



No. UOM/Acad/20/77

Dated: 07-Feb-2020

NOTIFICATION

It is notified for the information of all concerned that the Syndicate in its 34th meeting held on January 10, 2020 (vide Agenda Item No. 12(03)(03)), **approved** recommendations of the Academic Council made in its 11th meeting held on December 24, 2019 (vide agenda item No. 03(03)) regarding the Scheme of Studies for MPhil and PhD Biochemistry.

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Registrar

Copy for information and necessary action (if any) to:

1. Dean, Faculty of Biological Sciences
2. Chairperson, Department of Biochemistry, with the request to prepare/provide triplicates of the under reference scheme of studies, duly signed/stamped for the office of 1) Registrar, 2) the Controller of Examinations, and his office record
3. Controller of Examinations, UOM
4. Deputy Registrar Admissions, UOM
5. Network Administrator with the directives to approach the office of Controller of Examinations for uploading the aforesaid scheme of studies on the UOM website
6. PS to Vice-Chancellor
7. PA to Registrar
8. Relevant File


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SCHEME OF STUDIES FOR MPhil & PhD BIOCHEMISTRY

Eligibility Criteria

Title of Degree Program **Master of Philosophy in Biochemistry**

MPhil Biochemistry: BS (4 Year) Biochemistry or equivalent 16 years of education in the relevant fields along with other admission requirements approved by the University.

Title of Degree Program **Doctor of Philosophy in Biochemistry**

PhD Biochemistry: MPhil Biochemistry or equivalent 18 years of education in the relevant fields along with other admission requirements approved by the University.

List of MPhil & PhD Biochemistry Courses

Course Code	Name of Subject	Credits
BCH 750	Advances in Molecular Genetics	3+0
BCH 751	Advances in Biochemistry	3+0
BCH 752	Advances in Clinical Biochemistry	3+0
BCH 753	Advances in Molecular Biology	3+0
BCH 754	Advances in Endocrinology	3+0
BCH 755	Advances in Biotechnology	3+0
BCH 756	Advanced Biostatistics	3+0
BCH 757	Advanced Bioinformatics	3+0
BCH 758	Recent Trends in Immunology	3+0
BCH 759	Advanced Fermentation Biotechnology	3+0
BCH 760	Teaching Practice in Biochemistry	3+0
BCH 810	Community Nutrition	3+0
BCH 811	Protein Structure, Functions & Engineering	3+0
BCH 812	Advances in Enzymology	3+0
BCH 813	Advances in Cell Biology	3+0
BCH 814	DNA Techniques and Clinical Applications	3+0
BCH 820	Special Topics in Biochemistry	3+0
BCH 850	Good Laboratory Practices and Quality Control	3+0
BCH 851	Biochemistry of Metabolic Disorders	3+0
BCH 852	Biochemistry of Natural Products	3+0
BCH 853	Recombinant DNA Technology	3+0
BCH 854	Research Methodology	3+0
BCH 855	Advanced Biochemical Techniques	3+0
BCH 856	Genomics, Proteomics and Metabolomics	3+0
BCH 857	Gene Expression and Regulation	3+0
BCH 858	Food Biochemistry	3+0

BCH 859	Renewable Bioenergy Resources	3+0
BCH 870	Selected Topics in Lipid Metabolism	3+0
BCH 871	Special Topics in Carbohydrates Biochemistry	3+0
BCH 872	Special Topics in Proteins Biochemistry	3+0
BCH 873	Special Topics in Nucleic acid Biochemistry	3+0
BCH 874	Special Topics in Vitamins Biochemistry	3+0
BCH 875	Special Topics in Plant Biochemistry	3+0
BCH 876	Liquid Chromatography	3+0
BCH 877	Special Topics in Enzyme Kinetics	3+0
BCH 900	Molecular Mechanism of Disease	3+0
BCH 901	Molecular Evolution	3+0
BCH 902	Drug Designing and Metabolism	3+0
BCH 903	Forensic Serology and DNA Analysis	3+0
BCH 920	Applications of Nanomaterials in Biosciences	3+0
BCH 921	Stem Cell and Therapeutics	3+0
BCH 922	Neuroscience	3+0
BCH 930	Structural Bioinformatics	3+0
BCH 931	Plant Genomics	3+0
BCH 941	Biochemistry of Drugs and Their Resistance	3+0
BCH 942	Biochemistry of Control system	3+0
BCH 943	Biochemistry of Carotenoids	3+0
BCH 950	Biochemistry of Carcinogenesis	3+0
BCH 955	Computer Aided Drug Designing	3+0
BCH 965	Molecular Medical Physiology	3+0
BCH 966	Biochemistry of Phytosterols	3+0

Note: Scholar may opt ONLY ANY TWO relevant courses from related Departments (Biotechnology, Botany, Zoology, Pharmacy and Chemistry) subject to the recommendation of supervisor & chairman.

LIST OF THE RELEVANT APPROVED COURSES IN OTHER DEPARTMENTS

Department of Biotechnology

Course Code	Course Title	Credits
BT-804	Bioprocess Technology	3
BT-805	Advances in Cell and Molecular Biology	3
BT-806	Recent trends in Molecular Diagnostics	3
BT-807	Research Methods in Biotechnology	3
BT-813	Advances in Protein Chemistry	3
BT-814	Advances in Bioinformatics	3
BT-816	Advances in Fermentation Technology	3
BT-826	Protein Engineering and Enzyme Technology	3
BT-827	Bioremediation and biodegradation	3
BT-828	Biotechnology of Non-renewable Resources	3

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BT-829	Advances in Plant Biotechnology	3
BT-830	Metabolic Engineering and Biofuels	3
BT-831	Advances in Agriculture Biotechnology	3
BT-833	Advances in Industrial Biotechnology	3
BT-834	Advances in Animal Biotechnology	3
BT-835	Advances in Biosensor Technologies	3
BT-839	Medicinal Plant Biotechnology	3
BT-840	Recombinant DNA Technology	3
BT-844	Microbial Enzyme Technology	3

Department of Botany

Course Code	Course Title	Credits
BOT-701	Methods in Plant Cell Tissue and Organ Culture	3
BOT-707	Research Techniques and Instrumentation	3
BOT-708	Advances in Environmental Biology	3
BOT-709	Advances in Plant Anatomy	3
BOT-713	Forensic Botany and Applied Botany	3
BOT-715	Fungal Biology	3
BOT-717	Phytoremediation and pollution	3

Department of Zoology

Course Code	Course Title	Credits
ZOOL-812	Biological Toxicology	3
ZOOL-815	Clinical Bacteriology	3
ZOOL-816	Clinical Endocrinology	3
ZOOL-817	Clinical Immunology	3
ZOOL-820	Diagnostic Parasitology	3
ZOOL-821	Environmental Toxicology	3
ZOOL-822	Epidemiology	3
ZOOL-903	Advances in Cell Biology	3
ZOOL-910	Lab and Biosafety	3
ZOOL-915	Molecular Physiology	3
ZOOL-916	Research Methodology	3
ZOOL-918	Stem Cell Technology	3
ZOOL-919	Toxicology	3

Department of Pharmacy

Course Code	Course Title	Credits
PHARM-710	Metabolic Pathway I	3
PHARM-711	Metabolic Pathway II	3

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PHARM-714	Hormones, Autacoids and Their Antagonists	3
PHARM-719	Natural Products I	3
PHARM-801	Kinetic principles and Stability Testing	3
PHARM-804	Spectrophotometric Methods of Pharmaceutical Analysis	3
PHARM-805	Mass Spectrometry	3
PHARM-807	Drug Metabolism	3
PHARM-809	Biopolymers	3
PHARM-811	Antibiotic & Chemotherapeutic Agents	3
PHARM-814	Natural Products-II	3
PHARM-815	Phytochemistry	3
PHARM-816	Neurotransmitters Systems and Drug Dependence Mechanisms	3
PHARM-820	Carbohydrate Chemistry	3
PHARM-822	Medicinal And Poisonous Plants of Pakistan	3
PHARM-825	Advance Pharmacokinetics and Pharmacodynamics	3
PHARM-828	Special Topics in Pharmaceutical Chemistry	3
PHARM-830	Pharmacology of Anticonvulsant Drugs	3

Department of Chemistry

Course Code	Course Title	Credits
CHEM-701	Volumetric Techniques	3
CHEM-702	Separation Techniques	3
CHEM-703	Atomic Spectroscopy	3
CHEM-734	Chemical Toxicology	3
CHEM-753	Bio-Inorganic Chemistry	3
CHEM-757	Scientific Writing	3
CHEM-758	Bio-Statistics	3
CHEM-761	Phytochemistry	3
CHEM-763	Biosynthesis and Natural Products Synthesis	3
CHEM-772	Molecular Spectroscopy	3
CHEM-783	Methods of Determination of Reactions Mechanism	3
CHEM-787	Water Purification Processes	3
CHEM-790	Chemistry of Biominerals	3
CHEM-852	Nuclear Biomedical Instrumentation	3
CHEM-854	Bio-Informatics	3
CHEM-881	Mass Spectrometry	3
CHEM-901	Modern Chromatographic Techniques	3
CHEM-952	Organometalic Chemistry	3
CHEM-960	Medicinal Chemistry	3
CHEM-965	Biotransformation	3
CHEM-978	Nanomaterials and their applications	3

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research papers.

Recommended Books

- 1) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017).
- 2) Litwack, G. *Human Biochemistry*. 1st Ed. Academic Press, London, (2017).
- 3) Rodwell, V.W., Bender, D. A., Botham, K. M., Kennelly, P. J., Weil, P. A., *Harper's Illustrated Biochemistry*, 31st Ed. McGraw-Hill Education, (2018).

BCH 752 ADVANCES IN CLINICAL BIOCHEMISTRY (3+0)

Course Objective

- This course will provide advanced concepts in clinical biochemistry
- The practical component will cover advanced techniques for clinical diagnosis.

