Learning Outcomes-based Curriculum Framework (LOCF) for Post-graduate Programme

DEPARTMENT OF
BIOCHEMISTRY
UNIVERSITY OF KERALA

Name of the Programme:
M.Sc. Biochemistry

(Syllabus effective from 2020 Admission onwards)

UNIVERSITY OF KERALA

2020

PREAMBLE

The role of higher education is vital in securing the gainful employment and providing further access to higher education comparable to the best available in the world-class institutions elsewhere. The improvement in the quality of higher education, therefore, deserves to be given tom-most priority to enable the young generation of students to acquire skill, training and knowledge to enhance their thinking, comprehension and application abilities and prepare them to compete, succeed and excel globally. Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes across all undergraduate programs in science, humanities, commerce and professional streams of higher education.

One of the significant reforms in the undergraduate education is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. The University Grants Commission (UGC) took the initiative of implementing the LOCF in the Colleges and the Universities of the country. Accordingly, the University of Kerala has decided to implement the LOCF in all its departments under the auspices of Internal Quality Assurance Cell (IQAC). A series of teacher training workshops were organised by IQAC and the office of the Credit and Semester System (CSS), and the departments have revised the syllabus accordingly, through workshops and in consultation with academic experts in the field.

GRADUATE ATTRIBUTES (GAs)

The Graduate Attributes (GAs) reflect particular qualities and abilities of an individual learner including knowledge, application of knowledge, professional and life skills, attitudes and human values that are required to be acquired by the graduates of University of Kerala. The graduate attributes include capabilities to strengthen one's professional abilities for widening current knowledge and industry-ready skills, undertaking future studies for global and local application, performing creatively and professionally, in a chosen career and ultimately playing a constructive role as a socially responsible global citizen. The Graduate Attributes define the characteristics of learners and describe a set of competencies that are beyond the study of a particular area and programme.

The GAs of University of Kerala

- Continue life-long learning as an autonomous learner
- Continuously strive for excellence in education
- Apply and nurture critical and creative thinking
- Promote sustainable development practices
- Promote co-operation over competition
- Balance rights with responsibilities
- Understand and respect diversity & difference
- Not be prejudiced by gender, age, caste, religion, or nationality.
- Use education as a tool for emancipation and empowerment of humanity

BRIEF HISTORY OF THE DEPARTMENT

Department of Biochemistry, University of Kerala, was established in the year 1961 as a division of department of Chemistry and established as an independent department in 1970. Dr. P. Achutha Kurup was the founder Professor and Head of the Department of Biochemistry, followed by Prof. R. Kaleysa Raj, Prof. P.R.Sudhakaran, Prof. T. Rajmohan and Prof. G. Muraleedhara Kurup and Prof. Annie Abraham. Dr. Mini. S is the present head of the department. The department had been a champion of excellence in teaching and research since its inception. The Department has successfully undertaken several externally funded research programs independently and in collaboration with various research institutions/laboratories in India and abroad. The Department is proud of its distinction as the best performing department of the University in terms of external research funding and research output on several consecutive years.

The department currently offers M.Sc. in Biochemistry, M.Phil. (Biochemistry, Genetics and Genomics) and Ph.D. in Biochemistry. The department has produced more than 280 Ph.Ds and published more than 900 research articles in leading national and international peer reviewed journals.

The thrust areas of research in the department are Lifestyle Diseases (Atherosclerosis, Cancer, Diabetes, Inflammation, Arthritis, Cataract, Alcoholism etc.) Phytochemisty (Phytochemical Evaluation, Bioactive Compound Isolation, Drug Development). The research program has diversified into newer areas of research like structural Biology, Epigenetics, Nano Biotechnology. Marine Biotechnology and Tissue Engineering. The Department is actively engaged in research on natural products with therapeutic applications in these thrust areas. The Department has also produced three patents. As a part of the research expansion of the department, Advanced Centre for Tissue Engineering (ACTE) was initiated in the Department of Biochemistry during 2015-16.

UNIVERSITY OF KERALA

Syllabus for M.Sc. Biochemistry

Programme Specific Outcomes (PSO*) for M.Sc. Biochemistry

PSO 1 To impart advanced knowledge on various concepts of biochemistry

PSO 2 Enable students to achieve capacity for inquisitive enquire in the field of biochemistry

PSO 3 To develop skills in students necessary for careers into advanced research

PSO4 Enrich the skills and applied knowledge of students towards current industry expectations from biochemists

***Acronyms used**

PSO – Program Specific Outcomes

CO – COURSE OUTCOME

Cognitive levels

R -Remember

U -Understanding

Ap -Apply

An -Analyze

E -Evaluate

C -Create

Programme Structure of M.Sc. in Biochemistry

Semester	Course Code	Name of the course	Core Courses (CC)	Discipline-Specific Elective (DE)	Generic Course (GC)	Skill Enhancement Elective (SE)	Credits
I	BCH-CC-511	Biomolecules	+				3
	BCH-CC-512	Advanced Techniques in Biochemistry	+				3
	BCH-CC-513	Microbial Biochemistry	+				3
	BCH-CC-514	Physiology and Specialized Tissues	+				3
	BCH-CC-515	Lab Course I (Biochemical and Microbial Techniques)	+				4
	BCH-DE-516	Methods in Research		+			2
	BCH-DE-517	Radioactivity and Radiation Biology		+			2
II	BCH-CC-521	Enzymes	+				3
	BCH-CC-522	Metabolism I	+				3
	BCH-CC-523	Metabolism II	+				2
	BCH-CC-524	Nutritional Biochemistry	+				2
	BCH-CC-525	Clinical Biochemistry	+				2
	BCH-CC-526	Lab Course -II (Clinical Biochemistry & Enzymology)	+				4
	BCH-DE-527	Bioinformatics		+			2
	BCH-DE-528	Tissue Engineering		+			2
III	BCH-CC-531	Molecular Cell Biology	+				4
	BCH-CC-532	Molecular Biology	+				4
	BCH-CC-533	Plant Biochemistry	+				2
	BCH-CC-534	Molecular Immunology	+				3
	BCH-CC-535	Lab Course III (Techniques in Molecular Biology, Immunology and Phytochemistry)	+				4
	BCH-DE-536	Developmental Biology		+			2
	BCH-DE-537	Environmental Biochemistry		+			2
IV	BCH-CC-541	Molecular Endocrinology	+				3
	BCH-CC-542	Genetics and genomics	+				2
	BCH-DE-543	Pharmaceutical Biochemistry		+			2
	BCH-DE-544	Biotechnology		+			2
	BCH-CC-545	Dissertation	+				6
Any Semester (I-IV)	BCH-GC-501	Radiation Biology and Health			+		2
	BCH-GC-502	Enzymology			+		2
	BCH-GC-503	Lifestyle diseases			+		2
Any Semester (I-IV)	BCH-SE-501	Laboratory Animal Experimentation				+	2
	BCH-SE-502	Effective Scientific Communication				+	2
	BCH-SE-503	Animal Cell Culture Techniques				+	2

SEMESTER I	Course Code: BCH-CC-511	Credits: 3

NAME OF THE COURSE: BIOMOLECULES

AIM: This course introduces the classifications, synthesis and reactions of biomolecules such as carbohydrates, proteins, nucleic acids and lipids. It will also emphasize on the three-dimensional structures and fundamental concepts of stereochemistry.

OBJECTIVE: The main objective of this course is to give students thorough knowledge on biomolecules, their characteristic properties and organization in carrying out all the living functions which constitute the life. The course deals in detail with study of definition, classification, structure and cellular functions of biomolecules - carbohydrates, lipids, proteins nucleic acids and vitamins

COURSE OUTCOME:
After the completion of this course, the student will be able to
CO1: Understand basic concepts about biochemistry (U)
CO2: Explain the structure function and classification of carbohydrates (Ap)
CO3: Define the structure, function and classification of Lipids (Ap)
CO4: Illustrates the role, structure and classification of Proteins (Ap)
CO5: Differentiate between structural aspects of nucleic acids (An)
CO6: Describe methods to study macromolecular interactions (An)

COURSE CONTENT

Module I: Physical aspects in Biochemistry: Concept and calculations based on normality, molarity, molality. Donnan-membrane equilibrium-biological applications. Buffers and biological buffer systems- significance of Henderson-Hasselbalch equation. Determination of pH and pKa. Basic techniques in preparation of reagents and buffers.

Module II: Carbohydrates: Classification of carbohydrates- mono, di and polysaccharides. Structure and functional details of mono, disaccharides, polysaccharides. Homopolysaccharides - storage polysaccharides (starch, dextrin, glycogen- structure, reaction, properties), structural polysaccharides (cellulose, chitin-structure, properties), Heteropolysaccharides- glycoproteins, proteoglycans, lipopolysaccharides.

Module III: Lipids: Simple and complex lipids, glycerophospholipids, sphingophospholipids, glycolipid, lipoproteins and proteolipids - structure, properties and function, Derived lipids- prostaglandins, thromboxanes, leukotriens, isoprenoids (carotenoids and terpenoids), steroids and sterols (cholesterol, ergosterol, stigmasterol, sitosterol) - structure, properties and function.

Module IV: Proteins: Introduction to amino acids, peptides and Proteins: Functional diversity of proteins, methods for isolation, purification, and characterization of proteins, protein sequencing. Peptides- solid phase synthesis, Protein stability, protein denaturation Collagen, elastin. Levels of structural organization in proteins - primary, secondary, tertiary and quaternary. determination of protein structure- Ramachandran Plot, X-ray crystallography,

NMR in revealing 3D structure of proteins, protein folding, CD as a sensitive indicator in chain conformation of proteins. Chaperones, structure - function relationships in protein families.

Module V: Nucleic acids: Structural aspects of nucleic acids - Watson - Crick model, A-DNA, B-DNA and Z-DNA, Right - handed and left – handed helix, super coiling, structural polymorphism in nucleic acids. Forces stabilizing DNA structure, Helix parameters, Watson – Crick and Hoogsteen base pairing.). Structural organization of the DNA in the nuclear material-general properties of histones, nucleosomes and solenoid structure. Packaging of DNA, chaperones and organization of chromosome in bacteria and eukaryotic cells. DNA and RNA - Physical properties of dsDNA (UV absorption spectra, denaturation and renaturation, cot curves, DNA hybridization, nucleic acids sequencing – Sanger's and Maxam-Gilbert's methods. Oligonucleotide synthesis, classes of DNA sequence, RNA – types of RNA, structural features of tRNA.

Module VI: Macromolecular interactions
Ribosome assembly, Protein-DNA interactions, methods to detect protein- DNA interactions-Chromatin immunoprecipitation (ChIP) assays, DNA electrophoretic mobility shift assay (EMSA), DNA pull-down assays,Protein–RNA interactions,RNA pull-down assay and Fluorescent in situ hybridization and co-localization, protein-protein interaction, methods to identify protein protein interaction – Yeast two hybrid assay, Co-immunoprecipitation, proteins that recognize glycans.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Metzler, David E. Biochemistry (2 Volume Set): The Chemical Reactions of Living Cells. Elsevier, 2003.
2. Tymoczko, John L., Jeremy M. Berg, and LubertStryer. Biochemistry: a short course. Macmillan, 2011.
3. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
4. Garrett, Reginald, and Charles Grisham. Biochemistry. Nelson Education, 2012.
5. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of biochemistry." New York: John Wiley & Sons 2008.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-CC-512	Credits: 3

NAME OF THE COURSE: ADVANCED TECHNIQUES IN BIOCHEMISTRY

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

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

COURSE OUTCOME

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

CO1: Obtain knowledge about the principle, applications and basic operational procedures of essential laboratory equipments like bright field and fluorescence microscopy, centrifugation and electrophoresis (R, Ap)

CO2: Get an understanding of various chromatographic techniques and its application in the isolation of nucleic acids, proteins, sugars and other bio molecules (U)

CO3: Develop an understanding about the principle and application of immunological techniques (U)

CO4: Understand the different processes employed in tissue histopathologic analysis (U)

CO5: Attain insights about how genetic material can be amplified by techniques like PCR and analysed to understand the source of biological samples (E)

CO6: Gain confidence to handle advanced laboratory equipments like atomic force microscopy and advanced spectroscopy (C)

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: Centrifugation and Electrophoresis: Basic principles, Centrifugation units, Different types: differential centrifugation, density gradient centrifugation and ultracentrifugation, Applications. Factors affecting electrophoresis, electrophoretic techniques- Slab, capillary, 2-D, pulsed field.

Module III: PCR and Immunological techniques: DNA amplification by PCR- conventional, reverse-transcriptase and Real-time PCR. Primer designing and sequence analysis. TaqMan MGB and molecular beacons. ELISA, Western Blotting, Immunohistochemistry, Immunoprecipitation, Radio immunoassay, flow cytometry, immuno-electrophoresis.

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, spectro-fluorimetry, flame photometry, atomic absorption spectrometry, luminometry.

Module VI: 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.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

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
5. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry: a short course. Macmillan, 2012.
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

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).

60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-CC-513	Credits: 3

NAME OF THE COURSE: MICROBIAL BIOCHEMISTRY

Aim: To get the students in depth knowledge of the different types of microbes, their morphology, functions and their applications in industry, agriculture and Medicine.

Objective: To impart knowledge of the basic principles of microbiology from the classification, developmental stages of bacteria, microbial genetics, viruses and application of microbiology in food industry, disease diagnosis and therapy.

