



No. UOM/Acad/20/75

Dated: 07-Feb-2020

NOTIFICATION

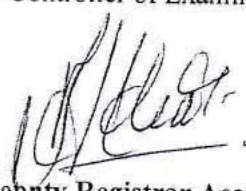
It is notified for the information of all concerned that the Syndicate, in its 34th meeting held on January 10, 2020 (vide Agenda Item No. 12(03) (01)), **approved** recommendation of the Academic Council made in its 11th meeting held on December 24, 2019 (vide agenda Item No. 03(01)), regarding the BS (4 Year) Biochemistry Scheme of Studies from 2019 and onwards.

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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


Deputy Registrar Academics

**WORKING PAPER
FIRST MEETING OF THE
BOARD OF STUDIES**



(14 November 2019)

[Signature]
Deputy Registrar
(Academics)
University of Malakand

[Signature]
20-11-2019
Chairman
Department of Biochemistry
University of Malakand

**DEPARTMENT OF BIOCHEMISTRY
UNIVERSITY OF MALAKAND**

Adopted from

**CURRICULUM OF
BIOCHEMISTRY**

(2018)



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By

[Signature]
20-2-2020
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HIGHER EDUCATION COMMISSION

ISLAMABAD

BS (4 YEAR) BIOCHEMISTRY SCHEME OF STUDIES FROM 2019 & ONWARDS

The courses are proposed by the Higher Education Commission in BS (4 Year) Biochemistry Program and will be adopted in the Department of Biochemistry, the University of Malakand for the Semester system from 2019 and onwards.

TITLE OF DEGREE PROGRAM

BS (4 Year) in Biochemistry

ELIGIBILITY CRITERIA

BS Biochemistry: FSc (Pre-Medical) or equivalent with at least 45% marks. Additional requirements, if any are as approved by the University.

STANDARDIZED FORMAT

FOR BS (4 YEAR) IN BIOCHEMISTRY

STRUCTURE

Sr. No	Categories	No. of courses	Credit Hours
1	Compulsory courses	9	26
2	General courses	8	24
3	Discipline specific foundation courses	10	30
4	Major courses (including Research Project/Internship)	15	44
5	Electives within the major	4	12
	Total	46	136

- Total numbers of credit hours 136
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 8
- Course load per semester 15-18 Credit hours
- Number of courses per semester 5-6


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LAYOUT FOR BS (4 YEAR) IN BIOCHEMISTRY

Compulsory Courses (C)		General Courses (G)	
9 courses		8 courses	
26 Credit hours		24 Credit hours	
Subject	Cr. hr	Subject	Cr. hr
1. English I	3+0	1. Introduction to Sociology/Population Dynamics of Pakistan	3+0
2. English II	3+0	2. Organic Chemistry	2+1
3. English III	3+0	3. Inorganic Chemistry	2+1
4. Pakistan studies	3+0	4. Physical Chemistry	2+1
5. Islamic studies	3+0	5. Analytical Chemistry	2+1
6. Mathematics	3+0	6. Genetics	3+0
7. Introduction to Biostatistics	3+0	7. Microbiology	2+1
8. Food Chemistry	2+0	8. Cell and Tissue Culture	3+0
9. Introduction to Information & Communication Technologies	2+1		

Discipline-Specific Foundation Courses (F)		Major Courses (M)		Elective Courses within the Major (E)	
10 courses		15 courses		4 courses	
30 Credit hours		44 Credit hours		12 Credit Hours	
Subject	Cr. hr	Subject	Cr. hr	Subject	Cr. hr
1. Introductory Biochemistry	2+1	1. Biosafety and Ethics	3+0	1. Biochemistry of Antioxidants	2+1
2. Carbohydrates and Lipids	2+1	2. Plant Biochemistry	2+1	2. Antimicrobials & Chemotherapeutics	3+0
3. Proteins & Nucleic acids	2+1	3. Clinical Biochemistry	2+1	3. Elective-I	2+1
4. Human Physiology	2+1	4. Bio membranes & Cell Signalling	3+0	4. Elective-II	2+1
5. Enzymology	2+1	5. Bioenergetics	3+0		
6. Molecular Biology	3+0	6. Research Planning & Scientific Writing	3+0		
7. Metabolism of Carbohydrates & Lipids	3+0	7. Nutritional Biochemistry	2+1		
8. Metabolism of Amino Acids, Proteins & Nucleic Acids	3+0	8. Bioinformatics	2+1		
9. Cell Biology	2+1	9. Industrial Biochemistry	2+1		
10. Biochemical Techniques	1+2	10. Immunology	3+0		
		11. Current Trends in Biochemistry	3+0		
		12. Biotechnology	2+0		
		13. Environmental Biochemistry	2+1		
		14. Methods in Molecular Biology	1+2		
		15. Research Project/Internship	0+3		