Learning Outcome

After completing this course, students should be able to;

- 1) Discuss and explain the pathophysiology and biochemistry associated with diagnostic tests performed in clinical biochemistry laboratories
- 2) Understand the significance of quality assurance and quality control in diagnostic procedures
- 3) Have the necessary skills to promote the significance of clinical diagnosis in treatment strategies


Course Outline

Biochemical investigation and quality control; Use, acquisition and interpretation of biochemical data in clinical medicine; Use of chemistry analyzer in clinical diagnostics; Fluid and electrolyte disorders; Acid-base disorders; Disorders of calcium, magnesium and phosphorus; Renal disorders: Proteinuria, Renal tubular disorders and renal calculi; Hepatic disorders: Acute and chronic liver disease; Clinical enzymology and biomarkers; Abnormalities of lipid metabolism; Thyroid diseases; Diabetes mellitus; Reproduction endocrinology; Biochemical nutrition; Specific protein markers; Cancer biochemistry and tumour markers; Use of isotopes in medical diagnosis; Autoimmune and immunodeficiency disorders; Literature / leaflet review of concerned practical and instruments

Recommended Books

- 1) Devlin, T., *Textbook of Biochemistry with Clinical Correlations*. 7th Ed. Wiley, (2010).
- 2) Ahmed, N., *Clinical Biochemistry (Fundamentals of Biomedical Science)*. Oxford University Press (2011).
- 3) Marshall, W., Bangert, S., *Clinical Biochemistry: Metabolic and Clinical Aspect*. 2nd Ed. Churchill Livingstone, (2008).


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BCH 753 ADVANCES IN MOLECULAR BIOLOGY (3+0)

Course Objective

- To impart advanced knowledge of life processes at the molecular level
- To motivate students for using advanced molecular biology techniques
- To understand the theory behind the new technologies

Learning Outcome

Upon successful completion of the course, the student will be able to:

- 1) Describe cell to cell adhesion and cell to cell communications
- 2) Describe and discuss transcription and post-transcriptional modifications leading to the synthesis of proteins.
- 3) Perform the following wet laboratory techniques

Course Outline

Replication & proofreading, Transcription – post-transcriptional modifications, Translation, Post-translational modifications, Human genome project & Mutations, Bioinformatics (Applications); Purine Metabolism and Pyrimidine Metabolism; Cell signalling & membranes: Composition & Chemistry of membranes of the Cells & Organelles; Receptors & transport channels Second messenger system, Ca, IP3 mechanism; Role of the G Proteins, Protein Kinases/Tyrosine Kinases, Nitric Oxide synthase, Pheromones, Plant hormones; Hands-on experience to the various wet laboratory molecular biology techniques.

Recommended Books

- 1) *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Wilson, K., Walker, J. (Editors). Cambridge University Press (2010).
- 2) Katoch, R., *Analytical Techniques in Biochemistry and Molecular Biology*. Springer Science & Business Media, (2011).
- 3) Carson, S., Miller, H. B., Srougi, M. C., Witherow, D. S., *Molecular Biology Techniques: A Classroom Laboratory Manual*. Academic Press, (2019).

BCH 754 ADVANCES IN ENDOCRINOLOGY (3+0)

Course Objective

- To understand the pathways for the release and control of different hormones
- To update the students with current developments in the field of endocrinology

Learning Outcome

After completing this course, students should be able to:

- 1) Explain the latest achievements related to endocrinology
- 2) Comprehend the possibilities to target endocrinology against metabolic diseases like obesity, diabetes, etc.


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Course Objective

- To design Biological trials
- To address major issues in the design of a study
- To use the latest statistical tools

Learning Outcome

After completing this course students should be able to;

- 1) Handle their data sets independently
- 2) Evaluate and optimize experiments based on statistical analysis performed
- 3) Develop an awareness of Total Quality Management

Course Outline

Statistics of repeated measurements, Significance tests and the quality of analytical measurements; Modern Regression Analysis; Theory and Quantitative Methods in Epidemiology; Applied Epidemiologic Methods in Regression; Binary Data, Quantitative Methods and Measurements, Clinical Trials, Decision Analysis and Cost-Effectiveness, Methods for Accommodating Missing Data; Event surveillance and mathematical modeling of dispersion; Advanced Probabilistic Concepts; Advanced Predictive Modeling and Simulation; Response surface methodology, survival analysis using the proportional hazards (Cox) regression model, and linear models; Experimental Design, Multivariate Data Analysis, Principle components analysis (PCA), Support Vector Machine (SVM) Analysis for Multivariate Data, Canonical Correlation Analysis, Discriminate Analysis, Neural Network Models and MANOVA

Recommended Books

- 1) Campbell, R. C., *Statistics for Biologists*. Cambridge University Press, (1989)
- 2) Motulsky, H., *Intuitive Biostatistics*, Oxford University Press, (1995).
- 3) Heath, D., *An Introduction to Experimental Design and Statistics for Biology*, UCL Press, (1995).

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Course Objective

- To evaluate the results from different types of sequence-based analyses, domain comparisons, profile, and secondary/tertiary structure analyses
- To comprehend different, representative types of bioinformatics problems. This includes gene ontology analysis, sequence and phylogenetic analysis, gene expression analysis, genome annotation and analysis, bioimaging, analysis of genome variation, models of gene regulation, and systems biology models.
- To have an understanding of how to interpret different types of sequencing data from meta-genomic projects

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Learning Outcome

At the end of the course, the students would be able to:

- 1) Search databases accessible on the internet for literature relating to molecular biology and biotechnology
- 2) Manipulate DNA and protein sequences using stand-alone PC programs and Webservers
- 3) Find homologues, analyze sequences, construct and interpret evolutionary trees
- 4) Analyze protein sequences, identify proteins, and retrieve protein structures from databases.
- 5) Understand structure determination, homology modelling and computational drug design.
- 6) Process biological data, interpret and model biological information and apply this to the solution of biological problems in any arena involving molecular data.

Course Outline

Primary and derived bioinformatics data; Genomes and genome analysis methods; UniProt and sequence analysis methods; Statistical, information-theory and linguistic aspect of data; Coding algorithms for biological sequence analysis; Structural data analysis and PDB; Gene Ontology and functional data analysis; Multiple sequence alignment, intro to evolutionary analysis; Orthologs, paralogs/gene families, phylogenetic analysis; Protein, network-based analysis and Systems Biology; Integration of data from multiple sources for genomics and proteomics; Molecular Docking Simulation; Molecular Mechanics Simulations; Quantum Mechanical Computations; Visualization tools; Bioinformatics and nanotechnology: DNA computing, sequencing by hybridization; Recent trends

Recommended Books

- 1) Christianini, N., Hahn, M. W., *Introduction to Computational Genomics: A Case Studies Approach*. Cambridge University Press, (2007)
- 2) Jones, N. C., Evzner, P. A., *An Introduction to Bioinformatics Algorithms*. MIT Press, (2004).
- 3) Xiong, J., *Essential Bioinformatics*. Cambridge University Press, (2006).

BCH 758 RECENT TRENDS IN IMMUNOLOGY (3+0)

Course Objective

- To acquaint students with the principle and working of the immune system
- To equip students with recent developments and research in immunology
- To enable students to identify challenges related to autoimmune diseases

Learning Outcome

After completing this course students should be able to;

- 1) Understand recent challenges in the field of immunology
- 2) Describe the principals involved in the immune response


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Course Outline

Overview and elements of the immune system; Cells and Organs of the Immune System; Immunogens & Antigens; Antibody Structure and Function; Complement System; Genetic Basis of Ab Structure; Role of Major Histocompatibility Complex (MHC) in the Immune Response; The T Cell Receptor: Structure and Genetic Basis; Adaptive Immune Response; Antigen-Antibody Interactions – Immuno-Assays; Antibody and Cell-Mediated Reactions; Immunology of HIV Infection; Infection and Immunity; Immunopathology, Immune Regulation & Tolerance; Autoimmunity; Clinical Scenarios; Transplantation; Immunoprophylaxis (Vaccines); Disorders of the Immune Response; Immunology of Cancer; Modern Antibody Therapy

Recommended Books

- 1) Lewis, R. E., Cruse, J. M., *Atlas of Immunology*. 3rd Ed. CRC Press, (2010).
- 2) Rich *et al.*, *Clinical Immunology: Principles and Practice*. 5th Ed. Elsevier, (2018).
- 3) Abbas, A. K., Lichtman, A. H., Pillai, S., *Basic Immunology*. 6th Ed. Elsevier, (2019).

BCH 759 ADVANCED FERMENTATION BIOTECHNOLOGY (3+0)

Course Objective

The course has been designed to provide:

- Provide comprehensive knowledge about advanced techniques involved in industrial fermentation processes and their control
- All aspects of physiology and biochemistry of microorganisms during the fermentation process
- Technical skills to development economic production processes for different industrial products

Learning Outcome

After studying this course, the students are expected to:

- 1) Isolate, characterize Select microbial strains for different fermentation processes
- 2) Develop efficient and optimum fermentation processes for different products
- 3) Scale up the fermentation processes from lab scale to industrial fermenters

Course Outline

Industrial biotechnology and microbial cultivation in industrial processes; Transport phenomena in bioprocesses: Gas, heat and mass transfer, stirring and mixing; Fermenter designs and scale-up: From flask to industrial-scale fermenters; Monitoring and process control in liquid and solid-state cultures; Microbial metabolism and its control; Product recovery and analysis; Improvement of fermentation process, process optimization through classical and statistical strategies; Improvement of microbial strains: Chemical and radiation mutagenesis, recombination and genetic engineering; Alcoholic fermentation: Simultaneous and sequential processes; Production and applications of microbial enzymes and other fermentation products in food, pharmaceutical, paper and pulp, textile, detergent, leather and other industries;


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Bioremediation potential of microorganisms and their enzymes; Acclimated single and mixed microbial cultures; Immobilization of microbial cultures using different materials

Recommended Books

- 1) Cino, J., *Fermentation Methods: Methods in Biotechnology*. Human Press Inc., (2007)
- 2) Moo-Young, M., *Comprehensive Biotechnology*. 2nd Ed. Elsevier Inc., (2011).
- 3) Stanbury, P. F., Whitaker, A., Hall, S. J., *Principles of Fermentation Technology*. 3rd Ed. Butterworth-Heinemann, (2016).

