CURRICULUM

FOR

TWO-YEAR ASSOCIATE DEGREE/BS

(4-YEAR) IN BIOCHEMISTRY

2023 AND ONWARD

DEPARTMENT OF BIOCHEMISTRY
UNIVERSITY OF MALAKAND

Chairman
Department of Biochemistry
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

SCHEME OF STUDIES FOR TWO-YEAR ASSOCIATE DEGREE/ BS (4-YEAR) IN BIOCHEMISTRY

STRUCTURE/CATEGORIES OF COURSES

Sr.	Categories	No. of courses Min – Max	Credit Hours Min – Max
1.	General Education Courses (Cluster)	12	30
2.	Major Courses	26	78
3.	Interdisciplinary Courses	06	18
4.	Field Experience / Internship	01	03
5.	Capstone Project / Thesis	01	03
	Total	**46**	**132**

- Total Numbers of Credit Hours 132
- Duration 4 years
- Semester Duration 16-18 Weeks
- Semesters 8
- Course Load per Semester 15-18 Credit Hours
  - Number of Courses per Semester 5-7

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➢ LAYOUTS OF COURSES

General Education Cluster	Number of Courses	Credit Hours	Course(s) Selected
Arts and Humanities *	1	02	Introduction to Philosophy, Urdu, Pashto, History, Art and Design
Natural Sciences *	1	03 (2+1)	Physics, Chemistry, Botany, Geology, Ecology, Everyday Science, Science
Social Sciences *	1	02	Sociology, Political Science, Social Work, Psychology, Anthropology, Economics, International Relations, criminology, law, Journalism and Mass communication, archaeology
Functional English **	1	03	Functional English
Expository Writing **	1	03	Expository Writing
Quantitative Reasoning **	02	06	Quantitative Reasoning, I and II. Mathematics-I/Discrete Structure, Introductory Statistics/Mathematic-II, Logic and Critical Thinking, Logic of Quantitative Reasoning/Data Analysis, Econometrics
Islamic Studies **	1	02	Islamic Studies, Religious Education
Ideology and Constitution of Pakistan **	1	02	Ideology and Constitution of Pakistan
Applications of Information and Communication Technologies (ICT) **	1	03 (2+1)	Applications of Information and Communication Technologies (ICT)
Entrepreneurship **	1	02	Entrepreneurship
Civics and Community Engagement **	1	02	Civics and Community Engagement
Total	**12**	**30**	

*University may offer any course within the specific broader subject domain/cluster to meet the given credits.

** HEC designed model courses may be used by the university.

General Education Cluster

Courses = 12	Credit hours
1. ENG 101: Functional English	3
2. CHEM 110/GS 117: Chemistry in everyday life/General Science	3
3. SOC 116/PSC 112: Introduction to Sociology/ Introduction to Political Science	2
4. CS 110: ICT (Information & Communication Technology)	3 (2+1)
5. ISL 112: Islamic Studies	2
6. ENG 102: Introduction to Expository Writing	3
7. QR 101: Quantitative Reasoning-I (Mathematics)	3

8. PSC 111: Ideology and Constitution of Pakistan	2
9. SOC 114: Civic and community engagements	2
10. ISL 113: Seerah & its contemporary applications سیرت رسول ﷺ اور اس کی عصری معنویت	2
11. MGT 201: Entrepreneurship	2
12. QR 102: Quantitative Reasoning-II (Statistics)	3
Total Credit Hours =	**30**

Interdisciplinary course

Courses = 6	**Credit hours**
1. CHEM-271: Physical Chemistry	3 (2+1)
2. BCH-212: Genetics	3
3. BCH-222: Cell and Tissue Culture	3 (2+1)
4. BCH-315: Plant Biochemistry	3 (2+1)
5. BCH-321. Biotechnology	3 (2+1)
6. BCH 414: Pharmacology	3
Total Credit Hours =	**18**

Major courses

Courses = 26	**Credit hours**
1. BCH-112 Introductory Biochemistry	3 (2+1)
2. BCH-114: Carbohydrates and Lipids	3 (2+1)
3. BCH-213: Proteins and Nucleic Acids	3 (2+1)
4. BCH-214: Cell Biology	3 (2+1)
5. BCH-221: Food Chemistry	3
6. BCH-223: Microbiology	3 (2+1)
7. BCH-215: Human Physiology	3 (2+1)
8. BCH-216: Enzymology	3 (2+1)
9. BCH-227: Biosafety and Bioethics	3
10. BCh-311: Metabolism of Carbohydrate and Lipids	3
11. BCH-312: Molecular Biology	3
12. BCH-313: Nutritional Biochemistry	3 (2+1)
13. BCH-314: Immunology	3
14. BCH-316: Environmental Biochemistry	3 (2+1)
15. BCH-317: Metabolism of Ammino Acids, Proteins and Nucleic Acids	3
16. BCH-318: Biochemical Techniques	3 (1+2)
17. BCH-323. Bioenergetics	3
18. BCH-324: Industrial Biochemistry	3 (2+1)
19. BCH-411: Research Planning and Scientific Writings	3
20. BCH-412: Bio membrane and Cell Signaling	3
21. BCH-413: Clinical Biochemistry	3 (2+1)
22. BCH-415: Biochemistry of Antioxidants	3 (2+1)
23. BCH-421: Current Trends in Biochemistry	3
24. BCH-422. Methods in Molecular Biology	3 (2+1)
25. BCH-423: Antimicrobials and Chymotryptic	3
26. BCH-424. Neuro Biochemistry	3
Total credit hours =	**78**

Field Experience/Internship

Courses = 22	**Credit hours**
1. BCH-399: Field Experience/Internship	3
2. BCH-500: Research Project/Thesis	3
Total credit hours =	**6**

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SEMESTER WISE DISTRIBUTION OF COURSES

Semester -1				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
ENG 101	Functional English	3	100	Gen-Ed
CHEM 110/ GS 117	Chemistry in everyday life/General Science	3	100	Gen-Ed
SOC 116/ PSC 112	Introduction to Sociology/ Introduction to Political Science	2	50	Gen-Ed
CS 110	Introduction to Information & Communication Technologies	3 (2+1)	100	Gen-Ed
ISL 112/ ETH 118	Islamic Studies / Ethics (for Non-Muslims)	2	50	Gen-Ed
BCH 112	Introductory Biochemistry	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**16**	**500**	

Semester 2				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
ENG 102	Introduction to Expository Writing	3	100	Gen-Ed
QR 101	Quantitative Reasoning-1 (Mathematics)	3	100	Gen-Ed
PSC 111	Ideology and Constitution of Pakistan	2	50	Gen-Ed
SOC 114	Civic and community engagements	2	50	Gen-Ed
ISL 113	Seerah & its contemporary applications سیرت رسول ﷺ اور اس کی عصری معنویت / any course from Arts & Humanities group (for Non-Muslims)	2	50	Gen-Ed
BCH 114	Carbohydrates and Lipids	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**15**	**450**	

Semester 3				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
MGT 201	Entrepreneurship	2	50	Gen-Ed
QR 102	Quantitative reasoning-2 (Statistics)	3	100	Gen-Ed
CHEM 271	Physical Chemistry	3 (2+1)	100	Int-Dis
BCH 212	Genetics	3	100	Int-Dis
BCH 213	Proteins and Nucleic Acids	3 (2+1)	100	Major
BCH 214	Cell Biology	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**17**	**550**	

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Semester 4				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 221	Food Chemistry	3	100	Major
BCH 222	Cell and Tissue Culture	3 (2+1)	100	Int-Dis
BCH 223	Microbiology	3 (2+1)	100	Major
BCH 215	Human Physiology	3 (2+1)	100	Major
BCH 216	Enzymology	3 (2+1)	100	Major
BCH-227	Biosafety and Bioethics	3	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**18**	**600**	

Semester 5				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 311	Metabolism of Carbohydrates & Lipids	3	100	Major
BCH 312	Molecular Biology	3	100	Major
BCH 313	Nutritional Biochemistry	3 (2+1)	100	Major
BCH 314	Immunology	3	100	Major
BCH 315	Plant Biochemistry	3 (2+1)	100	Int-Dis
BCH 316	Environmental Biochemistry	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**18**	**600**	

Semester 6				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 317	Metabolism of Amino Acids, Proteins & Nucleic Acids	3	100	Major
BCH 318	Biochemical Techniques	3 (1+2)	100	Major
BCH 321	Biotechnology	3 (2+1)	100	Int-Dis
BCH 323	Bioenergetics	3	100	Major
BCH 324	Industrial Biochemistry	3 (2+1)	100	Major
BCH 399	Field Experience/Internship	3	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**18**	**600**	

Semester 7				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 411	Research Planning & Scientific Writing	3	100	Major
BCH 412	Bio-membranes and Cell Signaling	3	100	Major
BCH 413	Clinical Biochemistry	3 (2+1)	100	Major
BCH 414	Elective I (Within the major)	3	100	Int-Dis
BCH 415	Biochemistry of Antioxidants	3 (2+1)	100	Major

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Teaching of the Holy Quraan with Translation	Non-Credit		
Total Credit Hours:	**15**	**500**	

Semester 8				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 421	Current Trends in Biochemistry	3	100	Major
BCH 422	Methods in Molecular Biology	3 (2+1)	100	Major
BCH 423	Antimicrobials & Chemotherapeutics	3	100	Major
BCH 424	Elective II (Within the major)	3	100	Major
BCH 500	Research Project/Thesis	3	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**15**	**500**	

Semester 01 -04 = 66
Semester 05 -08 = 66

Total Credit-Hours = 132

Note: Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website. For any query the office of the Registrar Academics may be approached for clarification/guidance.