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**SEMESTER-WISE SCHEME OF STUDIES FOR
BS (4 YEAR) IN BIOCHEMISTRY**

YEAR 1 / SEMESTER 1

Course Code	Name of Subject	Course Type	Total Marks	Credits
ENG 111	English-I	C	75	3+0
PS 116	Pakistan Studies	C	75	3+0
MATH 101	Mathematics	C	75	3+0
SOC 116/ POP 234	Introduction to Sociology/ Population Dynamics of Pakistan	G	75	3+0
BCH 111	Organic Chemistry	G	75	2+1
BCH 102	Introductory Biochemistry	F	75	2+1
	Total		450	18

YEAR 1 / SEMESTER 2

Course Code	Name of Subject	Course Type	Total Marks	Credits
ENG 112	English-II	C	75	3+0
ISL 112	Islamic Studies	C	75	3+0
CHEM 151	Inorganic Chemistry	G	75	2+1
STAT 218	Introduction to Biostatistics	C	75	3+0
BCH 122	Microbiology	G	75	2+1
BCH 104	Carbohydrates and Lipids	F	75	2+1
	Total		450	18

YEAR 2 / SEMESTER 3

Course Code	Name of Subject	Course Type	Total Marks	Credits
ENG 211	English-III	C	75	3+0
CS 114	Introduction to Information & Communication Technologies	C	75	2+1
CHEM 271	Physical Chemistry	G	75	2+1
BCH 212	Genetics	G	75	3+0
BCH 203	Proteins and Nucleic Acids	F	75	2+1
BCH 204	Cell Biology	F	75	2+1
	Total		450	18

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YEAR 2 / SEMESTER 4

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 221	Food Chemistry	C	50	2+0
BCH 222	Cell and Tissue Culture	G	75	3+0
BCH 223	Analytical Chemistry	G	75	2+1
BCH 205	Human Physiology	F	75	2+1
BCH 206	Enzymology	F	75	2+1
BCH 227	Biosafety and Bioethics	M	75	3+0
	Total		425	17

YEAR 3 / SEMESTER 5

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 301	Metabolism of Carbohydrates & Lipids	F	75	3+0
BCH 302	Molecular Biology	F	75	3+0
BCH 313	Nutritional Biochemistry	M	75	2+1
BCH 314	Immunology	M	75	3+0
BCH 315	Plant Biochemistry	M	75	2+1
BCH 316	Environmental Biochemistry	M	75	2+1
	Total		450	18

YEAR 3 / SEMESTER 6

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 305	Metabolism of Amino Acids, Proteins & Nucleic Acids	F	75	3+0
BCH 306	Biochemical Techniques	F	75	1+2
BCH 321	Biotechnology	M	50	2+0
BCH 322	Bioinformatics	M	75	2+1
BCH 323	Bioenergetics	M	75	3+0
BCH 324	Industrial Biochemistry	M	75	2+1
	Total		425	17

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YEAR 4 / SEMESTER 7

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 411	Research Planning & Scientific Writing	M	75	3+0
BCH 412	Bio-membranes and Cell Signalling	M	75	3+0
BCH 413	Clinical Biochemistry	M	75	2+1
BCH 414	Elective I	E	75	3+0
BCH 415	Biochemistry of Antioxidants	E	75	2+1
	Total		375	15

YEAR 4 / SEMESTER 8

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 421	Current Trends in Biochemistry	M	75	3+0
BCH 422	Methods in Molecular Biology	M	75	1+2
BCH 423	Antimicrobials & Chemotherapeutics	E	75	3+0
BCH 424	Elective II	E	75	3+0
BCH 499	Research Project/Thesis	M	75	0+3
	Total		375	15
Total Credit Hours: 136				

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Articles

Personal pronouns: Reflexive and emphatic pronouns; Demonstrative, indefinite and distributive pronouns; Relative pronouns; Interrogative pronouns