BCH 760 TEACHING PRACTICE IN BIOCHEMISTRY (3+0)

Course Objective

- To learn and deliver practical skills of teaching
- To develop relevant teaching skills

Learning Outcome

Students completing this course will be able to:

- 1) Explore relevant topics in biochemistry
- 2) Equipped with teaching skills

Course Outline

The student will teach an undergraduate course or some of its parts assigned by the teacher. The teacher will monitor the teaching methodology and skills throughout the semester.

BCH 810 COMMUNITY NUTRITION (3+0)

Course Objective

Students completing this course will have a broader understanding of

- Fundamental concepts in community nutrition.
- Nutrition problems on the population level and identification of groups at risk for malnutrition.
- Local, national and international community nutrition assistance programs and their analysis
- The practical component will impart basic laboratory skills.

Learning Outcome

Upon successful completion of this course, the students should be able to;

- 1) Demonstrate an understanding of community nutrition practices
- 2) Carry out community nutritional assessment.
- 3) Demonstrate understanding of culture, religion, beliefs, values and behaviours on community nutrition status.


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- 4) Collect, analyse and critically evaluate data on nutrition problems in communities.
- 5) Manage time and demonstrate skills in written and oral communication.

Course Outline

Basic concepts in community/public health nutrition; Role of community/public health nutritionists; Nutrition epidemiology; Healthy lives, determinants of health and leading health indicators; Eating disorders; Nutritional assessment at individual and population level; Assessment of physical activity; National and international nutrition and food assistance programs; Food and nutrition guidelines.

Recommended Books

- 1) Nnakwe, N., *Community Nutrition*. 3rd Ed. Jones & Bartlett Learning, (2016).
- 2) Boyle, M. A., *Community Nutrition in Action: An Entrepreneurial Approach*. 7th Ed. Cengage Learning, (2016).
- 3) Edelstein, S., *Public Health Nutrition*. 4th Ed. Jones & Bartlett Learning, (2017).

BCH 811 PROTEIN STRUCTURE, FUNCTIONS & ENGINEERING **(3+0)**

Course Objective

- To develop an understanding of the basic chemistry of proteins, folding pathways, stability and function.
- To become familiar with standard methodologies and procedures for analyzing, sequencing and synthesizing peptides and proteins.
- To perform ligand interaction and homology modelling

Learning Outcome

After studying this course, the students will be able to:

- 1) Utilize the knowledge of proteins physical properties to develop strategies for purification and/or analysis
- 2) Design strategies for identifying protein-protein or protein-small molecule interactions
- 3) Analyse the purity and stability of proteins for efficient storage
- 4) Design proteomic approaches to the study of proteins
- 5) Design experimental approaches to protein engineering and expression

Course Outline

Biological and recombinant protein synthesis Protein structure, function and bioinformatics; Structure determination by X-ray crystallography and NMR spectroscopy; Structure modeling and analysis using molecular graphics; Introduction to protein sequence and structure databases; Protein bioinformatics tools and methods; Prediction and design of protein structures: Homology and ab-initio method for protein structure prediction; Phage display systems; Structure-based drug design; Protein Arrays; Strategies for protein engineering; Random and site-directed mutagenesis; Role of low-fidelity enzymes in protein engineering; Gene shuffling and Directed evolution of proteins; Protein backbone changes; Antibody and

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enzyme engineering

Recommended Books

- 1) Branden, C., Tooze, J., *Introduction to Protein Structure*. 2nd Ed. Garland Press, (1999).
- 2) Voet, D., Pratt, C. W., Voet, G. J., *Principles of Biochemistry*. 4th Ed. Wiley, (2012).
- 3) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman (2017).

BCH 812 ADVANCES IN ENZYMOLOGY (3+0)

Course Objective

- This course will cover the details of structures and conformations of enzyme molecules, active sites, reaction mechanisms in enzyme active sites and factors affecting enzyme activity
- The contents will provide an understanding of biochemical reaction types, derivation of kinetic equations and their transformations for single and multi-substrate enzyme-catalysed reactions
- The practical component will impart skills for running enzyme assays and determining the pH- activity, temperature-activity and thermo-stabilities profiles of enzymes

Learning Outcome

After completing this course students should be able to;

- 1) Understand the molecular mechanisms of enzyme-catalyzed reactions
- 2) Acquire advanced knowledge for characterization of enzymes through kinetic studies for their clinical and industrial applications
- 3) Use spectrophotometric and other techniques for running enzyme assays
- 4) Determine substrate affinities, catalytic efficiencies, pH-activity profiles and thermo-stabilities of enzymes

Course Outline

Introduction to chemical kinetics and reaction rates; Types of enzyme catalysed reactions, rate equations, rate constants and steady states; Free energy of activation, transition state and effect of enzymes; Importance of enzyme kinetics in the study of mechanisms of enzyme catalysed reactions; Catalytic mechanisms: Lock and Key model and Induced fit model; Catalytic groups in enzyme active sites and their role in catalysis; Factors contributing to catalytic efficiency of enzymes: proximity and orientation; strain and distortion; covalent, general acid-base, concerted acid-base and metal ion catalysis; Derivation of Michaelis-Menton equation for one substrate enzyme catalysed reactions; effect of substrate concentration on rates of enzyme catalysed reactions; Transformations of Michaelis-Menton equation: Lineweaver-Burk reciprocal plots; Eddie Hofstee plots; Determination of catalytic parameters like V_{max} , K_m and K_{cat} ; Kinetics of competitive, non-competitive, uncompetitive and mixed inhibition; Kinetics of two-substrate and multi-substrate reactions; Non-Michaelis-Menten Kinetics; Kinetics of Allosteric and regulatory enzymes; Types of enzyme activity assays; Types of enzyme activity units and their relationships; Significance of enzyme kinetics in clinical and industrial applications.

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75
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Course Outline

RT-PCR and RFLP; qPCR; Blotting Techniques such as Southern, northern, western, dot blot; Flow cytometry; Karyotyping; Fluorescent *in situ* hybridization (FISH); Chromogenic *in situ* hybridization (CISH); Analysis of amniotic fluids and various DNA tests; Maternal serum testing; Use of Chorionic; Villous Sampling for the detection of chromosomal and genetic disorders

Recommendation Books

- 1) Ream, W., Field, K. G., *Molecular Biology Techniques: An Intensive Laboratory Course*. Academic Press, (1998).
- 2) Carson, S., Miller, H. B., Srougi, M. C., Witherow, S., *Molecular Biology Techniques: A Classroom Laboratory Manual*. 4th Ed. Academic Press, (2019).
- 3) Buckingham, L., *Molecular Diagnostics: Fundamentals, Methods and Clinical Applications*. 3rd Ed. F. A. Davis Company, (2019)

BCH 820 SPECIAL TOPICS IN BIOCHEMISTRY (3+0)

Course Objective

- The students will be able to learn with structural and properties of proteins.
- This course will focus on the knowledge about the advanced techniques used for proteins analysis and determination.

Learning Outcome

Upon successful completion of the course, the student will be able to:

- 1) Understand the structure and analysis of proteins
- 2) Acquire the basic knowledge about the technologies involved in genomics, proteomics and metabolomics.

Course Outline

Amino acids and peptides chemistry; Transcription and translation; Protein folding, modification and transport; Protein Post translation modifications; Protein mutation; Classical analytical methods: Amino acid analysis, Amino-Terminal Sequencing by Edman Degradation, Polyacrylamide Gel Electrophoresis, Isoelectric Focusing, Two Dimensional IEF-PAGE, Polyacrylamide Gel Electrophoresis; Chemical Methods for Protein Characterization; Protein targeting. Transport, storage, regulatory and receptor proteins; Protein purification; Protein sequencing and Biological role

Recommended Books

- 1) Walsh, G., *Proteins: Biochemistry and Biotechnology*. 2nd Ed. Wiley-Blackwell, (2014)
- 2) Almeida, P., *Proteins: Concepts in Biochemistry*. 1st Ed. Garland Science, (2016)
- 3) Whitford, D., *Proteins: Structure and Function*. 1st Ed. Wiley, (2005)


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77
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BCH 850 GOOD LABORATORY PRACTICES AND QUALITY CONTROL (3+0)

Course Objective

- To introduce principles of good laboratory practices (GLP)
- To impart the importance of GLP and quality controls within a regulated laboratory environment
- To provide insights into quality control and assurance
- To understand components of laboratory quality management system and sources of laboratory errors

Learning Outcome

After completing this course, students should be able to;

- 1) Understand the difference between quality control and quality assurance
- 2) Acquire basic knowledge of laboratory design and management
- 3) Understand pre and post-analytical errors
- 4) Technically defend scientific data by its quality and reliability using GLP
- 5) Apply the regulations and standards associated with GLP
- 6) Understand the consequences of non-compliance regulated laboratories.

Course Outline

Certification and Accreditation; Elements of Laboratory Quality Management System; Personal Protective Equipment; Standard Operating Procedures; Laboratory Design; Equipment selection and Equipment Operating Procedures; Preventive Maintenance; Inventory; Pre-analytical errors; Collection, receipt/transport and storage of samples; Qualitative and Quantitative tests; Calibration; Quality Control; Quality Assurance; LJ-Charts; Application of Westgard Rules; External Quality Assurance Schemes; Post-analytical errors

Recommended Books

- 1) Allport-Settle, M. J., *Good Laboratory Practice: Nonclinical Laboratory Studies Concise Reference*. Pharma Logica Inc, (2010).
- 2) Weinberg, S., *Good Laboratory Practice Regulations*. 4th Ed. CRC Press, (2007)
- 3) Slomiany, M. G., *The Indispensable Guide to Good Laboratory Practice*. 2nd Ed. Pinehurst Press, (2009).

