituents by test tube methods – Alkaloids, phenolics, flavonoids, glycosides, steroids, triterpenoids, saponins, tannins.

3. Identification of alkaloids in a mixture by TLC

4. Quantitative analysis of phytoconstituents by various methods

a. Determination of total phenolic content
b. Determination of total flavonoid content
c. Determination of total antioxidant activity

5. Screening of herbal extracts/products for free radical scavenging and antioxidant activities.

6. Isolation of natural products by column chromatography and Spectroscopic analysis of extract for phytochemicals.

Practical Examination Scheme

Immunotechniques and Phytochemical analysis

Duration: 6 hrs **Maximum: 75 Marks**

I. IMMUNOTECHNIQUES (25 marks):

i. Principle and procedure - 5 marks
ii. Demonstration of immune reaction (steps and result) - 10 marks
iii. Antigen- antibody reaction (steps and result) - 10 marks

II. PHYTOCHEMICAL ANALYSIS (40 marks):

I. Qualitative analysis (positive and negative reactions & confirmatory test) - 10 marks.

II. Quantitative determination of phytoconstituents - total phenolics/ flavonoids/antioxidant activity - 30 marks:

i. Principle and procedure - 5 marks
ii. Tabulation- 5 marks
iii. Graph – 5
iv. Calculation- 5 marks
v. Final value- 10 marks

III. Spot test/ practical based short answer type questions (10 numbers) - 10 marks (Answer in a word or sentence)

SEMESTER - IV

Course Code	Title of the Course	Instructional Hours/Week			Maximum Marks		
		L	T	P	CA	ESA	Total
BC 541	Molecular Endocrinology	5	1	0	25	75	100
BC 542	Biotechnology and Genetic Engineering	5	1	0	25	75	100
BC 543	Practical IV: Techniques in Molecular Biology	0	0	10	25	75	100
BC 544	Dissertation	0	0	5	0	60	80
	Presentation and Viva Voce of Dissertation	0	0	0	0	20	
BC 545	Comprehensive Viva Voce	0	0	0	0	20	20

Semester - IV	Course Code: BC 541	Number of Hours/Week: 5

MOLECULAR ENDOCRINOLOGY

AIM: To impart knowledge on molecular and cellular mechanisms of action of hormones.

OBJECTIVE: This course focus on molecular and cellular mechanisms of hormones including gene regulation, cell biology, signalling, mutations, transgenesis, various diseases associated with hormonal dysfunction as well as the integration of developmental events.

COURSE OUTCOME

After the completion of this course, the student will be able to:

- Get an idea on the endocrine system and its mode of operation
- Develop an understanding about the roles of the endocrine system in homeostasis, growth, development and reproduction
- Obtain knowledge on the response of endocrine organs to environmental changes
- Develop an understanding about the role of hormone receptors in hormone action
- Get an idea on the mechanism of action of hypothalamus, pituitary, thyroid, pancreatic, adrenal, gastrointestinal hormones
- Understand the pathophysiological processes associated with hormone imbalance

COURSE CONTENT

Module I: Introduction to endocrinology

Overview of hormones**,** Classification of hormones, Hormone receptors - general features. Role of Plasma membrane receptors - G protein coupled receptors, Receptor protein tyrosine kinases, non-receptor protein tyrosine kinases, Steroid hormone receptors and thyroid receptors. Mechanism of hormone action and signal transduction- Group I and Group II hormones.

Module II: Hypothalamus and Pituitary hormones

Biochemistry and mechanism of action of Hypothalamus and Pituitary hormones, Hypothalamic releasing factors, Anterior Pituitary hormones, Vasopressin, Oxytocin. Regulation of synthesis. Lactogenic hormones. Glycoprotein hormones of the POMC family, endorphins, MSH, Hypo and hyper activity of Pituitary hormones - gigantism, acromegaly, dwarfism, syndrome of inappropriate ADH secretion.