The verb: Verbs of incomplete predication

Active and passive voice

Mood

Tenses: Introduction; The uses of the present and past tenses and the future tenses

The verb: person and number: The infinitive; The participle; The gerund; Irregular verbs; Auxiliaries and modals

The adverb: Comparison of adverbs; Formation of adverbs; Position of adverbs

The preposition: Words followed by prepositions

The conjunction

Direct and Indirect Narration

Recommended Books

- 1) Howe, D. H, Kirkpatrick, T. A., Kirkpatrick, D. L., *Oxford English for Undergraduates*. Oxford University Press, (2004).
- 2) Eastwood, J., *English Practice Grammar* (New edition with tests and answers). Oxford University Press, (2004).
- 3) Murphy, R., *Grammar in Use*. Cambridge University Press, (2003).

PS 116

PAKISTAN STUDIES

(3+0)

Course Objective

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

Historical Perspective; Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam M. Ali Jinnah; Factors leading to Muslim separatism; People and Land: Indus Civilization; Muslim advent; Location and geophysical features. Government and Politics in Pakistan; Political and constitutional phases: 1947-58; 1958-71; 1971-77; 1977-88; 1988-99 and 1999 onward; Contemporary Pakistan; Economic institutions and issues; Society and social structure; Ethnicity; Foreign policy of Pakistan and challenges; Futuristic outlook of Pakistan

Course Outline

Introduction: Definition, Scope, and Subject Matter; Sociology as a Science; Historical background of Sociology

Basic Concepts: Group, Community, Society; Associations; Non-Voluntary; Voluntary; Organization; Informal, Formal; Social Interaction, Levels of Social Interaction, Process of Social Interaction, Cooperation, Competition, Conflict, Accommodation, Acculturation and diffusion, Assimilation, Amalgamation

Social Groups: Definition & Functions; Types of social groups: In and out-groups, Primary and Secondary group, Reference groups, Informal and Formal groups, Pressure groups

Culture: Definition, aspects and characteristics of Culture: Material and non-material culture, Ideal and real culture; Elements of culture: Beliefs, Values, Norms and social sanctions; Organizations of culture: Traits, Complexes, Patterns, Ethos, Theme; Other related concepts: Cultural Relativism, Sub Cultures, Ethnocentrism and Xenocentrism, Cultural lag

Socialization & Personality: Personality, Factors in Personality Formation; Socialization; Agencies of Socialization; Role & Status

Deviance and Social Control: Deviance and its types; Social control and its need; Forms of Social control; Methods & Agencies of Social control

Collective Behavior: Collective behaviour, its types; Crowd behaviour; Public opinion; Propaganda; Social movements; Leadership

Recommended Books

- 1) Brown, K., *Sociology*. Polity Press, (2004).
- 2) Giddens, A., *Introduction to Sociology*. Polity Press, (2002).
- 3) Hameed, T. A., *An Introduction to Sociology*, Lahore, (2000)

POP 234 POPULATION DYNAMICS OF PAKISTAN (3+0)

Course Objectives

In this course the students will understand relevant concepts regarding population dynamics in Pakistan. It will also enable them to learn relevant theory and socio-economic and cultural dimensions of population growth. Further the students will study different population variables including fertility, mortality, migration, urbanization and population control strategies.

Course Outline

Introduction: An overview of Pakistan's population, Demographic data and its utilities, Sources of population data, Scope and significance of the subject with relevance to Pakistan

Demographic Process and Variables


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- 2) Understand the mechanistic pathways for synthesis of molecules
- 3) Apply acquired knowledge in the allied fields of chemistry
- 4) Perform any laboratory-related task within the scope of course independently

Course Outline

Bonding and hybridization localized and delocalized bonding, aromaticity, inductive effect, dipole moment, resonance and its rules, hyper-conjugation, classification and nomenclature of organic compounds. Different types of organic reactions and mechanism. Saturated, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and substitution reactions; preparation and properties of alcohols, phenols, ethers, amines, carbonyl compounds; Types of stereoisomers, RS and EZ notation, optical activity, stereo-selectivity and stereo-specificity, conformational analysis.

Practicals

- Qualitative analysis of compounds with different functional groups.
- Techniques for the synthesis of organic compounds like reflux, distillation, filtration, recrystallization, and yield calculation.
- Preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol.