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DETAIL OF THE COURSES
YEAR 1 / SEMESTER 1

Semester -1				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
ENG 101	Functional English	3	100	Gen-Ed
CHEM 110/ GS 117	Chemistry in everyday life/General Science	3	100	Gen-Ed
SOC 116/ PSC 112	Introduction to Sociology/ Introduction to Political Science	2	50	Gen-Ed
CS 110	Introduction to Information & Communication Technologies	3 (2+1)	100	Gen-Ed
ISL 112/ ETH 118	Islamic Studies / Ethics (for Non-Muslims)	2	50	Gen-Ed
BCH 112	Introductory Biochemistry	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**16**	**500**	

BCH 112 Introductory Biochemistry 3 (2+1)

Course Objective

This course will provide:

- Fundamental concepts in biochemistry
- Understanding of classification, structures, properties and biological functions of major macromolecules
- Basic laboratory skills

Learning Outcome

After completing this course students should be able to:

1) Understand the scope of biochemistry
2) Understand the biochemical basis of life
3) Acquire basic knowledge of biomolecules

Course Outline

A general introduction to the science of biochemistry; Importance and the scope of biochemistry; Prebiotic molecular evolution and rise of living systems; Forms, functions and brief classification of prokaryotes; Cellular architecture and diversity of eukaryotes; Structure, physical properties and importance of water; pH and buffer; Biologically important organic compounds; Composition, properties and functions of proteins, carbohydrates, lipids and nucleic acids; Brief introduction of vitamins, hormones and enzymes

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Practicals

- Safety measures in the laboratory
- Preparation of solutions routinely used in biochemical experiments (e.g., percent, normal and molar solutions)
- pH determination using various methods
- Preparation of buffers

Recommended Books

1) 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).
2) Mathews, C. K., Van Holde, K. E., Ahern, K.G. *Biochemistry*. 3rd Ed. Prentice Hall (1999).
3) Voet, D. J., Voet, G.J. Pratt, C. W., *Fundamentals of Biochemistry: Life at the Molecular Level*. 3rd Ed. Wiley & Sons Inc, (2008)

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YEAR 1 / SEMESTER 2

Semester 2				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
ENG 102	Introduction to Expository Writing	3	100	Gen-Ed
QR 101	Quantitative Reasoning-1 (Mathematics)	3	100	Gen-Ed
PSC 111	Ideology and Constitution of Pakistan	2	50	Gen-Ed
SOC 114	Civic and community engagements	2	50	Gen-Ed
ISL 113	Seerah & its contemporary applications سیرت رسول ﷺ اور اس کی عصری معنویت / any course from Arts & Humanities group (for Non-Muslims)	2	50	Gen-Ed
BCH 114	Carbohydrates and Lipids	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**15**	**450**	

BCH 114 Carbohydrates and Lipids 3 (2+1)

Course Objective

- To demonstrate the in-depth knowledge on occurrence, classification, chemical structure, physical properties and biological importance of different types of carbohydrates and lipids
- To impart practical knowledge of different methods for qualitative and quantitative analysis of carbohydrates and lipids

Learning Outcome

1) Acquire detailed knowledge of structures, properties and involvement of different types of carbohydrates and lipids in different parts of the biological system
2) Analyze different types of carbohydrates and lipids
3) Use different instruments and equipment for analysis of biomolecules

Course Outline

Introduction, occurrence and biological significance of carbohydrates; Nomenclature and classification of carbohydrates; Structures, chemical and physical properties of monosaccharides, oligosaccharides and polysaccharides. Introduction, classification and biological functions of lipids; Classification, nomenclature, structures and properties of fatty acids; Structure and properties of simple and mixed triglycerides and waxes; Structure, properties and functions of phospholipids, sphingolipids and glycolipids; Lipoprotein system: Chylomicrons, HDL, LDL, IDL and VLDL and their functions; Structure and biological significance of cholesterol, bile salts, bile acids and other steroids

Practicals

- Qualitative and quantitative analysis of carbohydrates in unknown samples
- Extraction of starch from plant sources and its confirmative tests
- Extraction of lipids from animal and plant sources
- Extraction of Glycogen from animal sources
- Qualitative tests for lipids and fatty acids
- Determination of saponification value, rancidity, acid value, iodine value and Reichert – Meissl number

Recommended Books

1) Mathews, C. K., Van Holde, K. E., Ahern, K.G., *Biochemistry*. 3rd Ed. Prentice Hall (1999).
2) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman (2017).
3) Voet, D. J., Voet, G.J. Pratt, C. W., *Fundamentals of Biochemistry: Life at the Molecular Level*. 3rd Ed. Wiley & Sons Inc, (2008).

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YEAR 2 / SEMESTER 3

Semester 3				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
MGT 201	Entrepreneurship	2	50	Gen-Ed
QR 102	Quantitative reasoning-2 (Statistics)	3	100	Gen-Ed
CHEM 271	Physical Chemistry	3 (2+1)	100	Int-Dis
BCH 212	Genetics	3	100	Int-Dis
BCH 213	Proteins and Nucleic Acids	3 (2+1)	100	Major
BCH 214	Cell Biology	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**17**	**550**	

CHEM 271 Physical Chemistry 3 (2+1)

Course Objective

The specific objectives are:

- To understand the basic concepts of physical chemistry
- To strengthen the understanding of principles of kinetics and thermodynamics
- To attire graduates with elementary practical skills

Learning Outcome

Students completing this course will be able to;

1) Elaborate the fundamental principles of physical chemistry
2) Analyze physical chemistry-related matters
3) Apply the obtained knowledge of physical chemistry in biochemical sciences

Course Outline

States of Matter & Solution Chemistry

State function, ideal and real gases, the real gas equation; Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment and their applications; Amorphous and crystalline Solids; Ideal and non-ideal solution, Raoult's law and its applications; Henry's law, osmotic pressure and its measurement

Chemical Thermodynamics & Equilibrium

Introduction to thermochemistry; Laws of thermodynamics (first, second & third) and their applications, pressure-volume work, reversible and non-reversible processes; Spontaneous

and non-spontaneous processes, relations of entropy and Gibbs free energy with the equilibrium constant; General equilibrium expressions, reaction quotients

Chemical Kinetics

The rates of reactions; Order of reactions; zero, first, second and third-order reactions with same initial concentrations, half-lives of reactions; Experimental techniques for rate determination & order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

Practicals

- Determination of viscosity and refractive index of liquids.
- Determination of percent composition of liquid solutions viscometrically.
- Determination of refractive index and molar refractivity.
- Determination of percent composition of liquid solutions by refractive index measurements.
- Determination of molecular weight of a compound by elevation of boiling point ebullioscopic method).
- Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
- Determination of heat of solution by solubility method.
- Determination of heat of neutralization of an acid with a base. Kinetic study of acid-catalyzed hydrolysis of ethyl acetate.

Recommended Books

1) Atkins, P., Paula, J. D., *Atkin's Physical Chemistry*, 9th Ed. Oxford University Press, (2010).
2) Chaudhary, S . U., *Textbook of Physical Chemistry*, 2nd Ed., Ilmi Kitab Khana Lahore, (2013).
3) Linder, B., *Elementary Physical Chemist*ry, World Scientific Publishing Co. Ptv. Ltd., (2011).

BCH 212 Genetics 3

Course Objective

- The basic concepts of genetics
- The molecular basis of heredity
- Principles of inheritance

Learning Outcome

After completing this course, students should be able to:

1) Understand the scope of genetics

2) Use the principles of Mendelian genetics to predict the progeny of crosses of known genotypes
3) Deduce parental genotypes based upon progeny ratios and use a pedigree and the laws of inheritance to calculate the risk of affected children in a specific mating

Course Outline

Introduction; classification, the Nature of Genetic Material, scope and brief history of genetics; Mendelian inheritance; Laws of dominance, segregation, independent assortment, Punnett square, concept of monohybrid, dihybrid, back cross and test cross, complete; Non-Mendelian inheritance; The Cytoplasm in Hereditary, The Maternal Effect, Extra Nuclear Inheritance, incomplete and codominance; Gene interaction, epistasis and multiple alleles; ABO blood type alleles and Rh factor alleles in human; Structure of Chromosomes, organization of gene and genome. Sex-Linked Inheritance, Sex Determination in Drosophila & Man; Significant Features of Sex-Linked Inheritance; Linkage and crossing over: Definition, linkage groups, construction of linkage maps, detection of linkage; Pedigree analysis; Mutations: Chromosomal aberrations: Changes in the number of chromosomes. Aneuploidy and euploidy; Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation; Population genetics

Recommended Books

1) Hartwell, L., Hood, L., Goldberg, M., Reynolds, A., Silver, L., Veres, R., *Genetics: From Genes to Genomes*, McGraw-Hill Science, 3rd Ed, (2006).
2) Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A. *Essentials of Genetics*. 9th Ed. Pearson, (2015)
3) Pierce, B. A. *Genetics: A conceptual approach*. 6th Ed. W. H. Freeman, (2016).