BCH 851 BIOCHEMISTRY OF METABOLIC DISORDERS (3+0)

Course Objective

- To identify enzyme defects that produce glycogen storage diseases and lipid storage diseases
- To provide an overview of inborn errors of amino acid metabolism.
- To describe the Lesch- Nyhan Syndrome, Gout and action of allopurinol.
- Characterize Diabetic Syndrome.

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- Explain the basis of laboratory test relevant to the diagnosis of inborn- errors of metabolism and glucose homeostasis.

Learning Outcome

After completing this course students should be able to;

- 1) Learn the underlying molecular basis of the metabolic disorders.
- 2) Relate the cause to the clinical characteristic of the disorder.
- 3) Understand how obesity is related to non-insulin dependent Diabetes Mellitus.
- 4) Correlate hypercholesterolemia to the development of atherosclerosis.
- 5) Distinguish Insulin dependent and non-insulin dependent diabetes mellitus.

Course Outline

Introduction to Metabolic disorder/ Inborn errors of metabolism; Neonatal presentation: Problems of synthesis and break down of complex molecules, intoxication, energy deficiency states and seizure disorders; Glycogen storage diseases; Lysosomal storage diseases or Lipidosis; Inborn errors of metabolism related to amino acids; Disorders related to Nucleotide metabolism i-e Lysch-Nyhan syndrome; Diabetes Mellitus; Disorders leading to primary hypercholesterolemia. Biochemical basis of Tangiers disease

Recommended Books

- 1) Devlin, T. *Textbook of Biochemistry with Clinical Correlations*. 7th Ed. Wiley, (2010).
- 2) Ahmed, N., *Clinical Biochemistry (Fundamentals of Biomedical Science)*. Oxford University Press, (2011).
- 3) Marshall, W., Bangert, S., *Clinical Biochemistry: Metabolic and Clinical Aspect*. 2nd Ed. Churchill Livingstone, (2008).

BCH 852 BIOCHEMISTRY OF NATURAL PRODUCTS (3+0)

Course Objective

- To give deep insights into natural products biochemistry
- To extend basic knowledge about the metabolism of natural products

Learning Outcome

Scholars completing this course will be able to;

- 1) Understand the deeper concepts of natural products biochemistry
- 2) Explain the mechanistic pathways for the metabolism of natural products
- 3) Discuss the implication of natural products in biological pathways
- 4) Discover the application of course in related fields

Course Outline

Introduction to natural products in biological system; Common mechanisms in biological chemistry for metabolism of natural products; Biosynthesis of lipids and their catabolic

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 Head of Department
 Department of Biochemistry
 University of Malakand

[Handwritten Signature]
 Dr. Anil Kumar
 Head of Department
 Department of Biochemistry
 University of Malakand

reactions; Fatty acids, steroids and terpenoids biosynthesis; Pathways involved in the biosynthesis fatty acids, steroids and terpenoids; Biosynthesis of thromboxanes, leukotrienes, prostaglandins' biosynthesis and their catabolic mechanism; Carbohydrates transformation to different natural products; Biosynthesis of secondary metabolites (alkaloids) using amino acids as starting material; Synthesis of polyketides in biological systems; Biosynthesis of some representative natural products; Penicillin, cephalosporins, erythromycin, morphine, coenzyme B12 and tetrapyrroles

Recommended Books

- 1) Dewick P. M., *Medicinal Natural Products: A Biosynthetic Approach*, 3rd Ed., Wiley, (2009).
- 2) *Plant-Derived Natural Products: Synthesis, Functions and Applications*. Osbourn, A. E., Lanzotti, V. (Editors), Springer, (2009)
- 3) Newman, D. J., Cragg, G. M., Grothaus, P., *Chemical Biology of Natural Products*, CRC Press, (2017).

BCH 853 RECOMBINANT DNA TECHNOLOGY (3+0)

Course Objective

- To clarify creative use of modern tools and techniques for manipulation of genomic sequences
- To expose students to the application of recombinant DNA technology in biotechnological research

Learning Outcome

After studying this course, the students will be able to:

- 1) Describe the mode of the action of molecular scissors and various enzymes involved
- 2) Understand the methods employed for recombinant DNA techniques
- 3) Discuss different methods for creating gene library
- 4) Describe cloning in yeast and prokaryotes
- 5) Apply recombinant DNA technology in various fields

Course Outline

Recombinant DNA Technology; Necessary tools required for recombinant DNA technology; Restriction endonucleases, Types, functions and mode of action of DNA ligases; Cloning Vectors; Methods for introducing Target DNA and Screening Procedures; Methods of creating and screening the genomic and cDNA Libraries; Molecular Cloning: Strategies and screening assays; Application of Recombinant DNA Technology

Recommended Books

- 1) Primose, S., Twyman, R., Old, R. W., *Principles of Gene Manipulation*. 6th Ed. Wiley-Blackwell, (2002)
- 2) Glick, *et al*, *Molecular Biotechnology: Principles & Applications of Recombinant DNA*. ASM Press, (2009)

Course Objective

- To give students a deeper understanding of basic concepts of research and its methodologies
- To provide knowledge and skill to students to handle the design of a health-related research proposal
- To provide training in literature searching

Learning Outcome

After completing this course students should be able to;

- 1) Understand the concepts and identify the overall process of research design
- 2) Select an appropriate qualitative or quantitative method for data collection
- 3) Write a research proposal suitable for submission to a research funding body
- 4) Understand academic malpractice, including plagiarism, and how to avoid it

Course Outline

Introduction to Research; Role of Research and Types of Research; Epidemiological Studies, Basic Studies; Descriptive & Analytical Studies; Research Methods, Samples and Population, Probability and Nonprobability Sampling Problems and Hypotheses; Formulation of Research Hypotheses, Importance of Problems and Hypotheses; Study Design; Selection of Research Topic and Research Supervisor; Variable; Independent & Dependent Variables; Methods of Data Collection; Review of Literature and Literature Citations; Bibliography/ References, Research Ethics, Plagiarism and its Consequences; Writing of Research Grant Application; Writing of Synopsis, research Thesis, Writing of Manuscript and, Research Report

Recommended Books

- 1) Creswell, J. W., Creswell, J. D., *Research Design: Qualitative, Quantitative, and Mixed Method Approach*. 5th Ed. SAGE Publications Inc, (2018)
- 2) *Research Methodology in Medical and Biological Sciences*. Laake, P., Benestad, H. B., Olsen, B. R., (Editors), 1st Ed. Academic Press, (2007)
- 3) Kumar, R., *Research Methodology: A Step-by-Step Guide for Beginners*. 5th Ed. SAGE Publications Ltd, (2019)

Course Objective

- To provide information about principles & mechanism of different types of equipment and analysis of advance Biochemical techniques and Biological sampling
- To Provide students with a “snapshot” of a career in research
- To Improve problem-solving and deductive reasoning skills
- Transition student’s knowledge to practical applications


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Learning Outcome

On successful completion of this course the students will be able to:

- 1) Describe the principles behind a number of common biochemical techniques.
- 2) Explain the strengths and weaknesses of a technique for particular applications.
- 3) Combine different biochemical methods to address a complex biological question.
- 4) Troubleshoot biochemical methods based on their scientific principles.
- 5) Read, communicate and critically evaluate course-related scientific literature

Course Outline

Standard Operating Procedures (SOP): Quality controls and quality assurance; Validations of analytical methods: Specificity, selectivity, linearity, accuracy, precision, quality controls and reference standards; Protein isolation techniques: TLC, gel filtration, Column Chromatography, gas chromatography, Affinity Chromatography, ion-exchange chromatography, hydrophobic interaction chromatography, HPLC, FPLC, LC-MS, GC-MS, GC-FID; Gel electrophoresis techniques for DNA and protein characterization: PAGE, SDS-PAGE, 2D BN-PAGE, Immuno-electrophoresis, Immuno-blotting, Radioimmunoassay, ELISA; UV/VIS, IR spectrometry, Atomic absorption spectrophotometry; NMR, MRI, PCR; Ultrafiltration, Centrifugation, and lyophilisation; Electron Microscopy, scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Uses of isotopes in biochemistry

Recommended Books

- 1) *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Wilson, K., Walker, J (Editors). Cambridge University Press (2010).
- 2) Katoch, R., *Analytical Techniques in Biochemistry and Molecular Biology*. Springer Science & Business Media, (2011).
- 3) Carson, S., Miller, H. B., Srougi, M. C., Witherow, D. S., *Molecular Biology Techniques: A Classroom Laboratory Manual*. Academic Press, (2019).

BCH 856 GENOMICS, PROTEOMICS AND METABOLOMICS (3+0)

Course Objective

- The course is designed to familiarize the students with structural and functional genomics, proteomics and metabolomics
- This course will focus on the theory of 'omics' and deliver knowledge about the advanced techniques used in 'omics' research.

Learning Outcome

Upon successful completion of the course, the student will be able to:

- 3) Understand the complex terms used in 'omics'
- 4) Acquire the basic knowledge about the technologies involved in genomics, proteomics and metabolomics.
- 5) Evaluate how these technologies provide a better understanding of the complexities of


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whole organisms and biological systems.