Recommended Books

- 1) Clayden J., Greeves N., Warren S., *Organic Chemistry*. Oxford University Press, (2012).
- 2) John, E. M., *Organic Chemistry*, 8th Ed. Brooks/Cole Publishing Co, (2012).
- 3) Younus M., *A Textbook of Organic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2006).

BCH 102 INTRODUCTORY BIOCHEMISTRY (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


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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

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

Course Code	Name of Subject	Course Type	Total Marks	Credits
ENG 112	English-II	C	75	3+0
ISL 112	Islamic Studies	C	75	3+0
CHEM 151	Inorganic Chemistry	G	75	2+1
STAT 218	Introduction to Biostatistics	C	75	3+0
BCH 122	Microbiology	G	75	2+1
BCH 104	Carbohydrates and Lipids	F	75	2+1
Total			450	18

ENG 112

ENGLISH II

(3+0)

Course Description

The course focuses on the basic strategies of composition and writing skills. Good writing skills not only help students obtain good grades but also optimize their chances to excel in professional life. The course includes modes of collecting information and arranging it in appropriate manner i.e. chronological order, cause and effect, compare and contrast, general to specific etc. It would enable the students to write, edit, rewrite, redraft and proofread their own documents for writing effective compositions. Because of the use of a significant amount of written communication on a daily basis, sharp writing skills have always been valued highly in academic as well as professional spheres.

Course Objectives

- Assist students to identify the audience, message, and the purpose of writing
- Develop rhetorical knowledge and critical thinking
- Enable them to express themselves in a variety of writing styles
- Help students write well organized academic texts including examination answers with topic/thesis statement and supporting details.
- Make students write argumentative essays and course assignments

Course outcome

By the end of the course, students are expected to:

- Use different mechanics of writing to produce various types of compositions effectively keeping in view the purpose and the audience
- Demonstrate rhetorical knowledge
- Demonstrate critical thinking in well-organized forms of academic texts
- Properly use punctuation marks
- Write well organized and coherent compositions
- Organize paragraph to make longer compositions


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Course Outline

Writing Process

Invention; Generating Ideas (collecting information in various forms such as mind maps, tables, lists, charts etc.); Identifying Audience, Purpose, and Message; Ordering Information; Chronology for a narrative; Stages of a process; From general to specific and vice versa; From most important to least important; Advantages and disadvantages; Comparison and contrast; Problem solution pattern; Drafting; Free Writing; Revising; Editing

Paraphrasing

Cohesion and Coherence: Cohesive Devices; Paragraph unity

Summary and Précis Writing

Creative Writing

Essay Writing

Developing a thesis statement; organizing an essay; writing effective introduction and conclusion; different types of essays; use of various rhetorical modes including exposition, argumentation and analysis

Reading Comprehension

Recommended Books

- 1) Goatly, A., *Critical Reading and Writing: An Introductory Course*. Taylor & Francis, (2000).
- 2) Hamp-Lyons, L. Heasley, B., *Study writing: A Course in Written English for Academic and Professional Purposes*. Cambridge University Press, (1987).
- 3) Howe, D. H, Kirkpatrick, T. A., Kirkpatrick, D. L., *Oxford English for Undergraduates*. Oxford University Press, (2004).

ISL 112

ISLAMIC STUDIES

(3+0)

Course Objective

- To provide Basic information about Islamic Studies
- To enhance understanding of the students regarding Islamic Civilization
- To improve Students skill to perform prayers and other worships
- To enhance the skill of the students for understanding of issues related to faith and religious life.

Course Outline

Introduction to Quranic Studies

Basic Concepts of the Quran, History of Quran, Uloom-ul-Quran


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Study of Selected Text of Holly Quran

- Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
- Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

Study of Selected Text of Holly Quran

- Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1,14)

Seerat of Holy Prophet (S.A.W) I

- Life of Muhammad Bin Abdullah (Before Prophet Hood)
- Life of Holy Prophet (S.A.W) in Makkah
- Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

- Life of Holy Prophet (S.A.W) in Madina
- Important Events of Life Holy Prophet in Madina
- Important Lessons Derived from the life of Holy Prophet in Madina

Introduction To Sunnah

- Basic Concepts of Hadith: History of Hadith, Kinds of Hadith, Uloom-ul-Hadith, Sunnah & Hadith, Legal Position of Sunnah