Module III: Thyroid Hormones

Thyroid Hormones- synthesis, secretion, transport metabolic fate and biological actions. Antithyroid agents. Thyroid diseases- thyrotoxicosis, goiter, hypothyroidism, Graves' disease, Hashimoto’s thyroiditis. Thyroid function tests. Parathyroid hormone - Biological actions, regulation of calcium and phosphorus metabolism. Calcitriol, Calcitonin - Pathophysiology.

Module IV: **Pancreatic hormones and Gastrointestinal hormones**

Pancreatic hormones - Islets of Langerhans. Insulin biosynthesis, regulation of secretion, biological actions and mechanism of action. Insulin receptor- intracellular mediators. Insulin signaling pathways. Glucagon, somatostatin, pancreatic polypeptide, insulin like growth factors. Diabetes Mellitus.

Gastrointestinal hormones - synthesis, structure, functions and mechanism of action of secretin, GIP, VIP,gastrin, CCK and other peptides.

Module V: Adrenal hormones

Adrenal hormones - Glucocorticoids, Mineralocorticoids - synthesis, secretion transport, metabolic fate, biological actions and mechanism of action. Adrenal androgens metabolic effects and functions. Hormones of Adrenal Medulla - Catecholamines - Biosynthesis, storage, metabolism, regulation of synthesis. Abnormal secretion of Adrenal hormones- Addison's disease, Cushing's syndrome, Congenital Adrenal Hyperplasia, phaeochromocytoma. Gonadal hormones - Androgens, estrogens. Biological actions. Ovarian cycle. Pregnancy, Biochemical changes in pregnancy.

References

1. Melmed, Shlomo, Kenneth S. Polonsky, P. Reed Larsen, and Henry M. Kronenberg. Williams textbook of endocrinology. Elsevier Health Sciences, 2011.
2. C.R. Austin, R.V. Short, Mechanisms of Hormone Action, Cambridge University Press, 1979
3. Granner, Robert K. Murray Darryl K., and Peter A. Mayes Victor W. Rodwell. Harper's illustrated Biochemistry (Harper's Biochemistry). McGraw-Hill Medical, 2006.
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FOURTH SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTIONS

BC 541: MOLECULAR ENDOCRINOLOGY

Time: 3 hours **Max. Marks: 75**

Part - I

Answer any ten of the following. Each question carries 3 marks

1. Classification of hormones
2. Ovarian hormones
3. Addison's disease
4. GIP and VIP
5. Insulin secreting cells
6. Parathyroid hormones
7. Gigantism
8. Feedback regulation of hormones
9. Hormones -Anterior & Posterior hormones
10. Gonadotropin hormones
11. Dwarfism
12. Mineralocorticoids

(10 X 3 = 30 Marks)

Part - II

Answer any five of the following. Each question carries 5 marks

13. Explain diabetes mellitus
14. Explain thyroid function tests
15. Write about hypo and hyper activity of pituitary hormones
16. Explain hypothyroidism, Graves' disease
17. Explain insulin signaling pathway
18. Describe biosynthesis and regulation of catecholamines
19. Give an account on glucagon, insulin like growth factor
20. Explain the biological function of oxytocin and vasopressin

(5 X 5 = 25 Marks)

Part - III

Answer any two of the following. Each question carries 10 marks

21. Explain the synthesis, transport, biological actions of adrenal hormones

22. Explain the synthesis of thyroid hormones and about any two thyroid diseases

23. Describe hormone receptors and their mechanism of action

(2 X 10 = 20 Marks)

Semester - IV	Course Code: BC 542	Number of Hours/Week: 5

BIOTECHNOLOGY AND GENETIC ENGINEERING

AIM: To familiarize students with molecular and genetic tools used to analyse and modify genetic material and explore the diverse applications of the biotechnology.

OBJECTIVE: The objective of the study is to understand the molecular and genetic tools used to analyse and modify genetic material to produce desired small molecules and proteins.