Course Outline

Introduction to omics and genomics; DNA Databases; Genome Sequencing and Annotation, Next-generation sequencing; Human genome project, Genome Mapping and organization; Gene Discovery - Expressed Sequencing Tags (ESTs); Chromosome walking; Structural Variation in the Genomes; Sequence polymorphisms in genomes and SNPs; Techniques: microarrays, Serial analysis of gene expression (SAGE); Proteomics: Introduction to Proteomics; Protein database; Proteomics technologies: 2D-gel electrophoresis, mass spectrometry, yeast 2-hybrid system, Tandem affinity purification, protein microarray; Protein sequencing; Protein linkage mapping; Strategies for protein identification; Protein modifications and proteomics; Applications of proteome analysis to drug and biomarker discovery; Interaction Proteomics; Metabolomics: Introduction to Metabolomics; Metabolic pathways resources: KEGG, Biocarta; Nuclear Magnetic Resonance Spectroscopy and Mass Spectrometry in metabolomics.

Recommended Books

- 1) *Fundamentals of Advanced Omics Technologies: From Genes to Metabolites*. Volume 63, Simo, C., Cifuentes, A., Garcia-Canas, V. (Editors), Elsevier, (2014)
- 2) Lesk, A., *Introduction to Genomics*. 2nd Ed. Oxford University Press, (2012).
- 3) *Metabolomics: From Fundamentals to Clinical Applications*. Sussulini, A. (Editor), Springer, (2017)

BCH 857 GENE EXPRESSION AND REGULATION (3+0)

Course Objective

- To provide an overview of gene expression pathways
- To provide knowledge about regulatory mechanisms
- To elaborate the techniques used for the analysis of gene expression

Learning Outcome

Upon successful completion of the course, the student will be able to:

- 1) Understand the basics of gene expression pathways
- 2) Understand and analyse features involved in expression regulation.
- 3) Analyse expression data and deduce regulatory patterns.

Course Outline

Introduction of gene structure and regulatory elements; Transcription initiation in prokaryotes and role of promoters; Transcription initiation in eukaryotes from variable promoters; Regulation of transcription initiation in prokaryotes and eukaryotes; Post-transcription regulation at various levels; Chromatin and nucleosome structure; Histone modification; Chromatin remodelling; Epigenetic regulation; Translation initiation in prokaryotes and eukaryotes; Regulation of translation; Post translation regulation at different levels; Techniques used for gene expression studies


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Recommended Books

- 1) Lodish, *et al. Molecular Cell Biology*. 8th Ed. W. H. Freeman, (2016).
- 2) Cooper, G., *The Cell: A Molecular Approach*. 8th Ed. Oxford University Press, (2018).
- 3) Huang, S., Litt, M. D., Blakey, C. A., *Epigenetic Gene Expression and Regulation*. 1st Ed. Academic Press, (2015)

BCH 858 FOOD BIOCHEMISTRY (3+0)

Course Objective

- To provide students with the key concepts of Food, nutrition and human health
- To describe the role of essential components of a balanced diet
- To integrate chemistry and biochemistry principles into real-world food science and nutritional problems

Learning Outcome

On successful completion of this course the students will be able to:

- 1) Explain the absorption, storage and metabolic function of macro and micronutrients.
- 2) Describe the role of nutrients in the optimal functioning of key biochemical pathways in the body.
- 3) Integrate biochemical mechanisms with disease pathology and clinical treatment options.
- 4) Provide a coherent argument for the use of nutrient supplementation and food therapy
- 5) Promoting health and wellbeing through optimal biochemical pathway functions.

Course Outline

Food selection and meal planning for healthy individuals; Absorption, storage and metabolic function of macro and micronutrients; Balanced diet: recommended dietary allowances for different categories of the human beings; Water's importance in Food Chemistry: Phases of water, the role of water as a solvent in food systems, the concept of water activity, Measurement of energy of foods and expenditures; Direct and indirect caloric measurement; Basal metabolism, Food borne diseases, Nutritional aspects and dietetic treatment of a few important primary nutritional and general diseases; Fasting, Starvation, Food intolerance and food allergies, Clinical surveys, Physical examinations, Laboratory examinations, Dietary surveys, Micronutrients: Sources, Daily allowance, Deficiency diseases; Biological importance of vitamins and minerals; Nutrigenomics (influence of genetic variation on nutrition, effects of nutrition, nourishment or lack of nutrition on the genetic expression and correlating gene expression or SNPs with a nutrient's absorption); Preservation of food by UV-radiation / chemical method

Recommended Books

- 1) DeMan, J. M., Finley, J. W., Hurst, W. J., Lee, C. Y., *Principles of Food Chemistry*. Aspen Publishers, (1999).
- 2) Belitz, H. D., Grosch, W., *Food Chemistry*. Springer Berlin, (2013).
- 3) Zeb, A., *Food Frying: Chemistry, Biochemistry and Safety*. 1st Ed. John Wiley & Sons, (2019).

Course Objective

- The objective of this course is to provide students with the basic principles of biofuels and bioenergy systems design
- Students in this course will identify biofuels and bioenergy sources; describe biofuels and bioenergy technologies, applications and efficiency
- To analyse biofuels and bioenergy manufacturing, distribution and integration issues; evaluate biogas and its sources and site location; design a biofuels and bioenergy process and its related components

Learning Outcome

Students completing this course will be able to:

- 1) Demonstrate knowledge of biofuels and bioenergy best practices
- 2) Have a critical view on problems related to biofuel efficiency
- 3) Evaluate biofuel and bioenergy equipment
- 4) Recognize the various types of biofuels and bioenergy systems and components in use
- 5) Understand the market and economics of biofuels and bioenergy systems
- 6) Understand the types of process technologies and standards that apply to biofuel and bioenergy
- 7) Improve the quality of biofuels and bioenergy facilities

Course Outline

Energy perspective, Current methods, Biomass possibilities; Fundamental concepts in understanding biofuel and bioenergy production of Mass Balances; Energy Balances, Thermodynamics, Organic compounds; Chemistry of plant materials, Production of bio-renewable resources including Herbaceous crops, Woody crops, Algae; Conversion of biomass into heat and power: Direct combustion, Thermal gasification, Anaerobic digestion; Processing of biomass into chemicals and fuels; Sugars, Alcohols, Biodiesel Thermochemical conversion, Fischer Tropsch Fuels etc, Ethanol - issues & future prospects; Biodiesel - uses, production, processes, Biomass & Bioenergy wrap-up; Fuel cells, Transportation - hybrids, flex fuels, fuel cells etc; Environmental impact of the bio-economy: Land use, Pollution, Climate change etc, *Natural burial*, Economics of bio-renewable resources with reference to Feedstock costs, Capital costs, operating costs

Recommended Books

- 1) Brown, R. C., *Biorenewable Resources: Engineering New Products from Agriculture* Blackwell Publishing Professional, (2003)
- 2) *Biofuels*. Soetaert, W., Vandamme, E. (Editors), Wiley, (2009)
- 3) Klass, E., *Biomass for Renewable Energy, Fuels, and Chemicals*. Academic Press, (1998)


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BCH 870 SELECTED TOPICS IN LIPID METABOLISM (3+0)

Course Objective

- The course is aimed to provide a detailed overview of the selected topics lipid metabolism.
- The course will provide sufficient knowledge for solving problems in lipid metabolism.

Learning Outcome

Students completing this course will be able to:

- 1) Demonstrate knowledge of selected topics in lipid metabolism
- 2) Have a critical view on problems related to lipids

Course Outline

Oxidation of fatty acids; Digestion, mobilization and transport of fats; Biosynthesis of triacylglycerol; utilization of triacylglycerol; Activation of fatty acids and their transportation to mitochondria; Beta-oxidation; bioenergetics of beta-oxidation; oxidation of unsaturated and odd chain fatty acids; Omega oxidation pathway; Biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis; Fatty acid synthetase (FAS) multi-enzyme complex; Biosynthesis of unsaturated fatty acids. Ketone bodies their biosynthesis, utilization and role in the tissues; Cholesterol metabolism: cholesterol biosynthesis and its regulation; Steroid hormones metabolism.

Recommended Books

- 1) Nelson, D. L., Cox, M. M. *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017).
- 2) Gurr, *et al.*, *Lipids: Biochemistry, Biotechnology and Health*. 6th Ed. Wiley-Blackwell, (2016).
- 3) Ridgway, N., McLeod, R., *Biochemistry of Lipids, Lipoproteins, and Membranes*. 6th Ed. Elsevier Science, (2015).

BCH 871 SPECIAL TOPICS IN CARBOHYDRATES **BIOCHEMISTRY** **(3+0)**

Course Objective

- To explore ideas from recent research on carbohydrates
- To understand and solve selected problems in carbohydrates biochemistry.

Learning Outcome

Students completing this course will be able to:

- 1) Explore topics with advance knowledge of carbohydrates
- 2) Identify and sort out research questions


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Course Outline

The content of the course will be decided by the concerned teacher on the relevance to the latest research on carbohydrates biochemistry.

BCH 872 SPECIAL TOPICS IN PROTEINS BIOCHEMISTRY (3+0)

Course Objective

- To explore ideas from recent research on proteins
- To understand and solve selected problems in proteins biochemistry.

Learning Outcome

Students completing this course will be able to:

- 1) Explore topics with advance knowledge of proteins
- 2) Identify and sort out research questions

Course Outline

The content of the course will be decided by the concerned teacher on the relevance to the latest research on proteins biochemistry.

BCH 873 SPECIAL TOPICS IN NUCLEIC ACID BIOCHEMISTRY (3+0)

Course Objective

- To explore ideas from recent research on nucleic acid
- To understand and solve selected problems in nucleic acid biochemistry.

Learning Outcome

Students completing this course will be able to:

- 1) Explore topics with advance knowledge of nucleic acid
- 2) Identify and sort out research questions

Course Outline

The content of the course will be decided by the concerned teacher on the relevance to the latest research on nucleic acid biochemistry.


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BCH 874 SPECIAL TOPICS IN VITAMINS BIOCHEMISTRY (3+0)

Course Objective

- To explore ideas from recent research on fat and water-soluble vitamins.
- To understand and solve selected problems in vitamins biochemistry.