Selected Study from Text of Hadith Introduction to Islamic Law & Jurisprudence

- Basic Concepts of Islamic Law & Jurisprudence
- History & Importance of Islamic Law & Jurisprudence
- Sources of Islamic Law & Jurisprudence
- Nature of Differences in Islamic Law
- Islam and Sectarianism

Islamic Culture & Civilization

- Basic Concepts of Islamic Culture & Civilization
- Historical Development of Islamic Culture & Civilization
- Characteristics of Islamic Culture & Civilization
- Islamic Culture & Civilization and Contemporary Issues

Islam & Science

- Basic Concepts of Islam & Science
- Contributions of Muslims in the Development of Science


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- Quranic & Science

Islamic Economic System

- Basic Concepts of Islamic Economic System
- Means of Distribution of wealth in Islamic Economics
- Islamic Concept of Riba
- Islamic Ways of Trade & Commerce

Political System of Islam

- Basic Concepts of Islamic Political System
- Islamic Concept of Sovereignty
- Basic Institutions of Govt. in Islam

Islamic History

- Period of Khlaft-E-Rashida
- Period of Umayyads
- Period of Abbasids

Social System of Islam

- Basic Concepts of Social System of Islam
- Elements of Family
- Ethical Values of Islam

Recommended Books

- 1) Hasan, A., *Principles of Islamic Jurisprudence*. Islamic Research Institute, International Islamic University, Islamabad (1993)
- 2) Waliullah, M., *Muslim Jurisprudence and the Quranic Law of Crimes* Adam Publishers & Distributors, (1990).
- 3) Zia-ul-Haq, M., *Introduction to Al-Sharia Al Islamia*. Allama Iqbal Open University, Islamabad (2001)

CHEM 151 INORGANIC CHEMISTRY (2+1)

Course Objective

The specific objectives are:

- To provide an overview of fundamental topics in inorganic chemistry
- To give an understanding of underlying concepts of chemical bonding, acid-base equilibria, p-block elements and stoichiometry
- To galvanize the practical approach against the prescribed content

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Learning Outcome

Students completing this course will be able to;

- 1) Acquire the basic knowledge of inorganic chemistry
- 2) Identify the scope in related fields
- 3) Take on laboratory tasks relevant to inorganic chemistry

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Course Outline

Chemical Bonding

Types of chemical bonding, ionic, covalent bonding, and localized bond approach; Theories of chemical bonding, valence bond theory (VBT), hybridization and resonance, prediction of molecular shapes using Valence Shell Electron Pair Repulsion (VSEPR) model, molecular orbital theory (MOT) application on diatomic molecules, delocalized approach to bonding, bonding in electron-deficient compounds, hydrogen bonding.

Acids and Bases

Brief concepts of chemical equilibrium, acids and bases including soft and hard acids and bases (SHAB); Concept of the relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions; Theory of indicators, solubility, solubility product, common ion effect and their industrial applications.

P-Block Elements

Physical and chemical properties of p-block elements (Group V); Halogens, inter-halogens, pseudo-halogens and polyhalides

Stoichiometry

Atomic masses, mole, molar mass, percentage composition, balancing equations; Determining the formula of a compound, stoichiometric calculations; reactants and products, calculation involving rate-limiting reactant.

Practicals

- Lab safety and good laboratory practices, material safety data sheets (MSDS).
- Disposal of chemical waste and first-aid practices.
- Qualitative analysis of salt mixtures.
- Quantitative analysis through acid-base titrations.
- Preparation and standardization of acid and alkali solutions.
- Redox titrations; preparation and standardization of potassium permanganate solution and its use for the determination of purity of commercial potassium oxalate or oxalic acid, preparation and standardization of sodium thiosulfate solution and its use in the determination of copper in a given sample.
- Gravimetric analysis; determination of barium in a given sample, determination of chloride in a given solution.

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Recommended Books

- 1) Cotton, F. A., Wilkinson, G., *Advanced Inorganic Chemistry*, 6th Ed. John-Wiley & Sons, (2007).
- 2) House, J. E., *Inorganic Chemistry*, Academic Press, (2008).
- 3) Chaudhary S. U., *Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Lahore, (2013).

