SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY
PESHAWAR

APPROVED CURRICULUM FOR BS, MS AND PhD
DEPARTMENT OF BIOCHEMISTRY

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DEPARTMENT OF BIOCHEMISTRY

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DEPARTMENT OF BIOCHEMISTRY

Department Curriculum Committee

1. _____ (Dr. Bushra Ahmad Incharge, Assistant Professor)
2. _____ (Dr. Sidra Pervez (Assistant Professor)
3. _____ (Dr. Kiran Saba, (Lecturer)

Curriculum Revamp Committee

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Dr. Farhat Amin. Associate Professor
Department of Bioinformatics, SBBWU
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Ms. Sadia Nazeer (Member)
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Department of English. SBBWU

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Dr. Samra Kiran (Member)
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Ms. Mehwish Asmat Ullah (Member)
Deputy Director.
Quality Enhancement Cell, SBBWU

Ms. Tashfeen Zia (Member)
Deputy Director.
Affiliation and Monitoring, SBBWU

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Dr. Rubi Bilal (Secretary)
Controller of Examinations, SBBWU

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Dr.Safia Ahmed (T.I)
Dean Faculty of Sciences & Social Science,
SBBWU

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DEPARTMENT OF BIOCHEMISTRY

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SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

Vision and Mission Statement of University

Vision:

Shaheed Benazir Bhutto Women University aspires for excellence in learning, education, creativity, research and innovation.

Mission:

The mission of Shaheed Benazir Bhutto Women University is to contribute to the society through transformative power of education and research with a focus on diversity, linkages, entrepreneurship, creativity and innovation. We aim to prepare individuals with problem solving attitude, humanistic outlook, critical thinking and the ability to respond to socio-economic challenges.

Introduction to Department of Biochemistry

Biochemistry takes the practices of general chemistry one step further by focusing on this chemistry makeup of and reactions within, living things. By specializing the chemical nature of living systems, biochemists develop skills that have broad applications within a variety of industries. The Undergraduate programme of Biochemistry at the University is committed to the professional and personal growth of undergraduate students through the development of new scientific knowledge, critical thinking, problem–solving strategies, active learning, self-realization and participation in research discoveries. It is our mission to create a stimulating and personal growth that environment for our students. We strive to provide ample opportunities for professional and personal growth that will allow our graduates to excel in future endeavor, such as industrial work in medicine and pharmacy.

Vision Statement of Department of Biochemistry

The Department of Biochemistry envisions itself to be the leading department of KPK, by providing theoretical knowledge in physical and life sciences, with quality research & practical hands on skills to develop professionals and researchers in the fields of pharmaceutical, environmental, industrial biochemistry and medical sciences and to become a working and sustainable component of the university in teaching, research, and community services.

Mission Statement of Department of Biochemistry

- To provide quality education and learning experience for female students in the area of biochemistry through
    - the application of innovative teaching methods and emphasis on the development of critical thinking and problem-solving skills.
    - the provision of a stimulating, exciting and collaborative scientific environment.
    - To make a research atmosphere that will equip our graduates with transferable skills and an awareness of research ethics in the field of biochemistry.
    - Effective teaching, quality research, and relevant community services to develop them into well-rounded responsible individuals.
- To mold its students into competent professionals in the field of Biochemistry with provision of opportunities for career development for both students and staff.
- To contribute to the public understanding of the life-sciences and molecular medicine.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

Revised Scheme of Studies as per HEC New UEP 2023

STRUCTURE

Sr.	Categories	Credit Hours Min – Max
1.	General Education (Gen Edu) Requirements: Mandatory Courses of General Education.	30 – 30
2.	Major (Disciplinary) Requirements: Area of Study in Which the Degree is offered	*72 ≥
3.	Interdisciplinary/Allied Requirements (To Support Horizon of the Major)	**12 ≥
4.	Field Experience/Internship (Practical Work Experience related to a Student's Field of Study or Career interest)	03 – 03
5.	Capstone Project or Capstone Research Project	03 – 06
	Total	**120 – 144**

***The Credit Hours for the courses of Major Disciplines may vary but not less than 72 Credit Hours.**
****The Credit Hours for Interdisciplinary/Allied Courses may vary but not less than 12 Credit Hours.**

- Total number of Credit hours 134
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 8
- Course Load per Semester 15-18 Cr hr
- Number of courses per semester 4-6 (not more than 3 lab / practical courses)

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

SCHEME OF STUDIES OF BS -4 -YEAR PROGRAM BIOCHEMISTRY (MAJOR)

(SESSION 2023 & Onwards)

Semester	Category	Course Codes	Course Title	Lectures	Lab	Cr. Hrs
Semester 1	Art & Humanities	AH-301	Basics of Art	2	0	2
	Ideology and Constitution of Pakistan	PST-313	Ideology and Constitution of Pakistan	2	0	2
	Interdisciplinary/Allied	MB-301	Introduction to Microbiology	3	1	4
	Functional English	ENG-303	Functional English	3		3
	Major I	BCHM-302	Introductory Biochemistry	2	1	3
	Major II	BIT-303	Cell Biology	2	1	3
			Total	**14**	**3**	**17**
Semester 2	Social Sciences	MS-307	Essential of management	2	**0**	**2**
	Expository Writing	ENG-304	Expository Writing	3	0	3
	Interdisciplinary/Allied	BIT-311	Essential of Genetics	3	1	4
	Islamic Studies/Religious Studies/Ethics	ISL-301	Islamic Education/Religious Education	2	0	2
	Major III	BCHM-313	Carbohydrates & Lipids	3	1	4
	Major IV	CHM-651	Chemistry of Natural product	3	0	3
			Total	**16**	**2**	**18**
Semester 3	Quantitative Reasoning (QR I)	MTH-401	Quantitative Reasoning QR I	3	**0**	**3**
	Application of Information and Communication Technologies.	CSC-308	Application of Information and Communication Technologies	2	1	3
	Natural Science	BIT- 414	Climate Change and Human Health	3	0	3
	Entrepreneurship	MS-309	Introduction to Entrepreneurship	2	0	2
	Major V	BCHM-413	Amino acids and Proteins	2	1	3
	Major VI*	BCHM-414	Metabolism I	3	0	3
			Total	15	2	17
Semester 4	Civic and Community Engagement	PSC-418	Civic and Community Engagement	2	**0**	**2**
	Quantitative Reasoning (QR II)	MTH-402	Quantitative Reasoning QR II	3	**0**	**3**
	Major VII	BIT-413	Molecular Biology	2	1	3
	Major VIII	BCHM-417	Enzymology	2	1	3
	Major IX	BCHM-418	Human Physiology	3	0	3
	Major X	BCHM-419	Metabolism II	3	0	3

			Total	15	2	17
Semester 5	Interdisciplinary/Allied Course	BIT-301	Principles of Biotechnology	3	1	4
	Interdisciplinary/Allied Course	STAT-401	Biostatistics	3	0	3
	Major XI	BI-527	Computational Biochemistry	2	1	3
	Major XII	BCHM-513	Plant Biochemistry	3	0	3
	Major XIII	BCHM-515	Clinical Biochemistry	2	1	3
			Total	13	3	16
Semester 6	Major XIV	BCHM-517	Industrial Biochemistry	2	1	3
	Major XV	BCHM-518	Nutritional Biochemistry	2	1	3
	Major XVI	BCHM-519	Biosafety and Bioethics	2	1	3
	Major XVII	BCHM-520	Bioenergetics	3	0	3
	Major XVIII	BCHM-521	Pharmacology	3	0	3
			Total	12	3	15
Semester 7	Internship (Mandatory)	BCHM-698	Internship (Mandatory)	3	0	3
	Major XIX (Elective I)	BCHM-617	Genomics	3	0	3
	Major XX	BCHM-612	Biomembranes & Cell Signaling	3	0	3
	Major XXI	BCHM-641	Environmental Biochemistry	2	1	3
	Major XXII	BCHM-642	Biochemical techniques	1	2	3
	Capstone Research Project OR Capstone Project + Optional Course	BCHM 699/	Capstone Research Project (Mandatory) or		3	**3**
			Optional Course for those who opted for Capstone Project	3 (optional course)		
			Total	12	3	18
Semester 8	Major XXII (Elective II)	MB-503	General Immunology	3	1	3
	Major XXIII	BCHM-643	Methods in Molecular Biology	1	2	3
	Major XXIV	BCHM-616	Cancer Biology	3	0	3
	Major XXV	BCHM-620	Cell and tissue culture	3	0	3
	Capstone Research Project OR Capstone Project + Optional Course	BCHM 699/	Capstone Research Project		3	3
			Optional Course for those who opted for Capstone Project	3 (optional course)		
			Total	13	**3**	**16**

DETAIL OF ELECTIVE COURSES

LIST OF ELECTIVE COURSES

LIST OF OPTIONAL SUBJECTS

COURSE TITLE	CREDIT HOURS	COURSE CODE
Vitamins and hormones	3	BCHM-613
Current Trends in Biochemistry	3	BCHM-615
Cancer Biology	3	BCHM-616
Genomics	3	BCHM-617
Proteomics	3	BCHM-618
General Virology	3	BCHM-619
Cell and tissue culture	3	BCHM-620
Pharmacology	3	BCHM-621
Antimicrobials and Chemotherapeutics	3	BCHM-622
Functional Genomics	3	BCHM-623
Structural Biology	3	BCHM-624
Drug Development	3	BCHM-625
Fermentation Biotechnology	3	BCHM-626
Neurochemistry	3	BCHM-627
Toxicology	3	BCHM-628
General Immunology	4	MB-503

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – I

Course Title: Basics of Art	**Course Code: AD- 305**
Course Structure: Lectures: 1, Labs: 1	**Credit Hours:** 2(1,1)
Prerequisites: None	
Course Objective: • It is a manual course where art material techniques and its application and its forms will be taught This knowledge is imperative for an art and design student to gain technical know-howfor working in various art medium. • Students will further recognize and evaluate basic elements of design and Principal of design.Famous artists will be taught to the students for better visualization of paintings and art work.	
Course Outline: Introduction to Elements of Art, Line, Shape & Volume and Form types and itsuses, Value and Color, Space & Texture, Principles of Art, Balance & Contrast, Emphasis & Movement, Pattern & Rhythm, Unity/Variety , Mediums and Artists,,Graphit Pencil, Charcoal ,Pastels, Watercolors ,Oil Painting ,Acrylics, Pen and Ink.	
Recommended Books: • Aspects of Art An Essential Textbook for Students of Art in Pakistan By Marjorie Husain • Illustrated Elements of Art and Principles of Design. by Consultant: Gerald F. Brommer Art Is Fundamental: Teaching the Elements and Principles of Art in Elementary School by Eileen S. Prince	

Course Title: Islamic Studies	Course Code: ISl-301
Course Structure: Lectures	**Credit Hours: 2**
Prerequisites: None	

Description This course is designed to provide students with a comprehensive overview of the fundamental aspect of Islam, its beliefs practices History and influence on society. It will further familiarize the students with a solid foundation in understanding Islam from an academic and cultural perspective. Through this course students will have and enhanced understating of Islam's multifaceted dimensions which will enable them to navigate complex discussions about Islam's Historical and contemporary role fostering empathy respect and informed dialogue.

Course outcomes : By the end of this course, Students will be able to :

1. Demonstrate enhanced knowledge of Islamic foundational beliefs, practices historical developmentspiritual values and ethical principles
2. Describe basic source of Islamic law and their application in daily life
3. Identify and discuss contemporary issue being faced by the Muslims world including social challenges, gender role and interfaith interactions.

Course outline: Introduction to Islam: Definition of Islam and its core beliefs The Holy Qura'n (Introduction, Revelation and compilation, Hadith and Sunnah (Compilation Classificationand Significance) Key theological concepts and themes (Tawhid , Prophet hood Akhiraha etc, **Seerat of Holy Prophet (S.A.W)** Life and legacy of the Holy prophet **(S.A.W** Diverse role of the Holy Prophet (as and individual, educator, peace maker, leader etc**), Islamic History and civilization** World Before Islam Rashidun Caliphate and expansion of Islamic rule, Contribution of Muslim scientists and philosophers in shaping world civilization,

Islamic Jurisprudence: (Fiqh) Fundamental Sources of Islamic Jurisprudence Pillars of Islam and their significance Major Schools of Islamic Jurisprudence **,** Significance and principles of Ijtihad, **Family and Society in Islam** Status and rights of woman in Islamic Teachings, Marriage,Family, and gender roles in Muslim society, Family structure and values Muslim society, **I**slam &the Modern World.