COURSE OUTCOME:

After the completion of this course, the student will be able to:

- Get basic idea about recombinant DNA (rDNA) technology, tools and the steps in involved in the process.
- Gain knowledge on the requirements, steps and applications of gene cloning.
- Know the basis of gene mapping and its usage.
- To judge the importance of genetically modified organisms.
- Get an awareness on the various applications of biotechnology and genetic engineering.

COURSE CONTENT

Module I: Introduction to recombinant DNA technology

Principles, procedures and applications of recombinant DNA technology. Construction of genomic and c-DNA library. Restriction endonucleases, Types of restriction endonucleases, recognition sequences, cleavage patterns, Vectors: properties of good vector, Cloning vectors and expression vectors: Plasmids, Bacteriophages, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids: Artificial chromosome vectors (YACs; BACs); expression vectors. Screening of DNA libraries; Gene Cloning methods: Cohesive end cloning, blunt end cloning, cloning using adapters, linkers and homopolymer tailing, Gene transfer methods.

Module II: Advanced molecular techniques

Genome Sequencing: Next Generation Sequencing, illumina sequencing, pyrosequencing, Solid Sequencing, human genome project overview; Gene mapping: Molecular Marker's for Gene Mapping- RFLP, RAPD, AFLP, SSR, and SNP; Physical Mapping: Restriction Mapping, FISH, STS mapping.

Module III: Medical biotechnology

Vaccines, Production of vaccines, Diagnosis of genetic defects, eugenics, anti-natal diagnosis, foetus sexing, Therapeutic proteins, Stem cell transplantation and its applications, Organ transplantation and types of transplants, Gene Therapy, Artificial blood. Introduction to

Nanobiotechnology. Applications of Nanobiotechnology in diagnosis and therapy.

Module IV: Plant and animal biotechnology

Basic Concepts about Plant and Animal Cell Culture: Transgenic plants: Genetic engineering of plants, Ti plasmid, Transgenic plants with herbicide and insect resistance, BT toxin, Transgenic animals: Creation of transgenic animals, Recombinant protein production, Knockout mice, Inducible endogenous promoters, Transgenic insects, Natural transgenesis.

Module V: Environmental and industrial biotechnology

Definition and application - bio indicators, biopesticides, biological mining, bioremediation, biofuel, Environmental monitoring; biofertilizers; technology for production of major biofertilizers; ethical, social and biosafety aspects of biotechnology; biological containment. Bioreactors: Introduction to bioreactors - Aerobic and anaerobic fermentation; solid state and submerged fermentation; Types of Bioreactors: Batch, continuous and fed-batch (variants).

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2. U Satyanarayana, Biotechnology, Books and Allied (p) Limited, 2013.
3. John E. Smith, Biotechnology, Cambridge University Press, 2009.
4. Sandhya Mitra, Genetic Engineering: Principles and Practice, McGraw-Hill Education, 2015.
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FOURTH SEMESTER M.SC. BIOCHEMISTRY DEGREE EXAMINATION

MODEL QUESTIONS

BC 542: BIOTECHNOLOGY

Time: 3 hours **Max. Marks: 75**

Part - I

Answer **any ten** of the following. **Each** question carries **3** marks

1. Shuttle vectors
2. YAC and BAC
3. Gene cloning
4. GMO crops
5. Homopolymer railing
6. Primary cell lines
7. Reporter genes
8. FISH
9. SNP
10. Somatic hybridization
11. Vaccines
12. Artificial blood

(10 X 3 = 30 Marks)

Part - II

Answer **any five** of the following. **Each** question carries **5** marks

13. General characteristics of cloning vectors
14. Human genome project
15. Write down the applications of nanotechnology
16. Explain Ti plasmid as a vector
17. Explain molecular markers for gene mapping
18. Differentiate between phagemids and cosmids.