STAT 218 INTRODUCTION TO BIOSTATISTICS (3+0)

Course Objective

After completion of this course the student should be able to:

- Understand the use of the essential tools of basic Statistics and Probability
- Apply the concepts and the techniques in their respective discipline and research work.

Course Outline

What is Statistics? Definition of Statistics, Scope, Characteristics, Importance and Limitations; Population and sample; Descriptive and inferential Statistics, Observations, Data, Discrete and continuous variables, Errors of measurement

Presentation of Data: Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram

Measures of Central Tendency and Dispersion: Introduction, Different types of Averages, Box and Whisker Plot, Stem and Leaf Display, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Coefficient of variation

Regression and Correlation: Introduction, simple linear regression, estimation of parameters and their interpretation. r and R^2 . Correlation; Coefficient of linear correlation, its estimation and interpretation; multiple regression and interpretation of its parameters

Probability and Probability Distribution: Events, Probability and applications of Probabilities. Binomial, Poisson and Normal distributions, Properties and application of Probability Distributions, Normality

Test of Significance: Introduction

- **t-test:** Basic Idea, Testing hypothesis about mean, difference between two means, proportion.
- **Chi-Square test:** Basic Idea, Test of goodness of fit, testing of Association and Contingency Tables.
- **F-test:** Introduction, One and Two way ANOVA, Multiple comparison Tests and application of ANOVA (LSD, Duncan's Multiple range and Bonferroni tests).

Design of Experiment: Concept of Design, planning of an experiment, Principles of experiment (Randomization, replication and local control), Field plot technique, Layout and

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man Biochemistry
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Analysis of CR Design, RCB Design, Latin Square, Factorial Design and Treatment comparison

Recommended Books

- 1) Zar, J., *Biostatistical Analysis*, 5th Ed. John Wiley & Sons, (2000).
- 2) Daniel, W.W., *Biostatistics: A Foundation for the Health Sciences*. 6th Ed. John Wiley & Sons, (1996).
- 3) Rosne, B., *Fundamentals of Biostatistics*. 4th Ed. Duxbury Press, (1994).

BCH 122

MICROBIOLOGY

(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


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Recommended Books

1. Pommerville, C. J., *Alcarno'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 104 CARBOHYDRATES AND LIPIDS (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) Analyse 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; Blood groups, Oligo and polysaccharides and their importance in blood transfusion, and tissue/organ transplants; 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; Chemical structures and functions of Prostaglandins, thromboxanes and leukotrienes; 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


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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).

YEAR 2 / SEMESTER 3

Course Code	Name of Subject	Course Type	Total Marks	Credits
ENG 211	English-III	C	75	3+0
CS 114	Introduction to Information & Communication Technologies	C	75	2+1
CHEM 271	Physical Chemistry	G	75	2+1
BCH 212	Genetics	G	75	3+0
BCH 203	Proteins and Nucleic Acids	F	75	2+1
BCH 204	Cell Biology	F	75	2+1
Total			450	18

ENG 211

ENGLISH III

(3+0)

Course Description

For professional growth and future development, effective presentation and interpersonal communicative skills are very important. This course offers methods, techniques, and drills which are significant and useful in optimizing communication and presentation skills of the learners, enabling them to face divergent groups of the audience with poise and confidence. The course has been divided into modules relating to the essentials, contents, gestures, technology, and a variety associated with communication and presentations skills. The section on presentation skills focuses on preparing students for the long-life skill of preparing and giving presentations. Communication is a vital part of our daily routine. The section on communication skills focuses on developing good communication skills among students.

Course Objectives

The course aims to:

- help students identify essential components of a presentation
- develop the awareness, knowledge, skills and attitudes required to deliver effective academic presentations and communicate clearly


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- help students learn various presentation and communication styles and techniques
- provide techniques to facilitate effective interpersonal and interactive communication
- guide how to build stronger relationships through powerful communication
- Develop the communication skills of students
- Cultivate poise and confidence in students

Course Outline

Communication Skills: Introduction

Understanding the purpose of Communication; Analyse the Audience; Communicating with words as well as with body language; Writing with a Purpose; Process of communication; Barriers in Communications; Types of Communications; Job Interviews and Communicating Skills; Communication in a Team

Presentation skills

Delivering your presentation; Speaking with Confidence; Basic concepts, fazes of speech preparation; Effective presentation structure – introduction and conclusion; Expert presentation core structure; Verbal aspect of a presentation; Linguistic tools; Auditory aspect of a presentation; Non-verbal aspect of a presentation – body language; Speech visualization, effective presentation techniques basics; Expert presentation specifications; Q&A – preparation for an expert discussion; Stress management during a presentation.