COURSE OUTCOME:

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

CO1: Distinguish different groups of microbes, their nutritional requirement and genetic aspects (Ap)

CO2: Discuss the morphology, classification and replication of virus and viral infections (Ap)

CO3: Apply the theoretical knowledge on various microbial techniques to practical purpose (Ap)

CO4: Acquire basic knowledge on microbiology of food, water and antimicrobial drugs (U)

CO5: Apply the knowledge in microbial nutrition for the culturing of microbes in laboratory (Ap)

CO6: Explain emerging infectious diseases (An)

CO7: Apply the knowledge in clinical microbiology for identifying the microbe in laboratory (A)

CO8: Control food spoilage and food borne diseases (A)

CO9: Apply the knowledge in water purification and sanitary analysis (A)

CO10: Understand the mode of action of important antibiotics (U)

COURSE CONTENT

Module 1: Morphology and classification: History of microbiology. Principles of classification of microbes; A brief introduction to major group of microorganisms - bacteria, viruses, fungi, protozoa, algae. Ultrastructure of bacteria, Chemical composition of cell wall, Staining techniques-simple, differential, special staining techniques and negative staining.

Module II: Microbial growth and Nutrition: Microbial growth - definition, physical conditions required for growth, Nutritional requirements of bacteria, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, factors

affecting growth, Sterilization and disinfection, Bacteriological media -types of media, preparation of media.

Module III: Microbial genetics: The inheritance of characteristics and variability, phenotypic and genotypic changes, mutations, plasmids, bacterial recombination, bacterial conjugation, transduction, bacterial transformation. Genetic engineering of microorganisms for biotechnology - recombinant microbes, recombinant plants, recombinant animals.

Module IV: Viruses: Morphology, classification, nomenclature and replication of viruses, DNA viruses and RNA viruses. Bacteriophage - general characteristics, viral oncogenes and retroviruses, virus-host interaction, viral infections- Emerging infectious diseases.

Module V: Clinical Microbiology: Biosafety, Identification of microorganism from spacemen - direct identification, culture-based methods, isolation of pure culture, biochemical tests used for identification and differentiation of bacteria, microscopic and molecular methods, Indirect identification of infectious agents.

Module VI: Applied Microbiology and antimicrobial therapy: Microbiology of food-food spoilage, controlling food spoilage, types of food borne diseases, microbiology of fermented food, Applied environmental microbiology- water purification and sanitary analysis. Biodegradation, bioremediation, bioaugumentation. Antimicrobial Drugs-Interaction between drugs and microbes, antimicrobial action of important antibiotics-Penicillin, Streptomycin, Tetracyclin, Chloramphenicol and Rifampicin, Antibiotic resistance.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Pelczar, M. J., E. C. S. Chan, and N. R. Krieg. *Microbiology. Fifth edition, Tata Mcgraw-hill Publishing Company Ltd., New Delhi* (2004).
2. Willey, J. M. *Prescott, Harley, and Klein's Microbiology-7th international ed.*: McGraw-Hill Higher Education, 2008.
3. Pommerville, Jeffrey. *Alcamo's fundamentals of microbiology: Body systems*. Jones & Bartlett Publishers, 2012.
4. Microbiology by Tortora, Funke and Case.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-CC-514	Credits: 3

NAME OF THE COURSE: PHYSIOLOGY & SPECIALIZED TISSUES

AIM: To study the basic anatomy and physiological aspects of organ systems, organs and tissues of the human body.

OBJECTIVE: To study how foods are digested and absorbed, to help in study anatomy, physiological and biochemical functions of circulatory, respiratory, renal, muscular, and nervous system of the body. It also deals with characteristics and biochemical functions of specialized tissues like connective tissues epithelial tissues and photochemical reactions of eye**.**

COURSE OUTCOME

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

CO1: Assessment of digestion and absorption of macro and micro nutrients of food by gastrointestinal tract (E)

CO2: Create knowledge on the different types of epithelial, connective tissues and membranes in different organ system and biochemical role of eye (C)

CO3: Memorize blood components and how gaseous exchange occur in lungs, respiratory adaptation and the role of hemoglobin (R)

CO4: Critically analyze and discuss the structure, muscle proteins and molecular events of muscle contraction (An)

CO5: Comprehend how neuron and synapse transmit nerve impulses and path to brain (U)

CO6: Appreciate the role of kidney in urine formation and detoxification mechanism occurring in the liver (U)

COURSE CONTENT

Module I: Digestion and Absorption: Gastrointestinal tract (GIT) - Salivary gland, stomach, pancreas, intestine, liver, gall bladder- structure, secretions, composition and physiological functions. Secretion of digestive enzymes as zymogen- mechanism of secretion, activation and regulations by secretogogues - gastrointestinal hormones. Digestion and absorption of carbohydrates - action of endosaccharidases and exosaccharidases, glucose transporters. Digestion and absorption of proteins: action of endopeptidases, exopeptidases, amino acid transporters. Digestion and absorption of lipids: role of bile acids, and bile salts, lipases, colipase, micelle formation, Digestion and absorption of nucleic acid and nucleoproteins.

Module II: Epithelial Tissue, Connective Tissue, Membranes and Eye: Epithelial tissue - general character and functions, classification – simple and stratified. Connective tissue – areolar tissue, adipose tissue, white fibrous tissue, yellow elastic tissue, recticular tissue, lymphoid tissue, cartilage, – structure and function. Reticuloendothelial system. Membranes - cutaneous, mucous membrane, serous membrane, endothelium, synovial membrane. 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 III: Biochemistry of Blood and Respiration: Composition of blood, Plasma proteins, Formed elements - overview, RBC - erythropoiesis, biochemical information and principal proteins of red cell membrane, synthesis of hemoglobin, catabolism of hemoglobin,

formation of bile pigments, Iron metabolism, Blood coagulation - hemostasis, thrombosis, clotting factors, activation of platelets, formation of fibrin, fibrinolysis, anticoagulants. Haemoglobin – structure, different types of Hb, transport of oxygen, oxygen dissociation curve and Bohr Effect, factors influencing combination of oxygen with Hb, transport of carbon dioxide - Isohydric and chloride shift, mechanism of hemoglobin action.

Module IV: Biochemistry of Muscle: 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, Ca^{2+} ATPase, Relaxation, Role of NO in muscle relaxation, sources of energy for muscular work.

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.

Module VI: Renal Function and Liver detoxification: Structure and function of nephron, Renal blood flow and its importance, Formation of Urine- Ultrafiltration, glomerular filtration rate, tubular reabsorption, threshold substances, tubular secretion. Composition of urine-normal and abnormal, Osmoregulation, Hormonal regulation of kidney. Biotransformation reaction - phase I and phase II, microsomal and non-microsomal metabolism of drugs – role of cytochrome P450 enzymes and subtypes.

Diseases related to these topics are not included.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. 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.
2. Devlin, Thomas M. Textbook of biochemistry: with clinical correlations. John Wiley & Sons, 2011.
3. Hall, John E. Guyton and Hall textbook of medical physiology. Elsevier Health Sciences, 2010.
4. Ganong, W. H. Review of Medical Physiology. Appleton and Lange 1999.
5. White, A., P. Handler, and E. L. Smith. Principles of Biochemistry. New York, McGraw-Hill 1117 (1954).

6. Sherwood, Lauralee. Human physiology: from cells to systems. Cengage learning, 2015.
7. Biochemistry – U. Satyanarayana, U. Chakrapani , third edition, ISBN 81-87134-80-1

On-line Sources
https://fokt.pw/textbookofbiochemistry.pdf

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-CC-515	Credits: 4

NAME OF THE COURSE: LAB COURSE I (BIOCHEMICAL AND MICROBIAL TECHNIQUES)

Aim: To give hands on training in basic and advanced 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 OUTCOME:
After the completion of this course, the student will be able to:
CO1: Isolate, purify and detect biomolecules (Ap).
CO2: Perform light, phase contrast and fluorescent microscopy for the imaging of cells (Ap)
CO3: Perform UV-visible and fluorescent spectroscopy (Ap)
CO4: Separate molecules using chromatographic and electrophoretic techniques (Ap)
CO5: Conduct sterilization techniques and prepare microbial culture media (Ap)
CO6: Differentiate bacteria using different staining techniques (An)
CO7: Isolate pure culture and identify the organism using biochemical techniques(Ap)
CO8: Determine the quality of milk and water (E)

COURSE CONTENT

BIOCHEMICAL TECHNIQUES
Module I: General scheme for Isolation, purification and detection of biomolecules. Methods for lysis of plant and animal cell. Use of detergents in isolation of membrane proteins. Lyophilisation. **Microscopy:** Light microscopy- Enumeration and viability testing of cells.

Phase contrast microscopy -Imaging live cells. Fluorescence microscopy- Specimen preparation and imaging.

Module II: Spectroscopy: Visible light, Ultraviolet and Fluorescence spectroscopy - representative experiments. **Chromatography**: Basic principles and applications of TLC, Paper chromatography, Molecular exclusion chromatography

Module III: Centrifugation: Density gradient centrifugation- Separation of cells. Ultracentrifugation - Sub-cellular fractionation and marker enzymes. **Electrophoresis:** Polyacrylamide gel electrophoresis (use of SDS) -separation and molecular weight determination of proteins. Agarose gel electrophoresis- separation of nucleic acids. Isoelectric focusing.

MICROBIAL TECHNIQUES

Module IV: Sterilization techniques - Chemical agents for the control of microbial growth. Physical agents for the control of microbial growth. **Preparation of media:** Liquid, solid, and semi solid media. (Deep, Slant and plate preparation).

Module V: Staining techniques: Simple, Differential and Special staining. **Motility test:** Hanging drop method. **Pure culture techniques**: Streak plate, Pour plate. **Total viable count determination** - streak plate, pour plate.

Module VI: Biochemical tests for identification: IMViC reactions, Oxidase, catalase, Urease, Carbohydrate fermentation. **Detection of enzyme activity**- amylase, caseinase, Phosphatase test for the quality of milk. **Water analysis**.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Practicals evaluation
- Record evaluation

LEARNING RESOURCES

References

1. Scopes, Robert K. *Protein purification: principles and practice*. Springer Science & Business Media, 2013.
2. Osterman, Lev Abramovich. *Methods of protein and nucleic acid research: Chromatography*. Springer-Verlag, 2012.
3. Birnie, George David, and David Rickwood, eds. *Centrifugal separations in molecular and cell biology*. Butterworth-Heinemann, 2014.
4. Wilson, Keith, and John M. Walker. *Principles and techniques of practical biochemistry*. Cambridge University Press, 2000.
5. Goldman, Emanuel, and Lorrence H. Green, eds. *Practical handbook of microbiology*. CRC Press, 2015.
6. Dubey, R. C., and D. K. Maheshwari. *Practical microbiology*. S. Chand, 2002.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-DE-516	Credits: 2

NAME OF THE COURSE: METHODS IN RESEARCH

AIM: The course is designed to act as an introduction to students on the fundamentals of scientific aptitude and analytical skills in research, issues of ethics and plagiarism.

OBJECTIVES: To nurture analytical skills and awareness on various aspects of research in biochemistry.

COURSE DESCRIPTION

The course introduces students to the fundamentals of scientific aptitude and analytical skills in research, issues of ethics and plagiarism.

COURSE OUTCOME

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

CO1: Define the purpose and scope of research methodology (R, U)

CO2: Develop an understanding on various kinds of research, objectives of doing research, research process, research designs, sampling (U) and to explore research methodology seen in literature (E)

CO3: Propose a research design and identify different methods to conduct a research project (C)

CO4: Understand the need to develop a research methodology for the research question (U)

CO4: Nurture analytical skills and awareness on various aspects of research in biochemistry (C)

CO5: Identify good laboratory practices (E)

CO6: Gain knowledge in statistical techniques used in data analysis (Ap)

CO7: Understand the ethics in research involving human samples, embryo and stem cell research (U) and to identify plagiarism and data fabrication (E)

COURSE CONTENT

Module I: Research Methodology: Definition, purpose - relevance and scope, Motivation and objectives -Research methods *vs* Methodology. Types of research- pure versus applied, incremental versus innovative; multidisciplinary research. s; Importance of literature review in defining a problem, Formulation of research objectives; Hypothesis, Research design- Meaning and need- induction - deduction.

Module II: Biostatistics: Measures of central value - Mean, median and mode. Statistics of Dispersion- SD and SEM; Coefficient of variation; Simple correlation and regression. 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-way ANOVA.

Module III: Bioethics involving research on Animals: 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.

Module IV: 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: Good Laboratory Practices: Management of chemicals- corrosive, inflammable and oxidizing. Measures to minimize fire and chemical hazards. Efficient management of reagents and materials. Personnel training and laboratory management. Biosafety with hazardous materials and waste management.

Module VI: 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.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Research Methodology: Methods and Techniques. C.R. Kothari, New Age International, 2004.
2. Practical Research: Planning and Design. Paul D. Leedy, Jeanne Ellis Ormrod, Prentice Hall Publications. 2004.
3. Brody, B.A. (1998). The Ethics of Biomedical Research: An International Perspective. Oxford University Press: NY.
4. Hart, L.A. (Ed.) (1998). Responsible Conduct with Animals in Research. Oxford University Press: NY.

On-line Sources

1. https://www.e-ir.info/2017/01/05/online-resources-research-methods/
2. https://study.sagepub.com/kumar5e
3. https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=51427&printable=1

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-DE-517	Credits: 2

NAME OF THE COURSE: RADIOACTIVITY AND RADIATION BIOLOGY

AIM: To introduce the students to the theoretical aspects of radioactivity and radiation biology.

OBJECTIVE: **T**he course is designed to act as an introduction to students on the principle and applications of radiation and the effects of radiation on health.