BCH 213 Proteins and Nucleic Acids 3 (2+1)

Course Objective

The objectives of this course are:

- To understand the basic concepts related to the structure and functions of amino acids and proteins
- To acquire the knowledge of the chemistry of nucleic acids
- To understand the differences between RNA & DNA

Learning Outcome

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

1) Describe different levels of protein structure
2) Identify the different amino-acids and nucleic acids
3) Isolate and analyse the proteins and nucleic acids
4) Draw the chemical structure of amino acids and small peptides

5) Explain the double helix structure of DNA

Course Outline

Proteins: Introduction to amino acids and classification; Introduction to proteins and its types; Acid-base properties of amino acids; pH-dependent ionization of amino-acids; Identification of amino acids by different methods; Chemical and enzymatic reactions of amino acids; Structural organization of proteins; Protein denaturation and renaturation; protein folding and misfolding, Proteins sequencing.

Nucleic acids: Brief introduction of nucleic acids; Composition and structure of DNA & RNA; Types of DNA and RNA; Function of the DNA & RNA; Compaction of DNA in the nucleus; Extra-nuclear DNA

Practicals

- Qualitative tests of proteins & amino acids: Biuret Test; Ninhydrin Test; Xanthoproteic Test; Pauly's Test; Hoplein's Test; Ehrich's Test; Sakaguchi Test; Sodium nitroprusside Test; Sullivan Test; sulphate Test Phosphate Test; Aldehyde Test;
- Extraction of proteins from plant sources and their confirmative tests.
- Separation of Amino Acids using Paper and Thin Layer Chromatography;
- Determination of total proteins by using different methods (Bradford, Lowery and biuret methods); Protein estimation by using UV/Visible spectrophotometer
- Isolation of DNA and RNA from plants and blood sample

Recommended Books

1) McCammon, J., Harvey, S., *Dynamics of Proteins and Nucleic Acids*. Cambridge University Press, (1987).
2) *Proteins and Nucleic Acids: The Biochemistry of Plants*. Marcus, A. (Editor). Elsevier (2014).
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 214 Cell Biology 3 (2+1)

Course Objective

- Gain knowledge of cell emphasizing the chemical & morphological basis of life

Learning Outcome

By the end of the course, the student shall be able to:

1) Describe features of the cell as a unit of life
2) Explain the structure and functions of the cytoplasmic organelles and nucleus
3) Compare the eukaryotic and prokaryotic cell

Course Outline

Introduction to prokaryotic and eukaryotic cell & their differences; Composition and functions of lipid bilayer transport across cell membrane; role of glycolipids and glycoproteins as receptors in cellular signalling; The functions, isolation and molecular organization of cellular organelles specifically the endoplasmic reticulum, Golgi bodies, ribosomes, lysosome, micro-bodies, mitochondria; The structure and function of chromosomes and role of nucleus in regulation of metabolism; The concept of cell cycle, mitosis and meiosis and cell death; Structure and function of cytoskeleton, centriole and function of cilia and flagella in cell movement.

Practicals

- Microscopy and staining techniques;
- Study of prokaryotic, eukaryotic cells; cellular reproduction;
- Mitosis: smear/squash preparation of onion roots.

Recommended Books

1) Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., Roberts, K., Walter, P. *Essential Cell Biology*. Garland Science, (2013).
2) Cooper, G. M., Hausman, R. E., Hausman, R. E., *The Cell: A Molecular Approach* (Vol. 10). ASM Press, (2000).

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YEAR 2 / SEMESTER 4

Semester 4				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 221	Food Chemistry	3	100	Major
BCH 222	Cell and Tissue Culture	3 (2+1)	100	Int-Dis
BCH 223	Microbiology	3 (2+1)	100	Major
BCH 215	Human Physiology	3 (2+1)	100	Major
BCH 216	Enzymology	3 (2+1)	100	Major
BCH-227	Biosafety and Bioethics	3	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**18**	**600**	

BCH 221 Food Chemistry 3

Course Objectives

- To gain an understanding of the chemical bases of food component, their reactivity and functionality.
- To develop skills for experimenting with food systems and to test various approaches for operating the chemical and/or functional properties of foods.

Learning Outcome

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

1) Students will be able to name and describe the general chemical structures of the major components of foods (water, proteins, carbohydrates, and lipids).
2) Students will be able to give a molecular rationalization for the observed physical properties and reactivity of major food components.

Course Outline

Water, lipids, carbohydrates, proteins, vitamins in foods, and their changes during food processing; Enzymes in foods; Physical properties of foods; Lipid oxidation in foods; Food deteriorations; Food processing & kinetics; Artificial and natural sweeteners; Food additives and contaminants; Regulation of food safety and assessment

Recommended Books

1) Belitz, H. D., Grosch, W., *Food Chemistry*. Springer Berlin, (2013).
2) Coultate, T. P. *Food: The Chemistry of its Components*. Royal Society of Chemistry, (2009).
3) Zeb, A., *Food Frying: Chemistry, Biochemistry and Safety*. 1st Ed. John Wiley & Sons, (2019).

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Course Objective

- To provide a thorough understanding of the importance of cell, tissue and organ cultures
- To strength the concepts of its application in life sciences

Learning Outcome

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

1) Understand the basics of cell, tissue and organ culture
2) Grow and handle different cell cultures
3) Prepare bioassays specific tissue culture

Course Outline

Plant cell and tissue culture

Requirements for *in vitro* cultures; media used for plant cell cultures; culture facilities; sterile techniques; media preparation and handling; callus cultures; cell suspension cultures; protoplast culture; haploid cultures, meristem culture for virus elimination; embryo culture and embryo rescue; regeneration of plants and micropropagation; soma-clonal variation; industrial uses of plant cell culture; tissue culture in genetic engineering and biotechnology.

Mammalian cell culture

Origin and principles of cell culture; qualitative characteristics of cell cultures; media used for mammalian cell cultures; cell counting and analysis; cryopreservation; cell banking and subculture (variety of different systems); primary cell culture techniques; development of immortalized cell line; detection of microbial contaminants; animal cells for bioassays; design and operation of animal cell culture; growth environment; Stem cell culture

Recommended Books

1) Nicholl, D. S. T., *An Introduction to Genetic Engineering*. 2nd Ed. Cambridge University Press, (2002).
2) Razdan, M. K., *Introduction to Plant Tissue Culture*. 2nd Ed. Intercept, (2003).
3) *Tissue Culture: Methods and applications*. Paul Jr, F. (Editor). Elsevier, (2012).

BCH 223 Microbiology 3 (2+1)

Course Objective

- This course will impart knowledge about the structure, growth, genetics, metabolism and ecology of microbes.
- This course will demonstrate suitable laboratory skills and techniques required for the

isolation, staining, identification, characterization and control of microbes.

Learning Outcome

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

1) Understand the fundamental principles of microbiology, relation of microbes with their habitat, their growth requirements, growth, genetics and metabolism.
2) elucidate the beneficial and harmful roles of microorganisms
3) Develop a wide range of microbiology-related skills and the ability to work independently in the lab.

Course Outline

Overview and history of microbiology; microbial diversity and ecology (Archaea, bacteria, fungi, algae, protozoa); Classification of micro-organism; Biophysical and biochemical factors for microbial growth; Microbial growth kinetics and methods of measurement of microbial growth; Transformation, transduction and conjugation; Microbial metabolism; Carbon, nitrogen, Sulphur and phosphorus cycles; Symbiosis; Structure and biology of viruses; Common microbial diseases; Control of microorganisms: sterilization and disinfection, Applications of microorganisms

Practicals

- Sterilization techniques
- Culturing of bacteria in liquid and solid medium
- Isolation and identification of microbes from different samples
- Colony morphology and colony count
- Preservation of culture
- Microbial cell/spore count and growth curves
- Gram-staining of bacteria
- Endospore staining
- Determination of sensitivity of isolates to different antibiotics

Recommended Books

1. Pommerville, C. J., *Alcamo's Fundamentals of Microbiology*. 9th Ed. Jones and Bartlett Learning Company, (2018).
2. Talaro, K. P., *Foundations in Microbiology Companion*. 8th Ed. McGraw Hill, (2015).
3. Black, J. G., *Microbiology: Principles and Explorations*. 7th Ed. John Wiley and Sons, (2007).

BCH 215 Human Physiology 3 (2+1)

Course Objective

This course is designed to:

- provide an overview of human physiology, structure and functions of various organs
- highlight digestion and absorption of major macromolecules
- overview the composition, characteristics and functions of blood

Learning Outcome

After completing this course students should be able to;

1) Understand the physiology of human along with structure and functions of various organs (normal vs disease conditions)
2) Inter-relate mechanisms of the digestion and absorption of major macromolecules
3) Comprehend the general composition of blood, its characteristics, and major functions

Course Outline

Introduction to Physiology; Functional organization of human body. General composition, characteristics and functions of blood, hemoglobin: chemistry, properties, synthesis, degradation, functions and derivatives. Blood coagulation and blood clotting factors; blood pressure, groups and buffers; Homeostasis and anemia types. Introduction to Respiratory system, hepatic system, excretion system and their functions; Hormones: Introduction, classification, chemical nature, the general mechanism of action, regulation, secretion, mode of action and biological functions of thyroid, parathyroid, pituitary, adrenal, gonadal and pancreatic hormones.

Practicals

- Use of stethoscope & measurement of human arterial blood pressure &Pulse
- Determination of bleeding time, and coagulation time in the human body
- Determination of RBC, WBC, Hb of human Blood
- Determination of the differential Leukocytes count in the blood
- To observe the shape of RBC in normal saline stem
- To determine the group of the blood sample
- Physiochemical & microscopic analysis of human urine sample
- Determination of visual acuity of a human subject by using Snellen's eye chart
- Demonstration of the use of ECG

Recommended Books

1) Hall, J. E., *Guyton and Hall Textbook of Medical Physiology*. Elsevier Health Sciences, (2015).
2) Litwack, G., *Human Biochemistry*. 1st Ed. Academic Press, (2017).
3) Sherwood, L., *Human Physiology: From Cells to Systems*, 9th Ed. Cengage Learning (2015).