Learning Outcome

Students completing this course will be able to:

- 1) Explore topics with advance knowledge of vitamins
- 2) Identify and sort out research questions

Course Outline

The content of the course will be decided by the concerned teacher on the relevance to the latest research on vitamins biochemistry.

BCH 875 SPECIAL TOPICS IN PLANT BIOCHEMISTRY (3+0)

Course Objective

- To explore ideas from recent research on plant biochemistry
- To understand and solve selected problems in plant metabolites.

Learning Outcome

Students completing this course will be able to:

- 1) Explore topics with advance knowledge of plant biochemistry
- 2) Identify and sort out research questions

Course Outline

The content of the course will be decided by the concerned teacher on the relevance to the latest research on plant biochemistry.

BCH 876 LIQUID CHROMATOGRAPHY (3+0)

Course Objective

- To understand the comprehensive knowledge of liquid chromatography
- To equip the student with the latest development in the field.

Learning Outcome

Students completing this course will be able to:

- 1) Explore topics with advance knowledge of liquid chromatography


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- 2) Identify and sort out research on the subject.

Course Outline

The concept of liquid chromatography (LC), components of LC, stationary phases, column, column packing, packing materials, column length, diameter; mobile phases, selection of mobile phase, mobile phase modifiers, basic terminology used in LC; retention time; capacity factor; resolution; HPLC, instrumentation, types of LC, normal phase LC, application, mechanism of separation; reversed-phase LC, application, mechanism of separation; LC detectors, detectors characteristics, LOD & LOQ, UV, DAD, FLD, ECD, MSD, RID and LSD detectors.

Recommended Books

- 1) Snyder, L. R., Kirkland, J. J., Dolan, J. W., *Introduction to Modern Liquid Chromatography*. 3rd Ed. Wiley, (2009)
- 2) Vitha, M. F., *Chromatography: Principles and Instrumentation*. 1st Ed. Wiley, (2016).
- 3) Holcapek, M., Brydwell, W. C., *Handbook of Advanced Chromatography /Mass Spectrometry Techniques*. 1st Ed. Academic Press, (2017)

BCH 877 SPECIAL TOPICS IN ENZYME KINETICS (3+0)

Course Objective

- To impart knowledge about the kinetics of enzymes
- To provide an overview of reactions and impact of different factors on their rate

Learning Outcome

Upon successful completion of the course, the student will be able to:

- 1) Understand the catalytic properties and mechanisms of enzyme action
- 2) Understand and analyse the kinetics of enzyme-catalysed reactions.
- 3) Evaluate the effect of different types of inhibitors on enzyme activity

Course Outline

General introduction: Enzyme, enzyme composition and structure, Active site, Co-factor, Prosthetic group, Co-enzyme, Factor affecting enzyme activities, Chemical kinetics

Kinetics of Mono-substrate Reactions: Reaction order, Zero-order reactions, first-order reactions, Second-order reactions, Work of Michaelis and Menten, Steady-state approximation, hyperbolic nature of Michaelis-Menten equation, Significance of kinetic parameters, Graphical representation of the data

Kinetics of Enzyme inhibition: Reversible and irreversible enzyme inhibition, Linear inhibition, Competitive inhibition, Uncompetitive inhibition, Non-competitive inhibition, Hyperbolic and parabolic inhibition, Enzyme Reactions with Two Competing Substrates

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Kinetics of Bisubstrate Reactions: Nomenclature, Ordered bi-bi mechanism, Random bi-bi mechanism, Ping pong bi-bi mechanism

Kinetics of Allosteric Enzymes: Hysteretic Enzymes, Kinetic Cooperativity, the Slow Transition Model

Recommended Books

- 1) Okotore, R. O., *Essentials of Enzymology*. Xlibris Corporation, (2015).
- 2) Price, N. C., Stevens, L., *Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins*, Oxford University Press, (1999).
- 3) Mathews, C. K., Van Holde, K. E., Ahern, K.G., *Biochemistry*. 3rd Ed. Prentice Hall, (1999).

BCH 900 MOLECULAR MECHANISMS OF DISEASES (3+0)

Course Objective

- To provide basic concepts of mechanisms of diseases
- To provide an understanding of mechanisms of genomic instability, signal transduction and the networks of cellular responses.

Learning Outcome

After completing this course, the student should be able to;

- 1) Understand the molecular and cellular mechanisms of disease
- 2) Acquire basic knowledge of microbial infections and genetic diseases.

Course Outline

A general introduction to basic mechanisms of disease and risk factors; Origin and development of the disease; Genetic diseases (Muscular dystrophy, bone deformities, skin diseases); Microbial Infections; Viral infections and its factors; Immunopathogenesis (Inflammation, Fibrosis, Hypersensitivity, Autoimmunity, Immunodeficiency); Degeneration; Pathogenesis of Cancer.

Recommended Books

- 1) Brownstein, M. J., Khodursky, A., *Functional Genomics*. Humana Press, (2010).
- 2) Strachan, T., Read, A., *Human Molecular Genetics*. 4th Ed. Garland Science, (2010).
- 3) Coleman, W. B., Tsongalis, G. J., *Molecular Pathology: The Molecular Basis of Human Disease*. 2nd Ed. Academic Press, (2017)


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Course Objective

- To introduce the evolutionary processes at molecular and genomic levels
- To introduce the biochemical effects of genomic molecular evolutions
- To discuss the medical, biotechnological and anthropological effects of molecular evolution

Learning Outcome

After completing this course the students should be able to:

- 1) Describe the evolutionary process at the molecular level
- 2) Apply molecular methods to study genetic variation within and between species
- 3) Explain and justify different models of sequence evolution and their application in phylogenetic analysis

Course Outline

Molecular basis of evolution; Allele dynamics in populations; DNA and amino acid sequence evolution; Rates and patterns of molecular evolution; Molecular phylogenetics and phylogenetic trees; Reticulate evolution and phylogenetic networks; Evolution by DNA duplication; Evolution by molecular tinkering; Mobile elements in evolution; Prokaryotic genome evolution; Eukaryotic genome evolution; The evolution of gene regulation; Experimental molecular evolution

Recommended Books

- 1) Gaur, D., *Molecular and Genome Evolution*. 1st Ed. Oxford University Press, (2016).
- 2) Bromham, L., *An Introduction to Molecular Evolution and Phylogenetics*. 2nd Ed. Oxford University Press, (2016).
- 3) Hahn, M. W., *Molecular Population Genetics*. 1st Ed. Oxford University Press, (2018).

Course objectives

- This course will provide basic and fundamental concepts of drug designing strategies and development.
- The contents will provide an understanding of drug designing and metabolic changes in drugs and other related organic compounds.
- Understanding of general pathways of drug metabolism. FDA Role and Responsibilities

Learning Outcome

After completing this course students should be able to;

- 1) Understand the drug designing strategies, drug distribution, acid-base properties
- 2) Acquire basic knowledge of general pathways of drug metabolism, computer-aided drug

- design,
- 3) Understand and explain the phases, structure, and analytical development of the drug, Drug Development Activities and Timeline

Course Outline

Drug Metabolism

General Pathways of Drug Metabolism; Sites of Drug Biotransformation; Role of Cytochrome P450, Monooxygenases in Oxidative Biotransformations; Oxidative Reactions, Reductive Reactions, Hydrolytic Reactions phase II, Conjugation Reactions; Factors Affecting Drug Metabolism

Drug Designing Strategies

Objectives of drug designing; Drug distribution, Acid-base properties; Phases of drug development, Cost and time factor in drug development, Market potential of the drug, Screening of natural products, Identification of lead molecules, Structure-based drug design; Analytical development, Stability studies, Sponsor Role and Responsibilities, FDA Role and Responsibilities, Regulations governing Drug Development, Drug development activities and timeline, Research and early development activities; Pre-clinical Evaluation/Testing, First in Human Evaluation; Clinical development: Phases and activities, NDA Application/Submission; Post-Approval Sponsor Responsibilities; Pre-formulation and formulation studies; Bioavailability testing; Establishment of drug standards; Chemical and toxicological evaluation; Determination of safety and efficacy in animals and humans; Establishment of dosing limits, Understanding of drug interaction; Drug modification

Recommended Books

- 1) *Foye's Principle of Medicinal Chemistry*. Williams, D. A. (Editor). 7th Ed. LWW, (2012)
- 2) *Burger's Medicinal Chemistry and Drug Discovery*. Abraham, D. J. (Editor), John Wiley & Sons, (2003)
- 3) Taylor, J. B., Triggler, D. J., *Comprehensive Medicinal Chemistry*, Pergamon Press, (2007).

BCH 903 FORENSIC SEROLOGY AND DNA ANALYSIS (3+0)

Course Objective

- To acquaint students with the understanding the forensic science with special reference to DNA and Serology.
- To help them understand the detection of human biological fluids and their importance.
- To understand the role and utility of biological fluids as evidence in the criminal investigation system.

Learning Outcome

At the end of the course, the students would be able to understand:

- 1) The importance of serological fluids like blood semen and saliva found on the crime


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- 2) Importance of Forensic DNA and Serology in legal investigations and the importance of quality control and quality assurance systems in Forensic Sciences.
- 3) How obtaining DNA profile helps in parentage testing and relationship/sibship testing and the importance of lineage markers and familial searching using the DNA database.
- 4) The significance of DNA profiling, different interpretations and outcomes.