Suggested Instructional Materials

1. The five Pillars of Islam: A journey thought the Divene Acts of Worship by Muhammad Mustafa Al Azami
2. The Five Pillars of Islam: A Framework for Islamic Values and Character Building by Musharraif Hussain
3. Towards Understanding Islam By Abul A' la Mawdudi
4. Islami Nazria e Hayat by Khurshid Ahmad
5. An Introduction to Islamic theology by John Rearard
6. Islamic Civilization Foundations Belief and Principles by Abul A la Mawdudi
7. Women and Social Justices An Islamic Paradigm by Dr Anis Ahmad
8. Islam its Meaning and Message " By Khushid Ahmad

Course Title: Introduction to Microbiology	**Course Code:** MB-301
Course Structure: Lectures 3, Lab: 1	**Credit Hours:** 4(3+1)
Prerequisites: None	

COURSE OBJECTIVES:

1. To introduce students with Microorganism, scope of Microbiology and its applications in different fields.
2. To learn about the growth requirements of Microorganisms.
3. To introduce the techniques of isolation and preservation of Microorganisms.
4. To know about the techniques used to control the growth of microorganisms.

COURSE CONTENT:

Introduction to microbiology. Microorganisms and their respective place in the living world. Historical development of Microbiology and its scope. Microscopy: An outline of the principles and applications of light and electron microscope. Differentiation between pro- and eukaryotic cells. Morphology, arrangement and detailed anatomy of bacterial cell. Bacterial taxonomy and nomenclature, basis of classification of bacteria. Growth, nutrition (physical and nutritional requirement and nutritional types; sources of energy, C, N, H, O, S, P, H_2O, trace elements, growth factors). Asexual and sexual reproduction of microorganisms. General methods of studying microorganisms: Cultivation, isolation, purification, characterization and preservation. Control of microorganisms by physical and chemical methods. Chemotherapeutic agents and antibiotics. Modes of action of antibiotics on microorganisms. Basic properties of virus, fungi, protozoa and algae.

PRACTICAL

1. Laboratory safety: Containment and decontamination.
2. Preparation and sterilization of bacteriological media and glassware.
3. Inoculation techniques. Study of colony characteristics of microorganisms.
4. Standard plate count technique (SPC) and colony morphology (Colour, shape and size)

Principles of Staining Procedures & Microscopy: Simple staining, Gram's staining, Acid-fast staining, cell-wall staining, flagellar staining, capsule staining, spore staining and spirochaete staining.

6. Study of cell motility by hanging drop preparation.

Recommended Books

1. Pearson, R.D., Gillespie, S.H., 2009. Principles and Practice of Clinical Parasitology.1st Edition .Wiley, John & Sons.
2. Sun, T., 2012. Progress in Clinical Parasitology. Springer-Verlag New York, LLC
3. Zeibig, E., 2012. Clinical Parasitology: A Practical Approach. 2nd edition. Elsevier Health Sciences.

Course Title: Functional English	**Course Code:** ENG-303
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3

Prerequisites: None

Course Objective:

This course will familiarize students with the essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language and usage: wordchoices, grammar and sentence structure. In addition, the course will enable students to grasp subtle messages and tailor their communication effectively through the application of comprehension and analytical skills in listening and reading. Moreover, the course encompasses a range of practical communication aspects including professional writing, public speaking and everyday conversation ensuring that students are equipped for both academic and professional spheres.

Course Outline: 1. Foundations of Functional English Vocabulary Building (contextual usage, synonyms, antonyms, and idiomatic expressions) Communicative Grammar (subject-verb agreement,
verb tenses, fragments, run-ons, modifiers, articles, word classes etc) Word Formation (affixation, compounding, clipping, back formation etc) Sentence Structure (simple, compound, complex and compound-complex). **Comprehension and Analysis.3.** Understanding Purpose, audience and context a.(reading for meaning, descriptive texts versus narrative texts , argumentative texts versus persuasive texts) 3. Contextual Interpretation (tones, biases, stereotypes, assumptions, inferences etc) 4. Reading Strategies (skimming, scanning, SQ4R, critical reading) 5. Active Listening (overcoming listening barriers, focused listening). **Effective Communication** Principles of Communication(clarity, coherence, correctness and courteousness). Structuring Documents (introduction, body, conclusion and formatting). Inclusivity in Communication (gender-neutral language and cross-cultural communication). Public Speaking (Speech/presentation: extemporaneous and prepared, public announcements and overcoming stage fright) Presentation Skills: a. (the elements of an effective presentation, using visual displays to present key facts, figures, charts, and graphs , steps to preparing an effective presentation, one-minute presentations and evaluate presentations, Informal Communication (small talk and networking),
Professional Writing (business e-mails, memos, reports, formal letters etc).

Course Outcomes: By the end of the course the students will be able to apply the enhanced English skills, comprehend a variety of literary and non-literary texts, and express effectively in spoken and written English in diverse social and cultural contexts.

Recommended Books: Latest Edition of Following Books

1. Murphy, Raymond. Grammar in Use Intermediate Student's Book without Answers. CambridgeUniversity Press, 2018.
2. Kaufman, Lester, and Jane Straus. The Blue Book of Grammar and Punctuation. 2021.
3. Axelrod, Rise B., and Charles R. Cooper. The St. Martin's Guide to Writing [with Access Code]. 2016.
4. Johnson-Sheehan, Richard, and Charles Paine. Writing Today. Pearson, 2019.

5. https://www.hec.gov.pk/english/services/universities/RevisedCurricula/Documents/2011-2012/Education/English2_Sept13.pdf

Course Name: Introductory Biochemistry	**Course Code:** BCHM-302
Course Structure: Lectures: 2, Labs: 1	**Credit Hours:** 3(2+1)

Prerequisites: None

Course Objective: The course aims to

- Course Objectives:
- This course aims to provide students with fundamental knowledge of the
- molecules of life, as well as their function in the context of a living cell.

Course Outline:

Introduction to biochemistry; water, Ph, buffers, and biochemical composition of cells; carbohydrates – structure and classification; proteins – overview with emphasis on their composition and structure, classification and function; lipids – structure, classification and biological significance; enzymes – properties, nomenclature, classification, and factors affecting enzyme activity including inhibitors and potentiators, basic kinetics, derivation of Km and Vmax; coenzymes and vitamins; nucleic acids – structure and function.

Practical:

Preparation of laboratory solutions and Ph determination; qualitative and quantitative tests for carbohydrates, proteins and lipids; enzyme assays and the effect of Ph, temperature and substrate concentration on enzyme activity.

Course Outcomes: At the end of this course students will be able to identify and classify the various biomolecules. They will have deep understanding of the function of biomolecules.

Recommended Books: Latest Edition of Following Books

1. Murphy, M., Srivastava, R., & Deans, K. (2023). *Clinical Biochemistry-E-Book: An Illustrated Colour Text*. Elsevier Health Sciences.
2. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. (2022). *Cell biology E-book*. Elsevier Health Sciences.
3. Satyanarayana, U., & Chakrapani, U. (2020). Biochemistry, (Updated and Revised Edition)-E-Book. Elsevier India.
4. Shanmugam, S., Kumar, T. S., & Panneer Selvam, K. (2019). Laboratory handbook on biochemistry. PHI Learning Pvt. Ltd.
5. Lehninger principle of biochemistry by David L.Nelson and Michael M.Cox, 7th latest edition,ISBN-10:1-4641-2611-9.
6. Biochemistry by Jeremy M. Berg , John L. Tymoczko; Lubert Stryer ,ISBN10:1429229365,ISBN-13:97814229229364, Berg, J. M.,Tymoczko,J. L., Lubert Stryer. 2010. Biochemistry. 7th Ed.
7. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D, Darnell, J. 2012. Molecular Cell Biology.

8. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan Worth Publishers, New York.

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DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – II

Course Title: Essential of Management	**Course Code:** MS-307
Course structure: Lectures: 2, Lab 0	**Credit Hours:**2
Prerequisites: None	

COURSE OBJECTIVES:

- The course aims to provide students with the basic managerial knowledge necessary for Business student. Upon successful completion of this course, students will be able to:
- Demonstrate theoretical knowledge in management course. Gain practical skills and personal attributes and competencies that is required for managerial position.
- Describe the four management functions of planning, organizing, leading, and controlling.Outline the historical evolution of management theories.
- Explain how decisions are made within an organization and how those decisions are communicated to the various stakeholders and can Relate the basic concepts of planning: theimportance of planning, strategic planning, and the types of objectives and plans developed by organizations.
- Describe the control process including: the importance of control, tools for measuring organizational performance, and managerial actions and Understand analytical, developmental, managerial and technical skills relate to Managing organizations

Course Name: Cell Biology	**Course Code: BIT-303**
Course Structure: Lectures: 2, Labs: 1	**Credit Hours: 2+1**
Prerequisites:	
Course Objective: This course provides the basic concepts of life science, 1. With emphasis on the diversity of life, the physical and chemical nature of living matter, and the form and function of cells and organisms. 2. Introduce students to the internal organization of the prokaryotic and eukaryotic cell, organelle and membrane function, cell-cell signaling, cell movement, cell adhesion, and the extracellular matrix.	
Course Outline: Introduction to cell biology, Form and function of the cell, Types of cells, The Chemical Basis of Life, the chemistry of cell, Cells and organelles overview, The Structure, function, and molecular organization of cellular organelles, Roles of different macromolecules, Enzymes Molecular organization of cells Protoplasm, Cell wall, Cell membrane, transport across membranes, organelles: mitochondria, endoplasmic reticulum, Golgi bodies, plastids, lysosomes, peroxisomes, The Structure and Function of the Plasma Membrane, Cytoplasmic Membrane Systems, cell internal structure, cytoskeleton, microtubules, microfilaments, intermediate filaments, structure of chromosomes, Photosynthesis, Components of Photosynthesis, cell division and cell cycle. The key roles of mitosis and meiosis during the life cycle. Compare and contrast different life cycle strategies, focusing on the human life cycle 13 Stages of mitosis and meiosis, Highlighting similarities and differences. Stages of the cell cycle Apoptosis, cell signaling, Cell visualization techniques. **Practicals:** Microscopy and staining techniques; study of prokaryotic, eukaryotic, plant and animal cells; cell structure in the staminal hair of Tradescantia; study of different types of plastids; cellular reproduction; Mitosis: smear/squash preparation of onion roots.	
Course Outcomes: Upon successful completion of the course, the student will be able to: 1. Acquire the basic concepts of cell biology. 2. Understand the metabolic processes of cells in terms of cellular organelles, membranes, and biological molecules. 3. Ability to understand the role of macromolecules regulating cellular processes. 4. Formulate the critical thinking skills and knowledge on cell.	
Recommended Books: 1. Alberts B and Johnson A, 2006. Molecular Biology of the Cell. 4th Edition; Garland Publishers, New York. (available at www.ncbi.nlm.nih.gov) 2. Karp, 2002. Cell and Molecular Biology. 3rd Edition; John Wiley and Sons, New York. 3. Bruce Alberts, Rebecca Heald, Alexander Johnson, Molecular Biology of the Cell 7th Edition, 2022. W.W. Norton and Company. 4. Alberts et al., 2009. Essential Cell Biology. 3rd Edition; Garland Publishers, New York. 5. Thomas D. Pollard, MD, William C. Earnshaw, PhD, FRS, Jennifer Lippincott-Schwartz, PhD and Graham Johnson, Cell Biology, 4th Edition (2023) ISBN : 9780323758000 6. Lodish et al,. 2007. Molecular Cell Biology. 6th Edition; Freeman and Company, New York. (available at www.ncbi.nlm.nih.gov) 7. Harvey Lodish, Arnold Berk, Chris A. Kaiser- 2016 8th Edition Molecular cell biology	

8. Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz 2007 2nd Edition Cell biology
9. S C Rastogi 2005 3rd Edition, Cell biology. Newage international Publishers.India.