BCH 216 Enzymology 3 (2+1)

Course Objective

- To impart knowledge about the nature of enzymes
- To provide an overview of reactions and impact of different factors on their rate
- To introduce the concept of catalysis and catalytic mechanisms

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 analyze the kinetics of enzyme-catalyzed reactions.
3) Evaluate the effect of different types of inhibitors on enzyme activity
4) Perform enzyme assays

Course Outline

Introduction to enzymes, nomenclature, classification; and chemical nature of enzymes; Isoenzymes, coenzymes and role of cofactors; active site and regulatory sites; Enzyme specificity and different types; Kinetics of chemical reactions; Michaelis-Menten equation and other models used to understand kinetics; Multi-enzyme system and two substrate reactions; Enzyme Inhibition and types of inhibition; Ribozyme; Enzyme catalysis; catalytic strategies and mechanisms of different enzymes; Regulation of enzyme activity; Effect of various factors on rate of reactions; Immobilization of enzyme; applications of enzymes

Practicals

- Extraction and estimation of enzymes from plant and animal sources.
- Acid and enzymatic hydrolysis of glycogen and starch
- Effect of Temperature, substrate, enzyme concentration and heat on enzymes activity.

Recommended Books

1) Mathews, C. K., Van Holde, K. E., Ahern, K.G., *Biochemistry*. 3rd Ed. Prentice Hall (1999).
2) 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).
3) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017).

BCH 227 Biosafety and Bioethics 3

Course Objective

- To acquaint the principles of biosafety and bioethical perspectives pertaining to biochemistry.
- To familiarize with standard laboratory procedures and safe practices.

Learning Outcome

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

1) Understand the importance of biosafety levels
2) Comprehend the use and significance of personal protective equipment
3) Handle samples and animals in laboratories

Course Outline

Introduction to biosafety; Definition, concept, uses and abuses of genetic information; Personal Protective Equipment (PPE); Biohazards; Good laboratory practices; Classification of laboratories on the bases of biosafety levels; Biosafety cabinets and their types; Biosecurity; Laboratory waste management; Introduction to bioethics; Ethical issues to use animals in research; Ethical issues related to GMOs; Euthanasia; Transgenic organisms; Biological and toxin weapons convention; Ethics related to reproductive and cloning technologies; Genetic counselling and related issues; Transplants and eugenics; Patenting, commercialization and benefit-sharing; Role of Institutional biosafety & bioethical committee; Role of national bioethics committee

Recommended Books

1) Campbell, A., *Bioethics: The Basics*. 2nd Ed. Routledge, (2017).
2) Vaughn, L., *Bioethics: Principles, Issues, and Cases*. Oxford University Press, 4th Ed. (2019).

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YEAR 3 / SEMESTER 5

Semester 5				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 311	Metabolism of Carbohydrates & Lipids	3	100	Major
BCH 312	Molecular Biology	3	100	Major
BCH 313	Nutritional Biochemistry	3 (2+1)	100	Major
BCH 314	Immunology	3	100	Major
BCH 315	Plant Biochemistry	3 (2+1)	100	Int-Dis
BCH 316	Environmental Biochemistry	3 (2+1)	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**18**	**600**	

BCH 311 Metabolism of Carbohydrates & Lipids 3

Course Objective

- To provide the concept of metabolism and regulation of carbohydrates and lipids
- To understand glycolytic and energy-generating pathways and other intermediary pathways for carbohydrates.
- To enhance knowledge about biosynthesis and degradative pathways of fatty acids and lipids.

Learning Outcome

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

1) Acquire the knowledge about intermediary biochemical processes
2) Demonstrate the metabolic pathways of carbohydrates and lipids - the energy-yielding and energy-requiring reactions in life.
3) Understand the diversity of metabolic regulation of two macromolecules, and how this is specifically achieved in different cells.

Course Outline

Carbohydrate metabolism

Role of glucose in the metabolism of animals and microorganisms; Glycolysis: reactions of glycolysis, the anaerobic fate of pyruvate, fermentation, control of metabolic flux. Regulation of glycolytic pathway; Metabolism of other monosaccharides; Conversion of Pyruvate to acetyl CoA; TCA cycle: Overview of TCA, Metabolic sources of Acetyl Coenzyme A, Regulation of TCA Cycle, Reactions of Electron Transport chain, Energetics, Shuttle systems; Other pathways of carbohydrate metabolism: Gluconeogenesis, Cori cycle, glycogenesis, glycogenolysis, Glyoxylate Cycle reactions, Pentose phosphate Pathway;

Lipid metabolism

Introduction to lipid digestion, absorption and transport; Lipolysis and utilization of glycerol; Types of fatty acids oxidation: β-oxidation of fatty acids; Ketogenesis, ketolysis and regulation; Biosynthesis of fatty acids, Elongase and Desaturase systems; Biosynthesis of triacylglycerols, Phospholipids, Prostaglandins: Prostacyclins, Thromboxanes and leukotrienes; Lipoproteins: metabolism of plasma lipoproteins; Metabolism of cholesterol

Recommended Books

1) Voet, D. J., Voet, G.J. Pratt, C. W., *Fundamentals of Biochemistry: Life at the Molecular Level*. 3rd Ed. Wiley & Sons Inc, (2008).
2) Mathews, C. K., Van Holde, K. E., Ahern, K.G., *Biochemistry*. 3rd Ed. Prentice Hall (1999).
3) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017)

BCH 312 Molecular Biology 3

Course Objective

- Understand the basic knowledge and life processes at the molecular level
- This course will impart knowledge about the structure and function of nucleic acids
- Understand the concept of the central dogma of molecular biology

Learning Outcome

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

1) Acquire the basic knowledge and concepts of molecular biology
2) Understand the process of DNA replication, DNA damage and repair, transcription and translation.
3) Understand and explain the concepts of basic principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, and basic research.

Course Outline

Introduction to molecular biology and history; Structure and function of nucleic acids; Organelles genome (Mitochondrial and chloroplast); DNA replication in prokaryotes and eukaryotes; DNA damage and repair; Transcription in prokaryotes and eukaryotes; Post-transcriptional processing (e.g., RNA splicing, alternative splicing, editing); Genetic code; Translation in prokaryotes and eukaryotes; Post-translational processing in prokaryotes and eukaryotes; Protein folding, targeting and turnover; Recombination and transposable elements; Gene regulation and expression in prokaryotes and eukaryotes; restriction enzymes. Eukaryotic genome and human genome project.

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Recommended Books

1) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman (2017).
2) Cox, M. M., Douda, J., O'Donnell, M., *Molecular Cell Biology*. 2nd Ed. W. H. Freeman, New York (2015).
3) Berg *et al*., *Biochemistry*. 8th Ed. W. H. Freeman, (2015)

BCH 313 Nutritional Biochemistry 3 (2+1)

Course Objective

- Biochemical activities of nutrients and food constituents in the human body
- To understand the role of nutrition in health and diseases
- Influence of dietary modification/nutrition intervention during the disease process

Learning Outcome

By the end of the course, the student must have acquired a reasonable working knowledge of:

1) Understand fundamental concepts in nutrition and health.
2) Describe the role of nutrients in the optimal functioning of key biochemical pathways in the body.
3) Integrate biochemical mechanisms with clinical problems resulting from nutritional deficiencies.
4) Skillfully perform a clinical examination, anthropometry and nutritional assessments.
5) Calculate the nutritional composition of different diets using WinDiets software.

Course Outline

Nutrients structure & functional characteristics; Role of nutrients in metabolism; Healthy diet: types and constituents; Recommended dietary allowance (RDA), adequate intake (AI), tolerable upper intake level, dietary reference intakes for macronutrients and micronutrients; Estimation of dietary intake (FFQ, 24 hour dietary recall, questionnaires); Nutritional status biomarkers; Basic metabolic rate (BMR), body mass index calculations (BMI); Respiratory quotient calculations; calorimetry; Nutritional disorders

Practicals

- Sample collection, processing and storage
- Anthropometric data collection (Weight, Height, BMI)
- Nutritional assessment
- Calculation of basal energy expenditure (BEE)
- Calculation of basal metabolic rate (BMR)
- Dietary analysis using Windiets© software

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Recommended Books

1) Trueman, P., *Nutritional Biochemistry*. MJP Publisher, (2019).
2) *Nutrition and Metabolism* (Vol. 5). Lanham-New, S. A., MacDonald, I. A., Roche, H. M. (Editors), John Wiley & Sons, (2011).
3) Brody, T., *Nutritional Biochemistry*, 2nd Ed. Academic Press, (1998).

BCH 314 Immunology 3

Course Objective

- To introduce important concepts related to immunology.
- To elaborate the components, principles and mechanisms of the immune system.
- To introduce the emerging use of immune molecules in diagnostics and therapeutics.

Learning Outcome

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

1) Understand the basic types and mechanisms of the immune system
2) Comprehend the roles and specializations of different anatomical sites involved with basic immunity
3) Appreciate the fine-tuning of all the different immune system components
4) Recognize the importance of the immuno-molecules as diagnostic and therapeutic means.