Recommended Books

- 1) Bradbury, A., *Successful Presentation Skills*. 4th Ed. Kogan (2010).
- 2) Carnegie, D., *How to Win Friends & Influence People*. General Press, (2018)

CS 114 INTRODUCTION TO INFORMATION & COMMUNICATION TECHNOLOGIES (2+1)


Course Description

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and the World Wide Web, and ICT based applications.

Learning Outcome

After completing this course, a student will be able to:

- 1) Understand different terms associated with computer
- 2) Identify various components of a computer system
- 3) Identify the various categories of software and their usage
- 4) Define the basic terms associated with communications and networking
- 5) Understand different terms associated with the Internet and the World Wide Web.
- 6) Use various web tools including Web Browsers, E-mail clients and search utilities.
- 7) Use text processing, spread sheets and presentation tools


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Course Outline

Basic Definitions & Concepts; Hardware: Computer Systems & Components Storage Devices, Number Systems; Software: Operating Systems, Programming and Application Software Introduction to Programming, Databases and Information Systems Networks; Data Communication; The Internet, Browsers and Search Engines; The Internet: Email, Collaborative Computing and Social Networking The Internet: E-Commerce; IT Security and other issues; Project Week; Review Week

Recommended Books

- 1) Norton, P., *Introduction to Computers*. 6th Ed. McGraw-Hill, (2006).
- 2) Sawyer, W., *Using Information Technology: A Practical Introduction to Computer & Communications*. 7th Ed. McGraw-Hill, (2006).
- 3) Hajek, D., Herrera, C., *Introduction to Computers*. Independently Published, (2019).

CHEM 271 PHYSICAL CHEMISTRY (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) Analyse 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


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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-catalysed 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 Chemistry*, World Scientific Publishing Co. Pvt. Ltd., (2011).

BCH 212

GENETICS

(3+0)

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


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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 203 **PROTEINS AND NUCLEIC ACIDS** **(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; Proteins


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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 204

CELL BIOLOGY

(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.


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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).

BCH 222 CELL AND TISSUE CULTURE (3+0)

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; somaclonal 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


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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 ANALYTICAL CHEMISTRY (2+1)

Course Objective

The specific objectives are:

- To provide basic concepts of analytical chemistry
- To offer knowledge of classical and instrumental techniques for analysis
- To develop expertise in practising chemistry in biochemical laboratories.

Learning Outcomes

Students completing this course will be able to;

- 1) Explain the fundamentals of analytical chemistry
- 2) Demonstrate an understanding of the working principles of different analytical techniques.
- 3) Analyse the chemical problems through a thought process and come up with the solution
- 4) Apply the learnt techniques in the laboratory for analysis of samples

Course Outline

Separation Methods

Principles of solvent extraction; Analytical separations, multiple batch extraction, counter current distribution, solid-phase extraction and solvent extraction by flow injection method; Principles of chromatography, classification of chromatographic techniques, an overview of the paper, thin layer, column, ion-exchange chromatography and electrophoresis.

Analytical Spectrophotometry

Properties of light and its interaction with matter, relation between frequency, velocity and wave number; Lambert-Beer's law and its limitations, single beam and double beam spectrophotometers, lamps and lasers as sources of light, monochromators, detectors, photomultiplier tube, photodiode array, charged coupled device; FT-IR spectroscopy, Fourier analysis, interferometry. Classical Analytical Methods: Acid-base, complexometric and redox titrations, gravimetric analysis.

Practicals

- Calibration of volumetric glassware, electronic and analytical equipment.
- Determination of hardness of water using EDTA.
- Determination of chloride in a tap water sample.
- Estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry.


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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 206

ENZYMOLGY

(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 analyse the kinetics of enzyme-catalysed 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


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YEAR 3 /SEMESTER 5

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 301	Metabolism of Carbohydrates & Lipids	F	75	3+0
BCH 302	Molecular Biology	F	75	3+0
BCH 313	Nutritional Biochemistry	M	75	2+1
BCH 314	Immunology	M	75	3+0
BCH 315	Plant Biochemistry	M	75	2+1
BCH 316	Environmental Biochemistry	M	75	2+1
Total			450	18

BCH 301 METABOLISM OF CARBOHYDRATES & LIPIDS (3+0)

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, Glyoxalate Cycle reactions, Pentose phosphate Pathway;


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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 302

MOLECULAR BIOLOGY

(3+0)

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

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 (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) Skilfully 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

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).