Course Outline: Introduction to Management-What is an Organization, The ManagementProcess, Kinds of managers. Basic managerial roles and skills. **History and Evolution of Management-** The Organization Environment, a. Internal Environment & External Environment. **Planning and Decision Making** -Decision making and planning process- Organizational Goals and their kinds, Organizational plans and their kinds a. Strategic, Tactical Plans &. Operational Plans. **Strategic Management-** Strategic Management Process, Strategy Formulation, Strategy Implementation Strategy Evaluation Organizing. **Organization Structure-**a. Tall Vs Flat, Narrow Vs Wide, c. Centralized Vs Decentralized, Strategy and Organization Design,. Corporate Level Strategy. Business Level Strategy & Organizational Functions. **Motivation and its theories-** Content Perspective of Motivation Maslow Hierarchy of Needs theory, ERG theory, Two Factor Theory, Process Perspective of Motivation Expectancy Theory, Equity Theory, Groups and Teams in Organization, Types of Groups and Teams group and Team Development Process.**Leadership and Power-** Leadership Styles.**Control-**Types, level & Process of control.

Course Outcomes:

- Apply management theories to solve complex real-world business challenges and can Demonstrate effective leadership and interpersonal skills essential for managerial roles.
- Can be able to explain the historical evolution of management theories and theircontemporary relevance.
- Demonstrate competence in decision-making and effective communication within organizations.
- Analyze and implement strategic planning and diverse organizational structures.
- Utilize control processes and performance measurement tools to enhance organizational efficiency.

Recommended Books:

- Ricky W. Griffin (2015). Introduction to Management. 8th Edition. Cengage Learning 20 Channel Center Street Boston, USA
- John R. Schermerhorn. (2015). Introduction to Management by John Wiley & Sons;13th Edition International Student Version (April 14, 2015).
- Drucker, P. F. (2008). Management: Tasks, responsibilities, practices. HarperCollins.
- Kotter, J. P. (1996). Leading change. Harvard Business Review Press.
- Covey, S. R. (1989). The 7 habits of highly effective people. Free Press.

Collins, J. C. (2001). Good to great: Why some companies make the leap... and othersdon't. Harper Business.

Course Title: Expository Writing	**Course Code:** ENG-304
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3
Prerequisites: None	
Course Objective: This is a sequential undergraduate course aimed at refining basic writing skills invarious contexts. Building upon its pre-requisite, Functional English Course, this course will enhancestudent's ability to produce clear, concise and coherent texts in English. This course will enable the students to produce well-structured essays and to refine their analytical skills.	
Course Outline: **1. Introduction to Expository Writing** Definition, Types, Characteristics (clarity, coherence &organization) **2. The Writing Process** Pre-writing Techniques (brainstorming, free-writing, mind- mapping, outlining), Drafting, Revising and Editing, Proof reading, Peer review and Feedback **3. Essay organization and Structure** Introduction, Thesis statement, Body paragraphs, Conclusion, Cohesion & Coherence **4. Different Types of Expository Writing** Description, Illustration, Classification, Cause and Effect, Process analysis, Comparative analysis 9. Writing for Different Purposes and Audiences Types of purposes (to inform, to analyze, to persuade, to entertain etc), Writing for Academic Audiences, Writing for Public Audiences, Different tones and styles Ethical Considerations Plagiarism and Originality, Citation and Referencing	
Course Outcomes: By the end of the course, the students will be able to; 1. Understand the essentials of the writing process (pre-writing, drafting, editing, proof reading etc) 2. Demonstrate mastery of diverse expository types 3. Uphold ethical practices to maintain originality in expository writing	
Recommended Books: Latest Edition of Following Books. 1. Axelrod, Rise B. and Charles Raymond Cooper. The Concise St. Martin's Guide to Writing. Bedford/ St. Martins, 2015. 2. Johnson-Sheehan, Richard, and Charles Paine. Writing Today. Pearson, 2019. Murphy, Raymond. Grammar in Use Intermediate Student's Book without Answers. Cambridge University Press, 2018.	

Course Name: Essential of Genetics	**Course Code:** BIT-311
Course Structure: Lectures:3 Practical: 1	**Credit Hours:** 4 (3+1)
Prerequisites: Biochemistry I	
Course Objective: This course provides the basic principles of inheritance. Students will gain experience in variety of molecular techniques used in gene analysis. 2. Course will help develop tools aid in the comparison of genetic and genomic data and more generally in the understanding of evolutionary aspects of molecular biology	
Course Outline: Genetics introduction, Patterns and principles of inheritance, Mendelian inheritance, modifications in Mendelian genetics, sex determination and sex-linked inheritance. Genetic linkage and gene mapping. Maternal inheritance and organelles. Physical structure of genes, chromosomes structure and aberrations, tetrad analysis, Probability and pedigrees analysis, transgenes. Polygenic inheritance, Mechanisms of Evolution, Population genetics, epigenetics and genetic variation, Hardy-Weinberg principle.	
Lab outlines Determine ABO blood typing. Problems solving related to Mendelian inheritance. Problems solving in ABO blood typing in Humans Problems solving in pedigree analysis	
Course outcomes: 1. This genetics course provides a comprehensive foundation in fundamental genetic principles, from Mendelian inheritance patterns to modifications and exceptions. 2. Students will delve into advanced topics such as genetic linkage, gene mapping, and maternal inheritance, gaining insights into chromosomal structures, aberrations, and tetrad analysis. 3. The course covers applied aspects, including probability and pedigrees analysis, transgenes, and polygenic inheritance, preparing students to analyze complex genetic traits.	
Recommended Books: 1.Essentials of Genetics 10th Edition by William Klug , Michael Cummings, Charlotte Spencer, Michael Palladino, Darrell Killian. 2019, Publisher: Pearson, ISBN-13: 978-0134898414 2. Gardner, “Principles of Genetics”, John Wiley and Sons. 3. Griffith et al., “An Introduction to Genetics analysis”, W. H. Freeman. 11 Edition edition (January 12, 2015) 4.James M. and David V. 1997. The Book of Genetics. 2nd Ed.Ser. ELDs Pub. 5.Tortora et al. 2001. Microbiology an introduction. 7 Ed. Benjanium Lumming.	

Course Title: Ideology and Constitution of Pakistan	**Course Code:** PST-313
Course Structure: Lectures: 2	**Credit Hours:** 2

Prerequisites:

Course Objective: This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistani citizens to enable them to function in a socially responsible manner.

Course Outline: 1. Introduction to the Ideology of Pakistan: Definition and significance of ideology. Historical context of the creation of Pakistan(with emphasis on socio-political. religious, and cultural dynamics of British India between 1857 till 1947). Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah etc. Contributions of women and students in the freedom movement for separate homeland for Muslims of British India. **2. Two-Nation Theory:** Evolution of the Two-Nation Theor(Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906,Allama lqbal's Presidential Address 1930,Congress Ministries 1937, Lahore Resolution 1940). Role of communalism and religious differences. **3. Introduction to the Constitution of Pakistan**. Definition and importance of a constitution. ldeological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949). Overview of constitutional developments in Pakistan. **4. Constitution and State Structure:** Structure of Ciovernment (executive, legislature, and judiciary). Distribution of powers between federal and provincial governments. 18th Amendment and its impact on federalism.**5. Fundamental Rights, Principles of Policy and Responsibilities:** Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28). Overview of Principles of Policy (Articles29-40). Responsibilities of the Pakistani citizens (Article 5). **6. Constitutional Amendments:** Procedures for amending the Constitution. Notable constitutional amendments and their implications.

Course Outcomes: By the end of this course, students will be able to:

1. Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding fathers of Pakistan.
2. Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.

Explain about the guiding principles on rights and responsibilities of Pakistani citizens asenshrined in the Constitution of Pakistan 1973.

Recommended Books: Latest Edition of the Following Books.

1. "The ldea of Pakistan" by Stephen P.Cohen.
2. "ldeology of Pakistan" by Javed lqbal.
3. “The Struggle for Pakistan”by l.H.Qureshi.
4. "Pakistan the Fornmative Phase"by Khalid Bin Sayeed.
5. "Pakistan:Political Rots and Development"”by Safdar Mahmood.

6. "ldeology of Pakistan'"by Sharif-ul-Mujahid.
7. "The Struggle for Pakistan:A Muslim Homeland and Global Politics" by Ayesha Jalal.
8. "Jinnah,Pakistan and Islamic Identity:The Search for Saladin" by Akbar S.Ahmed.
9. "The Making of Pakistan:A Study in Nationalism" by K.K.Aziz.
10. "Pakistan:A New History" by lan Talbot.
11. "Pakistan in the Twentieth Century:A Political History" by Lawrence Ziring.
12. "The Constitution of Pakistan 1973".Original.
13. "Constitutional and Political Development of Pakistan"by Hamid Khan.
14. "The Parliament of Pakistan" by Mahboob Hussain.
15. "Constitutional Development in Pakistan" by G.W.Choudhury.

"Constitution-Making in Pakistan:The Dynamics of Political Order" by G.W.Choudhury.

Course Name: Carbohydrates and Lipids	**Course Code:** BCHM-313
Course structure: Lectures: 3, Lab: 1	**Credit Hours:** 4 (3+1)
Prerequisites: None	

COURSE OBJECTIVES:

To understand the principles and concepts concerning the chemical, physical, and biological properties of carbohydrates and lipid in biological processes including signal transduction.

COURSE OUTLINE:

Introduction and historical background; occurrence, distribution in biosphere, and importance in life processes; structure, nomenclature and classification; general properties, synthesis and breakdown of monosaccharides, oligosaccharides and polysaccharides. Chemical reactions of some physiologically important monosaccharide and disaccharides.
Lipids: Structure, classification and their biological role.
Fatty acids: Structure, classification, nomenclature and properties of fatty acids. Prostaglandins, thromboxanes and leukotrienes. Triacylglycerols:
Nomenclature, physical and chemical properties including hydrolysis, saponification value, rancidity, acid value, iodine value and Reichert – Meissl number. Reactions of glycerol. Waxes, Phospholipids: Glycerophospholipids, Sphinogomyelins and glycolipids; their properties and functions. Steroids: Structure, classification, nomenclature and their biological role.
Cholesterol, structure and importance, HDL, LDL, VLDL,

PRACTICAL:

- Qualitative Analysis of known carbohydrates (e.g., Glucose, galactose, fructose, maltose, lactose, sucrose, starch glycogen and cellulose).
- Qualitative Analysis of carbohydrates of given unknown samples
- Extraction of starch from plant sources and its confirmative tests (e.g., Potato, Wheat, Rice, Pulses, Barely, Maize etc.).

- Extraction of Glycogen from animal sources (e.g., liver, muscle, etc.) & its confirmative tests.
- Qualitative tests for lipids and fatty acids;
- Extraction of lipids from animal and plant sources.

RECOMMENDED BOOKS:

1. Holesh, J. E., Aslam, S., & Martin, A. (2023). Physiology, carbohydrates. In StatPearls [Internet]. StatPearls Publishing.
2. Cooper, C. (2021). Fat activism: A radical social movement. Intellect.
3. Benardot, D. (2020). Advanced sports nutrition. Human Kinetics Publishers.
4. Mougios, V. (2019). Exercise biochemistry. Human Kinetics Publishers.
5. Harpers Illustrated Biochemistry. (2012). 29th Ed. By Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil. McGraw-Hill Medical.
6. Biochemistry. 7th Ed. By Jeremy M. Berg, John L. Tymoczko and Lubert Stryer. Publisher: Palgrave MacMillan; 7th revised international ed edition (April 1, 2011).
7. Lehninger Principles of Biochemistry. (2012) 6th Ed. By David L. Nelson, Michael M. Cox . W.H. Freeman; 6th Edition (November 21,2012).

Course Title: Chemistry of Natural Products	**Course Code:** CHM-651
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	

Course Objective:

1. Comprehend the principles underlying the biosynthesis, isolation, and structural elucidation of various classes of natural products such as fatty acids, flavonoids, terpenoids, steroids, and alkaloids.
2. Explore classical and modern synthesis techniques employed in creating natural products, gaining proficiency in analyzing and recreating these compounds through synthetic pathways.