19. Describe microinjection and gene-gun method of gene delivery

20. Give an account on restriction enzymes.

(5 X 5 = 25 Marks)

Part - III

Answer **any two** of the following. **Each** question carries **10** marks

21. Write the principles and applications of recombinant DNA technology

22. What is cDNA library? Explain the mechanism of preparation of a cDNA library

23. Describe in detail the principles, method and application of culturing animal cells.

(2 X 10 = 20 Marks)

Semester - IV	Course Code: BC 543	Number of Hours/Week: 10

PRACTICAL IV: TECHNIQUES IN MOLECULAR BIOLOGY

AIM: To give hands on training in the techniques in Molecular Biology.

OBJECTIVE: This lab helps students to provide hands own training in different techniques used in Molecular Biology.

COURSE OUTCOMES

After the completion of this course, the student will be able to:

- Gain insight of molecular biology techniques that are instrumental in analysis of genes at DNA level.
- Acquire practical experience in DNA and RNA extraction and their qualitative and quantitative analysis.
- Learn to isolate DNA and to perform Agarose gel electrophoresis of DNA.
- Understand theoretical and practical introduction to important methods like PCR and plasmid isolation.
- Decide and apply appropriate tools and techniques in molecular biology.

COURSE CONTENT

I. Nucleic acids

1. Isolation of RNA from yeast/ E. coli
2. Isolation of DNA from coconut endosperm/Plants/banana
3. Qualitative and quantitative analysis of extracted DNA- Spectrophotometric method,
4. Estimation of DNA by diphenylamine reaction
5. Estimation of RNA by orcinol method

II. Electrophoresis

1. Agarose gel electrophoresis of DNA

II. Amplification of DNA by PCR

III. Culture of E. coil cells and isolation of plasmid

Practical Examination Scheme

Practical IV – BC 543: Techniques in Molecular Biology

Duration: 6 hrs **Maximum: 75 Marks**

I. Nucleic acids – (55 marks)

- Procedure- 10 marks
- Isolation of DNA- 20 marks
- Estimation of DNA – UV/Colorimetry – (25 marks)

II. Electrophoresis- (10 marks)

Instrument setting – 10 marks

III. Spot test/ practical based short answer type questions (Answer in a word or sentence) (10 numbers) - **10marks**

Semester - IV	Course Code: BC 544	Number of Hours/Week: 5

DISSERTATION

AIM: The aim of this course is to expose students to different aspects of research methodology, molecular and biochemical research and data analysis.

OBJECTIVE: The primary objective of a dissertation work is to act as an introduction to biological research and its various aspects. Students shall carry out a research project specific to individual laboratory of the supervision teacher they are assigned with.

COURSE OUTCOME:

After the completion of this course, the student will be able to:

- Identify research methods
- Ask the right scientific questions
- Identify review of literature
- Critically think and evaluate on the topic that is chosen for research
- Combine theory and practice
- Apply the knowledge obtained on the topic to the research being conducted
- Develop a response on the results obtained and analysis done and thereby draw conclusions
- Apply appropriate methods to represent the results
- Communicate the scientific data effectively
- Demonstrate the research skills in career advancement or future work-related studies

COURSE CONTENT

Students are assigned to different faculties and are expected to carry out the research project under close supervision of the research faculty and their research scholars. Each student will work as an integral unit of the research team and thereby, understand and complete the assigned research work. On completion of the project, students are expected to submit a dissertation of the results and its discussion for expert evaluation. Topic of dissertation may be chosen from any area of biochemistry and may be laboratory based, field based or both or computational, with emphasis

on originality of approach. It may be started during 2nd / 3rd semester and shall be completed by the end of the 4th semester.

The dissertation to be submitted should include:

a) Background information in the form of introduction

b) Objectives of the study

c) Materials and methods employed for the study

d) Results and discussion

e) Summary and conclusions and

f) Bibliography

Apart from these sections, importance of the results, originality and general presentation also may be taken into consideration for evaluation. These data's may be presented using power point at the time of dissertation viva.