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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; Production of specific antibodies; Monoclonal and polyclonal antibodies; Structures and specificities of different antibody classes; Opsonisation and Phagocytosis; Antibody-dependent cellular cytotoxicity; Functions of antibodies at special anatomical sites; Autoimmunity and immunological tolerance; Immune responses against cancer and transplants; 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).

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:


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- 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 centre, photosystem-I, photosystem-II; electron transport chain, ATP C3 and C4 pathways; CAM photosynthetic pathways; CO₂ 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; Phytohormones and related compounds; Signal transduction in plant cells

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 (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

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 305	Metabolism of Amino Acids, Proteins & Nucleic Acids	F	75	3+0
BCH 306	Biochemical Techniques	F	75	1+2
BCH 321	Biotechnology	M	50	2+0
BCH 322	Bioinformatics	M	75	2+1
BCH 323	Bioenergetics	M	75	3+0
BCH 324	Industrial Biochemistry	M	75	2+1
Total			425	17

BCH 305 METABOLISM OF AMINO ACIDS, PROTEINS & NUCLEIC ACIDS (3+0)

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


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- 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 analyser
- 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 (2+0)

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., Lorocho, V., *Biotechnology for Beginners*. 2nd Ed. Academic Press, (2017).

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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

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


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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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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) Analyse 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., Cooney, C.L. (Editors). Pergamon Press, (1985).
- 3) Stanbury, P. F., Whitaker, A., Hall, S. J., *Principles of Fermentation Technology*. Elsevier, (2013).

YEAR 4 / SEMESTER 7

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 411	Research Planning & Scientific Writing	M	75	3+0
BCH 412	Bio-membranes and Cell Signalling	M	75	3+0
BCH 413	Clinical Biochemistry	M	75	2+1
BCH 414	Elective I	E	75	3+0
BCH 415	Biochemistry of Antioxidants	E	75	2+1
Total			375	15

BCH 411 RESEARCH PLANNING & SCIENTIFIC WRITING (3+0)

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, analyse, 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;


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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 SIGNALLING (3+0)

Course Objective

- To reintroduce the importance of cellular membranes and their role in cell signalling
- To elaborate the components, principles and mechanisms of the cellular signalling
- To explore the role of cellular signalling 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 signalling 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 signalling, receptors, transducers, primary and second messengers; signal amplification; The plasma membrane as transducer and amplifier; G-protein coupled receptors and hormones; Cellular signalling via protein phosphorylation and kinases; TGF beta; Cytokine receptors; JAK/STAT pathways; Pathways with signal-induced protein cleavage: Notch/Delta; Signalling pathways controlled by Ubiquitination: Wnt, Hedgehog and NF- κ B; mTOR/MAPK pathways, Signalling pathways involved in cancers; Signalling during metabolic dysfunctions leading to obesity, diabetes; Down-regulation of signalling; 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., Douma, 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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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); Immunoglobulin deficiencies; Disorders of carbohydrate metabolisms and Clinical correlations: Diabetes mellitus, Fructose intolerance, Lactic acidosis, Hypoglycemia, Galactosaemia; 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, tumour 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 Haemoglobin (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

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- 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 (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 antioxidants 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

Course Code	Name of Subject	Course Type	Total Marks	Credits
BCH 421	Current Trends in Biochemistry	M	75	3+0
BCH 422	Methods in Molecular Biology	M	75	1+2
BCH 423	Antimicrobials & Chemotherapeutics	E	75	3+0
BCH 424	Elective II	E	75	3+0
BCH 499	Research Project/Thesis	M	75	0+3
Total			375	15

BCH 421 CURRENT TRENDS IN BIOCHEMISTRY (3+0)

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 (1+2)

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


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- 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+0)

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.


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54
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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+0)

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).


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PHARMACOLOGY

(3+0)

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+0)

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.


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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+0)

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


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(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+0)

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


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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).

NEUROBIOCHEMISTRY

(3+0)

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) Analyse 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)


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