Course Outline:

Introduction: Primary and secondary metabolites; Importance of natural products; Classification and biosynthesis of natural products including fatty acids, flavonoids, terpenoids, steroids, and alkaloids. **Isolation**: General isolation scheme of natural products; Specific isolation strategies for fatty acids, flavonoids, terpenoids, steroids, and alkaloids. **Structure elucidation**: Classical and modern techniques for structure elucidation of natural products. **Synthesis of Natural Products**: Examples of the classical and modern synthesis of natural products for fatty acids, flavonoids, terpenoids, steroids and alkaloids.

Course Outcomes:

1. Acquire in-depth knowledge of the classification, biosynthesis, and isolation strategies specific to fatty acids, flavonoids, terpenoids, steroids, and alkaloids, discerning their significance in natural product chemistry.

2. Develop proficiency in utilizing classical and modern techniques for structure elucidation of natural products, applying spectroscopic methods and analytical tools to deduce molecular structures accurately. 3. Demonstrate competence in synthesizing natural products by implementing both classical and contemporary synthetic methodologies, applying learned principles to construct these compounds for specific applications or research purposes.
Recommended Books: 1. Ishikawa, H. Takayama, H. *New Tide of Natural Product Chemistry*, Springer, 2023. 2. Volova, T. G. Mahapatra, D. K. Khanna S. Haghi, A. K. *Natural Products Chemistry: Biomedical and Pharmaceutical Phytochemistry*, 1st ed., Apple Academic Press, 2020. 3. Nicolau, K. C. Chen, J. S. *Classics in Total Synthesis III*, VCH, Weinheim, 2011. 4. Clayden, J. Greeves, N. Warren S. Worthers, P. Organic Chemistry, Oxford University, 2001. 5. Ahluwalia, V. K. Kumar, L. S. Kumar, S. *Chemistry of Natural Products*, Ane Books India, 2006.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – III

Course Title: Quantitative Reasoning-I	**Course Code:** MTH-401
Course Structure: Lectures: 3	**Credit Hours:** 3
Prerequisites:	

Course Objectives

- Quantitative reasoning (I) as in introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concept and analysis.
- The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' ability to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises
- This course will also enable students cultivate their quantitative literacy and problem-solving skills while effectively expending their academic horizon and breadth of knowledge of their specific major/field of study.

Course Outline: 1. Numerical Literacy : Number system and basic arithmetic operation; Units and their conversion, dimension, area, parameter, and volume;Rates, ratio, proportion, and percentage; Types and sources of data; Measurement scales; Table and graphical presentation of data; Quantitative reasoning exercises using number knowledge; **2.Fundamental Mathematical Concept:** Basic of geometry (lines, angles, circles, polygons etc); Sets and their operations; Relations, functions, and their graphs;Exponent, factoring and simplifying algebraic expression; Algebraic and graphical solutions of linear and quadratic equations and inequalities;Quantitative reasoning exercises using fundamental mathematical concepts; **3. Fundamental Statistical Concepts:**Population and sample; Measure of central tendency, dispersion and data interpretation; Rules of counting (multiplicative, permutation, and combination);Basic probability theory; Introduction to random variables and their probability distribution;Quantitative reasoning exercises using fundamental statistical concept;

Course Outcomes: By the end of this course, student shall have:

- Fundamental numerical literacy to enable them work with numbers understand their meaning andpresent data accurately;
- Understanding of fundamental mathematical and statistical concept;

Basic ability to interpret data presented and various format including but not limited to tables, graphs, charts, and equations etc.

Recommended Books:

1. "Quantitative Reasoning: Tools for Todays Informs Citizen" by Bernard L. Madison. Lynn and Arthur Steen
2. "Quantitative Reasoning for the Information Age" by Bernard L. Madison. And David M. Bressoud.
3. "Fundamental of Mathematics" by Wade Ellis.
4. "Quantitative Reasoning: Thinking and Numbers" by Eric Zaslow.
5. "Thinking Clearly with Data: A Guide to Quantitative Reasoning and Analysis" by Ethan Bueno De Mesquita and Anthony Fowler.
6. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
7. "Decreet Mathematics and Its Application" by Kenneth H. Rosen.
8. "Statistics for Technologies: A Course in Applied Statistics" by Chatfield, C.

"Statistics: Unlocking the Power of Data" by Robin H. Lock, Patti Farzer Lock, Kari Lock,Morgan and Eric F. Lock.

Course Title: Applications of Information and Communication Technologies	**Course Code: CSC-308**
Course Structure: Lectures: 2 Lab:1	**Credit Hours: 3**

Prerequisites: None

Course Objective:

- This course is designed to provide students with an exploration of the practical applications of Information and Communication Technologies (ICT) and software tools in various domains.
- Students will gain hands-on experience with a range of software applications, learning how to leverage ICT to solve daily life problems, enhance productivity and innovate in different fields.
- Through individual and interactive exercises and discussions, students will develop proficiency in utilizing software for communication, creativity, and more.

Course Outline:

Introduction to Information and Communication Technologies: Components of Information and Communication Technologies (basics of hardware, software, ICT platforms, networks, local and cloud data storage etc.). Scope of Information and Communication Technologies (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.). Emerging technologies and future trends. **Basic ICT Productivity Tools:** Effective use of popular search engines (e.g., Google, Bing, etc.) to explore World Wide Web. Formal communication tools and etiquette (Gmail, Microsoft Outlook, etc.). Microsoft Office Suites (Word, Excel, PowerPoint).Google Workspace (Google Docs, Sheets, Slides).Dropbox (Cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft Office integration). Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas). Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.). Social Media applications (Linkedln, Facebook, Instagram, etc.). **ICT in Education:** Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.).Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.).Interactive multimedia and virtual classrooms. **ICT in Health and Well-being:** Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkccpcr, etc.).Telemedicine and online health consultations (OLADOC, Sehat Kahani, Marham, etc.).**ICT in Personal Finance and Shopping:** Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, Il LINK and MNET, Keenu Wallet, etc.).E-commerce platforms (Daraz.pk, Telcnoart, Shophivc, etc.)Digital Citizenship and Online Etiquette. Digital identity and online reputation. Netiquette and respectful online communication. Cyberbullying and online harassment. **Ethical Considerations in Use of ICT Platforms and Tools:** Intellectual property and copyright issues. Ensuring originality in content creation by avoiding plagiarism and unauthorized use of in fornication sources. Content accuracy and integrity (ensuring that the content shared through ICT platforms is free from misinformation, fake news, and manipulation).

Practical Requirements

As part of the overall learning requirements, the course will include guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as worcl processing software (e.g., Microsoft Word), presentation software (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools. Students may be assigned practical tasks that require them to create documents, presentations, and spreadsheets etc. Assigning tasks that involve creating, managing, and organizing files and folders on both local and cloud storage systems. Students will practice file naming conventions, creating directories, and using cloud storage solutions (e.g., Google Drive, OneDrive). The use of online learning management systems (LMS) where students can access course materials, submit assignments, participate in discussion forums, and take quizzes or tests. This will provide students with the practical experience with online platforms commonly used in education and the workplace.

Course Outcomes:

- By the end of this course, students will be able to Explain the fundamental concepts, components, and scope of Information and Communication Technologies (ICT).
- Identify uses of various ICT platforms and tools for different purposes.
- Apply ICT platforms and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.

Understand the ethical and legal considerations in use of ICT platforms and tools.

Recommended Books: Latest Edition of the Following Books.

1. Morley and Parker Computing Essentials, 2023, McGraw Hill.
2. Evans, Martin, and Poatsy. Technology in Action,2021, Pearson.Vermaat, Shaffer, and Freund, Discovering Computers, 2017, Cengage Learning.
3. Grauer and Poatsy. Exploring Microsoft Office,2016, Pearson.
4. Series by Gaskin, Vargas, and McLellan, GO! with Microsoft Office,2013, Pearson.

Course Title: Climate Change and Human Health	**Course Code:** BIT-414
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3
Prerequisites: None	
Course Objective: The course "Impact of Climate Change on Human Health" provides a comprehensive exploration of the complex relationship between climate change and its impacts on human well-being. It covers various aspects of climate change, its drivers, and the direct and indirect ways it affects human health.	
Course Outline: Introduction to Climate Change, Causes and Impact of Rapid Climate Change, Climate Change and Public Health, Extreme Weather, Extreme Temperature and Human Health, Climate Change and Air Quality, Vector-Borne Diseases and Changing Patterns, water born diseases and changing pattern, mental health and climate change, Water security and Climate Change, Measures Against Climate Change, Adaptation and Mitigation Strategies, Case Studies and Group Discussions, Communication and Advocacy.	
Course Outcomes:	
Recommended Books: Latest Editions of the Following Books. 1. Butler, C. D. (2018). Climate change and global health. CABI. 2. McMichael, A. J., & Lindgren, E. (Eds.). (2011). Climate change and human health: Risks and responses. World Health Organization. 3. Patz, J. A., Gibbs, H. K., & Olson, S. H. (2008). Climate change and global health: Quantifying a growing ethical crisis. EcoHealth, 5(4), 397-405.	

Course Title: Introduction to Entrepreneurship	**Course Code:** MS-309
Course Structure: Lectures:	**Credit Hours:** 2
Prerequisites:	
Course Objective: This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge, skills, abilities, enabling them to seize theidentified opportunities for initiating ventures and successful navigating the challenges that come withstarting a business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation of business, market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation.	

Course Outline:

Introduction to Entrepreneurship, Entrepreneurial Skills, . Opportunity Recognition and Idea Generation, Opportunity identification, evaluation and exploitation, Innovative idea generation techniques for entrepreneurial ventures, Marketing and Sales, Financial Literacy, Team Building for Startups & Regulatory Requirements to Establish Enterprises in Pakistan.

Course Outcomes: Upon successful completion of the course participants will:

- Have a basic understanding of the Islamic World and Muslim beliefs.
- Know the origins of the Islamic Banking and Finance.
- Appreciate the rationale behind the development of the Islamic finance industry.
- Be able to assess the nature and scope of the Islamic finance industry in relation to its conventional counterpart.
- Develop an appropriate level of understanding of the main principles of Islamic banking and finance.
- Acquire essential knowledge about the key Islamic financial contracts, as used by the industry.
- Know about Murabaha and Musharaka contracts, Ijara and Istisna'a financing methods, as well as Salam and Takaful insurance.
- Be familiarized with the Islamic financial infrastructure, international financial institutions, and regulatory bodies.

Recommended Books:

1. Barringer, B. R., & Ireland, R. D. (2012). Entrepreneurship: Successfully Launching New Ventures. Pearson.
2. Kuratko, Donald F. (2017). Entrepreneurship : Theory, Process, Practice (ed.10). United State of America: Cengage Learning.
3. Timmons, J. A., & Spinelli, S. (2003). New venture creation/entrepreneurship for the 21st century. Singapore City: McGraw-Hill.
4. Abrams, R. (2017). Entrepreneurship: A Real-World Approach (2nd ed., illustrated). Planning Shop.
5. Read, S., Sarasvathy, S., Dew, N., & Wiltbank, R. (2016). Effectual Entrepreneurship (2nd ed.). Routledge. https://doi.org/10.4324/9781315684826
6. Ries, E. . (2011).The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses.

Course Name: Amino acids and Proteins	**Course Code:** BCHM-413
Course structure: Lectures:2, Lab: 1	**Credit hours:** 3 (2+1)

Prerequisites: None

COURSE OBJECTIVES:

This course will cover the basic concepts about amino acids and proteins.

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.

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 nucleus, Extra nuclear DNA.

PRACTICAL:

1. 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; 2. Extraction of proteins from plant sources and their confirmative tests. 3. Separation of Amino Acids using Paper and Thin Layer Chromatography; 4. Determination of total proteins by using different methods (Bradford, lowery and biuret methods); Protein estimation by using UV/Visible spectrophotometer 5. Isolation of DNA and RNA from plants and blood sample 6. Quantification of DNA and RNA

BOOKS RECOMMENDED:

1. Medeiros, D. M., & Wildman, R. E. (2022). Advanced human nutrition. Jones & Bartlett Learning.
2. Saudagar, P., & Tripathi, T. (Eds.). (2022). Advanced spectroscopic methods to study biomolecular structure and dynamics. Elsevier.
3. Gedde, U. W., & Hedenqvist, M. S. (2019). Fundamental polymer science (Vol. 2). Cham: Springer.
4. Dill, K., Jernigan, R. L., & Bahar, I. (2017). Protein actions: Principles and modeling. Garland Science.
5. Lehninger Principles of Biochemistry. (2012) 6th Ed. By David L. Nelson, Michael M. Cox W.H. Freeman; 6th Edition (November 21, 2012).
6. Principles of Biochemistry. (2011) 5th Ed. by Laurence A. Moran, Robert A Horton, Gray Scrimgeour and Marc Perry.