COURSE OUTCOME

This course on radioactivity and radiation biology is aimed at providing an introduction to how different types of radiation affect matter and body. After the completion of this course, the student will be able to:

CO1: Describe a radioisotope (R)
CO2: Differentiate between ionizing and non-ionizing radiations and their consequence o exposure (An)
CO3: Conceptualize the different mechanisms of biological effects of radiation (R)
CO4: Appreciate the importance of PPE and development of radiation countermeasures (U)
CO5: Describe the use of radioactivity in treatment of health disorders like cancer (R)
CO6: Demonstrate proper use of procedures of protection from sources of radiation exposure (E)

COURSE CONTENT

Module I: Radioactivity: Introduction, Stable and unstable nuclei- radioactive decay, Types of radioactive decay and emissions: alpha, beta, x-ray and gamma-ray, physical properties of radiation- penetration potential and energy, background radiation and sources of radiation exposure, Units of radioactivity.

Module II: Applications of Radioactivity in Research and Health: Radioisotopes in biomedical research- isotopes of carbon, hydrogen, sulphur, iodine, etc. Contributions to progress of Biochemistry. Radiation oncology- applications of radiation in Medicine- x-ray and gamma knife.

Module III: Biological Effects of Radiation: ARS (Acute radiation syndrome) – target organs affected: gastrointestinal, hematopoietic and central nervous system toxicity. Symptoms and factors affecting lethality.

Module IV: Chronic Radiation Exposure: Chronic radiation exposure- definition. Limits of exposure, biology of endothelial tissue damage, chronic radiation induced cancer and bystander effect.

Module V: Radiation Safety: Personnel protective equipments (PPE) - protective apparels specific to types of radiation, Personnel monitoring equipments - TLD plates, Factors affecting dosage - time, distance and time, Management of radioactive waste from nuclear power plants.

Module VI: Radiation Hazard and Countermeasures: Incidence of mass and limited radiation exposure accidents - Chernobyl, Fukushima and Delhi, Scenario of pre and post exposure management- first responders vs population, Radiation countermeasures- past, present and future potential.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
References

1. Radiation Health and Dosimetry: An Introduction to Health Physics. Michael B. Stabin. 2007.
2. Radiation Protection in Medical Radiography. Mary Alice Shearer, Paula Visconti and Russell Ritenour. 2010.
3. Atoms, Radiation and Radiation Protection. James E. Truner. 2007.
4. The Radiation Biology of the Vascular Endothelium. David B. Rubin. CRC Press, 1998.

On-line Sources

1. https://www.iaea.org/resources/safety-standards
2. https://www.iaea.org/publications/search/type/human-health-series

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: BCH-CC-521	Credits: 3

NAME OF THE COURSE: 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.

COURSE OUTCOME:
After the completion of this course, the student will be able to:
CO1: Describe nomenclature and classification of enzymes (R)

CO2: Apply the knowledge on isolation and purification of enzymes for practical purpose (Ap)
CO3: Predict possible catalytic mechanism of a given reaction type (E)
CO4: Apply knowledge on enzyme kinetics for laboratory and research purpose (Ap).
CO5: Compare different types of enzyme inhibition and its kinetics (E)
CO6: Describe the major applications of enzymes in industry and medicine (R)
CO7: Understand the principles of enzyme immobilization techniques (U)
CO8: Describe the role of different coenzyme involved reactions (R)
CO9: Predict the type of enzyme inhibition from kinetic data (E)
CO10: Calculate and express the activity of enzymes in a reaction (E)

COURSE CONTENT

Module I: Classification, Purification and Active Site: General introduction, Nomenclature and classification of enzymes, isolation and purification of enzymes – by different methods, criteria of purity - specific activity. Enzyme units - Katal, IU. Active site - determination of active site amino acids - chemical probe, affinity label, and site-directed mutagenesis, Investigation of 3-D structure of active site.

Module II: Enzyme Kinetics and Inhibition: Kinetics of single substrate enzyme - catalysed reactions - Michaelis - Menten equation, importance of Vmax, Km, and turnover number; Lineweaver - Burk plot and other plots. Kinetics of bi substrate enzyme - catalysed reactions - Ping-pong bi-bi, random order and compulsory order mechanism. Reversible inhibition - competitive, uncompetitive, noncompetitive, mixed, substrate and allosteric inhibition. Irreversible inhibition.

Module III: Mechanism of Enzyme Action: Enzyme specificity, 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, lvsozyme, and ribonuclease.

Module IV: Enzyme Regulation: 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. Isoenzymes-LDH. A brief account of ribozymes and Abzymes.

Module V: Coenzymes: Coenzymes - prosthetic group, classification - vitamin and nonvitamin coenzymes, thiamine pyrophosphate –role enzyme catalysis, FMN and FAD –role in oxidation and reduction of flavin enzymes, NAD and NADP role in enzyme catalysis, PALP and PAMP - role of PALP in transamination and decarboxylation reaction, Coenzyme A involved reactions, biotin - carboxylation reaction, folate coenzymes, coenzymic role of vitamin Bl2 .

Module VI: Enzyme Technology: 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. Clinical enzymology - Enzymes as thrombolytic agents, anti-inflammatory agents, digestive aids.

Therapeutic use of asparginase, streptokinase. Diagnostic enzymes. Immobilization of enzymes and their applications.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
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).
3. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications. Second edition. New York, 2001.
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.

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	**Course Code: BCH-CC-522**	**Credits: 3**

NAME OF THE COURSE: METABOLISM I

AIM: This course is aimed at providing an insight into various metabolic pathways operating in living cells with special stress on carbohydrate, lipid metabolism and the electron transport chain.

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

COURSE OUTCOME:
After completion of the course, students shall be capable of-

CO1: Explain the metabolism of carbohydrates (R, U).
CO2: Detailed study on form of carbohydrate and significance (U)
CO3: Comprehend an overview on the oOligosaccharide Metabolism (U)
CO4: Illustrate the structure of mitochondria and how energy production occur in the organelle (Ap)
CO5: Compare and contrast aspects of lipid metabolism (An)
CO6: Comprehend the role of oxidative phosphorylation in bioenergetics and ATP generation (E)

COURSE CONTENT

Module I: Carbohydrate Metabolism: Overview of glycolysis and gluconeogenesis pathway. Detailed study of key enzymes and mechanism of reciprocal regulation. Anaerobic and aerobic adaptation significance. Cori cycle. Overview of citric acid cycle. Detailed study of regulatory mechanism and energetics. Importance of pyruvate dehydrogenase. Pentose phosphate pathway- significance and regulation machinery. Metabolism of galactose and fructose. Glyoxylate cycle- significance.

Module II: Metabolism of Glycogen: Storage form of carbohydrate and significance. Overview of glycogenesis and gluconeogenesis- detailed study of hormonal regulation and role of secondary messengers. Mechanism of blood glucose maintenance. Mechanisms to avoid futile cycles.

Module III: Oligosaccharide Metabolism: Biosynthesis of mucopolysaccharides- hyaluronic acid, chondroitin sulfate, dermatan sulfate, heparin and keratin. Metabolism of mucopolysaccharides, glycoproteins and proteoglycans.

Module IV: Lipid Metabolism: Biosynthesis of fatty acids – fatty acid synthase and regulation of fatty acid synthesis. Oxidation of fatty acids – alpha, beta and omega oxidation. 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. Metabolism of lipoproteins, prostaglandins.

Module V: Bioenergetics: Overview of thermodynamics, Relationship between G and Keq. High energy compounds, standard free energy of hydrolysis of ATP, structural basis of the group transfer potential of ATP. Oxidation reduction potential, different types of oxidation reduction reactions. Ultra-structure of mitochondria, anatomy, enzymes. Electron transport chain, Thermodynamics of electron transport, oxygen electrode, components and different complexes in detail. Mobile electron carriers. Proton transport during electron flow, inhibitors of electron transport chain. Mitochondrial electron transporters and shuttle systems. Electron transport in other membrane system- microsomal electron transport chain.

Module VI: Oxidative phosphorylation: History, mechanism, Chemical Chemiosmotic and conformational coupling, Proton gradient generation, redox loop, Q cycle, Bacteriorhodopsin. Proton pumping. Components of ATP synthase (F_1 F_0 ATPase). Binding charge mechanism of ATP synthase. Control of oxidative phosphorylation, phosphorylation potential.co-ordinated control of ATP production, inhibitors, P/O ratio, Pasteur effect, uncouplors, hormonally controlled uncoupling in Brown adipose tissue-UCP, Ionophores. Bioluminescence-

Bioluminescence cycle with fire fly as an example. Physiological implication of aerobic versus anaerobic metabolism, IF1 inhibition of F_1F_0 ATPase during hypoxia.

Diseases related to these topics are not included.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
References

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.

On-line Sources

1. https://www.longdom.org/bioenergetics.html
2. https://www.ncbi.nlm.nih.gov/books/NBK21208/
3. https://www.ncbi.nlm.nih.gov/books/NBK22416/

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: BCH-CC-523	Credits: 2

NAME OF THE COURSE: METABOLISM II

AIM: The course is designed to give the students insight into the metabolic fate of steroids, amino acids and nucleic acids, and their secondary derivatives in the human body.

OBJECTIVE: The main objective of this course is to make students familiar with the various control and metabolic regulation (hormonal and non-hormonal) and integrating mechanisms of diverse biochemical events in different metabolic processes.

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

CO1: Discuss the important biochemical steps in the metabolism of steroids, amino acids and nucleic acids (E)
CO2: Describe sterols and its role in the synthesis of vitamin D and hormones (R)
CO3: Identify the interrelationship between various metabolic pathways of the body (R)
CO4: Appreciate the key regulatory steps of metabolism and mechanisms of regulation (U)
CO5: Understand how hormones influence metabolic pathways (U)
CO6: Use the knowledge obtained in intermediary metabolism in addressing advanced analysis and research objective in their higher studies (Ap)

COURSE CONTENT

Module I: Steroid Metabolism: Cholesterol – Biosynthesis and regulation- HMG-CoA reductase and transcriptional regulation mechanisms. Biosynthesis of cholesterol derivatives, bile acids, vitamin D and steroid hormones. Phytosterols- types and synthesis.

Module II: Steroid transport and Elimination: Lipoproteins- Chylomicrons, VLDL, LDL and HDL. Composition of lipoproteins and their characteristic Apo proteins. Cholesterol transport and reverse cholesterol transport. Statins and drugs to lower hypercholesterolemia.

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

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

Module V: Nucleic Acid Metabolism: Nucleotide biosynthesis- de novo and salvage pathways for biosynthesis of purine and pyrimidine. Mechanisms of feedback regulation. Biosynthesis of dNTPs. Mechanism of purine and pyrimidine catabolism.

Module VI: Metabolism interrelationship: Integration of metabolic pathways- overview. Feedback and reciprocal regulation of metabolic pathways. Hormonal regulation.

Diseases related to these topics are not included.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Biochemistry. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer.

2. Lehninger Principles of Biochemistry. David L. Nelson and Michael M. Cox.
3. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin.
4. Biochemistry. Donald Voet and Judith Voet.

On-line Sources

1. http://metabolomicssociety.org/resources/tutorials
2. https://www.sciencedirect.com/book/9780126754117/biochemistry-of-metabolism

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: BCH-CC-524	Credits: 2

NAME OF THE COURSE: NUTRITIONAL BIOCHEMISTRY

AIM: To study the nutritional value of dietary foods.

OBJECTIVE: To get the idea about the balanced diet, their energy metabolism, daily requirement, nutritional aspects dietary foods- carbohydrates, lipids, proteins, vitamins, minerals, oxidative stress and antioxidants.

COURSE OUTCOME

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

CO1: Describe nutritive and energy value of food (R)
CO2: Explain the importance of a balanced diet (An)
CO3: Understand and explain how nutrients delivered to the body are metabolized (U)
CO4: Comprehend how energy metabolism differs among tissues (U)
CO5: Explain how absence of adequate vitamins and minerals lead to disease development (An)
CO6: Discuss the role of free radicals in the body and understand how antioxidants can counter the effect of free radicals (E)

COURSE CONTENT

Module I: Nutritive value of foods: Nutritional classification of foods- body building foods, energy yielding foods, protective foods. Balanced diet, bland diet, nutrient density, empty calorie food, Specific Dynamic Action (SDA) of foods.

Module II: Energy value of foods: Determination of Energy value using Bomb calorimeter- Respiratory Quotient (RQ), Basal metabolism, Determination of Basal Metabolic Rate (BMR),

Factors affecting BMR, Determination of energy metabolism during work, Energy expenditure for various types of activities, Recommended Daily Allowance (RDA).

Module III: Nutritional aspects of carbohydrates and lipids: Nutritional aspects of the carbohydrates, classification of dietary carbohydrates, functions. Dietary fibres- Sources, components, physiological and metabolic effects, functions. Nutritional aspects of lipids, fats in the body and foods, functions, Essential fatty acids, visible and invisible fat, obesity.

Module IV: Nutritional aspects of proteins - Dietary sources, requirements, utilization and functions. Essential amino acids, Limiting amino acids. Determination of nutritive value of proteins, Biological value of proteins (BV), Protein efficiency ratio (PER), Digestability coefficient, Net protein Utilization, Net Protein Ratio (NPR), Chemical Score, Protein energy malnutrition- Kwashiorkor, Marasmus.

Module V: Vitamins and minerals: Food sources, requirement, biochemical functions, deficiency disorders, hypervitaminosis. Minerals- Major and minor minerals, sources, requirements, functions and deficiency.