Course Outline

Introduction to the innate and adaptive immunity; their different types and involved components (cells, tissues); Role of innate immunity in stimulating adaptive immunity responses; Overview of immune responses to microbes; Microbial evasion of innate immunity; Antigen recognition and their presentation to lymphocytes; Role of histocompatibility complex molecules; Antigen receptors; T-cell mediated immunity; Biochemical pathways of T-cell activation; Types of T-cell mediated immunity; Humoral Immunity; Complement system; Activation of B-cells; Structures and specificities of different antibody classes; Opsonization and Phagocytosis; Antibody-dependent cellular cytotoxicity; Functions of antibodies at special anatomical sites; Autoimmunity and immunological tolerance; Hypersensitivity; Immunodeficiencies.

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).

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BCH 315 Plant Biochemistry 3 (2+1)

Course Objective

- To introduce key concepts of plant biochemistry.
- To impart knowledge regarding plant pigments, photosynthetic systems and pathways, phytohormones and naturally occurring compounds.

Learning Outcome

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

- Acquire basic knowledge of plant biochemistry
- Understand the nature of metabolic pathways relevant to plants.

Course Outline

Structure and functions of plant cell; Biosynthesis of starch; Photosynthesis; structure of chlorophyll, absorption of light energy, photosynthetic pigments; Photosynthetic reaction center, photosystem-I, photosystem-II; electron transport chain, ATP C3 and C4 pathways; CAM photosynthetic pathways; CO_2 fixation (Calvin Benson cycle); Hatch Slack pathway and photorespiration; Conversion of nitrogen into ammonia and other nitrogenous compounds; Introduction to types of plant metabolites: Alkaloids, Flavonoids, Terpenes, Terpenoids, Phenolics and other secondary plant metabolites and their biological functions.

Practicals

- Extraction and qualitative analysis of chlorophyll
- Extraction and qualitative analysis of starch
- Extraction and qualitative analysis of lipids
- Extractions and estimation of alkaloids, phenolics and flavonoids.

Recommended Books

1) Heldt, H. W., Piechulla, B., *Plant Biochemistry*. Academic Press, (2010).
2) Gleason, F., Chollet, R., *Plant Biochemistry*. Jones & Bartlett Publishers, (2012).
3) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017).

BCH 316 Environmental Biochemistry 3 (2+1)

Course Objective

- To impart essential concepts in the field of environmental biochemistry
- To develop a focused assessment of issues in environmental health

- To have the knowledge of bioremediation

Learning Outcome

After completing this course students should be able to:

- Acknowledge the importance of pollutants
- Understand the chemistry of pollutants in air, land and water
- Understand the pathways in bioremediation
- Apply the acquired knowledge to design ways for the eradication of pollutants

Course Outline

Air pollution and acid rains, atmospheric chemistry; Solid and hazardous waste, soil chemistry; Water pollution, aquatic chemistry; Effects of pollutants on plants, animals and humans; How pollutants mimic nature; Biochemical pathways for the removal of xenobiotics; Microbial bioremediation; Phytoremediation; Radiation hazards; Biomarkers used to assess environmental exposures

Practicals

- Detection of water temporary and total hardness.
- Water Quality Tests (Dissolved Oxygen, total solid, BOD, TDS etc)
- Determination of iron in solution
- Determination of cations and anions
- Coliform test
- Microbial isolation from industrial wastes involved in bioremediation
- Hydroponics growth of plants

Recommended Books

1) Manahan, S. E., *Toxicological Chemistry and Biochemistry*. CRC Press, (2002).
2) Hamilton, E., *Environmental Biochemistry*. Larsen and Keller Education, (2017).
3) Manahan, S. E. *Fundamentals of Environmental and Toxicological Chemistry: Sustainable Science*. CRC Press, (2013).

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YEAR 3 / SEMESTER 6

Semester 6				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 317	Metabolism of Amino Acids, Proteins & Nucleic Acids	3	100	Major
BCH 318	Biochemical Techniques	3 (1+2)	100	Major
BCH 321	Biotechnology	3 (2+1)	100	Int-Dis
BCH 323	Bioenergetics	3	100	Major
BCH 324	Industrial Biochemistry	3 (2+1)	100	Major
BCH 399	Field Experience/Internship	3	100	Major
Teaching of the Holy Quraan with Translation		Non-Credit		
Total Credit Hours:		**18**	**600**	

BCH 317 Metabolism of Amino Acids, Proteins & Nucleic Acids 3

Course Objective

- To provide the concept of metabolism of Proteins and Nucleic acids
- To describe the metabolism of essential and nonessential amino acids.
- To develop knowledge about biosynthesis and degradative pathways for Nucleic acids and their regulations

Learning Outcome

This course will enable students to:

1) Understand the metabolic pathways of proteins and nucleic acids
2) Understand the diversity of metabolic regulations of proteins and nucleic acids
3) acquire knowledge about inborn errors associated with these biochemical processes

Course Outline

Metabolism of Proteins and Amino acids

Digestion and absorption of proteins; General aspects of amino acid metabolism; Deamination, transamination, transmethylation, transpeptidation and decarboxylation; Amino acid degradation and urea cycle; Inborn errors of protein metabolism; Nitrogen balance; Biosynthesis of non-essential amino acids; Metabolic adaptation under starvation and Diabetes Mellitus

Metabolism of Nucleic acids

Biosynthesis, degradation and regulation of purine and pyrimidine bases; Biosynthesis, degradation and regulation of purine and pyrimidine nucleotides; Diseases associated with

nucleotides and nucleotide metabolisms such as gout, xeroderma pigmentosa, ADA, SCID and skin cancer; Lesch Nyhan syndrome and orotic aciduria

Recommended Books

1) Mathews, C. K., Van Holde, K. E., Ahern, K.G., *Biochemistry*. 3rd Ed. Prentice Hall (1999).
2) 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).
3) Nelson, D. L., Cox, M. M., *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017).

BCH 318 Biochemical Techniques 3 (1+2)

Course Objective

- The course is structured to provide the information of principles & mechanisms of different equipment and analysis of Biochemical and Biological samples
- The course will also focus on experimental design and result interpretation
- To provide hands-on experience with a variety of techniques

Learning Outcome

After completing this course students will be able to:

1) Apply an understanding of the methods and techniques associated with biomolecule separation and purification
2) Explain the principles behind major biochemical methods
3) Critically analyze and solve scientific problems

Course Outline

Introduction, principles and types of centrifugation; Ultrafiltration, dialysis and lyophilization; Chromatography: principles, methods and applications of column chromatography (ion exchange and gel filtration); Gas chromatography (GC), GC-MS/LC-MS; Hydrophobic interaction chromatography; Affinity chromatography; Electrophoresis, capillary electrophoresis; Introduction to MALDI; Flame photometer; Atomic absorption spectrophotometry (AAS); Amino acids analyzer; Electron microscopy; X-ray diffraction; Nuclear magnetic resonance; Eliza; Isotopic tracer techniques; cells and tissue lysis techniques

Practicals

- Centrifugation of fresh milk and Acetic Acid
- Fractionation of cells by density gradient centrifugation
- Separation of Biomolecules by affinity chromatography identification of sugars & proteins
- Separation of mixture proteins by using Ion-Exchange Chromatography

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- Separation of biomolecules using size exclusion chromatography
- Protein Separation by Protein Electrophoresis
- Purification of proteins or biomolecules by using hydrophobic interaction chromatography
- Preparation of sample for mineral analysis by ashing method and Wet digestion procedure of sample preparation for mineral analysis
- Determination of sodium and potassium content in blood serum by flame photometer
- Separation of amino acids by the amino acid analyzer
- Structural elucidation of biomolecules

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 321 Biotechnology 3 (2+1)

Course Objective

- To acquaint students with the basic concepts, significance and applications of biotechnology
- To introduce the foundation of biotechnology and recombinant DNA technology

Learning Outcome

1) To understand concepts in the field of Biotechnology
2) Able to effectively interact and work with other interdisciplinary professionals
3) Have an awareness of the global significance and application of biotechnology in different industries.

Course Outline

Biotechnology definition and history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture, food, livestock, fisheries, algae, fungi; Plant growth-promoting bacteria: nitrogen fixation and nodulation; bio-control of pathogens growth promotion by free-living bacteria; Microbial insecticides: Insecticidal toxins, baculovirus as biocontrol agents; Synthesis of commercial products by recombinant microorganisms: antibiotics and biopolymers; Production of biofuels by using different biotechnological strategies; Transgenic organisms: GMOs; Gene therapy; Introduction of Stem cells

Recommended Books

1) Daugherty, E., *Biotechnology: Science for the New Millennium*. 2nd Ed. EMC Paradigm,

(2017).
2) Thieman, W. J., Palladino, M. A., *Introduction to Biotechnology*. 4th Ed. Pearson, (2018).
3) Renneberg, R., Berkling, V., Loroch, V., *Biotechnology for Beginners*. 2nd Ed. Academic Press, (2017).