7. Fundamentals of Biochemistry (2010) 4th Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.4. Textbook of Practical Biochemistry.

8. Harpers Illustrated Biochemistry. (2012). 29th Ed. By Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil. McGraw-Hill Medical.

Course Name: Metabolism I	**Course Code: BCHM-414**

Course structure: Lectures: 3, Lab 0	**Credit Hours: 3**

Prerequisites: None

COURSE OBJECTIVES:

This overall goal of this course is to impart the essential aspects of intermediary metabolism and its importance to the overall biology of an organism.

COURSE CONTENTS:

Carbohydrate metabolism: Glucose central role in metabolism of plants, animals and micro-organism. Glycolysis, reactions of glycolysis. Fermentation: anaerobic fate of pyruvate, control of metabolic flux. Regulation of glycolytic pathway. Entry of Galactose, Mannose and fructose into glycolytic pathway. TCA cycle: Overveiw of TCA, Metabolic sources of Acetyl Coenzyme A. Amphibolic nature, anaplerotic reactions. TCA Cycle inhibitors, Regulation, pyruvate dehydrogenase complex enzyme. Other pathways of carbohydrate metabolism: Gluconeogenesis, cori cycle, glycogenesis, glygenolysis, glycogen storage diseases, Glyoxalate Cycle reactions, Pentose phosphate Pathway. Carbohydrate synthesis: Synthesis of starch, cellulose and peptidoglycan, glycoproteins. Glycogen metabolism, Synthesis and breakdown, glycogen synthetase and phosphorylase and their regulation, Glycogen Storage diseases. Lipid metabolism**:** Introduction to lipid metabolism, β-oxidation of fatty acids, ketogenesis. Biosynthesis of Fatty acids. Triacylglycerols and prostaglandins. Metabolism of phospholipids, glycolipids and cholesterol. Lipoproteins: metabolism of HDL Disorder of plasma lipoproteins, fatty liver, obesity, atherosclerosis. Biosynthesis of triacylglycerols, Phospholipids, Cardiolipids, Glycolipids and sphingolipids. Arachidonate metabolism, Prostaglandins: Prostacyclins, Thrombaxanes and eukotrienes, synthesis of cholesterol and steroid hormones; degradation to bile acids.

RECOMMENDED BOOKS:

1. Bender, D. A., & Cunningham, S. M. (2021). Introduction to nutrition and metabolism. CRC Press.
2. Coleman, M. D. (2020). Human drug metabolism. John Wiley & Sons.
3. Mougios, V. (2019). Exercise biochemistry. Human Kinetics Publishers.
4. Litwack, G. (2017). Human biochemistry. Academic Press.
5. Lehningher Principles of Biochemistry" by Nelson & Cox, 5th edition ISBN 13:978-0-7167-7108-1.
6. Harpers Illustrated Biochemistry 29th Edition (LANGE Basic Science) byRobert Murray, D. Bender, Kathleen M. Botham and P.J. Kennelly (Feb7, 2012)Fundamentals of Biochemistry (2008) 3rd edition By DJ Voet , GJ Voetand CW Pratt. J Wiley & Sons Inc.
7. Biochemistry (2007) 6th edition by JM Berg, JL Tymoczko& L Stryer WHFreeman &Co
8. Biochemistry 3rd Edition (Lippincott's Illustrated Reviews Series) byRichard A. Harvey.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – IV

Course Title: Civics and Community Engagement.	**Course Code:** PSC-418
Course Structure: Lectures: 2	**Credit Hours:** 2
Prerequisites:	
Course Objective: This course is designed to provide students with fundamental knowledge about civics, citizenship, and community engagement. In this course, the students will learn about the essentials of civil society, government, civic responsibilities, inclusivity, and effective ways to participate in shaping the society which will help them apply theoretical knowledge to the real-worldsituations to make a positive impact on their communities.	
Course Outline: **1. Civics and Citizenship:** Concepts of civics, citizenship, and civic engagement, Foundations of modern society and citizenship, Types of citizenship: active, participatory, digital, etc.**2. State, Government and Civil Society:** Structure and functions of government in Pakistan. The relationship between democracy and civil society. Right to vote and the importance of political participation and representation.**3. Rights and Responsibilities**: Overview of fundamental rights and liberties of citizens under the Constitution of Pakistan 1973. Civic responsibilities and duties. Ethical considerations in civicengagement (accountability, non-violence, peaceful dialogue, civility, etc.) **4. Community Engagement:** ·Concept, nature, and characteristics of community. ·Community development and socialcohesion. Approaches to effective community engagement. ·Case studies of successful community- driven initiatives.**5. Advocacy and Activism:** Public discourse and public opinion. Role of advocacy inaddressing social issues. Social action movements. **6. Digital Citizenship and Technology:** The use ofdigital platforms for civic engagement Cyber ethics and responsible use of social media. Digital dividesand disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship.**7. Diversity,** Inclusion and Social Justice: Understanding diversity in society (ethnic, cultural, economic, political etc.). Youth, women and minorities' engagement in social development. Addressing social inequalities and injustices in Pakistan. Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.	

Course Outcomes: By the end of this course, students will be able to:

1. Demonstrate fundamental understanding of civics, government, citizenship and civil society
2. Understand the concept of community and recognize the significance of community engagement for individuals and groups.
3. Recognize the importance of diversiy and inclusivity for societal harmony and peaceful co-existence.

Recommended Books: Latest Edition of the Following Books.

1. "Civics Today: Citizenship, Economics, & You" by McGraw-Hill Education.2 "Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman. 3."E Fngaaina V Youth in Civic Life" by James Youniss an Peter Levine.
4. "Digital Citizenship in Action: Empowering Students to Engage in Online Com Kristen Mattson. "Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby.
6. "Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch andSusan M. Omilian.
7. "Creating Social Change: A Blueprint for a Better World" by Matthew Clarke and Marie-Monique Steckel.

Course Title: Quantitative Reasoning II	**Course Code:** MTH-402
Course Structure: Lectures:3	**Credit Hours:** 3

Prerequisites:

Specific Objectives of Course

Quantitative reasoning (II) is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modelling/analysis technique to equip student with analytical skills and crtitical thinking abilities necessary to navigate the complexitiesof the modern world. The course is design to familiarize students with the quantitative concept and technique require to interpret and analyze numerical data to inculcate and ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the prerequisite course of quantitative reasoning I and its base, this course will enable students further their quantitative, logical and critical reasoning abilities to complement their specific major/field of study.

Course Outline:

1. Logic and Logical Critical Reasoning Introduction and Importance of logic; Inductive, deductive, and abductive approaches of reasoning; Prepositions, arguments (valid; invalid), logical connectives, truth tables and prepositional equivalences; Logical fallacies; Venn diagram; Predicates and quantifiers, Quantitative reasoning exercises using logical reasoning concepts and techniques;

2.Mathematical Modelling and Analysis, Introduction to deterministic models, Use of linear functions for modelling in real world situations; Modelling with system of linear equation and their solutions; Elementary introduction to derivatives and mathematical modelling; Linear and exponential growth and decay models; Quantitative reasoning exercises using mathematical modelling;

3. Statistical Modelling and Analysis: Introduction to probabilistic models; Bivariate analysis, scatter plots; Simple linear regression model and correlation analysis; Basics of estimation and confidence

interval; Testing of hypothesis (Z-test; T-test); Statistical inference in decision making; Quantitative reasoning exercises and using statistical modelling;

Course Outcomes

By the end of this course, student shall have:

- Understanding of logic and logical reasoning;
- Understanding of basics quantitative modelling and analysis;
- Logical reasoning skills and abilities to apply them to solve quantitative problems and evaluate arguments;
- Ability to critically evaluate quantitative information to make evidence based decisions through appropriate computational tools:

Recommended Books:

1. "Using and Understanding: A Quantitative Reasoning Approach" by Bennett, J.O., Biggs, W. L., and Badalamenti, A.
2. "Discrete Mathematics and Its Applications" by Kenneth H. Rosen.
3. "Discrete Mathematics with Applications" by Susanna S. Epp.
4. "Applied Mathematics for Business, Economics, and Social Sciences" by Frank S. Budnick.
5. "Elementary Statistics: A Step by Step Approach" by Allan Bluman.
6. "Introductory Statistics" by Prem S. Mann.
7. "Applied Statistical Modelling" by Salvatore Babones. 8."Barrons SAT" by Sharvonweiner Green, M. A and Lra K. Wolf.

Course Name: Molecular Biology	**Course Code: BIT-413**
Course Structure: Lectures: 2, Labs: 1	**Credit Hours: 3**
Prerequisites: Biochemistry I	

Course Objectives

1. To study classical and molecular aspects of cell.
2. The course emphasizes about the chromosome structure, transfers of genetic information, gene expression and regulation of gene activity.
3. The course is basis for structural biology, it aids in the simulation and modeling of DNA, RNA, and protein structures as well as molecular interactions.

Course Outline

Introduction to Molecular Biology. Basic concepts about DNA, RNA and proteins with special emphasis on nature of genetic material and its organization in viruses, prokaryotes and eukaryotes, Structure function and replication of DNA,DNA as Heritable material structure of DNA, Chromatin and Chromosome organization: physical structure of genes. Gene Expression Genetic Code, Codon, Anticodon, Ribosome, Translation, Gene Expression in Prokaryotes, the lac operon, Gene Expression in eukaryotes, Molecular Basis of Mutation Basis of mutation. DNA damage, DNA Repair Recombination. Types of mutations. Replication errors and their repairs: DNA repair – Single step and multistep: RNA processing, splicing and editing, translation and post-translational modifications, Regulation of gene expression in prokaryotes and eukaryotes. Introduction about plasmids and vectors. Recombinant DNA Technology, CRISPR/CAS9-Targeted Genome Editing. Molecular evolution; DNA based phylogenetic trees and their applications.

Course Outcomes:

1. Equip students with a comprehensive understanding of molecular biology.
2. Preparing them for careers in research, biotechnology, and various fields where molecular biology principles are applied.

Lab Outline: Isolation of DNA from plant cells, Protocols for isolation of DNA from blood. Protocols for Amplification of DNA by PCR. Gel Electrophoresis.

Recommended Books:

1. David M. P. Academic Press London, Methods in Cell Biology Lowery Sekivetz. Cell Structure and Function. John Willey and Sons Publication. 3 edition (October 7, 2011).
2. Jordanka Zlatanova. Molecular Biology: Structure and Dynamics of Genomes and Proteomes 2nd Edition Garland Science ISBN-13: 978-0367678098 April 21, 2023
3. Gerald Karp - Cell and molecular biology concepts and experiments - Hoboken, NJ - John Wiley - 2010 - 5th Ed.
4. Brown T. A. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, 2010
5. Robert Weaver. Molecular Biology. McGraw Hill, 5th Edition, 2007.
6. James D. Watson, Tania A. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, Pearson,7th Edition.2014.

Course Name: Enzymology	**Course Code:** BCHM-417
Course structure: Lectures: 2 Lab :1	**Credit Hours:** 3 (2+1)
Prerequisites: None	

COURSE OBJECTIVES:

The objective of this course is to provide in depth knowledge of how enzymes work as biological catalysts and how the rates of reactions are impacted by a variety of different factors and environmental conditions.

COURSE OUTLINES:

Introduction to enzymes, nomenclature, classification, ribozyme, general characteristics theories of enzyme catalysis, enzyme and substrate specificity, isozymes, allozymes, coenzymes, cofactors, regulation of enzyme activity, chemical kinetics and enzyme kinetics, Michaelis-Menten equation, effect of various factors on rate of reactions, inhibition of enzymatic reactions and kinetics, multienzyme system and bisubstrate reactions, catalytic mechanisms, regulatory enzymes, immobilised enzyme and enzyme assays.