Module VI: Oxidative stress and antioxidants: Free radicals- generation, damage, lipid peroxidation – initiation, propagation and termination phases, Antioxidants- enzymatic antioxidants (superoxide dismutase, glutathione peroxidase, glutathione reductase, catalase) and non-enzymatic antioxidants (vitamins, polyphenols).

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Swaminathan, M. S. Food science, chemistry and experimental foods. Bangalore Print. & Publishing Company, 1987.
2. Nelson, David L., Albert L. Lehninger, and Michael M. Cox. Lehninger principles of biochemistry. Macmillan, 2008.
3. Bamji, Mahtab S., Kamala Krishnaswamy, and G. N. V. Brahmam. Textbook of human nutrition. Oxford & IBH, 2009.
4. Srilakshmi B. Nutrition Science. New Age International (P) Ltd., 2015.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: BCH-CC-525	Credits: 2

NAME OF THE COURSE: CLINICAL BIOCHEMISTRY

AIM: To study the diseases/disorders related to metabolism of macromolecules, tropical disorders and various clinical function tests.

OBJECTIVE: To study the diseases related to digestion and absorption of foods and to study the metabolic errors in enzymes of carbohydrates, lipids, amino acids, nucleic acids and hemoglobin. This course enables to give the consequences, biochemical, clinical features, diagnosis and treatment of metabolic diseases of day today life. This study also introduces tropical disorders, liver diseases and all routinely used clinical parameters.

COURSE OUTCOME

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

CO1: Understand the etiology of diseases that occur due to improper digestion and absorption (U)

CO2: Recognize diseases related to carbohydrate, lipid, protein and nucleic acid metabolism (R)

CO3: Discuss and evaluate the pathology of each metabolic disorder with recent advanced signaling pathways (E)

CO4: Identify the diagnosis of clinical disorders through biomarkers (An)

CO5: Appreciate different tropical diseases and how these are transmitted (R)

CO6: Apply the role of clinical biochemistry in the screening, diagnosis, treatment and research (Ap)

COURSE CONTENT

Module I: Diseases related to digestion and absorption of foods: Gastritis, ulcers – peptic ulcer, Zollinger Ellison syndrome, Achlorhydria, Pancreatitis, Lactose intolerance, Disaccharidase deficiency, Disaccharidurıa, monosaccharide malabsorption, Steatorrhea, Chyluria, Cholelithiasis, and Sprue.

Module II: Diseases related to Carbohydrate Metabolism: Hypo and Hyper glycemia, glycaemic index, Diabetes mellitus - Risk factors, biochemical and clinical features, Symptoms, Diagnosis, Treatment. Pentosuria, Fructosuria, Galactosemia, Galactosuria, Hereditary fructose intolerance, Fructose-1, 6-diphosphatase deficiency, Diabetes insipidus, Glycogen storage diseases, Mucopolysaccharidosis.

Module III: Diseases related to Lipid Metabolism: Hypo and Hyperlipoproteinemia, Spingolipidosis, Hypercholesterolemia, Atherosclerosis- Risk factors, Biochemical and Clinical features, Symptoms, Diagnosis, Treatment -. Hypolipidemic drugs**.**

Module IV: Diseases related to Amino acid Metabolism: Phenylketonuria, Tyrosinemia I and II, Albinism, Alkaptonuria, Maple syrup urine disease, methyl malonic acidemia, Homocystinuria, defect in gamma glutamyl cycle.

Module V: Diseases related to Nucleic acid and Hemoglobin Metabolism: Gout, Lesch-Nyhan syndrome, Hyper and Hypouricemia, Orotic aciduria. Abnormal hemoglobin and their

deficiencies - Macrocytic and microcytic anemia, Sickle cell anemia, Thalassemia, Hereditary methemoglobinemia. Disorders of metabolism in brain, Neurodegenerative diseases and their biochemical basis.

Module VI: Tropical, liver diseases and routinely-used clinical parameters: Tropical diseases - Malaria, Filariasis, Tetanus, Leprosy – Transmission, Clinical features, Diagnosis and Treatment. Liver diseases – Porphyria, Jaundice, Liver cirrhosis, Liver and kidney functions tests.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
References

1. Nelson, David L., Albert L. Lehninger, and Michael M. Cox. Lehninger principles of biochemistry. Macmillan, 2008.
2. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin.
3. Bishop, Michael L., Edward P. Fody, and Larry E. Schoeff, eds. Clinical Chemistry: Principles, Techniques, and Correlations. Lippincott Williams & Wilkins, 2013.
4. Bahr, Manson, and D. R. Bell. "Manson's Tropical Diseases." The English Languages Book Society, Billiere, Tindall and Cassell, Ltd (1996).
5. Lawrence A.K. Amedeo J. P. and Steven C.K. Clinical Chemistry.

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: BCH-CC-526	Credits: 4

NAME OF THE COURSE: LAB COURSE II (CLINICAL BIOCHEMISTRY AND ENZYMOLOGY)

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

CO1: Perform liver function test (An)
CO2: Estimate cardiac markers (An)
CO3: Analyze biochemical markers of diabetes (An)
CO4: Perform thyroid function test (Ap)
CO5: Trained on handling and isolation of enzymes from biological sample (Ap)
CO6: Assay enzymes and express the activity in different units (E)
CO7: To determine the kinetic parameters of any enzyme (An)
CO8: To determine the optimum pH, temperature, effect of activator/inhibitors on enzyme activity (An)

COURSE CONTENT

Module I: Liver Function Tests - Acid and alkaline phosphatase, ALT, AST, Bilirubin, protein, albumin, A/G ratio. Kidney Function Tests - Urea, uric acid, creatinine.

Module II: Cardiac Markers - Lipid profile (Cholesterol, Triglyceride, HDL-C, LDL-C), LDH, CRP, CPK.

Module III: Biochemical markers of Diabetes Mellitus - Blood glucose (RBS, FBS, PPBS), Glycosylated Hb, Glucose tolerance test.

Module IV: Thyroid function test – TSH, T3 and T4**.** Inborn errors of metabolism - β-hexosaminidase, β-Glucuronidase, glucokinase, Phenyl alanine.

Module V: Determination of enzymatic activity in biological samples - serum/plasma, liver, plant extracts etc - Amylase, Trypsin, Urease. Purification of enzymes.

Module VI: Enzyme kinetics - Amylase, Trypsin, Urease (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 catalyzed reaction, Effect of activators/electrolytes on velocity of enzyme catalyzed reaction.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Practicals evaluation
- Record evaluation

LEARNING RESOURCES

References

1. Bisswanger, Hans. *Practical enzymology*. John Wiley & Sons, 2013.
2. Wilchek, Meir, and Edward A. Bayer. "Methods in enzymology." (1990).
3. Sawhney, S. K., and Randhir Singh. *Introductory practical biochemistry*. Alpha Science Int'l Ltd., 2000.
4. A textbook of practical biochemistry- Joshi A. Reshmi
5. Practical clinical biochemistry- Harold Varley.

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: BCH-DE-527	Credits: 2

NAME OF THE COURSE: BIOINFORMATICS

AIM: To introduce the nature, scope, techniques and applications of bioinformatics to students.

OBJECTIVE: A brief awareness on the scope of Bioinformatics, the various tools, online resources and applications viz protein structure prediction and drug designing, 3D visualization, sequence aligning and retrieval of information from databases.

COURSE OUTCOME
After the completion of this course, the student will be able to:
CO1: Gain understanding of the basic concepts of bioinformatics (U)
CO2: Describe biological databases that provide information about nucleic acids and proteins (R)
CO3: Describe how to use bioinformatics for biological data analysis(R)
CO4: Discuss sequence analysis and microarray (E)
CO4: Attain knowledge about how to use free resources in the internet to visualize protein in 3D, protein sequence aligning and retrieval of information from biological databases (U)
CO5: Apply knowledge in protein structure prediction and drug designing (Ap)

COURSE CONTENT

Module I: Scope of Bioinformatics: Definition, history, Applications-evolutionary relationships -Drug discovery, genetic basis of disease- -personalized medicine and gene-based diagnostics. Introduction to biological databases - Types of databases. Specialized databases, Protein structure classification databases: SCOP and CATH, OMIM, Sequence retrieval system (SRS), ENTREZ.

Module II: Sequence analysis: Dot plot, local and global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm and Gap penalty. Sequence similarity search tools, FASTA and BLAST, PSI-BLAST and significance of alignments: E value, scoring matrices - PAM and BLOSSUM. Multiple sequence alignment- the consensus, computational complexity, manual methods, simultaneous methods, progressive methods, CLUSTAL W.

Modul III: Phylogenetics: Concept, Building methods- Distance and parsimony methods; Clustering methods. Rooted and unrooted trees, Bootstrapping, PHYLogeny Inference Package (PHYLIP)

Module IV: Microarrays: 2D gel –basics- principle technique-applications-Principles of genome annotation: Finding genes by computer-Detecting ORF-Detecting exons and introns-introduction to gene prediction in prokaryotes and eukaryotes using softwares.

Module V: Structural bioinformatics: Protein structure databases and visualization tools-structural alignment. Aligning 3D Structures-Predicting Protein Structure-Specialized Structural Regions- Secondary Structure Prediction-Tertiary Structure Prediction- Protein structure prediction methods- Comparative modeling, Threading. Abnitio, -RMSD-, introduction to common some structure prediction software packages.

Module VI: Computer aided drug design: Introduction to drug discovery -Drug discovery pipeline, structure-based drug design - ligand designing and optimization, docking, Quantitative Structure Activity Relationship (QSAR)- introduction to molecular docking software- applications of molecular modelling in drug.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates

LEARNING RESOURCES

References

1. Bioinformatics concepts, skills and applications- C S Rastogi, N Mendirattar and Y Rastogi, CBS Publishers, New Delhi.
2. Bioinformatics - Westhead, Parish and Twynan, Bios Scientific publishers, Oxford.
3. Introduction to Bioinformatics: A theoretical and practical approaches- S A Krawetzt, D DWomble, Human Press.
4. Bioinformatics: Sequence and genome analysis – D W Mount, CSH Lab Press.
5. Internet for molecular Biologist – S R Swindell, R R Miller, G S A Myers, Horizon Scientific Press.

On-line Sources

1. https://books.google.co.in/books?id=Guj1AgAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
2. https://ijpsr.com/bft-article/role-of-computer-aided-drug-design-in-drug-development-and-drug-discovery/?view=fulltext
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6155886/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: BCH-DE-528	Credits: 2

NAME OF THE COURSE: TISSUE ENGINEERING

AIM: To bring an advanced level of understanding on the applications of tissue engineering to students.

OBJECTIVE: To comprehend the ideas, concepts and techniques from basic to preclinical to clinical science of an emerging multidisciplinary medical field 'Tissue Engineering' - to develop functional tissue or organ substitutes for the purpose of repairing, replacing, maintaining, or enhancing organ function at affordable cost.

COURSE OUTCOME:

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

CO1: Describe the concept of tissue engineering (E)

CO2: Discuss structure-function relationship of normal and pathological mammalian tissue during condition like inflammation and wound healing (E)

CO3: Describe biological substitutes for restoring, maintaining or improving a tissue or organ function (E)

CO4: Understand the nature of stem cells and use stem cells for tissue engineering (U)

CO5: Identify, formulate and design, to create living tissue to replace or repair tissue, a failing organ or a damaged or missing body part (R)

CO6: Understand the strategy in drug delivery, cell or tissue transplantation and tissue regeneration (U)

CO7: Evaluate and interpret tissue response to implants/medical device and comprehend ideas, concepts and techniques from basic to preclinical to translational medicine (E)

CO8: Obtain understanding of the ethical processes and regulations pertaining to tissue engineering (U)

COURSE CONTENT

Module I: Biomaterials: Biomaterial; Biocompatibility; Biomaterial aspects of bioregenerative engineering – biological materials; polymers; metals, ceramics and composites.

Module II: Tissue Response to implants: Implantation in soft and hard tissue; Inflammation, Wound healing and the foreign body response; Tissue preparation; Evaluation of tissue response by Microscopy.

Module III: Tissue Engineering: Introduction to TE - History & scope; challenge, clinics and future perspectives. Types, structure; functional characteristics of stem cells and application of stem cells to regenerative engineering and medicine; cell identification, tissue scaffolds, tissue transplantation and functional tests.

Module IV: Applications of Tissue Engineering: Bone and Cartilage Tissue Engineering (Bones and cartilage; Skeletal disorders). Skin Tissue engineering (Skin, burn dressings).

Module V: Regulations and Ethics: Ethical issues; Standards; The Regulatory path from Concept to Market; Tissue-engineered medical products and industry.

Module VI: Biosafety Evaluations: Evaluation criteria for biosafety and biocompatibility.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates

LEARNING RESOURCES
References

1. Lanza RP, Langer R and Vacanti JP. Principles of Tissue engineering.

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER III	Course Code: BCH-CC-531	Credits: 4

NAME OF THE COURSE: MOLECULAR CELL BIOLOGY

AIM: To impart knowledge on molecular mechanisms which are the foundations of biological processes in cells and organisms, with an emphasis on eukaryotic cells.

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 and major cell organelles, 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, intercellular chemical messengers, receptor subclasses and their possible uses in cell signaling.