Course Outline

Essentials to Forensic Serology; Blood Serology; Semen Serology and saliva detection; Other biological fluids; Forensic genetics; Polymorphism DNA structure; STR's and SNP's; Screening of biological evidence; DNA extraction from evidence samples; Robotics in DNA extraction; Different DNA quantification methods; Amplification and Analysis of STR; Genotyping and Capillary Electrophoresis; Interpretation of genetic profiles; Artefacts in genotyping; Population genetics; Statistical interpretation; Lineage markers and familial searching; The basis of paternity and sibship testing; Non-human DNA typing; Role of Quality control and Quality Assurance in Forensic DNA and Serology; Criminal Justice System of Pakistan; Evidentiary value of DNA evidence

Recommended Books

- 1) William, G., Linacre, A., Hadi, S., *An Introduction to Forensic Genetics*. Vol. 2. John Wiley & Sons, (2011).
- 2) Butler, J. M., *Fundamentals of Forensic DNA Typing*. 2nd Ed. Academic Press, (2009).
- 3) Li, L., *Forensic Biology*. 2nd Ed. CRC Press, (2015).

BCH 920 APPLICATIONS OF NANOMATERIALS IN BIOSCIENCES **(3+0)**

Course Objective

- To give a historical and updated overview of the biomaterial-based devices
- To provide the knowledge in basics of nanotechnology in biotechnology.
- To introduce regulatory and ethical concerns dealing with the implementation and commercialization of biomaterials and medical devices.

Learning Outcome

After studying this course, the students will be able to:-

- 1) Understand the basic knowledge of Nanomaterials.
- 2) Understand the applications of nanomaterials in early medical diagnostics, drug targeting, drug delivery, Nano surgery and other biological fields.
- 3) Select and manipulate materials for a particular application in the human body.
- 4) Evaluate the performance of materials based on scientific knowledge of its composition, structure and properties.


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Course Outline

Introduction to Nanomaterials

Introduction to nanotechnologies for medicine and healthcare – challenges and opportunities, Nanoparticles in medicine, Recent developments in the safety of nanomaterials Nanotechnologies for regenerative medicine and tissue engineering, Nanotechnologies for regenerative medicine and tissue engineering – overview, Nanomaterials for regeneration of bone and cartilage, Scaffolds and nanocomposites for tissue engineering, Using stem cells in tissue engineering, Electrospinning in tissue engineering Nano-Diagnostics,

Introduction to nano-diagnostics

Extracellular vesicles in health and disease, Engineered nanoparticles for cancer diagnostics and therapy, Nanoparticles for medical imaging Nano-Biosensors, Requirements of biosensing systems, Electrochemical sensing methodologies, Optical sensing methodologies Nano-Pharmaceuticals, Nanotechnologies and nanoparticles for drug delivery and therapy, Approaches to nanoparticle targeting, Nano-Radiopharmaceuticals, Polymer-based nanoparticles for drug delivery and therapeutics, Nano-biosensors (devices) – examples from research and industry.

Recommended Books

- 1) Niemeyer, C. M., Mirkin, C. A., *Nanobiotechnology: Concepts, Applications and Perspectives*. Wiley-VCH, (2004).
- 2) Challa, S. S. R., Hormes, K. J., Leuschaer, C., *Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact*, Wiley-VCH, (2005).
- 3) Kotov, N. A., *Nanoparticle Assemblies and Superstructures*, CRC Press, (2006).

BCH 921 STEM CELLS AND THERAPEUTICS (3+0)

Course Objective

- TO introduce concepts and importance of stem cells
- To elaborate and update different types of stem cells with their therapeutic potential

Learning Outcome

After completing this course, the students should be able to:

- 1) Understand the basic types of stem cells and comprehend their possible therapeutic uses
- 2) Explain the differences between stem cell-based and regular drug-based therapies.

Course Outline

Introduction, concept, principles and applications of stem cells; Self-renewal and differentiation potential of stem cells, Maintaining Stemness: Interaction between HSCs and the cellular microenvironment, Stem cells and their specific molecular markers, Cell signalling in stem cells, Stem cells; Embryogenesis; Differentiation; Stem cells models, past, present and future; Immunobiology of stem cell transplantations; Types of stem cells and


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their clinical potential: Embryonic and non-embryonic stem cells; adult stem cells; Induced pluripotent stem cells; Stem cells in regenerative medicine, Regenerative medicine and reprogramming; Hematopoietic stem cells and their therapeutic potential; Use of stem cells in burns and wounds, ocular diseases, diabetes; Generation of specific cells from pluripotent stem cells; Commercial opportunities for iPSCs; Limitations in reprogramming and differentiation fields; Cancer stem cells and tumorigenesis; Stem cells and aging; Bioreactors of pluripotent stem cells and future challenges; Ethical issues in stem cell research

Recommended Books

- 1) Slack, J. M. W., *The Science of Stem Cells*. Wiley-Blackwell, (2018).
- 2) Vertes, A. A., Qureshi, N., Caplan, A. I., Babis, L. E., *Stem Cells in Regenerative Medicine: Science, Regulation and Business Strategy*. 1st Ed. Wiley Blackwell, (2015)
- 3) Sullivan, P. J., Mortensen, E. K., *Induced Stem Cells*. Nova Science Publishers Inc, (2012)

BCH 922

NEUROSCIENCE

(3+0)

Course Objective

- To provide basic and fundamental concepts of the nervous system
- To comprehend the role of neurotransmitters in the modulation of brain function
- To understand mechanism and signalling pathways in the brain in health and diseases

Learning Outcome

After completing this course students should be able to;

- 1) Acquire the understanding of the mechanism involved in the transmission of information in the brain
- 2) Describe the modulation of brain function
- 3) Analyze the role of neurotransmitters in various diseases
- 4) Understand the role of neuron-specific signalling pathways

Course Outline

Introduction to neuroscience: Nervous system, Sympathetic, Parasympathetic and motor nervous system and their functions, Brain and its functions, Neuron and glia, structure of a neuronal cell, types of glia, Blood-brain barriers; Neuronal Circuits: Neuronal circuit in emotional control, Neuronal circuit in reward and addiction, Neuronal regulation of stress; Receptors: Ionotropic and metabotropic receptors, signal transduction pathways, G-proteins, protein phosphorylation, Signalling to the nucleus. regulation of gene expression; Neurotransmitters: Excitatory and inhibitory amino acid neurotransmitters, Functions in the brain, Pain pathways in brain, Role of excitatory neurotransmitter in learning and memory, Diseases associated with the malfunctioning of these neurotransmitters, Neuronal degeneration; Catecholamines: Functions in the brain, Diseases associated with the malfunctioning; Neuroendocrine and motivational systems: Endocrine systems, Feeding behaviour, Stress; Diseases of the nervous system: Addiction, Depression, Schizophrenia, Epilepsy, Alzheimer, Parkinson, Prion, Motor Neuron Disease

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Recommended Books

- 1) Nestler, E., Hyman, S., Malenka, R., *Molecular Neuropharmacology: A Foundation for Clinical Neuroscience*. 3rd Ed. McGraw-Hill Education, (2015).
- 2) Brady, S., Siegal, G., Albers, R. W., Price, D., *Basic Neurochemistry: Principles of Molecular, Cellular and Medical Neurobiology*. 8th Ed. Academic Press, (2011).
- 3) Strange, P. G., *Brain Biochemistry and Brain Disorders*, Oxford Press, (1993)

BCH 930 STRUCTURAL BIOINFORMATICS (3+0)

Course Objective

- To provide concepts in structural bioinformatics
- To familiarize students with macromolecular structural data mining from online databases
- To enhance understanding of structural bioinformatics tools for protein structural analysis and structure-function relationships of major macromolecules.

Learning Outcome

Upon successful completion of the course, the student will be able to:

- 1) Acquire the knowledge of Structural Bioinformatics and Structural Biology
- 2) Understand and apply the concepts of structural bioinformatics in various fields

Course Outline

Concepts in structural bioinformatics; Overview of protein structure; Computational aspects of macromolecular structure determination by X-ray crystallography and NMR spectroscopy; Computer-aided molecular modelling and visualization; The Protein Data Bank, SCOP and CATH databases; Protein Structure Quality Assurance; protein structure validation. Protein structure comparison and alignment; Protein secondary structure assignment and prediction; Protein tertiary structure prediction: homology modelling, ab-intio prediction and fold recognition methods; Principles and methods of molecular docking and ligand design; Structural bioinformatics in drug discovery; Inferring protein function from structure; Using Programming Language (e.g. Python) to facilitate protein structural analysis.

Recommended Books

- 1) Gu, J., Bourne, P. E., *Structural Bioinformatics*. 2nd Ed. Wiley-Blackwell, (2009)
- 2) Arthur, L. *Introduction to Bioinformatics*. 5th Ed. Oxford University Press, (2019).
- 3) *Introduction to Bioinformatics: A Theoretical and Practical Approach*. Krawetz, S. A., Womble, D. D. (Editors), Humana Press (2003).

BCH 931 PLANT GENOMICS (3+0)

Course Objective

- To impart fundamental concepts of structural, functional, and comparative genomics of plants
- To develop an understanding of the latest *in-silico* tools and their applications in plant

sciences

Learning Outcome

At the end of the course, students will be able to;

- 1) Understand in-depth knowledge of plant genomics
- 2) Learn genomics-assisted advanced technologies and their applications in plant sciences
- 3) Gain a deeper insight into the execution and analysis of plant genomics data and related research work

Course Outline

Introduction: Basic concepts about plants and plant genomes (nuclear and organelle); Structural Genomics of Plants; Structure of the Plant Nuclear and Organelle Genomes; Sequencing of Plant Genomes; Exploration of Plants genomes databases and sequence comparisons; Functional Genomic Studies in Plants; Prediction of genes and detection of protein function using bioinformatics tools; Genetic transformation in plants; Construction of mutant libraries; The DNA Microarrays in Plants; Gene Expression studies and analysis strategies in plants; Proteomic and metabolomic profiling; Plant Models and role in understanding plants genomics; *Arabidopsis thaliana*, *Oryza sativa*, *Medicago truncatula*, Tomato, Sugarcane, *Physcomitrella patens*; Genomics and Genetic Variability in Plants; Molecular Markers assisted High-throughput genotyping; Analysis of Plant Biodiversity and Molecular Evolution; Candidate Gene analysis.