PRACTICAL:
Extraction and estimation of enzymes from plant source. Acid and enzymatic hydrolysis of glycogen and starch Biosynthesis of enzymes by fungi and bacteria. Effect of Temperature on enzymes activity. Effect of Substrate concentration on enzyme activity. Effect of Enzyme concentration on enzyme activity. Effect of heat on stability of enzyme.

RECOMMENDED BOOKS:

1. Punekar, N. S. (2018). Enzymes: catalysis, kinetics and mechanisms. Springer.
2. Whitaker, J. R. (2018). Principles of enzymology for the food sciences. Routledge.
3. Bharati, S. L., & Chaurasia, P. K. (Eds.). (2018). Research Advancements in Pharmaceutical, Nutritional, and Industrial Enzymology. IGI Global.
4. Biochemistry (2007) 6th edition by J.M. Berg, J.L. Tymoczko& L. Stryer W.H. Freeman & Co.
5. Fundamentals of Biochemistry (2008) 3rd Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.
6. Lehninger Principles of Biochemistry 5th Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers.
7. Lipponcots Illustrated reviews, 6theedition, by Denise R. Ferrier, Philadelphia, Pennsylvania.
8. Essentials of medical biochemistry by Mushtaq Ahmad, Vol. 1.

Course Name: Human Physiology	**Course Code:** BCHM-418
Course structure: Lectures: 3 Lab :0	**Credit Hours: 3 (3+0)**
Prerequisites: None	

COURSE OBJECTIVES

This course is designed to provide a holistic overview of the various aspects of human physiology

COURSE OUTLINE:

Introduction to Physiology: Functional organization of human body, Digestion and Absorption of Macromolecules: Digestion, absorption and transport of carbohydrate, lipid and Protein. Blood: General composition, characteristics

and functions; hemoglobin: chemistry, properties, synthesis, degradation, functions and derivatives. Blood coagulation and blood clotting factors; blood pressure, groups and buffers. Homeostasis Blood cell, anemia and its types. Specialized Systems: Gastro-intestinal Tract: Organization, and functions, Nutrition and Physiology of digestion, movement of the food to the alimentary canal, digestion and absorption in the gastrointestinal tract, Respiratory system: Pulmonary ventilation, physical principles of gaseous exchange, transport of oxygen and carbon dioxide in the blood and body fluid and regulation of respiration, Circulatory system: Heart as a pump, circulatory system as a circuit, Nervous system: Organization, three major levels of nervous system, Skeletal system: Bone anatomy, histology, development and growth and remodeling, Urinary system: Formation of urine by kidney, glomerular filtration, tubular function and regulation of acid-base balance, Hormones: Introduction, classification, chemical nature, general mechanism of action, regulation, secretion, mode of action and biological functions of thyroid, parathyroid, pituitary, adrenal, gonadal and pancreatic hormones. Endocrinology and Reproduction, male and female reproductive systems and their hormones.

RECOMMENDED BOOKS:

1. Smith, D. L., & Fernhall, B. (2023). Advanced cardiovascular exercise physiology. Human Kinetics.
2. Stipanuk, M. H., & Caudill, M. A. (2018). Biochemical, physiological, and molecular aspects of human nutrition-E-book. Elsevier health sciences.
3. Litwack, G. (2017). Human biochemistry. Academic Press.
4. Text Book of Medical Physiology (2008) 10th Edition by Arthur C. Gyton, John E. Hall, W. B Saunders Company.
5. Fundamentals of Biochemistry (2008) 3rd Edition by D. Voet, J. G. Voet, & C. W. Pratt, John Wiley and Sons, New York.
6. Principles of Biochemistry (2008), 5th Edition by A.L. Lehninger, D.L. Nelson and M. M. Cox, Worth Publishers, New York.
7. Human Physiology, (2003) 5th Edition Arthur J. Vender, James H. Sherman, Dorothy S. Luciano, McGraw-Hill Company.

Course Name: Metabolism II	**Course Code:** BCHM-419
Course structure: Lectures: 3 Lab :0	**Credit Hours:**3 (3+0)
Prerequisites:	

COURSE OBJECTIVES:

This overall goal of this course is to impart the essential aspects of intermediary metabolism and its importance to the overall biology of an organism.

COURSE CONTENTS:

Protein metabolism: Digestion and absorption of proteins; General aspects of amino acids metabolism, deamination, transamination, transmethylation, transpeptidation and decarboxylation. Amino acid degradation and urea cycle. Inborn errors of metabolism. Nitrogen balance, biosynthesis of non-essential amino acids. Major

pathways and strategies of energy metabolism: Organ specialization Brain, Muscle, Adipose tissue, liver.
Metabolic adaptation –Starvation, Diabetes Mellitus. Shuttle systems: Introduction, importance of Shuttle Systems, Glycerol Phosphate shuttle, Malate aspartate shuttle.

Metabolism of Nucleic acids: Biosynthesis, degradation and regulation of purine and pyrimidine bases. Biosynthesis, degradation and regulation of purine and pyrimidine nucleotides. Diseases associated with nucleotides and nucleotide metabolism such as gout,. xeroderma pigmentosa, ADA, SCID and skin cancer, Lesch nyhan syndrome and orotic acidura.

RECOMMENDED BOOKS:

1. Copeland, R. A. (2023). Enzymes: a practical introduction to structure, mechanism, and data analysis. John Wiley & Sons.
2. Bender, D. A., & Cunningham, S. M. (2021). Introduction to nutrition and metabolism. CRC Press.
3. Kenney, W. L., Wilmore, J. H., & Costill, D. L. (2021). Physiology of sport and exercise. Human kinetics.
4. Lehningher Principles of Biochemistry" by Nelson & Cox, 5th edition ISBN 13:978-0-7167-7108-1 (2014).
5. Harpers Illustrated Biochemistry 29th Edition (LANGE Basic Science) by Robert Murray, D. Bender, Kathleen M. Botham and P.J. Kennelly (Feb7, 2012)
6. Fundamentals of Biochemistry (2008) 3rd edition By DJ Voet, GJ Voet and CW Pratt. J Wiley & Sons Inc.
7. Biochemistry (2007) 6th edition by JM Berg, JL Tymoczko & L Stryer WH Freeman &Co
8. Biochemistry 3rd Edition (Lippincott's Illustrated Reviews Series) by Richard A. Harvey.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – V

Course Name: Principles of Biotechnology	**Course Code: BIT-301**
Course Structure: Lectures: 3, Labs: 1	**Credit Hours: 4**
Prerequisites: None	
Course Objective: 1. To acquaint students with the basic concepts and significance of biotechnology as it stands today. 2. To understand application of basic biology in the field of biotechnology to solve problems 3. To equip students with various techniques and concepts used in biotechnology	
Course Outline: Biotechnology, Introduction to biotechnology, definition, brief history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture (food, livestock, fisheries, algae, fungi, etc.),resistant varieties, bt crops ;emerging Techniques in biotechnology, genetic engineering, tools and steps, enzymes for ligation and cutting DNA, applications, Bioprocessing and fermentation technology, fermenters, primary and secondary metabolites, Biotechnology in medicine, antibiotics, vaccines, Animal biotechnology, better animal production, transgenic animals, Environmental biotechnology, waste management and treatment methods, Industrial and microbial biotechnology, single-cell proteins, bio-fertilizers, protection of biotechnological products; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world. **Practical:** Laboratory safety: Containment and decontamination. An introduction to microscopy. Principles of Staining Procedures: Simple staining, Gram's staining, Acid-fast staining, cell-wall staining, flagellar staining, capsule staining, spore staining and spirochaete staining. Study of cell motility by hanging drop preparation. Preparation and sterilization of bacteriological media and glassware. Inoculation techniques. Study of colony characteristics of microorganisms. Enumeration of bacteria from milk, water, food, and soil by standard plate count technique (SPC) and/or most probable number technique (MPN). Microbiological analysis of air. Microscopic study of fungi isolated from air. Estimation of moisture, ash, carbohydrates, protein, fat, crude fiber in food, Detection of proteases, amylases in milk. Determination of iodine number of fats. Determination of specific gravity of sugar. Separation of gluten from wheat flour. Detection of E.coli in drinking water. Detection of yeast and mould in dairy and bakery products. Production of cheese. Isolation of industrially important microorganisms - yeast and actinobacteria Preservation and maintenance of cultures Fermentor – components and functions Solid state fermentation – mushroom production Assay of amylase and antibiotics	

Isolation and characterization of lactic acid bacteria (LAB) for fermentation process
Recommended Books: 1. William J, Thieman J, Michael A (2003) 2nd edition, 'Introduction to Biotechnology' McGraw Hill Book company Inc 2. David, B., Jewell, T. R. 2000. Biotechnology: demystifying the concept, Oxford University Press. 3. Sedivy, J. M., Joyner, A. L. 2000. Gene targeting, Oxford University Press. 4. Mukhopadhyay, S.N, 2004. Process Biotechnology Fundamentals, 2nd Edition. Viva Books Pvt. Limited, New Delhi. 5. Goodsell, D.S., 2004. Bionanotechnology: Lessons from Nature . John Wiley & Sons Limited. 6. Purohit, S.S., 2002, Biotechnology: Fundamentals and Applications, Agrobios publishers. 7. Prave, P., Faust, U., Sittig, W., and Sukatsch, D.A., 2002. Fundamentals of Biotechnology, John Wiley & Sons

Course Title: Biostatistics	**Course Code:** STAT-401
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3
Prerequisites: None	
Course Objective: To provide knowledge of importance of and its application in Biological Sciences. Understanding of use of statistical techniques to summarize and analyze biological data	
Course Outline: Introduction to Biostatistics, scope. Types of data, variables; Categorical, numerical and censored data. Descriptive Statistics; Measure of central tendency; mean, median, mode. Measure of dispersion; Variance and standard deviation. Simple linear regression; model fitting. Correlation; correlation co-efficient, co-efficient of determination. Logistic regression. Logit transformations and their analysis, p values and its importance and role. Hypothesis testing.	
Course Outcomes: After completing the course, the students will be able to • Understand the applications of statistical tools in biological science. • Demonstrate an understanding of the central concepts of statistical theory in Biological Sciences. • Apply appropriate statistical techniques to biological data and analyze and communicate the results of statistical analysis effectively.	
Recommended Books: Latest Edition of the Following Books. 1. Antonisamy, B. Premkumar, P. and Christopher, S. (2017). *Principles and Practice of Biostatistics*. 1st edition. Elsevier, India. 2. Daniel, W.W. (2010). *Biostatistics: A Foundation for the Health Sciences*. 6th edition. John Wiley, New York. NY, USA.	

3. Sullivan, M.L. (2018). *Essentials of Biostatistics in Public Health*. 3rd edition. Jones and Bartlett Learning, Burlington, MA, USA.
4. Zar, J. (2000). *Biostatistical Analysis.* 5th Edition. John Wiley & Sons, New York, NY, USA.
5. Pagano, M., Gauvreau, K., & Mattie, H. (2022). *Principles of biostatistics*. CRC Press.
6. Gerstman, B. B. (2014). *Basic biostatistics*. Jones & Bartlett Learning, LLC.
7. Kaps, M., & Lamberson, W. R. (Eds.). (2017). *Biostatistics for animal science*. Cabi.

Course Name: Computational Biochemistry	**Course Code:** BI-527
Course Structure: Lectures: 2, Labs: 1	**Credit Hours:** 3

Course Description: This course introduces students to the fundamental principles and applications of computational tools and techniques in the field of biochemistry. The course explores the principles and applications of computational methods to understand biological systems, analyze biomolecular structures, and simulate biochemical processes. Students will gain a strong foundation in using computational tools to analyze and model biochemical systems.

Course Objective: The Students will be able to

1. Understand the fundamental principles of computational biochemistry and its role in modern biochemistry research.
2. Analyze and interpret bioinformatics data, including DNA and protein sequences, structural information, and biochemical pathways.
3. Apply computational methods to predict and analyze the structure and function of biomolecules.