COURSE OUTCOME
After the completion of this course, the student will be able to:
CO1: Characterise prokaryotic and eukaryotic cells and its organelles (R)
CO2: Define processes occurring in cells like membrane transport and the mechanisms involved (R)
CO3: Describe major stages of important cellular processes like cell cycle and apoptosis (R)

CO4: Illustrate cell-cell interactions and molecular players involved (Ap)
CO5: Discuss receptor mechanisms and role played by cell surface receptors (E)
CO6: Elucidate protein sorting and roles played by vesicles, lysosomes, Golgi apparatus and endoplasmic reticulum (R)

COURSE CONTENT

Module I: Cell Structure and Transport Mechanisms: Cell theory, Ultrastructure of organelles, subcellular fractionation, Cytoskeleton organization- Microtubules, Microfilaments and intermediary filaments. Structure and function of plasma membrane, different models, Membrane proteins, Membrane lipids and membrane fluidity, Transport mechanisms-different types, Ion channels, Endocytosis, Exocytosis, Phagocytosis, Pinocytosis, Role of clathrin.

Module II: Extracellular Matrix and Cellular Interactions: Overview of Extracellular Matrix components – Glycoproteins, Proteoglycans, Fibronectin, Laminin, Cell adhesion molecules, Proteins involved in Cell – Cell communications. Cell matrix interaction, Integrins, Focal adhesion, Hemidesmosomes. Cell – Cell interaction, Cadherin, Ig Super family, Selectins. Adherens junctions and desmosomes. Tight junction, Gap junction, Plasmodesmata.

Module III: Cell Signalling: Signalling molecules, receptors and their functions– G protein coupled receptors, Receptor protein tyrosine kinases, Steroid hormone receptors, Non-Receptor protein tyrosine kinases, Nitric oxide, neurotransmitters, Growth factors, Eicosanoids. Intracellular signalling Pathways – Cyclic AMP, Cyclic GMP, IP3, Calcium, Ras and Raf, MAP kinase pathway, JAK/STAT Pathway. PPAR, ATP Binding Cassette Transporters, Toll like receptors.

Module IV: 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 V: Cell Cycle and Regulation: Cell division – Mitosis and Meiosis – Role of Cytoskeleton – Microtubules – Microfilaments and Intermediary filaments. Phases of Eukaryotic cell cycle. Regulation of cell cycle, Cyclins, MPF, Cyclin dependent kinases, Growth factors, Nuclear Laminins, inhibition of cell cycle progression, MPF and progression to Metaphase, Proteolysis and MPF, Regulation of MPF activity. Check points in cell cycle regulation.

Module VI: Apoptosis and Cancer: 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.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
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.

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER III	**Course Code: BCH-CC-532**	**Credits: 4**

NAME OF THE COURSE: 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 OUTCOME
After the completion of this course, the student will be able to:

CO1: Describe cellular processes like DNA synthesis, RNA synthesis and protein synthesis and how they relate to each other (R)

CO2: Discuss the Central dogma of molecular biology and its importance (E)

CO3: Define gene expression and how a stimulus can affect the expression of a gene (R)

CO4: Describe different regulatory mechanisms of gene expression (R)

CO5: Describe how RNA functions as genetic material in some organisms (R)

CO6: Explain how misfolded proteins cause diseases in the body (An)

CO7: Discuss the applications of molecular biology in the modern world like PCR, RNA interference, CRISPR-Cas9 (E)

COURSE CONTENT

Module I: Overview of DNA: Introduction to genetic material - DNA/ RNA as genetic material in bacteria, bacteriophage, virus; The structure and toplology of DNA and RNA molecules; Central dogma of molecular biology; Genes – structure of genes, gene families, gene expression, gene promoters, introns, exons, psuedogenes; DNA supercoiling; Complexity of genome – DNA denaturation, RNA renaturation, 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 evolution – DNA mutation, DNA damage, DNA repair; Detection and analysis of nucleic acids; DNA amplification

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 both prokaryotes and eukaryotes; Detailed mechanism of synthesis and processing of mRNA, rRNA and tRNA; RNA processing in eukaryotic cells; RNA Splicing- spliceosome machinery, role of ribozymes.

Module IV: Regulation of Transcription: Regulation of prokaryotic transcription, σ factor, RNA polymerase switching, operon, enhancer, promoters, co-activators, riboswitches; Structure of transcription factors; Role of transcription factors in regulating gene expression; Transcriptional activation – Glucocorticoid receptor; Transcriptional repression; Alternative splicing- trans splicing exon shuffling; Techniques used to understand genome sites that interact with transcription factor – Deletion mapping, DNA foot printing, genome wide location analysis

Module V: Genetic code and Translation: Overview of genetic code- codon, anticodon interactions, Wobble rules; Translation machinery – ribosomes tRNA, amino acyl tRNA synthetase – classification, second genetic code, prood reading activity of amino acyl tRNA synthetase; Detailed mechanism of translation initiation, elongation and termination;

Eukaryotic translation – initiation, elongation and termination; mRNA surveillance; Protein folding – molecular chaperons, ubiquitination, sumoylation.

Module VI: Regulation of Translation: mRNA specific regulatory proteins- repressor proteins, activator proteins; Global regulation of translation in mammalian cells – phosphorylation of components of protein machinery; Translation in virus infected cells; Translation and neurological disorders like amyloidosis, prion; Regulating gene expression – RNA interference, mechanism and applications; microRNA – its role in translational regulation and cancer; Manipulating cellular mRNA translation - Crispr-Cas technology.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

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.
3. Garrett, Reginald, and Charles Grisham. Biochemistry. Nelson Education, 6th edition 2017.
4. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of biochemistry." New York: John Wiley & Sons 5th edition 2016.
5. Karp, Gerald, and Nancy L. Pruitt. Cell and molecular biology: concepts and experiments. J. Wiley, 8th edition 2015.
6. Zubay, Geoffrey L., William W. Parson, and Dennis E. Vance. Principles of biochemistry: student study art notebook. Wm. C. Brown, 1995.
7. Lewin, Benjamin, and Gabby Dover. Genes v. Vol. 299. Oxford: Oxford University Press, 1994.
8. Lizabeth A Allison, Fundamental Molecular Biology, Blackwell publishing 2007.
9. Hadjiolov AA. The Nucleolus and Ribosome Biogenesis (Cell Biology Monographs, Vol 12) Springer Verlag 1985.
10. Harry F Baker, Rosalind M Ridley (Eds), Prion Diseases, Springer, 1996.
11. Morie A Gertz, Vincent S Rajkumar (Eds) Amyloidosis, Springer 2010.
12. Chang-Hui Shen Diagnostic Molecular Biology. Academic Press. Elsevier 2019.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER III	Course Code: BCH-CC-533	Credits: 2

NAME OF THE COURSE: PLANT BIOCHEMISTRY

AIM: This course aims to give a thorough knowledge on the plant secondary metabolites, the disease resisting mechanisms in plants, along with the basic biochemical processes occurring in plants.

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.

COURSE OUTCOME:

After completion of the course, students shall be capable to-

CO1: Define plant processes like photosynthesis (U).

CO2: Discuss the importance of photorespiration and electron transport chain in plants (An).

CO3: Explain the value of secondary metabolites produced in plants in pharmaceutical, food, agricultural industries and ecology (U).

CO4: Discuss the role of plant hormones and how these regulate plant functions (Ap).

CO5: Describe the process of photomorphogenesis and aging in plants (U).

CO6: Discuss host-pathogen interaction, plant resistance and disease development in plants (An).

COURSE CONTENT

Module I: Photosynthesis: Photosynthesis - Introduction, light and dark phase, structure of chloroplast, excitation of molecules by absorption of light, structure and properties of chlorophyll, Photochemical reaction system, photosynthetic electron transport chain, cyclic and noncyclic photophosphorylation - Calvin cycle, regulation, Hatch-Slack pathway (C4 pathway), Photorespiration, comparison of mitochondrial and photosynthetic electron transport chain.

Module II: Secondary metabolites: Phenols - Functions, Shikimate Arogenate Pathway, Phenyl Alanine/ Hydroxycinnamate pathway, Phenyl propanoids pathway, Hydroxycinnamate 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, Caffiene and Cocaine. Toxic secondary metabolites, secondary metabolites of medicinal importance.

Module III: Plant Hormones: Structure and function of plant hormones such as Ethylene, Cytokinins, Auxins, Indole Acetic Acid, Absicic acid, Florigin and Gibberlins. Photochemical and hormone control in plants.

Module IV: Photomorphogenesis: Phytochromes - Structure, properties, function. Mechanism of action of phytochromes, Calcium and Calmodulin mediated Pfr responses.

Module V: Senescence: Various levels of senescence, Factors affecting senescence, Mechanism of different biochemical changes during senescence, Senescence related to stress, Regulation of Senescence.

Module VI: Biochemical basis of Plant diseases: Host pathogen interaction, Mechanism of pathogenesis, Enzymes, Toxins, Mechanism of Plant resistance, Phytoallexins, Elicitors, Pathogen related proteins.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

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).

On-line Sources

1. https://en.wikibooks.org/wiki/Structural_Biochemistry/Lipids/Isoprenoids
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

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER III	Course Code: BCH-CC-534	Credits: 3

NAME OF THE COURSE: MOLECULAR 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 **s**erological reactions used in the diagnostic laboratory to detect interactions between antigens and antibodies.

COURSE OUTCOME:

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

CO-1: Understand the basics of immune system and the various cells and organs involved (U)
CO-2: Understand the concept of antigen-antibody interaction and their molecular aspects (U)
CO-3: Distinguish the various components of innate immunity and their mechanism of action (E)
CO-4: Evaluation of the role of B-lymphocytes in humoral immune response at the molecular level (E)
CO-5: Evaluation of the role of T-lymphocytes and Antigen-presenting cells in cell mediated immune response (E)
CO-6: Correlate serological reactions used in the diagnostic laboratory to detect interactions between antigens and antibodies (An)
CO7: Justify reasons for vaccination, immunization and immunotherapy (E)
CO8: Discuss the different immunodeficiency disorders that affect humans (E)
CO9: Explain monoclonal antibody production (An)

COURSE CONTENT

Module I: Overview of the Immune system: Introduction, historical perspective, 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. Cellular components of the immune system - Hematopoiesis, stem cells, granulocytes- Neutrophil, eosinophil, basophil and mast cell, Mononuclear cells - Lymphocytes, monocytes, macrophages, NK cells and dendritic cells.

Module II: Nature of Antigen and Antibody: Antigen: Concept of antigenic determinants and immunogens, factors that influence immunogenicity, Classes of antigen, Epitopes, Haptens. Antibody: Immunoglobulin genes, Molecular Structure - general features, light and heavy chains, Hyper variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes, Synthesis, Assembly and Expression of Ig molecules, Immunoglobulin superfamily.

Module III: Innate Immunity: Anatomical and physiological barriers, Soluble factors, PRR, PAMPs and DAMPs, Inflammation-characteristics, initiation of the inflammatory response, Recruitment of phagocytic cells, recognition by receptors, adhesion molecules, Chemotaxis, Phagocytosis, Acute inflammatory response, Role of innate immunity. Non-cellular

components of the immune system -Lipid mediators, Cytokines, Complement system, Acute phase proteins, Kinin system.

Module IV: Humoral Immunity: MHC molecules - genes, different classes, structure and function, Antigen processing and presentation: Endogenous and exogenous pathways. B cell development and selection, BCR, B-Cell maturation, activation, differentiation, generation of plasma cells and memory B cells, effector mechanism of humoral immunity.

Module V: Cell-mediated immunity : T cell development, structural organization of T cell receptors, T cell maturation, activation, differentiation, proliferation , B cell – T cell interaction, germinal centre reactions, class switch recombination, generation of $CD4^+$ and $CD8^+$ cell responses, primary and secondary immune responses, regulation of immune response, effector mechanism of cell-mediated immunity.

Module VI: Clinical Immunology: Antigen – antibody interactions - Affinity, avidity, cross reactivity, precipitation, agglutination reactions, complement fixation, HLA typing, leukocyte migration inhibition technique, delayed hypersensitivity techniques, cytotoxicity assay, Immunodiffusion, Immunoelectrophoresis, Immunofluorescence. Diagnostic techniques - RIA, ELISA, Western blotting, Flow cytometry and FACS. Monoclonal and polyclonal antibodies formation and applications. Immunodeficiencies**:** Hypersensitivity (Type I – IV), autoimmunity- organ specific and Systemic autoimmune diseases – Rheumatoid arthritis, Primary and secondary immune deficiencies. Immunotherapy: Vaccination and immunization – active and passive acquired immunity.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments
- Field work and survey

LEARNING RESOURCES

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.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-CC-535	Credits: 4

NAME OF THE COURSE: LAB COURSE III (TECHNIQUES IN MOLECULAR BIOLOGY, IMMUNOLOGY AND PHYTOCHEMISTRY)

AIM: The course is designed to provide students with hands on training in molecular biology and immunological techniques 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 molecular biology, 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 molecular biology, immunology and phytochemistry. After the completion of this course, the student will be able to:

CO1: Perform isolation of DNA from tissue sources and estimate the amount of DNA in sample (Ap)
CO2: Perform transformation of plasmid into E. coli (Ap)
CO3: Isolate plasmid and insert a DNA sequence into a vector plasmid (Ap)
CO4: Identify recombinant DNA by PCR amplification techniques (An)
CO5: Perform various immunological techniques like immunodiffusion, immunoelectrophoresis and ELISA (Ap)
CO6: Develop an analytical thinking on how to test a biological sample and derive data (An)
CO7: Comprehend classical and modern techniques to isolate phytochemicals from plants (An)
CO8: Would have acquired practical laboratory experience to expand understanding of biological processes and build a career (U)

COURSE CONTENT

MOLECULAR BIOLOGY

Module I: 1. Isolation of DNA from blood and liver., 2. Qualitative and quantitative analysis of extracted DNA- Spectrophotometric method, 3. Plasmid restriction mapping, 4. Insertion and ligation of foreign DNA in to vector plasmid.