BCH 323 Bioenergetics 3

Course Objective

- To impart basic and advanced knowledge of thermodynamic and bioenergetics principles
- To provide a comprehensive understanding of the sequence of electron carriers of ETC
- To understand the energy-generating pathways and mechanisms of ATP synthesis

Learning Outcome

After completing this course, the students will be expected to:

1) Understand the bioenergetics principles
2) Demonstrate a detailed understanding of the electron transport chain
3) Acquire an in-depth understanding of the mechanism of ATP synthesis and its regulation

Course Outline

Introduction to bioenergetics and energy transduction in biological system; Endergonic and exergonic reactions; Biological redox reactions in mitochondria and redox enzymes; Synthesis and importance of high energy compounds; Coupling of reactions; Substrate level phosphorylation, oxidative phosphorylation and photophosphorylation; Redox potential and sequence of the carriers of electron transport chain; Complexes of ETC, their composition and flow of electrons through the complexes; Shuttle systems for transport of cytoplasmic NADH in different organs; Proton pumping, proton motive force and mechanism of ATP synthesis; Components of ATP synthase and their specific role in ATP synthesis; Chemi-osmotic theory and Binding change model for ATP synthesis; Auto-regulation of ATP synthesis according to cell energy charge; Un couplers and inhibitors of electron transport chain

Recommended Books

1) Voet, D. J., Voet, G.J. Pratt, C. W., *Fundamentals of Biochemistry: Life at the Molecular Level*. 3rd Ed. Wiley & Sons Inc, (2008).
2) 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).
3) Nelson, D. L., Cox, M. M. *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017).

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BCH 324 Industrial Biochemistry 3 (2+1)

Course Objective

- Equip students with a basic understanding of industrial biochemical systems and processes for the production of products with commercial value.
- Enable students to use microorganisms in the production of pharmaceuticals, foods, enzymes and organic acids that have direct economic value.

Learning Outcome

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

1) Understand metabolites with respect to their industrial importance.
2) Evaluate bioprocesses to manipulate for large scale production of a chosen material/ metabolite.
3) Analyze the limitations of industrial biological processes.

Course Outline

Introduction to industrial biochemistry; Types of industries; Introduction to fermentation and its applications; Selection of industrially important organism for food, pharmaceutical, fertilizer, textile, tanneries, paper and other related industries; Brief introduction to microbial metabolites; Production of enzymes, antibiotics, acetic acid and ethanol by microbial fermentation; Manipulation of fermentation for enhanced production of targeted metabolite; Plant extraction and purification of extracted components; Manufacturing of glucose from rice, corn, potato and wheat for their industrial applications; Quality assurance and value addition

Practicals

- Determination of ethanol percentage in the fermentation broth
- Estimation of total proteins in the given sample
- Purification of proteins by column chromatography
- Determination of citric acid by titration method in the fermentation medium
- Extraction of plant seeds oil by using Soxhlet apparatus
- Determination of acid value of oil extracted from plant seeds
- Determination of Iodine value of Fat/oil
- Separation of phospholipids by Thin Layer Chromatography
- Preservation of food by UV-radiation /chemical method

Recommended Books

1) *Kent and Riegel's Hand Book of Industrial Chemistry and Biotechnology.* 11th Ed. Kent, J. A. (Editor). Springer, (2007).
2) *Comprehensive Biotechnology.* Moo-Yong, M., Coooney, C.L. (Editors). Pergamon

Press, (1985).
3) Stanbury, P. F., Whitaker, A., Hall, S. J., *Principles of Fermentation Technology*. Elsevier, (2013).

BCH 399 Field Experience/Internship 3

Course objectives

- Enable students to learn the practical uses of biochemistry in different fields.
- Enable students to learn working as a team and presentation of data in a proper way acceptable to scientific community.

Learning Outcome

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

1) Choose a profitable profession in their practical lives.
2) How to work in a team and promote their future profession in diverse environments
3) How to present scientific data.

Course details and evaluation

During field experience and internship, all the students will be placed in different labs, hospitals and relevant organization for data collection, analysis, screening and presentation. The students will be placed as individual or in group (not exceeding 3 student) under the supervision of available faculty (supervisor). At the end of the field experience, all the students will present field report in hard and presentation will be made in front of a committee including the supervisor, semester coordinator and the HOD. The allotted 100 marks will be divided into two halves (50 marks for report and 50 for presentation and viva voce).

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YEAR 4 / SEMESTER 7

Semester 7				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 411	Research Planning & Scientific Writing	3	100	Major
BCH 412	Bio-membranes and Cell Signaling	3	100	Major
BCH 413	Clinical Biochemistry	3 (2+1)	100	Major
BCH 414	Elective I (Within the major)	3	100	Int-Dis
BCH 415	Biochemistry of Antioxidants	3 (2+1)	100	Major
Total Credit Hours:		**15**	**500**	

BCH 411 Research Planning & Scientific Writing 3

Course Objective

- To impart knowledge regarding literature survey and review
- To develop/structure research synopsis for thesis and research grants
- To develop the technical skills for writing research reports, articles and thesis

Learning Outcome

After completing this course, the students will be expected to:

1) Search literature relevant to their research using different databases
2) Record, analyze, manipulate and effectively present data
3) Write a research report and thesis
4) Be proficient in preparing and publishing the results of their findings in quality journals

Course Outline

Introduction of research philosophy and types of research; Extensive literature review to develop new research ideas; Project selection and its development, role of students & supervisor; Designing and structuring different sections of the synopsis for thesis and research grants; Experimental design and investigation, methodology, control, sampling methods; Primary and secondary data sources; Data recording, analysis (mean, standard deviation, analysis of variance) and presentation in the form of suitable and self-explanatory tables and figures; Interpretation of results and discussion; Report writing; Selection of relevant and suitable journals for publishing research papers; Preparing and submitting research papers according to specific journal formats and requirements; Review process, reviewer's comments/suggestions, preparing and sending a revised manuscript and acceptance letter; Compilation of results and write up of research reports and thesis; Acknowledgements, conflict of interest, ownership of data, similarity index, plagiarism issues and how to avoid plagiarism; Preparing and delivering effective scientific presentation; Written essays, poster preparation and presentation

Recommended Books

1) Leedy, P. D., Ormrod, J. F., *Practical Research: Planning & Design.* Bobbs-Merrill Educational Publications (2009)
2) Hofmann, A. H., *Scientific Writing and Communication: Papers, Proposals, and Presentations*. Oxford University Press, (2014).
3) Blackwell, J., Martin, J., *A Scientific Approach to Scientific Writing*. Springer Science & Business Media, (2011).

BCH 412 Biomembranes and Cell Signaling 3

Course Objective

- To reintroduce the importance of cellular membranes and their role in cell signaling
- To elaborate the components, principles and mechanisms of the cellular signaling
- To explore the role of cellular signaling molecules in the diagnosis of diseases and therapeutics

Learning Outcome

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

1) Understand the basic principles of signal transduction mechanisms
2) Describe the mechanisms by which different receptors may be activated by their respective ligands
3) Comprehend the importance of cellular signaling mechanisms in metabolic diseases

Course Outline

Introduction of structural and functional properties of natural and synthetic Biomembranes; Fluid mosaic model; Types of transport across biomembranes; Membranes of erythrocytes, intestinal mucosa, retinal cells and nerve cells; Introduction to concepts of cellular signaling, receptors, transducers, primary and second messengers; signal amplification; The plasma membrane as transducer and amplifier; G-protein coupled receptors and hormones; Cellular signaling via protein phosphorylation and kinases; TGF beta; Cytokine receptors; JAK/STAT pathways; Pathways with signal-induced protein cleavage: Notch/Delta; Signaling pathways controlled by Ubiquitination: Wnt, Hedgehog and NF-κB; mTOR/MAPK pathways, Signaling pathways involved in cancers; Signaling during metabolic dysfunctions leading to obesity, diabetes; Down-regulation of signaling; Integration and controlling signals.

Recommended Books

1) Nelson, D. L., Cox, M. M. *Lehninger's Principles of Biochemistry*. 17th Ed. W. H. Freeman, (2017).
2) Cox, M. M., Douda, J., O'Donnell, M., *Molecular Cell Biology*. 2nd Ed. W. H. Freeman, (2015).
3) Lodish, *et al. Molecular Cell Biology*. 8th Ed. W. H. Freeman, (2016).

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BCH 413 Clinical Biochemistry 3 (2+1)

Course Objective

- Understand the basic concepts of clinical biochemistry
- Enhance the understanding of the biochemical basis of human disease with relevance to clinical diagnosis.

Learning Outcome

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

1) Identify, interpret and perform the role of plasma enzymes in the diagnosis of various clinical disorders
2) Assess the severity of disorder/cell damage
3) Correlate the enzymes deficiencies with inborn errors of metabolism
4) Determine the role of enzymes as a prognostic indicator

Course Outline

Diagnostically important Plasma Enzymes & Proteins: Identification and treatment of enzyme deficiencies, Assessment of cell damage, Factors affecting results of plasma enzyme assays. Abnormal plasma enzymes activities: isoenzymes in plasma (Lactate dehydrogenase, Creatine kinase, Amylase); Immunoglobin deficiencies; Disorders of carbohydrate metabolisms and Clinical correlations: Diabetes mellitus, Fructose intolerance, Lactic acidosis, Hypoglycemia, Galactosemia; Glycogen storage Diseases; Disorders of Lipid Metabolism (hyperlipidemia, cholesterol and cardiovascular diseases); Disorders of purine and pyrimidine metabolism (Gout, Arthritis); Metabolic Bone Diseases; Liver Diseases (cirrhosis', specific liver diseases, hepatitis, obstructive jaundice); Haemoglobinopathies, Disorders of iron and porphyrin metabolism; Cancer diagnosis, tumor markers, ectopic hormone production, Biosensors.