Course Outline:

Introduction to Computational Biochemistry, the importance and role of computational methods in biochemistry. Identify various software and tools used in computational biochemistry Bioinformatics and. Sequence Analysis: Use bioinformatics tools to analyze DNA, RNA and protein sequences. Predict open reading frames, gene structures, and motifs. Perform sequence alignment and phylogenetic analysis. Structural Bioinformatics: Understand protein structure determination methods. Utilize molecular modeling software to visualize and manipulate biomolecular structures. Analyze protein structures using molecular visualization techniques and software like PyMOL. Predict protein secondary structure and solvent accessibility. Predict the impact of mutations on protein structure and function. Explain the role of structural biology in understanding biomolecular function. Analyze protein-ligand complexes and their structural features. Interpret experimental structures and their relevance to biochemistry. Molecular Dynamics Simulations, Explain the principles of molecular dynamics simulations. Perform basic simulations of biomolecules. Analyze and visualize molecular dynamics trajectories. Apply simulation techniques to understand protein folding and conformational changes. Docking and Drug Discovery, Understand molecular docking techniques. Perform protein-ligand docking. Analyze and interpret docking results for drug discovery. Ligand Binding and Drug Design, Calculate binding energies and predict ligand-receptor interactions. Design small molecules and drugs targeting specific biomolecules. Evaluate the principles of structure-based drug design. Systems Biology and Pathway Analysis, Explore metabolic and signaling pathways. Analyze and model biochemical pathways. Understand network properties and their role in biological processes. Special Topics in Computational Biochemistry: Cover advanced topics such as protein-ligand interaction analysis, homology modeling, and structural bioinformatics of nucleic acids.

Course Outcomes: By the end of this course, students should be able to:
1.Explore the relationship between structure and function in biochemical systems.
2. Gain hands-on experience in using computational tools for practical research in biochemistry.

Recommended Books: Latest Edition of Following Books

1. Christopher J. Cramer, Essentials of Computational Chemistry: Theories and Models.1st edition, May 2002. Wiley, John & Sons.
2. Stan Tsai, An Introduction to Computational Biochemistry, Wiley, John & Sons.
3. Paul Harrison, Computational Methods in Physics, Chemistry and Biology: An Introduction, Wiley, John & Sons.
4. Eberhard O. Voit, Antonio E. Ferreira, Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists, Cambridge University Press
5. Frank Jensen, Introduction to Computational Chemistry, Wiley, John & Sons.

Course Name: Plant Biochemistry	**Course Code:** BCHM-513
Course structure: Lectures: 3 Lab :0	**Credit Hours:3 (3+0)**

Prerequisites: None

COURSE OBJECTIVES:

The objective of this course is to cover the key concepts of plant biochemistry. Topics to be covered are plant pigments, photosynthetic systems and pathways as well as phyto-hormones and related naturally occurring compounds.

COURSE OUTLINES:

Structure and functions of plant cell. Plant cell wall. Photosynthesis; structure of chlorophyll, absorption of light energy, photosynthetic pigments, photosystem-I, photo system-II. Hill's reaction, electron transport chain, ATPC3, C4 and CAM photosynthetic pathways, CO2 fixation (Calvin Benson cycle). Hatch Slack pathway and photorespiration. Conversion of nitrogen into ammonia and other nitrogenous compounds. Biosynthsis of flavonoids and Alkaloids and their biological functions. Terpenes and Terpenoids. Phenolics and related compounds. Phyto-hormones and related compounds. Extraction and qualitative analysis of chlorophyll, starch, lipids, enzymes, auxins, alkaloids, phenolics and flavonoids

RECOMMENDED BOOKS:

1. Singh, B. N., Hidangmayum, A., Singh, A., Shera, S. S., & Dwivedi, P. (2019). Secondary metabolites of plant growth promoting rhizomicroorganisms. Berlin, Germany: Springer.
2. Dashek, W. V. (2018). Methods in plant biochemistry and molecular biology. CRC Press.
3. Bhatla, S. C., & Lal, M. A. (2018). Plant physiology, development and metabolism. Springer. Lehninger, A. L., Nelson, D.L. and Co. N.M., (2008). Principles of Biochemistry. W. H. Freeman; 5th Edition.
4. Plant Biochemistry by T. Wood & Mercer (2012).

Course Name: Clinical Biochemistry	**Course Code:** BCHM-515
Course structure: Lectures: 2 Lab :1	

	Credit Hours:3 (2+1)

Prerequisites: Introductory Biochemistry

COURSE OBJECTIVES:

Provide students with advanced understanding and applied knowledge in the theory and practice of Clinical Biochemistry and equip them with a critical understanding of how biochemical investigations are employed to develop a clinical diagnosis. Emphasis will also be placed on understanding the biochemical basis of human disease.

COURSE CONTENTS:

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): Abnormalities of proteins in plasma: immunoglobins deficiencies, Disorders of carbohydrate metabolisms and Clinical correlations: Diabetes mellitus, Fructose intolerance, Lactic acidosis, Hypoglycemia, Galactosaemia; Glycogen storage Diseases (enzyme defect in different forms of glycogen storage diseases); Disorders of Lipid Metabolism (lipoproteins, classification of lipoproteins, hyperlipidemia, cholesterol and cardiovascular diseases); Disorders of purine and pyrimidine metabolism (Gout, Arthritis); Metabolic Bone Diseases (Calcium balance, Biological functions of calcium, phosphate and magnesium metabolism); Liver Diseases (cirrhosis', specific liver diseases); Hemoglobinopathies, Disorders of Iron and porphyrin metabolism. Cancer and its consequences- tumor progression, tumor markers, oncogenes, local effects of tumor, cancer cachexia, Ectopic hormone production, consequences of cancer treatment.

PRACTICAL:

Phelobotmy (blood sampling), serum/plasma isolation procedure, Complete blood count, isolation of tissues samples and storage; Total protein determination in serum and plasma; Blood glucose test, Glucose tolerance test for diabetes mellitus, Glycation (HbA1c); Liver function tests, Renal Function tests, Cardiac enzymes, Albumin determination; Determination of lipid profile, serum and urine electrolytes.

RECOMMENDED BOOKS:

1. Clinical Chemistry: Principles, Procedures, Correlations by Michael L.Bishop, Edward P. Fody, Larry E. Schoeff Publisher: LippincottWilliams & Wilkins; 5th Edition (July 6, 2004)

2. Tietz Fundamentals of Clinical Chemistry by Carl A. Burtis, Edward R.Ashwood. Publisher: W.B. Saunders Company; 5th Edition (January 15,2001).

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – VI

Course Name: Industrial Biochemistry	**Course Code:** BCHM-517
Course Structure: Lectures: 2, Lab: 1	**Credit Hours:** 3(2+1)

Prerequisites: None

COURSE OBJECTIVES:

This course provides information about how large-scale biochemistry is done in multinational companies and academic labs. The focus of this course will be on how locally available inexpensive raw materials may be used to develop products with good commercial value.

COURSE OUTLINES:

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 dustrial applications Quality assurance and value addition

PRACTICAL:

Visit to industries, Extraction of oil by Soxhelation method, Determination of Acid value, Determination of Iodine value, Purification of oil by column chromatography, Separation of phospholipids by TLC, Determination of ethanol percentage in the fermentation broth, Determination of citric acid by titration method in the fermentation medium, Preservation of food by UV-radiation / chemical method, Estimation of total proteins, reducing sugar, total sugar from extract of seasonal fruits.

RECOMMENDED BOOKS:

1. Abdel-Azeem, A. M., Yadav, A. N., Yadav, N., & Usmani, Z. (Eds.). (2021). Industrially Important Fungi for Sustainable Development: Volume 1: Biodiversity and Ecological Perspectives. Springer International Publishing.
2. Jain, A., Jain, R., & Jain, S. (2020). Basic Techniques in Biochemistry, Microbiology and Molecular Biology (pp. 9-10). New York, NY, USA:: Springer.
3. Arora, N. K., Mishra, J., & Mishra, V. (Eds.). (2020). Microbial enzymes: roles and applications in industries (pp. 1-110). Berlin Heidelberg: Springer.
4. Gupta, R., & Singh, R. L. (2019). Advances in biological treatment of industrial waste water and their recycling for a sustainable future (pp. 225-66). R. L. Singh, & R. P. Singh (Eds.). Singapore: Springer.
5. Kent and Riegel's Hand Book of Industrial Chemistry and Biotechnology (2007) 11th Edition by J.A. Kent. Springer.
6. Introduction to Cane Sugar Technology. by G.H. Jenkins Elsevier British pharmacopoeia.

Course Name: Nutritional Biochemistry	**Course Code:** BCHM-518
Course structure: Lectures: 2 Lab :1	**Credit Hours:**3 (2+1)
Prerequisites: None	

COURSE OBJECTIVES:

This course covers key concepts of nutrition and human health and the essential components of a balanced diet.

COURSE OUTLINES:

Food selection and meal planning for healthy individuals. Balanced diet; recommended dietary allowances for different categories of the human beings. Measurement of energy of foods and expenditure. Direct and indirect caloric measurement. Basal metabolism. , Obesity and Factors affecting BMR. Respiratory quotient, Food borne diseases, Nutritional aspects and dietetic treatment of a few important primary nutritional and general diseases, Fasting, Starvation and anorexia nervosa, Endemic goiter, Idiosyncrasies, Food intolerance and food allergies, Clinical surveys, Physical examination, Anthropometry, Laboratory examinations, Dietary surveys, FAO global information and early warning system for food and agriculture. Micronutrients: Sources, Daily allowance, Deficiency diseases, Biological role of the water and fat soluble Vitamins; Biological importance of minerals. Nutrigenomics.

PRACTICAL:

Assessment and surveillance: Clinical surveys; physical examination, anthropometry, laboratory examinations, dietary surveys; calculations of energy values of food; calculation of recommended daily allowance (RDA); calculation of basal energy expenditure (BEE) & basal metabolic rate (BMR); BMI, estimation of vitamins, sodium, potassium, phosphorus etc. by different methods from plant & animal sources.

RECOMMENDED BOOKS:

1. Krause's Food, Nutrition and Diet Therapy L. Kathleen Mahan Sylvia Escott-Stump(2009) 11th Ed. Saunders
2. Understanding Nutrition. E. N. Whitney & S. R. Rolfes (2002) 9th edition Wads worth / Thomson learning: New York, 2002
3. Nutrition & Dietetics. S.A. Joshi 2nd Ed. 2002, Tata McGraw Hill Publishers
4. Nutrition Health Promotion Approach. Webb (2008) 3rd Ed. Oxford University Press.
5. Fundamentals of Biochemistry. by J. I. Jain (2008) S. Chand & Co. India
6. Biochemistry, 3rd edition by U. Sataya narayna& U. Chakarapani (2006) Books and Allied: Kolkata.
7. Nutritional biochemistry Current Topics in Nutrition Research Edited by Chad Cox,2015, Apple Academic Press

Course Name: Biosafety and bioethics	**Course Code:** BCHM-519

Course structure: Lectures: 2 Lab :1	**Credit Hours**:3 (2+1)
Prerequisites: None	

COURSE OBJECTIVES:

To acquaint students with principles of biosafety and ethical perspectives pertaining to biochemistry as well as biotechnology

COURSE CONTENTS:

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

PRACTICAL

Use of PPEs, Hand washing procedure, hand sanitization, donning of PPEs according to biosafety levels, Safe glove removal methods, bootie dance. Liquid waste management, spill clean up.

RECOMMENDED BOOKS:

1. Nasyrova, F., & Espona, M. J. (2023). 14. Development of Bioethics and Biosafety Programme for professionals in life sciences. Planetary Health and Bioethics, 288.
2. Van Rooyen, M. (2021). Environmental and Biosafety Research Ethics Committees: Guidelines and Principles for Ethics Reviewers in the South African Context (Doctoral dissertation, Stellenbosch: Stellenbosch University).
3. Katsara, Z. (2020). Content development for a Biotechnology, Bioethics and Biosafety platform.
4. Altman A and Hasegawa PM, 2012. Plant Biotechnology and Agriculture: Prospects for 21st Century. 1st Edition; Academic Press.
5. Laboratory Biosafety Manual, WHO, 2006. 3rd Edition; AITBS Publishers and Distributors, India. (Available online).
6. Krishna VS, 2007. Bioethics and Biosafety in Biotechnology. New Age International Publishers.
7. National Biosafety Guidelines, 2005. Pakistan Environmental protection Agency (*Available online*)

Course Name: Bioenergetics	**Course Code:** BCHM-520
Course structure: Lectures: 3 Lab :0	**Credit Hours:** 3
Prerequisites: None	

COURSE OBJECTIVES:

This course provides insights into energy, its production and regulation in living system.