Module II: 1. E. coli transformation with recombinant plasmid- heat shock method, 2. Screening of plasmid uptake – plate culture-based identification, 3. Recombinant plasmid isolation for E. coli broth culture

Module III: 1. PCR based identification of recombinant DNA insert., 2. Agarose gel electrophoresis of total, plasmid and recombinant plasmid isolates, 3. DNA sequencing-

conventional methods and next generation methods- overview, 4. Real-time PCR analysis of gene expression- demonstration.

IMMUNOLOGY

Module IV: 1. Immunodiffusion, 2. Immunoelectrophoresis, 3. Competitive ELISA.

PHYTOCHEMISTRY

Module V: 1. Extraction Methods- Choice of solvents based on polarity, 2. Extraction Procedure- Cold and Hot solvent extraction, 3. Qualitative analysis of secondary metabolites- Estimation of phenols, Estimation of Tannins, Estimation of alkaloids, Estimation of saponins

Module VI: 1. Separation techniques: Paper chromatography, Thin Layer Chromatography, Column Chromatography, Spectroscopic analysis of extract fractions for phytochemicals.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENTS

Suggested Classroom Activities:

- Practicals evaluation
- Record evaluation

LEARNING RESOURCES

References

1. Short Protocols in Molecular Biology. Frederick M. Ausubel, Roger Brent, Robert E. Kingston and David D. Moore. 2002.
2. Methods in Molecular Biology and Protein Chemistry: Cloning and Characterization of Enterotoxin Subunit. Brenda D. Sprangler. 2002.
3. Current Protocols in Molecular Biology. Wiley Online Library. 2013.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER III	Course Code: BCH-DE-536	Credits: 2

NAME OF THE COURSE: DEVELOPMENTAL BIOLOGY

AIM: The life science discipline Developmental Biology (DB) aims to enable the students to give the knowledge on how an organism is developed from a single cell.

OBJECTIVE: The objective of this course is to understand the processes that lead from the fertilization of an egg cell to the formation of a well-structured and functional multi-cellular

organism. This course aims to make students aware of basic concepts of development, gamete formation and fertilization, early and post stages of development of an organism and the signalling events involved in development.

COURSE OUTCOME

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

CO1: Understand the basic concepts of development biology and how an organism develops from a single cell (U)

CO2: Describe different stages of the development of an organism from gamete formation to zygote(R)

CO3: Creatively study the molecular functions of individual genes in early embryonic development of organs (C)

CO4: Elucidate the role of signalling events like Fgf, Wnt, Hedgehog and TGF-beta in development by cell-cell communication (E)

CO5: Illustrate the process of metamorphosis and how hormones play an important role (R)

CO6: Evaluate the role of regeneration with brief underlying mechanism and different steps involved in the process of aging (An)

COURSE CONTENT

Module I: Introduction to basic concepts of development: Potency, Commitment, Specification – Autonomous, conditional and syncytial, determination and differentiation, induction and competence, morphogenic gradients in cell specification, cell fate, fate map and cell lineages.

Module II: Gametogenesis and fertilization: Gamete formation (sperm and egg), acrosome reaction, recognition of egg and sperm, gamete fusion and prevention of polyspermy, fusion of genetic material and cytoplasmic rearrangements.

Module III: Early embryonic development and pattern formation: Early development- stages of development- zygote, blastula, and gastrula, germ line formation, pattern formation in drosophila with special focus to the genes involved (Maternal genes –bicoid and nanos and hunchback. Gap genes, pair rule genes, segmentation genes, homeotic genes).

Module IV: Cell signaling in development: Paracrine factors and signaling cascades involved in organ induction- fibroblast growth factors and RTK signaling, Hedgehog signaling, Wnt signaling –canonical Wnt signaling and non-canonical Wnt signaling, TGF beta –smad signaling.

Module V: Organ development: Limb development and regeneration in vertebrates, Lens induction in amphibians, neuronal differentiation in vertebrates, Sex determination – chromosomal sex determination in drosophila, dosage compensation.

Module VI: Post embryonic development: Metamorphosis in amphibians, hormonal control of metamorphosis, Regeneration – stem cell mediated, epimorphosis, morphallaxis and compensatory regeneration (definition only), Ageing.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments

- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Scott F Gilbert. Developmental Biology, Sinauer Associates, 2013.
2. Berrill, N.J. Developmental Biology. Tata McGraw Hill, 1986.
3. Tyler M.S. Developmental Biology: A Guide for Experimental Study. 3.1 Edition. Sinauer.

On-line Sources

1. https://www.pdfdrive.com/pdf-developmental-biology-eleventh-edition-scott-f-gilbert-free-online-e30618558.html
2. https://www.openaccessgovernment.org/developmental-biology-important/41386/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER III	Course Code: BCH-DE-537	Credits: 2

NAME OF THE COURSE: ENVIRONMENTAL BIOCHEMISTRY

AIM: The goal of Environmental biochemistry is to minimize the risks of pollutants and create high value products.

OBJECTIVE: This course is designed to understand the environment's effect on living organisms as they interact with environmental pollutants.

COURSE OUTCOME: After completion of the course, students shall be capable to
CO1: Define basic concept of ecosystem (U)
CO2: Understand worldwide environmental issue (U)
CO3: Explain about environmental pollution(Ap)
CO4: Discuss about control mechanism of water pollution (Ap)
CO5: Describe waste water treatments (Ap)
CO6: Critically analyse the role of biopesticides in integrated pest management (An)

COURSE CONTENT

Module I: Introduction to ecosystem: Basic concepts - interactions between environment and biota - concept of habitat and ecological niches - limiting factor.

Module II: Global environmental problems: Ozone depletion - UV-B greenhouse effect and acid rain - their impact and approaches for management.

Module III: Environmental pollution: Types of pollution - methods for the measurement of pollution - methodology of environmental management.

Module IV: Water pollution and control I: Need for water management – measurement and sources water pollution - kind of aquatic habitats (fresh and marine) - distribution and impact of environmental factors on the aquatic biota. Waste water treatment - waste water collection - physico – chemical properties of water - physical -chemical and biological treatment processes - activated sludge - oxidation ditches - trickling filter –towers - rotating discs - rotating drums - oxidation ponds.

Module V: Water pollution and control II: Waste water treatment – anaerobic digestion - anaerobic filters - up flow anaerobic sludge blanket reactors - treatment schemes for waste waters of dairy - distillery tannery - sugar - antibiotic industries.

Module VI: Biopesticides: Biopesticides in integrated pest management - bioremediation of contaminated soils and wastelands - solid waste - sources and management (composting, vermiculture and methane production) - environmental mutagenesis and toxicity testing.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Stanley E. Manahan, Environmental Chemistry, CRC Press, 2009.
2. Odum, Eugene Pleasants, Howard T. Odum, and Joan Andrews.Fundamentals of ecology. Philadelphia: Saunders, 1971.
3. Hutzinger, Otto, ed. The handbook of environmental chemistry.Springer Science & Business Media, 1980.
4. Harbison, Raymond D., Marie M. Bourgeois, and Giffe T. Johnson.Hamilton and Hardy's industrial toxicology. John Wiley & Sons, 2015.
5. Landis, Wayne G., and Ming-Ho Yu. Introduction to environmental toxicology: impacts of chemicals upon ecological systems. Crc Press, 2003.
6. Lu, Frank C. "Basic toxicology: fundamentals, target organs, and risk assessment. Taylor & Francis, 1996.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER IV	Course Code: BCH-CC-541	Credits: 3

NAME OF THE COURSE: MOLECULAR ENDOCRINOLOGY

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

OBJECTIVE: This paper 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:

CO1: Elucidate endocrine system and its mode of operation (R)

CO2: Illustrate the roles of the endocrine system in homeostasis, growth, development and reproduction (R)

CO3: To impart knowledge on the response of endocrine organs to environmental changes (An)

CO4: Resolve the role of hormone receptors in hormone action (An)

CO5: Describe the mechanism of action of hypothalamus, pituitary, thyroid, pancreatic, adrenal, gastrointestinal hormones (R)

CO6: Unravel the pathophysiological processes associated with hormone imbalance (R)

CO7: Develop a basic understanding on diagnostic tests to determine hormonal imbalance (R)

COURSE CONTENT

Module I: Introduction to endocrinology: Introduction, History of Endocrinology, Classification of hormones, overview of circulation, modification and degradation. Target tissue feedback control. Hormone receptors - general features, structure and regulation. Mechanism of hormone action.

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

Module V: Gastrointestinal hormones: Gastrointestinal hormones- location of. peptide producing cells, synthesis, structure, functions and mechanism of action of secretin, GIP, VIP, gastrin, CCK and other peptides.

Module VI: 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 syndrorne, Congenital Adrenal Hyperplasia, phaeochromocytoma. Gonadal hormones - Androgens, estrogens. Biological actions. Ovarian cycle. Pregnancy, Biochemical changes in pregnancy.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

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.
4. White, Abraham, Philip Handler, and Emil L. Smith. "Principles of Biochemistry."Academic Medicine 39.12 (1964).
5. Mac E. Hadley, Endocrinology, Prentice Hall, 2012.

On-line Sources

1. https://guides.uflib.ufl.edu/c.php?g=147527&p=969344
2. https://www.endocrine.org/topics

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER IV	Course Code: BCH-CC-542	Credits: 2

NAME OF THE COURSE: GENETICS AND GENOMICS

AIM: The overall aim of the Genetics and Genomics is to harness advances in genetics, genome biology and genome technologies to improve the understanding and management of genetic disorders.

OBJECTIVE: The objective of the course is to make students aware of the Mendelian genetics and the deviations from Mendelian principles. It also deals with genome sequencing technologies and applications.

COURSE OUTCOME

After the completion of this course, the student will be able to:
CO1: Describe Mendelian principles of heredity (R)
CO2: Explain the nature of inheritance and how it results in phenotype (An)
CO3: Describe genetic consequence of mutations and chromosome abnormalities (R)
CO4: Understand the concept of genome sequencing (U)
CO5: Explain the organization of the genome (An)
CO6: Differentiate genomics and proteomics (An)
CO7: Illustrate genomic approach and explain its applications (Ap)
CO8: Understand the cause behind genetic diseases and their pattern of inheritance (U)

COURSE CONTENT

Module I: Mendelian genetics: Mendel's study of heredity, Phenotype, Genotype, Dominant and Recessive alleles, Principle of dominance, Principle of segregation, Monohybrid crosses, Dihybrid crosses, Trihybrid crosses, Test Cross, Back cross, Alleles, Co-dominant alleles, Multiple alleles, Lethal Genes.

Module II: Human genetics: Pedigree analysis, Probability theory, Linkage analysis, Chromosome mapping. Human disorders follow Mendelian patterns of inheritance, Genetics counselling, Genome imprinting, VNTRs, Paternity test.

Module III: Chromosomal Aberrations: Chromosome banding and karyotyping, Chromosome aberrations - Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy), Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomes and Trisomes. Structural- Deletions, Duplication, Translocation and Inversions (emphasis on the following disorders: Turner's syndrome, Klinefelter's syndrome, Triple X syndrome, Down's syndrome and Trisomy 18.)

Module IV: Concept of gene: Genome, genome size, higher order genome organization and histone modification – acetylation, methylation, methylation of CpG islands.

Module V: Overview of Genome sequencing: Genome sequencing –whole genome shortgun sequencing and next-generation sequencing, sequencing platforms - Illumina (Solexa) sequencing, pyro sequencing, SOLiD sequencing, Human genome project overview,

Module VI: Structural Genomics and Functional Genomics: Structural genomics–Genome annotation and assembly, methods to identify protein structure – *De novo* methods (X ray diffraction and NMR), and modelling based approaches, Functional genomics –Forward genetics, Reverse genetics -Directed deletions and point mutations, gene silencing and interference.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Essential cell biology. Garland Science, 2013.
2. Lewin, Benjamin, Jocelyn E. Krebs, Elliott S. Goldstein, and Stephen T. Kilpatrick. Lewin's Genes XI.Jones & Bartlett Publishers, 2014.
3. Snustad, D. P., and M. J. Simmons. Principles of genetics.6th edition.John Wiley & Sons, Hoboken (2012).
4. Guttman, Burton. Genetics: The Code of Life. The Rosen Publishing Group, Molecular Genetics: Klug and Cummings(2011).
5. Carroll, Sean B., Jennifer K. Grenier, and Scott D. Weatherbee. From DNA to diversity: molecular genetics and the evolution of animal design. John Wiley & Sons, 2013.

On-line Sources

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3816999/
2. https://www.genome.gov/genetics-glossary/Gene
3. https://books.google.co.in/books?id=swOl70ibPz4C&printsec=frontcover&dq=Genetics&hl=en&sa=X&ved=2ahUKEwjq7O6R4p7rAhWXb30KHTadAoMQ6AEwBHoECAQQAg#v=onepage&q=Genetics&f=false

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER IV	Course Code: BCH-DE-543	Credits: 2

NAME OF THE COURSE: PHARMACEUTICAL BIOCHEMISTRY

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 OUTCOME

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

CO1: Define a drug and to know its nature, classification, dose-response and how to design/develop drugs (U)

CO2: Express various drug targets like receptors, enzymes, hormones etc and drug-receptor interaction with theories(R)

CO3: Critically evaluate what drug does to the body by drug-protein interactions (E)

CO4:Analyse and come to know what the body does to a drug through absorption, distribution, metabolism and excretion of drugs by the body (An)

CO5: Comprehend the concept of pharmacogenomics and its applications (U)

CO6: Illustrate the diverse modes of drug action of common diseases (Ap)

COURSE CONTENT

Module I: Pharmaceutical chemistry: Drugs – definition, source and nature, types of classification and nomenclature, dose response curve - ED50 and LD50. Role/importance of drugs, Drug design/drug development.