Practicals

- Blood sampling technique, serum/plasma isolation procedure
- Determination of total plasma proteins
- Determination of serum Albumin
- Blood glucose estimation (Fasting and Random)
- Glycosylated Hemoglobin (HbA1c).
- Glucose tolerance test for borderline diabetics
- Liver function tests
- Renal Function tests
- Cardiac enzymes (CPK, MB, LDH)
- Determination of lipid profile
- Serum and urine electrolytes
- CSF analysis in cases of meningitis

Recommended Books

1) Bishop, M. L., Fody, E. P., Schoeff, L. E., *Clinical Chemistry: Principles, Procedures*. 6th Ed. Lippincott Williams & Wilkins, (2004)
2) *Clinical Biochemistry: Metabolic and Clinical Aspects*. Marshall, W. J., Bangert, S. K. (Editors), Elsevier Health Sciences, (2008).
3) *Clinical Biochemistry*. Ahmed, N. (Editor), Oxford University Press, (2016).

BCH 415 Biochemistry of Antioxidants 3 (2+1)

Course Objective

The course objectives are to:

- To provide students with theoretical and practical knowledge of antioxidants
- To know the synthetic and natural antioxidants.
- To equip the student with understanding the mechanism of antioxidants
- To provide the latest developments in the antioxidant's biochemistry

Learning Outcome

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

- Understand the mechanism of action and reactivity.
- Describe the tendencies of antioxidants in the field of biochemistry
- Apply knowledge in a variety of fields

Course Outline

Concept of free radicals; types of free radicals: ROS, NOS, effects of free radicals; Concept and types of antioxidants; Classification of antioxidants; Synthetic antioxidants, chemistry, biochemistry, applications and effects; Natural antioxidants (polyphenols, vitamin E, vitamin C, carotenoids, glutathione), their chemistry, biochemistry, applications and effects; Antioxidant enzymes; Analysis of antioxidants

Practicals

- Determination of DPPH radical scavenging activity & IC50 value
- Determination of Total phenolic contents in plant samples
- Determination of glutathione in serum
- Determination of different antioxidants activities

Recommended Books

1) *Antioxidant Biochemistry*. Gilmour, N. (Editor). Syrawood Publishing House, (2016)
2) Packer, L., *Handbook of Antioxidants*. 2nd Ed. Dekker, (2007).
3) Zeb, A., *Phenolic Antioxidants in Foods. Chemistry, Biochemistry and Analysis*. Springer Nature Switzerland, (2020).

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YEAR 4 / SEMESTER 8

Semester 8				
Code	**Title**	**Cred. Hrs.**	**Marks**	**Course status**
BCH 421	Current Trends in Biochemistry	3	100	Major
BCH 422	Methods in Molecular Biology	3 (2+1)	100	Major
BCH 423	Antimicrobials & Chemotherapeutics	3	100	Major
BCH 424	Elective II (Within the major)	3	100	Major
BCH 500	Capstone Project/Thesis	3	100	Major
Total Credit Hours:		**15**	**500**	

BCH 421 Current Trends in Biochemistry 3

Course Objective

The main objectives of this course are:

- To encourage the students to recognize the importance of new biochemical techniques
- To develop the research approach in the students
- To provide the information about the latest developments and revolutions in the biochemistry

Learning Outcome

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

- Describe the recent research tendencies in the field of biochemistry
- Review the research work published in national and international journals
- Evaluate the methodology and results given in the publications

Course Outline

Latest developments in areas of current interest will be covered. Course contents will be based on recent reviews and research publications in peer review journals.

BCH 422 Methods in Molecular Biology 3 (2+1)

Course Objective

- This course aims at introducing rDNA technology and familiarizing students with basic techniques in molecular Biology
- To acquaint students with the modern concept of molecular biology

Learning Outcome

1) The students will be capable to acquire basic knowledge of recombinant DNA technology
2) This course will enable the students to understand the biochemical and molecular basis of life
3) The students will be equipped with the basic techniques of chemistry and biology of macromolecules.
4) After completing this course student will be equipped with experimental aspects of molecular biology

Course Outline

Introduction to recombinant DNA technology; Cloning and expression vectors and their types; Expression of recombinant proteins and their purification by affinity chromatography; Polymerase chain reaction (PCR) types; (inverse, touch- down, nested, hemi-nested, pit stop, multiplex, reverse transcriptase, RACE, real-time) and its applications; Detection of mutations and/or SNPs; Analysis of nucleic acids by gel electrophoresis – horizontal, vertical, pulse-field, denaturing gradient gel electrophoresis; Blotting: Southern, Western and Northern; DNA sequencing technologies; Introduction to genome editing techniques.

Practicals

- Preparation of stock and working solutions;
- Isolation of nucleic acids and their quantification;
- Polymerase chain reaction (PCR);
- Gel electrophoresis;
- Restriction digestion of DNA and preparation of restriction maps;
- Detection of mutations by restriction fragment length polymorphism;
- Preparation of chemically competent cells;
- Transformation of bacteria with plasmid DNA;
- Analysis of proteins by SDS- PAGE

Recommended Books

1) T. A. Brown., *Gene Cloning and DNA Analysis: An Introduction*,7th Ed. Wiley-Blackwell, (2016).
2) Green, M. R., Sambrook. J., *Molecular Cloning: A Laboratory Manual*. 4th Ed. Cold Spring Harbor Laboratory Press, (2014).
3) Wilson, K., Walker, J., *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Cambridge University Press, (2010).

BCH 423 Antimicrobials & Chemotherapeutics 3

Course Objective

- This course will provide the basic principles of chemotherapy of cancer and infectious disease
- This course will provide the basic concepts of selective toxicity and resistance;

- This course will also provide an understanding of the molecular mechanisms behind the action of anticancer and anti-infective drugs.

Learning Outcome

After completing this course student should be able to;

1) Understand the basic principles of chemotherapy of cancer and infectious disease
2) Acquire basic knowledge of selective toxicity and resistance.
3) Understand the molecular mechanism of anti-cancer and anti-infective drugs

Course Outline

Introduction to chemotherapy, chemotherapeutic agents and antimicrobial therapy; Classification of antimicrobials: Antibacterial, anti-viral, anti-malarial and antifungal; Classification of Antibacterial agents based on their mode of action: Cell Wall Synthesis inhibitors (β-lactam antibiotics), Protein synthesis inhibitors (Aminoglycosides and Chloramphenicol), DNA Synthesis Inhibitors (Fluoroquinolones), RNA synthesis inhibitors (Rifampin), Folic Acid inhibitor (Sulfonamides & Trimethoprim) and Mycolic acid synthesis inhibitors (Isoniazid); Chemistry, mode of action and structure-activity relationship of antibiotics. Selective toxicity, spectrum of activity and side effects; Antiviral chemotherapy; Malaria and its treatment; Antifungal agents; Antibiotic resistance mechanism and synergism; Minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC) and LC50; Cancer Chemotherapy: DNA alkylating/Crosslinking drugs, Antimetabolites (5-fluorouracil, 6-mercaptopurine (6-MP etc.)), DNA Topoisomerase inhibitors and DNA Repair Enzymes and Mitotic poisons (often plant alkaloids)

Recommended Books

1) Ritter, J. A., Levis, L. D., *A Textbook of Clinical Pharmacology*, 5th Ed. Oxford University Press, (2008).
2) Katzung, B. G., *Basic and Clinical Pharmacology*, 11th Ed. McGraw-Hill Medical (2009).
3) Brunton, L. L., Lazo, J. S., Parker, K. L., *Goodman & Gilman's The Pharmacological Basis of Therapeutics*. 11th Ed. The McGraw-Hill Companies, Inc. (2006).

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LIST OF ELECTIVE COURSES

Water, Minerals and Vitamins 3

Course Objective

The course is focused on:

- Introducing the biological role of water in intracellular and extracellular fluids, and acid-base balance
- Complete understanding of the interactions of minerals with biomolecules
- Educating the students on the role of water-soluble and fat-soluble vitamins in the biological system
- Elaborating the deficiency disorder and hypervitaminosis

Learning Outcome

After completing this course, the students are expected to:

1) Be well versed with roles of minerals and vitamins in normal human physiology
2) Demonstrate the interactive effects of vitamins and minerals with other biomolecules
3) Work out therapies for the diseases related to deficiencies of vitamins and minerals

Course Outline

Minerals: Definition, history and classification of vitamins; Water-soluble vitamins: Sources, requirements, activation, metabolism, physiological functions and deficiency disorders and symptoms of B- complex vitamins, clinical significance of water-soluble vitamins; Fat- soluble vitamins: Sources, requirements, metabolism and biological functions; Hypervitaminosis; Role of vitamins in digestive, urinary, bone and skin health, body weight and related health concerns; Definition and classification of minerals. Metabolism, absorption, excretion, distribution, functions, deficiency symptoms and clinical manifestations of different minerals; Interactions of B-complex vitamins, enzymes and minerals

Recommended Books

1) Rodwell, V., Weil, A., Botham, K. M., Bender, D., Kennelly, P. J., *Harpers Illustrated Biochemistry*. 30th Ed. McGraw-Hill Education, (2015)
2) Voet, D. J., Voet, G.J. Pratt, C. W., *Fundamentals of Biochemistry: Life at the Molecular Level*. 3rd Ed. Wiley & Sons Inc, (2008)

3) West, E. and Todd, W. *Text Book of Biochemistry*. Macmillan Co. (1970).