Recommended Books

- 1) *Plant Omics: Trends and Applications*. 1st Ed. Hakeem, K. R. Tombuloğlu, H., Tombuloğlu, G. (Editors) Springer, (2016).
- 2) Caetano-Anolles, G., *Evolutionary Genomics and Systems Biology*. Wiley-Blackwell, (2010)
- 3) Pevsner, J., *Bioinformatics and Functional Genomics*. Wiley- Blackwell, (2009).

BCH 941 BIOCHEMISTRY OF DRUGS AND THEIR RESISTANCE (3+0)

Course Objective

- This course will introduce the major classes of antimicrobials and other drugs
- To understand the mode of action of different drugs
- To understand the mechanisms of drug resistance in different diseases

Learning Outcome

After completing this course, students should be able to;

- 1) Familiarize with major classes of antimicrobials, the molecular basis of their mode of action and resistance
- 2) Understand the use of antimicrobials in clinical practice along with detection of antimicrobial sensitivity for antimicrobial stewardship


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3) Analyse emerging drug resistance issues in real life

Course Outline

Indiscriminate use of medicines; Introduction to antibiotics; Classes of drugs and their mode of action; Drug side effects and drug-drug interactions; Mechanisms of drug resistance; Drug resistance detection; Antimicrobial prophylaxis and empiric therapy; Antimicrobial stewardship; Human consumption of antibiotics through food chain; Antibiotic Sensitivity Test; MRSA; Roll Back Malaria; Drug resistance issues: MDR, TDR and XDR Tuberculosis; Emerging and re-emerging drug resistance issues.

Recommended Books

- 1) *Antibiotic Drug Resistance*. Capelo-Martínez, J., Igrejas, G. (Editors), 1st Ed. Wiley, (2019)
- 2) Boslaugh, S., *Drug Resistance (Health and Medical Issues Today)*. Greenwood, (2017).
- 3) Hait, W. N., *Drug Resistance*. Springer, (1996)

BCH 942 BIOCHEMISTRY OF CONTROL SYSTEM (3+0)

Course Objective

The course aims to provide:

- Information on the significance of different control systems for normal physiological functions
- Comprehensive knowledge about structures, classification, and properties of hormones
- Understanding of the mechanism of action and diseases associated with hormones

Learning Outcome

After completing this course the students will be able to:

- 1) Elaborate the role of different control systems
- 2) Demonstrate advanced knowledge on mechanisms of hormone action
- 3) Consolidate the knowledge regarding interaction of hormone, enzymes and other molecules

Course Outline

Homeostatic control system: General characteristics and the balance concept; Chemical homeostasis and components of homeostatic systems; Receptors, signal transduction mechanisms for plasma-membrane receptors.

Neural control system: Structure of the nervous system mechanism of neural transmission; Synapses and their functional anatomy, synaptic effectiveness; Neurotransmitters and neuromodulators; Neural growth and regeneration; Blood-brain barrier and cerebrospinal fluid;

Sensory control System: Pathways and basic characteristics of sensory coding; Somatic sensation; Vision, hearing, vestibular system; Chemical senses, association cortex and perceptual


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processing Muscles: Structure of skeletal muscles and muscle fibers; Molecular mechanisms of muscle contraction and relaxation; Skeletal-muscle energy metabolism; Smooth muscles, voluntary and involuntary actions, local control of motor neurons

Hormones: Definition and characteristics of hormones; Major endocrine systems and their target tissues; Synthesis and chemistry of various hormones, and their mechanism of release; Plasma membrane and intracellular receptors and transportation of hormones; Molecular mechanisms of signal transduction and role of G-proteins; Second messengers cAMP, cGMP, Ca²⁺; Termination of signal transduction and cross-talk among signalling systems; Physiological functions and interrelations of various hormones and enzymes in metabolism.

Recommended Books

- 1) Hall, J. E. *Guyton and Hall Textbook of Medical Physiology*. Elsevier Health Sciences, (2015).
- 2) Johnson, B., Ober, W., Garrison, C., Silverthorn, A., *Human Physiology: An Integrated Approach*. 8th Ed. Pearson, (2018)
- 3) Fox S. I., *Human Physiology*. 14th Ed. McGraw-Hill Education, (2015)

BCH 943 BIOCHEMISTRY OF CAROTENOIDS (3+0)

Course Objective

The course aims to provide:

- Detailed overview of the carotenoids, structure, function and biosynthesis
- Biosynthesis of major carotenoids in plants
- Understanding of the mechanism of antioxidant action of carotenoids

Learning Outcome

After completing this course the students will be able to:

- 1) Identify and characterize pigments and carotenoids
- 2) Demonstrate advanced knowledge on carotenoids biochemistry
- 3) A clear idea of analytical tools used for carotenoids analysis.

Course Outline

Introduction to carotenoids, classification, structural features and functions of carotenes and xanthophylls; biosynthesis of lycopene, β -carotene and lutein in plants; the physiological and biochemical role of lycopene, β -carotene and lutein in plants and their medical and industrial importance; Analytical methods used for carotenoids analysis in plants

Recommended Books

- 1) *Carotenoids Esters in Foods: Physical, Chemical and Biological Properties*. 1st Ed. Mercadante, *et al.* (Editors). Royal Society of Chemistry, (2019).
- 2) *Carotenoids, Properties and Applications*. Galanakis, C. M. (Editor). 1st Ed. Academic Press, 2019)


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- 3) *Carotenoid: Physical, Chemical, Biological Functions and Properties*. 1st Ed. Landrum, J. T. (Editor), CRC Press, (2009).

BCH 950 BIOCHEMISTRY OF CARCINOGENESIS (3+0)

Course Objective

The course aims to provide:

- Detailed overview of the carcinogenesis
- Understanding of the mechanism of carcinogenesis

Learning Outcome

After completing this course the students will be able to:

- 1) Identify and characterize cancer cells
- 2) Demonstrate advanced knowledge on cancer biochemistry

Course Outline

Introduction to Cancer; types of cancers; Theories of carcinogenesis; Properties of cancer cells; Carcinogens: chemical and biological carcinogens; mutation; genetics and epigenetics of cancers; DNA damage; tumour suppressing genes; Anti-cancer drugs; mechanism of anti-cancer drugs; Latest data of carcinogenesis from the literature.

Recommended Books

- 1) *Molecular Carcinogenesis and the Molecular Biology of Human Cancer*. 1st Ed. Warshawsky, D., Landolph Jr, J. R. (Editors). CRC Press, (2005)
- 2) Poirier, M. C. *Carcinogens, DNA Damage and Cancer Risk: Mechanisms of Chemical Carcinogenesis*. World Scientific Publishing Company, (2018)
- 3) *Mechanisms of Molecular Carcinogenesis*. 1st Ed. Haybaeck, J. (Editor). Springer, (2017)

BCH 955 COMPUTER AIDED DRUG DESIGNING (3+0)

Course Objective

The course aims to provide:

- Understanding of drug designing and development using computer
- Uses of computer software for drug designing

Learning Outcome

After completing this course the students will be able to:

- 1) Essential knowledge of drug design and development
- 2) Apply the computer software for drug design

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Course Outline

Drug target; types of drug designing; Recent advances in the mechanistic approach to discovery new drugs; Computer graphics, molecular mechanics and dynamics, Current research on pharmaceutical insights into emerging trends and concepts

Recommended Books

- 1) *Drug Design and Simulation*. Lehmann, S. (Editor). Hayle Medical, (2019)
- 2) *Formulation and Analytical Development for Low-dose Oral Drug Products*. Zheng, J. (Editor). John Wiley & Sons, (2009).
- 3) *Computer-Aided Drug Design: Methods and Applications*. 1st Ed. Perun, T. J., Propst, C. L. (Editors). CRC Press, (1989)

BCH 965 MOLECULAR MEDICAL PHYSIOLOGY (3+0)

Course Objective

The course aims to provide:

- Overview of molecular physiological process
- Structure and dynamics of molecular process.

Learning Outcome

After completing this course the students will be able to:

- 1) Understand the medical physiology at molecular level
- 2) Inter-relate the molecular mechanism of different physiological processes

Course Outline

Structural, mechanistic understanding of molecular physiological processes; essential principles behind the transmission and expression of genetic information at the level of DNA, RNA, and proteins; Molecular mechanism of diseases progression and treatment; Recent advances in the molecular physiological processes

Recommended Books

- 1) Marks, F., Klingmüller, U., Müller-Decker, K., *Cellular Signal Processing: An Introduction to the Molecular Mechanisms of Signal Transduction*. 2nd Ed. Garland Science, (2017)
- 2) Zlatanova, J., van Holde, K. E., *Molecular Biology: Structure and Dynamics of Genomes and Proteomes*. 1st Ed. Garland Science, (2015)
- 3) *Essential Medical Physiology*. Johnson, L. R. (Editor). Elsevier, (2003).


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Course Objective

The course aims to provide:

- Comprehensive overview of plant sterols
- Biological synthesis and latest scientific understanding of plant sterols

Learning Outcome

After completing this course the students will be able to:

- 1) Chemistry and biochemistry of plant sterols
- 2) Understand the reactions, importance and analysis of Phytosterols

Course Outline

Introduction to phytosterols, chemistry of Phytosterols, biosynthesis of plant sterols, phytosterols composition in foods, effects of processing on phytosterols composition, oxidation of phytosterols, physiological role of phytosterols, analysis phytosterols.

Recommended Books

- 1) Parish, E. J., Nes, W. D., *Biochemistry and Function of Sterols*. 1st Ed. CRC Press, (1997)
- 2) Patterson, G. W., *Physiology and Biochemistry of Sterols*. 1st Ed. AOCS Publishing, (1992)
- 3) Goad, J., Akihisa, T., *Analysis of Sterols*. Springer, (1997)

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