Module II: Pharmacodynamics: Drug targets – Enzymes, receptors, carrier proteins; Structural proteins, nucleic acids, lipids and carbohydrates, Drug – protein interactions, Drug structure and activity relationship. Forces involved in drug – receptor interaction and receptor theories.

Module III: Pharmacokinetics I: Routes of drug administration, Absorption and distribution of drugs, Factors affecting drug action - volume of distribution, rate of clearance, half-life of drug, drug accumulation, bioavailability, rate of absorption.

Module IV: Pharmacokinetics II: Drug metabolism - Chemical pathways of drug metabolism, Biotransformation reactions - phase I and phase II reactions – Microsomal and non-microsomal metabolism of drugs – role of cytochrome p450 enzyme and subtypes, Drug elimination – role of liver and kidney.

Module V: Pharmacogenomics: Basic concepts of pharmacogenomics and genetics diseases, Genetic variability in enzymes and transporters, Structural influence in the Drug response, Prediction of structural changes among sequences by the influence of polymorphisms.

Module VI: Mode of Action of Some Pharmaceuticals: Anti-malarial, Antibiotic, Anti-neoplastic and antihypertensive drugs - mechanism of action and potential side effects of drugs.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
References

1. Essentials of Pharmacotherapeutics, Barar F.S.K S. 2004.
2. Basic and Clinical Pharmacology. 13 edition, Bertram Katzung, Susan Masters and Anthony Trever. 2011.
3. Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy. David E. Golan, Armen H. Tashjian Jr., Ehrin J. Armstrong and April W. Armstrong, 2011.
4. Pharmacology, Salil K. Bhattacharya, P. Sen and A.Ray. second editon., 2004.

On-line Sources

1. https://www.pdfdrive.com/basic-clinical-pharmacology-e34443843.html
2. https://www.pdfdrive.com/basic-and-clinical-pharmacology-14e-e149308167.html

ASSESSMENT
40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER IV	Course Code: BCH-DE-544	Credits: 2

NAME OF THE COURSE: BIOTECHNOLOGY

AIM: Biotechnology is the integrated use of many biological technologies - from molecular genetics to biochemical engineering. This integration is essential for the effective translation of novel research into application.

OBJECTIVE: The objective of the study is to understand the molecular and genetic tools used to analyze 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:

CO1: Describe the basics of recombinant DNA (rDNA) technology and the steps in involved in the process (R)
CO2: Explain the tools used in rDNA technology (An)
CO3: Discuss gene cloning – the requirements and steps in gene cloning (E)

CO4: Illustrate the applications of gene cloning (Ap)
CO5: Explain the basis of gene mapping and its usage (An)
CO6: Discuss the purpose of transgenesis (E)
CO7: Judge the importance of genetically modified organisms (E)
CO8: Explain the various mammalian cell culture techniques (An)
CO9: Describe the goals of the human genome project (R)
CO10: Explain various applications of biotechnology (An)

COURSE CONTENT

Module I: Introduction to recombinant DNA technology : Restriction endonucleases, Types of restriction endonucleases, nomenclature, 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: pMal; pET-based vectors; Protein purification; His-tag; GST-tag; shuttle vectors.

Module II: Gene cloning : Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), method of producing cDNA, Construction of cDNA library, Construction of Genomic library, Screening of DNA libraries; Gene Cloning methods: Cohesive end cloning, blunt end cloning, cloning using adapters, linkers and homopolymer tailing, Gene transfer methods.

Module III: Molecular markers and maps : Gene mapping: Molecular Marker's for Gene Mapping-Restriction fragment length polymorphisms (RFLP), Random amplification of polymorphic DNA (RAPD), amplified fragment length polymorphism (AFLP), Simple Sequence Repeat (SSR), and Single Nucleotide Polymorphisms (SNP); Physical Mapping :Restriction Mapping, Fluorescent in situ hybridization (FISH),Sequence tagged site (STS) mapping.

Module IV: Transgenic plants and transgenic animals: Transgenic plants and transgenic animals: Genetic engineering of plants, golden rice, Ti plasmid, Transgenic plants with herbicide and insect resistance, BT toxin, Creation of transgenic animals, Recombinant protein production, Knockout mice, Inducible endogenous promoters, Transgenic insects, Natural transgenesis.

Module V: Animal Cell Culture: Animal cell culture : History, animal organ, tissue and cell culture, animal cell culture techniques, Primary cell cultures and secondary cell cultures, immortalized cell cultures, cell lines, Media – media components and physical parameters, Instruments and equipments needed for animal cell cultures, uses of animal cell cultures.

Module VI: Applications of biotechnology: Vaccine production, Therapeutic proteins, Stem cell transplantation and its applications, Organ transplantation and types of transplant, Gene Therapy, Artificial blood. Human Genome project. Introduction to Nanobiotechnology. Applications of Nanobiotechnology in diagnosis and therapy.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments

- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Rapley, Ralph, and David Whitehouse, eds. Molecular biology and biotechnology. Royal Society of Chemistry, 2014.
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.
5. B. D. Singh, "Biotechnology expanding horizons." Kalyani, India (2009).
6. Clark, David P., and Nanette J. Pazdernik. Biotechnology: applying the genetic revolution. Newnes, 2015.
7. Pamela Peters, Biotechnology: a guide to genetic engineering, Wm. C. Brown Publishers, 1993.
8. S. B. Primrose, Molecular Biotechnology, Blackwell Scientific Publications,1991
9. James D. Watson, Recombinant DNA, W. H. Freeman,1992
10. Firdos Alam Khan, Biotechnology fundamentals. CRC Press, 2011.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER IV	Course Code: BCH-CC-545	Credits: 6

NAME OF THE COURSE: 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:

CO1: Identify research methods (Ap)
CO2: Ask the right scientific questions (Ap)
CO3: Identify review of literature (AP)
CO4: Critically think and evaluate on the topic that is chosen for research (An)
CO5: Combine theory and practice (C)

CO6: Apply the knowledge obtained on the topic to the research being conducted (Ap)
CO7: Develop a response on the results obtained and analysis done and thereby draw conclusions (C)
CO8: Apply appropriate methods to represent the results (Ap)
CO9: Communicate the scientific data effectively (C)
CO10: Demonstrate the research skills in career advancement or future work-related studies (C)

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.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT
Suggested Classroom Activities:

- Seminar Presentation on selected topics
- Field work and survey

LEARNING RESOURCES
References
Area of study specific

On-line Sources
Area of study specific.

ASSESSMENT
Dissertation presentation and viva-voce.

SEMESTER – I-IV	Course Code: BCH-GC-501	Credits: 2

NAME OF THE COURSE: RADIATION BIOLOGY AND HEALTH

AIM: The course is designed to act as an introduction to students on the principle and applications of radiation and the effects of radiation on health.

OBJECTIVE: To sensitize the student to various aspects of radiation biology, its hazards and potential remedial measures.

COURSE OUTCOME:
This course is designed for students of diverse background, some of whom might be new to biology itself. After the completion of this course, the student will be able to:

CO1: Describe the principle and applications of radiation (R)
CO2: Discuss the biological effect of radiation and the reason for their lethality (E)
CO3: Explain about the usage of personnel protection equipments and safety measures (An)
CO4: Differentiate between acute and chronic radiation syndrome and the mechanisms of their onset (E)
CO5: Explain the current developments in the area of radiation countermeasure development (An)
CO6: Identify the key targets of radiation biology for countermeasure development (An)

COURSE CONTENT

Module I: Introduction to Radiation: Types of radiation- ionizing and non-ionizing radiations. Ionizing emission- alpha, beta, x-ray and gamma-ray. Radioactivity and radiation. Units of radioactivity. Physical properties of radiation- penetration potential and energy. Background radiation and sources of radiation exposure.

Module II: Applications of Radiation: Applications of radiation in Medicine- x-ray and gamma knife. Cancer radiology. Radioisotopes in biomedical research. Radioactive materials used in power generation- Uranium and Thorium.

Module III: Acute Radiation Syndrome: Acute radiation syndrome (ARS) - range of dose and consequences. Classification of ARS: gastrointestinal, hematopoietic and central nervous system toxicity. Symptoms, progression and lethality.

Module IV: Chronic Radiation Exposure Effects: Chronic radiation exposure- biology of endothelial tissue damage. Consequences of low dose radiation exposure. Case studies on chronic radiation exposure. Prevalence of cancer and genetic mutations. Bystander effect- Factors contributing to Bystander effect.

Module V: Safety Measures: Radiation monitoring equipments- GM counter. Personnel radiation protection- protective apparels and accessories. Time, distance and shielding. Personnel monitoring equipments: TLD plates. Maximum permissible dose equivalent. Medical radiology and risk assessment. Management of radioactive waste from nuclear power plants.

Module VI: Radiation Countermeasures:
Incidence of mass and limited radiation exposure accidents- Chernobyl, Fukushima and Delhi. Scenario of pre and post exposure management- first responders vs population. Radiation countermeasures: past, present and future potential.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates

LEARNING RESOURCES

References

1. Radiation Health and Dosimetry: An Introduction to Health Physics. Michael B. Stabin. 2007.
2. Radiation Protection in Medical Radiography. Mary Alice Shearer, Paula Visconti and Russell Ritenour. 2010.
3. Atoms, Radiation and Radiation Protection. James E. Truner. 2007.
4. The Radiation Biology of the Vascular Endothelium. David B. Rubin. CRC Press, 1998.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER -I-IV	Course Code: BCH-GC-502	Credits: 2

NAME OF THE COURSE: ENZYMOLOGY

AIM: The course is aimed to provide the students with basic knowledge of enzymes and their biochemical aspects.

OBJECTIVE: Introduction to the general aspects of enzymes and a brief awareness on the kinetics, mechanism and applications of them.

COURSE OUTCOME

After the completion of this course, the student will be able to:
CO1: Define enzyme and enzyme activity(R)
CO2: Describe enzyme nomenclature and classify enzymes (R)
CO3: Explain factors that affect enzyme activity (An)
CO4: Explain various enzyme techniques (An)
CO5: Illustrate the kinetics and mechanism of action of enzymes (Ap)
CO6: Discuss industrial, pharmaceutical and clinical applications of the enzymes (E)

COURSE CONTENT

Module I: Introduction to Enzymes: Brief description of general aspects of enzymes; apoenzyme – holoenzyme – cofactors and coenzymes – ribozymes – abzymes – nomenclature and classification.

Module II: **Enzyme Techniques:** Enzyme techniques: reaction system – activity – specific activity – detection of enzyme activity – unit of enzyme activity – units of enzyme activity: katal, IU.

Module III: Enzyme Kinetics-Part I: Kinetics: Velocity of a reaction – progress curve for enzyme catalyzed reaction – Michaelis Menton equation (no derivation) – Line Weaver Burk Curve.

Module IV: Enzyme Kinetics-Part II: Vmax and Km – factors affecting enzyme catalyzed reaction: substrate concentration, pH, Temperature, enzyme concentration – inhibition – allosteric enzymes.

Module V: Mechanism of Enzyme Action: Mechanism of enzyme action: Enzyme specificity – active site – mechanisms at active site – covalent catalysis – acid base catalysis – proximity and orientation effects – zymogens – multi enzyme complexes

Module VI: Enzyme technology: Enzyme technology, industrial uses of enzymes: food pharmaceutical industries clinical enzymology serum enzymes in health and diseases immobilized enzyme technology.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

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).
3. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications.Second edition. New York, 2001.
4. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology. John Wiley & Sons, 2012.
5. Copeland, Robert A. Enzymes: a practical introduction to structure, mechanism, and data analysis. John Wiley & Sons, 2004.

On-line Sources

1. https://books.google.co.in/books?id=VNInDwAAQBAJ&printsec=frontcover&dq=enzyme+kinetics&hl=en&sa=X&ved=2ahUKEwio9pS33Z7rAhUCeisKHRY3BD8Q6AEwAHoECAMQAg#v=onepage&q=enzyme%20kinetics&f=false
2. http://www1.lsbu.ac.uk/water/enztech/kinetics.html
3. https://books.google.co.in/books?id=0wrbDwAAQBAJ&printsec=frontcover&dq=enzyme+technology&hl=en&sa=X&ved=2ahUKEwjE8veh3p7rAhUTeysKHQ_oAx0Q6AEwAnoECAYQAg#v=onepage&q=enzyme%20technology&f=false

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I	Course Code: BCH-GC-503	Credits: 2

NAME OF THE COURSE: LIFESTYLE DISEASES

AIM: To create a general awareness on the modern lifestyle diseases and their biochemical mechanisms, prevention and management.

OBJECTIVE: The objective of the course is to give the students a brief awareness of the diseases like Atherosclerosis, Dementia, Parkinson's, Cancer, Diabetes and Hypertension that are a part of the changing lifestyle habits of the modern world

COURSE OUTCOME

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

CO1: Describe different lifestyle disorders like atherosclerosis, dementia, AD, PD, Type 1 and type 2 diabetes, hypertension (R)

CO2: Describe symptoms of various lifestyle disorders (R)

CO3: Identify reasons for the development of life style disorders (R)

CO4: Illustrate the known molecular mechanisms by which various lifestyle disorders are caused (Ap)

CO5: Describe methods of prevention and management of lifestyle disorders (R)

CO6: Create general awareness of the lifestyle diseases (C)

COURSE CONTENT

Module I: Lifestyle Diseases: General awareness: Definition - General introduction to lifestyle diseases - Risk factors: Lifestyle, food habits, Physiological stress, Free radicals and Oxidative stress- Preventive factors: Exercise, healthy food habits, antioxidants.