Pharmacology 3

Course Objective

The course objectives are to:

- Provide basic and fundamental concepts in pharmacology
- Knowledge of the mechanism of action of different drugs
- Familiarize with various factors affecting the actions of drugs

Learning Outcome

1) Describe fundamental concepts in pharmacology
2) Classify drugs based on action
3) Understand the mechanism of action of different types of drugs
4) Explain the factors affecting the drugs
5) Illustrate the obtained knowledge for good healthcare

Course Outline

Definition of pharmacology, definition of drug and drug nomenclature, pharmacopoeias, formularies, branches of pharmacology, sources of drugs, dosage forms and doses of drugs; Drug administration, absorption of drugs and processes involved in drug absorption, factors modifying absorption of drugs; Bioavailability, clinical significance and factors affecting bioavailability; Drugs reservoirs, distribution and redistribution of drugs, plasma protein binding; Pro-drug, biotransformation of drugs, plasma half-life of drugs, steady-state concentration, its clinical importance and factors affecting it, excretion of drugs. Mechanism of drug action; Dose-response curves, structure-activity relationship, factors modifying action and doses of drugs, drug-drug interactions. Locally acting drugs (demulcents, emollients, irritants), drugs acting on gastrointestinal tract, cardiovascular drugs, anti-arrhythmic drugs, Inotropic drugs, anti-hypertensive drugs, thrombolytic, anti-hyperlipidemic drugs, diuretics, autacoids, analgesics (opioids, non-steroidal anti-inflammatory drugs).

Recommended Books

1) Ritter, J. A., Levis, L. D., *A Textbook of Clinical Pharmacology*, 5th Ed. Oxford

University Press, (2008).
2) Katzung, B. G., *Basic and Clinical Pharmacology*, 11th Ed. McGraw-Hill Medical (2009).
3) Qayum, A., *Fundamentals of Experimental Pharmacology*. Ghandhara University, Peshawar, (2004).

Toxicology 3

Course Objective

- To explain the molecular, cellular and pathophysiological responses resulting from exposure to chemical agents.
- To educate students to obtain knowledge and practical skills in the recognition of toxins.

Learning Outcome

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

1) To interpret and integrate a broad range of toxicological information.
2) To tackle with Toxicological assessment of poisons including heavy metals & pesticides.

Course Outline

Thanatology (study of death); Introduction to toxicology, toxinology (poisonous plants and herbal medicines) and toxicological substances; Toxicokinetics (Metabolism of Xenobiotics, Absorption, Distribution, and Excretion of Toxicants); Toxicodynamics; Different routes of exposure to toxicants; Factors affecting toxicity; An approach towards poisoned patient; Toxic effects of pesticides and alcohols, mycotoxin, aflatoxin and heavy metals (mercury, lead and arsenic)

Recommended Books

1) Hodgson, E., Smart, R.C., *Introduction to Biochemical Toxicology*. 4th Ed. John Wiley and Sons, (2008).
2) Gupta, P. K., *Fundamentals of Toxicology: Essential Concepts and Applications*. Academic Press, (2016).
3) Reichl, F. X., Ritter, L. *Illustrated Handbook of Toxicology*. Thieme, (2010).

Drug Development 3

Course Objective

- To understand the basic concepts of drug development
- This course will provide understanding of drug discovery
- This course acquaints the students in related fields of pharmaceutical sciences, clinical trial and evidence based medicine with the necessary study design concepts and statistical practice to allow them to understand how drug developers plan and evaluate

their drug development.

Learning Outcome

After completing this course student should be able to;

1) Understand the basic concept of drug development
2) Acquire basic knowledge of drug discovery.
3) Apply the knowledge to plan and evaluate drug development.

Course Outline

Introduction to drug development, the regulatory environment for new drug development: the food and drug administration, sponsor and regulatory agency responsibilities, the new drug applications; Drug discovery and non-clinical research (pre-clinical research and development): overview of pharmacokinetics, pharmaceutics and pharmacodynamics, toxicological studies; methodology analysis, design and methodology in clinical trials (clinical research and development): ethical aspects of design and methodology; clinical study protocols, monitoring clinical trials, statistical analysis; types of clinical data, descriptive and inferential statistics, employment of hypothesis testing (statistical significance), employment of confidence intervals (clinical significance), sample size estimation; safety assessment in clinical trials, efficacy assessment in clinical trials, pharmaceutical and biopharmaceutical drug manufacture (post marketing phase).

Recommended Books

1) Turner, J. R., *New Drug Development: An Introduction to Clinical Trails*. 2nd Ed. Springer, (2010)
2) Blass, B., *Basic Principals of Drug Discovery and Development*. 1st Ed. Academic Press, (2015)
3) Ng, R., *Drugs from Discovery to Approval.* 3rd Ed. Wiley-Blackwell, (2015).

Fermentation Biotechnology 3

Course Objective

This course will cover

- The historical background and the advancement in fermentation Biotechnology
- Basic knowledge on microbial metabolism
- Screening and genetic modification of microorganisms

Learning Outcome

By the end of the course, the student should be able to

1) Understand the rules of fermentation biotechnology

2) Describe the types and operation of bioreactors, equipment and tools used in the control of fermentation
3) Explain relationship of microbiology to Industrial fermentation.

Course Outline

Fermentation and Microorganisms; Different types of fermentation: alcoholic & lactic acid fermentation; Industrial fermentation; Chronological review and perspectives in fermentation biotechnology; Microbial metabolism; Respiro-fermentative metabolism of yeasts; Screening and selection of industrial cultures; Genetic manipulations of industrial strains; The maintenance of the cultures; Raw materials and the composition of substrate of fermentation; Fermentation processes, batch, extended batch, batch with cell recycle, continuous process; Kinetic of microbial growth and fermentation products; Principal parameters of fermentation process; measurements and regulations of principal fermentation parameters; Fermentation technology upscaling, Bioreactors: agitation and aeration technology, fermentation plant (fundamental and auxiliary equipment, modality of sterilization and product recovery); downstream processing

Recommended Books

1) Pommerville, C. J., *Alcamo's Fundamentals of Microbiology*. 9th Ed. Jones and Bartlett Learning Company, (2018).
2) Talaro, K. P., *Foundations in Microbiology Companion*. 8th Ed. McGraw Hill, (2015).
3) *Fermentation and Biochemical Engineering Handbook*. Vogel, H. C., Todaro, C. C. (Editors). 3rd Ed. William Andrew, (2014).

Neuro-biochemistry 3

Course Objective

- To study neurons and neurotransmitters along with the underlying mechanism of action
- To understand the biochemical basis of neurological diseases

Learning Outcome

After completing this course, students should be able to;

1) Acquire the understanding of mechanism involved in the transmission of information in the brain
2) Analyze the role of neurotransmitters for various diseases

Course Outline

Neuroanatomy: Gross appearance, Fluid compartments, Microscopic appearance, Neurons, Glial cells. The synapses; Brain composition: Central and peripheral nervous system, Lipids, Myelin and membranes, structure of Myelin, Function of Myelin, Electrolytes, Proteins (structure and Properties); Neurotransmission: Resting potential, sodium pump, Action

potential and nerve conduction, Identification and occurrence of neurotransmitters, Neurotransmitters and Neuropeptides, Inhibitory and excitatory synapse, GABA and other inhibitory transmitters, Mechanism of action of dopamine, Opiate receptors, cyclic nucleotides; Brain Functions: Adaptive processes in the brain, inducible enzymes, Adaptation to specific substrates, Adaptation to product of an alternate pathway, Adaptation involving coenzymes; Biochemistry of Neurological disorders: Genetic and metabolic disorders, Metabolic basis of Schizophrenia, Epilepsy, Multiple Sclerosis, Parkinson's disease

Recommended Books

1) *Basic Neurochemistry, Molecular, Cellular, and Medical Aspects.* Siegel et al. (Editors) 6th Ed. Academic Press, (2005)
2) Handbook of Neurochemistry and Molecular Neurobiology. Lajtha, et al. (Editors). Springer, (2010)
3) Wild, G. C., Benzel, E. C., *Essentials of Neurochemistry*. 1st Ed. Jones and Bartlett Learning, (1994)

BIOINFORMATICS 3 (2+1)

Course Objective

- To familiarize students with biological data mining from online databases.
- To provide an understanding of bioinformatics tools for biological sequence analysis and structure-function relationships of major macromolecules.
- The practical component will impart bioinformatics practical skills.

Learning Outcome

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

1) Acquire the basic knowledge of Bioinformatics and Computational Biology
2) Understand the concepts in bioinformatics and use them efficiently

Course Outline

Basic concepts in bioinformatics; Biological Sequence Databases (including Genomic Databases); Information Retrieval from Biological Databases; Predictive Methods Using DNA Sequences; Sequence Polymorphisms; Predictive Methods Using Protein Sequences; Assessing Pairwise Sequence Similarity: BLAST and FASTA; Creation and Analysis of Protein Multiple Sequence Alignments; Phylogenetic Analysis; Computational Approaches in Comparative Genomics; Proteomics and Protein Identification; Molecular modeling and visualization; Protein Structure Prediction and Analysis; Molecular docking & dynamic simulation. Machine learning base virtual screening, QSAR.

Practicals

- Survey of Biological Sequence Databases.
- Sequence alignment by dot plot method.
- Sequence database searching by BLAST.
- Secondary structure prediction.
- Homology modelling of proteins.
- Genomic sequence analysis by ENSEMBL.

Recommended Books

1) Arthur, L., *Introduction to Bioinformatics*. Oxford University Press. 5th Ed. (2019).
2) Mount, D., *Bioinformatics: Sequence and Genome Analysis*, 2nd Ed. CSHL Press (2004).

Bioinformatics: A Practical Handbook of Next Generation Sequencing and Its Applications. Low, L., Tammi, M. (Editors), World Scientific Publishing Co, (2017).

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website. For any query the office of the Registrar Academics may be approached for clarification/guidance.

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