Module II: Atherosclerosis: Signs and symptoms, causes - modifiable and non-modifiable - Biochemical mechanisms of atherogenesis: including lipid peroxidation, plaque formation, and thrombosis - Diagnosis, Treatment and Prevention of Atherosclerosis.

Module III: Alzheimer's and Parkinson's Disease: Dementia, Types of Dementia - Alzheimer's disease: stages of disease - causes: genetic, cholinergic hypothesis, amyloid hypothesis, tau hypothesis, pathophysiology and disease mechanism, disease Management - Parkinson's disease: causes, Symptoms, Molecular pathophysiology, prevention and disease management.

Module IV: Hypertension: Characteristics, Causes, Risk factors - Obesity. Mechanism of obesity induced hypertension - Pathophysiology of hypertension in cardiovascular diseases (CVD) - Prevention and Management of hypertension.

Module V: Diabetes mellitus: Classification – type 1, type 2, gestational - Complications of diabetes mellitus: Diabetic cataract, retinopathy, cardiomyopathy, nephropathy and neuropathy

through advanced glycation end products - Role of glucose transporters in insulin resistance - Management of diabetes mellitus and treatment options.

Module VI: Cancer: Overview, Types, Causes, Genetic basis of cancer: tumor suppressor genes - oncogenes and gene expression. Molecular basis of cancer: disregulation of cell cycle and mutation of p53 and Rb. Strategies for cancer treatment: immunotherapy, inhibition of cancer promoting proteins and inhibition of angiogenesis - prevention and management.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES

References

1. Biochemistry – U. Satyanarayana, U. Chakrapani, third edition, ISBN 81-87134-80-1
2. Textbook of Medical Physiology, by Arthur C Guyton, John E Hall Prism Saunders 9th Edition **ISBN: 81-7286-034-X.**
3. **Molecular biology of the cell, by Alberts, Johnson, 5th Edition, Garland science ISBN: 978-0-8153-4105-5**
4. Cell and Molecular Biology by Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.
5. Disease and Drug consult: Neurologic Disorders, Lippincott, Ist edition, Lippincott Williams and Wilkins ISBN-13: 978-1605470504.

On-line Sources

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6515727/
2. https://www.niddk.nih.gov/health-information/diabetes/overview/what-is-diabetes
3. https://www.who.int/news-room/fact-sheets/detail/dementia

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I-IV	Course Code: BCH-SE-501	Credits: 2

NAME OF THE COURSE: LABORATORY ANIMAL EXPERIMENTATION

AIM: The course is aimed at all researchers who plan, conduct, evaluate and improve animal experiments, under consideration of the latest ethical criteria and species appropriate animal husbandry practices.

OBJECTIVE: The objective of the course is to make students familiar with the use of laboratory animals in research with proper selection of animal models, the basic physiology, anatomy and nutritional requirements of Laboratory animals their management. Moreover, the course explains the laws, regulations and authorities relevant to use of laboratory animals. Additionally, allow to understand safe practices and specific health hazards while working with laboratory animals.

COURSE OUTCOME:

The main objective of this course is to familiarize the researchers to conduct animal experiments in a scientific manner. On completion of this course, students shall be able to

CO1: Understand the anatomy and physiology of laboratory animal models. (U)
CO2: Gather comprehension of the legal framework for animal experimentation (U)
CO3: Evaluate the merits of proper animal handling and housing techniques (E)
CO4: Acquire knowledge on the techniques of sample collection (U)
CO5: Evaluate the different anesthetics to be used in animal experimentation (E)
CO6: Get an understanding of different surgical procedures for animal experimentation (U)

COURSE CONTENT

Module I : Introduction to Laboratory animals : Use of animals in research, Responsibility of researchers, need for guidelines, ethical principles/3R principles, Common Laboratory animals- Rat, Mice, Rabbit - different strains, Physiology-peculiarity in digestion, Anatomy-different body parts, Nutrition-species specific requirements, temperature ,humidity requirement and general management, selection of suitable animal models –Exploratory, explanatory and Predictive models.

Module II: Legal requirements for animal experiments: Why animal experimentation, animal welfare, ethics, Laws, regulations and authorities relevant to use of laboratory animals, CPCSEA – principles, guidelines and functions, different forms, Filling of B forms , IAEC – structure - members.

Module III: Standard Operating Procedures in Animal House: Basic guidelines to follow in animal rooms, Bio safety-standard safety practices in animal rooms, health, hygiene and laboratory attire, Training of animal caretakers and users, procurement of research animals-quarantine of animals, Animal health check, cage preparation and cage change, Animal waste disposal - disposal of bedding material, Cleaning and sanitizing of- animal rooms - cages, use of DMBA in animals.

Module IV: Animal handling and basic procedures : Basic handling of Rat- Mice -Rabbit, different routes of drug administration-Rat, Mice ,Rabbit- subcutaneous, oral, Intra peritoneal, intramuscular and intravenous route- volume to be administered, blood extraction -tail vein, ear vein, retro orbital bleeding, heart puncture, euthanasia in Lab animals- accepted methods.

Module V: Experimental animal anaesthesia: Basic requirements in small animal surgery – External temperature regulation- species specific consideration, different anaesthetics and analgesics used- ketamine, Xylazine – dose, Anaesthesia monitoring.

Module VI: Animal surgical procedure: common surgical procedures- Recovery - Post operative care - wound management.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Demonstration of simple experiments

LEARNING RESOURCES

References

1. Handbook of Laboratory Animals: Abhijit Paintal (Dominant publishers).

On-line Sources

http://www.ahwla.org.uk/site/tutorials/.html
http://www.cpcsea.nic.in

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I-IV	Course Code: BCH-SE-502	Credits: 2

NAME OF THE COURSE: EFFECTIVE SCIENTIFIC COMMUNICATION

AIM: This course is aimed at imparting basic elements of good scientific communication skills to students.

OBJECTIVE: This course is designed to cover various aspects of written and verbal communication skills in reading, analyzing, writing, speaking and visual media presentation formats.

COURSE OUTCOME:

On completion of the course, the student will be able to have an understanding on

CO1: Basic elements of good scientific writing such as the structure of sentences and paragraphs (U)
CO2: Effective communication and different presentation skills to enable students to develop their competency in scientific communication (U)
CO3: The different styles and sentence construction and means to effectively present scientific information using professional ICT media and verbal communication formats (U)
CO4: The common mistakes in written formats, describe the stages of the scientific communication processes (prewriting, drafting, revising, final edits, analyzing audience and purpose (U)
CO5: Plagiarism and how can it be avoided (U)
CO6: Authentic scientific literature sources and predatory journals (U)
CO7: How to present scientific papers and posters at scientific forums (Ap)

COURSE CONTENT

Module I: Written Skills - Common mistakes in sentence structuring. Importance of punctuation and grammar.

Module II: Spoken Skills - Importance of verbal and non-verbal communication. Voice modulation and emphasizing key phrases.

Module III: Contribution to scientific literature - Identification of authentic scientific literature sources. Publishing and predatory journals. Identification of strong points in classic journal articles. Articulate representation of ideas and findings.

Module IV: Contribution to scientific forums - Posters– Identification of scope of scientific forums- conferences, seminars and symposiums. Poster presentation techniques. Key features of an attractive scientific poster.

Module V: Contribution to scientific forums- ICT tools - Features of a good oral presentation. Effective utilization of ICT tools- PPTs and multimedia.

Module VI: Effective PowerPoint presentations: Feature of a good PPT presentation. Strategies for effective communication.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates

LEARNING RESOURCES

References

1. Effective Science Communication - A practical guide to surviving as a scientist. Sam Illingworth and Grant Allen Published, IOP Publishing Ltd., 2016. ISBN: 978-0-7503-1171-7.

2. Science Communication - A Practical Guide for Scientists. Laura Bowater, Kay Yeoman, Wiley-Blackwell, 2013, ISBN: 978-1-119-99312-4.
3. Communication Skills for Engineers and Scientists. Sangetha Sharma and Binod Mishra. Prentice Hall India Learning Private Limited. 2009. ISBN-13: 978-8120337190.

On-line Sources

1. https://iversity.org/en/courses/scientific-writing-skills
2. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1258

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

SEMESTER I-IV	Course Code: BCH-SE-503	Credits: 2

NAME OF THE COURSE: ANIMAL CELL CULTURE TECHNIQUES

Aim: To provide knowledge on basic animal cell culture techniques.

Objective: The course aims to provide the student with knowledge to carryout basic cell-culture techniques properly and safely.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO1: Describe basic requirements for cell culture (U)
CO2: Know how to set up a mammalian cell culture facility (C)
CO3: Maintain good laboratory practices and aseptic techniques (Ap)
CO4: Understand different nutritional requirements for various cell types (U)
CO5: Maintain primary cells and a cell lines (Ap)
CO6: Avoid cell culture contamination and perform methods to identify cell culture contamination (E)
CO7: Apply basic cell culture techniques for diagnosis and research (Ap).

COURSE CONTENT

Module I: Historical background of tissue culture, Advantages and limitations. Good laboratory practices. Basic aseptic techniques, Design of tissue culture laboratory, Equipments: Laminar flow, CO2 incubator, Inverted Microscope, Centrifuge, Refrigerator, Freezers, Pipetting aids, Media aspiration unit, Hemocytometer, Liquid nitrogen storage facility and other small Equipments.

Module II: Cell culture types- Substrate culture and suspension culture, Primary cell culture, Cell lines. Cell culture matrix, Cell culture wares for adherent and suspension culture., Handling and maintenance of culture. Contamination -monitoring and handling.

Module III: Nutritional requirements- Minimal essential medium. Serum dependent and independent medium, cell specific media. Sterilization and Media preparation. Growth conditions-Temperature, pH, atmosphere, antibiotics.

Module IV: Basic techniques of mammalian culture. Primary cell culture isolation, separation of cells, quantification of viable cell count and maintenance of culture. Cell line maintenance and subculture. Trypsinization and passaging of cells. Cryopreservation and reviving of cells.

Module V: Biology and characterization of cultured cells. Contamination-monitoring and handling, cytotoxicity and viability checking- Trypan blue method, MTT assay, quantitation of cell culture-Cell counting, nucleic acid content, protein estimation. Applications of animal cell culture-as model system, toxicity testing, virology, cancer research, genetic engineering, gene therapy, production of -viral vaccine, monoclonal antibody & recombinant proteins.

Module VI: Visit to cell culture laboratory, Familiarization of aseptic techniques, instruments and culture wares. Media preparation and basic cell culture techniques-Observation of cultured cells, primary cell isolation, counting of cells, viability-trypan blue test, Cell line-Trypsinization and subculture, cryopreservation of cultured cells, Quantitation of cell culture-protein estimation, contamination and waste handling.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Classroom Activities:

- Assignments
- Seminar Presentation on selected topics
- Demonstration of simple experiments

LEARNING RESOURCES

References

1. Freshney R. Ian, "Culture of animal cells: A manual of Basic Technique and specialized applications", WilleyBlackwell Publisher, 7th edition ,2016 .
2. Michael Aschner, Cristina Suñol, Anna Bal-Price, Cell culture techniques, Springer protocols, Humana press (2011).
3. S.J Morgan & D.C. Darling, "Animal cell Culture". Bios scientific publishers,1993.
4. C.D. Helgason &C.L. Miller, Basic cell culture Protocols, Third edition,Humana Press, 2005.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-Semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT*

(*Specimen to show the pattern of End-semester question paper is provided here)

FIRST SEMESTER M. Sc (CSS) DEGREE EXAMINATION, ……..2020

Branch: Biochemistry

BCH-CC-513: MICROBIAL BIOCHEMISTRY

(2020 ADMISSION ONWARDS)

Time -3 Hrs **Marks-60**

PART-A

Answer **all** questions. Each question carries **1** mark.

1. Give any two methods to preserve microorganism.
2. How capnophiles differ from other organisms?
3. What is synchronous growth?
4. Mention the important contributions of (a) Edward Jenner (b) Alexander Fleming.
5. Differentiate between disinfection and sterilization.
6. What is generation time?
7. What is a protoplast?
8. How will you demonstrate a capsulated organism?
9. Name two methods to demonstrate motility of an organism.
10. What is a CFU?

(10x1=10 marks)

PART-B

Answer **ANY FIVE** questions. Each question carries **2** marks.

11. Give the significance of staining in microbiology.
12. Differentiate between selective medium and indicator medium with suitable example.
13. Give the mode of action of penicillin.
14. What is catalase test? Give its importance?
15. Give any one method to demonstrate endospore.
16. Write note on sterilizing gases.
17. Give the importance of agar- agar.

(5x2=10 marks)

PART-C

Answer **ANY FIVE** questions. Each question carries **4** marks.

18. Describe the general characteristics of a bacteriophage.
19. Explain with labelled diagram, the growth curve of bacteria.
20. Describe how an organism is differentiated by gram staining?
21. Comment on the germ theory of diseases.
22. How will you demonstrate mycobacterium tuberculosis by staining technique?
23. Describe bacterial conjugation.
24. Analyse the processes by which an organism can be isolated in pure culture.

(5x4=20 marks)

PART-D

Answer **ANY TWO** questions. Each question carries **10** marks.

25. Compare and comment on the different methods for controlling food spoilage.
26. Critically evaluate the physical and nutritional requirements for culturing bacteria.
27. Create a flow chart and discuss the different techniques used in microbiology to identify an organism.

(2x10=20 marks)