COURSE OUTLINE:

Introduction to bioenergetics and energy transduction in biological system, Basic principles and laws of thermodynamics, Free energy, enthalpy, entropy and their relationships, Free energy change and standard free energy change in biochemical reactions, Endothermic, exothermic, endergonic and exergonic reactions

70, 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, Chemiosmotic 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. Weber, C., Möst, D., & Fichtner, W. (2022). Economics of power systems: Fundamentals for sustainable energy. Springer Nature.Harper's Illustrated Biochemistry, 27th Ed. By R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw Hill
2. Yadav, M., & Yadav, H. S. (Eds.). (2021). Biochemistry: fundamentals and bioenergetics. Bentham Science Publishers.
3. Hallenbeck, P. C. (Ed.). (2017). Modern topics in the phototrophic prokaryotes: metabolism, bioenergetics, and omics. Springer
4. Physical Chemistry (2002) 7th Edition by P.W. Atkin Oxford University Press
5. Physical Chemistry (2004) 4th Edition by R.J. Sibley, R.A. Alberty & M. G. Bawendi J.Wiley & Sons.

Course Name: Pharmacology	**Course Code:** BCHM-521
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3 (3+0)
Prerequisites:	

Course Objective: The course objectives are to:

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

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 (anti emetics, drugs affecting motility of GIT, ulcer healing drugs, laxatives), cardiovascular drugs anti-arrhythmic drugs, Inotropic drugs, anti-hypertensive drugs, anti-anginal drugs, thrombolytic, anti-hyperlipidemia drugs), diuretics, autacoids, drugs acting on autonomic nervous system (cholinergic drugs, anti-cholinergic drugs, adrenergic drugs, anti-adrenergic, Adrenergic, neuron blockers, autonomic ganglionic blockers, skeletal muscle relaxants, central nerves system (sedative-hypnotics, antiepileptic, anesthetics, anxiolytics), analgesics (opioids, non-steroidal anti-inflammatory drugs).
Course Outcomes: Describe fundamental concepts in pharmacology Classify drugs based on action Understand the mechanism of action of different types of drugs Explain the factors affecting the drugs Illustrate the obtained knowledge for good healthcare
Recommended Books: Latest Edition of Following Books 1. McCuistion, L. E., DiMaggio, K. V., Winton, M. B., & Yeager, J. J. (2021). Pharmacology: A Patient-Centered Nursing Process Approach. Elsevier Health Sciences. 2. Hill, R. G., & Richards, D. (Eds.). (2021). Drug discovery and development E-book: technology in transition. Elsevier Health Sciences. 3. Satoskar, R. S., & Bhandarkar, S. D. (2020). Pharmacology and pharmacotherapeutics. Elsevier India. 4. James M Ritter and Lionel De Levis, A Text book of Clinical Pharmacology, 5th Ed Oxford University Press, New York, 2008. 5. J D Tripathy, Essential of Medical Pharmacology, Japees Brother, New Delhi, 6th Ed., 2008. 6. Katzung B G, Basic and Clinical Pharmacology, McGraw-Hill Medical Publishers, New York, 11th Ed., 2009. 7. Lippincott, Pharmacology, 4th Ed, Lippincott William & Wilkins, USA, 2008.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – VII

Course Name: Internship (Mandatory)	**Course Code:** BCHM-698
Course Structure: 3 Cr. Hrs	**Credit Hours:** 3

Course Name: Genomics	**Course Code:** BCHM-617
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3
Prerequisites: None	
Course Objective: To provide students with a thorough overview of theoretical and experimental aspects of structural and functional genomics. To equip students with basic applications of genomics to molecular techniques and software programs.	
Course Outline: Organization and structure of genomes. Genetic mapping (RFLP, microsatellite, SNP); High-resolution physical mapping (STS, EST); flow cytometry; Somatic cell and radiation hybrids; artificial chromosomes in bacteria and yeast; Hierarchical and whole genome shotgun sequencing; DNA sequencing strategies - manual and automated sequencing, pyrosequencing, Solexa, Helicos, Roche 454, real-time and nanopore sequencing; Sequence assembly, obstacles and solutions; estimating gene number – over-prediction and under-prediction, homology searches, Exon prediction programs, integrated gene-finding software packages. Structural variation in the genome and its applications; Microarray and RNA interference.	
Course Outcomes: At the end of the course the student will be able to: • Understand genomic processes and its application in various techniques. • Evaluate the structure of genome and know how to apply software programs and integrated gene-finding packages. • Appraise observed heritable traits through study of DNA sequences and phylogenetics under a model of evolution of these traits.	
Recommended Books: Latest Edition of Following Books 1. Thompson & Thompson, Genetics and Genomics, 2023, Publisher Elsevier. 2. UK Devisetty. Deep Learning for Genomics: Approaches for genomics applications in life sciences and biotechnology, 2022, Packt Publishing. 3. Michael L. Goldberg, Janice A. Fischer, Leland Hartwell, Leroy E. Hood, Genetics From Genes to Genomes, 2021, Springer. 4. Aparna B. Gunjal, Javid Ahmad Parray, Rebecca Thombre. Genomics, Physiology and Biotechnological Applications, 2021, IGI Global. 5. Strachan T and Read AP, 2010. Human Molecular Genetics. 4th Edition; Garland Science. 6. Krebs et al., 2010. Lewin Genes X. 10th Edition; Jones and Bartlett Publishers.	

Course Name: Biomembranes and Cell Signaling	**Course Code:** BCHM-612
Course structure: Lectures: 3 Lab :0	**Credit Hours:**3 (3+0)
Prerequisites: None	
COURSE OBJECTIVES:	

The aim of this course is to equip students with understanding the structures of biological membranes as well as signal transduction pathways. Topics to be covered include membrane structure and functions, membrane transport, and signal transduction networks and how they communicate with each other and impact gene expression.

COURSE OUTLINES:

Introduction of structural and functional properties of natural and synthetic Biomembranes, Fluid mosaic model, Types of transport across biomembranes, Membranes of erythrocytes, intestinal mucosa, retinal cells and nerve cells, Introduction to concepts of cellular signaling, receptors, transducers, primary and second messengers; signal amplification; The plasma membrane as transducer and amplifier; second messengers; DAG, calcium, Cyclic AMP, Cyclic GMP, Inositol 3 Phosphate; cell signaling pathways and networks: their activation and impact on gene expression; G-protein and G-protein coupled receptors. Neurotransmitters. Cellular signaling via protein phosphorylation and kinases; TGF beta; Cytokine receptors; JAK/STAT pathways

RECOMMENDED BOOKS:

1. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. (2022). Cell biology E-book. Elsevier Health Sciences.
2. Standring, S. (Ed.). (2021). Gray's anatomy e-book: the anatomical basis of clinical practice. Elsevier Health Sciences.
3. Waller, D. G., Sampson, A., & Hitchings, A. (2021). Medical pharmacology and therapeutics E-Book. Elsevier Health Sciences. Molecular Cell Biology (2007) 6th Edition. H. Lodish, C.A. Kaiser, M. Krieger. M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira, W.H.Freeman.
4. Biochemistry (2007) 6th edition by J.M. Berg, J.L. Tymoczko& L. StryerW.H. Freeman & Co.
5. Molecular Biology of the Cell, (2008) 5th Editon .B. Alberts, A. Johnson, J.Lewis, M. Raff, K. Roberts & P. Walter 5th Edition Garland Sciences,Taylor and Francis
6. Molecular Cell Biology (2007) 6th Edition. H. Lodish, C.A. Kaiser, M.Krieger. M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira, W.H.Freeman.
7. Cell and Molecular Biology: Concepts and Experiments (2008) by G.Karp John Wiley &Sons

Course Name: Environmental Biochemistry	**Course Code:** BCHM-641
Course structure: Lectures: 2, Lab :1	**Credit Hours:**3 (2+1)
Prerequisites: None	

COURSE OBJECTIVES:

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

COURSE OUTLINES:

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, Waste water treatment, Radiation hazards, Biomarkers used to assess environmental exposures. EPA Guidelines.

PRACTICAL:

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, Hydroponics growth of plants.

RECOMMENDED BOOKS:

1. Manahan, S. E. (2022). Environmental biochemistry. CRC press.
2. Yadav, A. N., Mishra, S., Kour, D., Yadav, N., & Kumar, A. (Eds.). (2020). Agriculturally important fungi for sustainable agriculture. Cham: Springer.
3. Fahad, S., Hasanuzzaman, M., Alam, M., Ullah, H., Saeed, M., Khan, I. A., & Adnan, M. (Eds.). (2020). Environment, climate, plant and vegetation growth. Springer International Publishing.
4. Cockerham, L. G., & Shane, B. S. (2019). Basic environmental toxicology. Routledge. Environmental Biochemistry Vol-3 Neelima Rajvaidya, Dilip Kumar Markandey, APH Publishing.
5. Enviornmental Biochemistry Eric Hamilton, 2013.
6. Understanding Environmental Pollution, Hill, M.K., 2nd Edition. Cambridge University Press, 2005.
7. Environmental Contaminants: Assessment & Control, Dairel, A.V., Academic Press, USA, 2005.
8. Standard Methods for the Examination of Water & Wastewater. American Public Health Association (APHA), 2003.
9. An Air That Kills Andrew Schneider and David McCumber Berkley Publishing (Penguin Group) January 2005

Course Name: Biochemical Techniques	Course Code: BCHM:642
Course structure: Lectures: 1, Lab :2	**Credit Hours:** 3 (1+2)

Prerequisites: None

COURSE OBJECTIVES:

This course provides the information of principles & mechanism of different equipment and analysis of Biochemical and Biological samples.

COURSE OUTLINES:

Homogenization, centrifugation, ultra-centrifugation, paper, TLC, and column chromatography, Gel filtration, ion exchange chromatography, affinity chromatography, HPLC, lyophilization, Gel electrophoresis, flame photometry, spectro-fluorimetry, UV / visible spectrophotometry and use of radioisotopes. Blotting techniques including Southern and western blotting, ELISA, Microarray,

PRACTICAL:

Preparation of sample for mineral analysis by ashing method; Wet digestion procedure of sample preparation for mineral analysis; Mineral analysis of plant tissues using atomic absorption spectrophotometer. Separation of Biomolecules by affinity chromatography identification of sugars, proteins etc. by uv/vis spectrophotometer. Determination of sodium and potassium content in blood serum by flame photometer. Separation of amino acids by amino acid analyzer. Gel chromatography and ion exchange chromatography. Determination of molecular weight of a given protein by gel filtration. Separation of Hb and serum proteins by electrophoresis. Disk-gel electrophoresis of proteins. Separation of proteins by isoelectric focusing.

RECOMMENDED BOOKS:

1. Rouessac, F., & Rouessac, A. (2022). Chemical analysis: modern instrumentation methods and techniques. John Wiley & Sons.
2. Mahon, C. R., & Lehman, D. C. (2022). Textbook of diagnostic microbiology-e-book. Elsevier Health Sciences.Hawk's Physiological chemistry McGraw-Hill publishing company
3. Boldura, O. M., Balta, C., & Awwad, N. (Eds.). (2020). Biochemical Analysis Tools: Methods for Bio-Molecules Studies. BoD–Books on Demand.
4. Shanmugam, S., Kumar, T. S., & Panneer Selvam, K. (2019). Laboratory handbook on biochemistry. PHI Learning Pvt. Ltd.
5. Principles and Techniques of Biochemistry and Molecular Biology 6th Edition. Edited by K. Wilson & J. Walker.
6. *Pierce Genetics Conceptual Approach 4th,2012, by W. H. Freeman and Company.41 Madison Avenue New York.*

Course Name: Capstone Research project	**Course Code:** BCHM-699
Course Structure: 3 Cr. hrs. Research	**Credit Hours:** 3

Course Name: Capstone project	**Course Code:** BCHM-697
Course Structure: 3 Cr. hrs. project	**Credit Hours:** 3

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILED COURSE OUTLINE OF BS 4 YEAR PROGRAM WITH MAJOR BIOCHEMISTRY

SEMESTER – VIII

Course Title: General Immunology	Course Code: MB-503	Credit Hours: 4(3+1)
Prerequisites: None		

OBJECTIVES

1. To understand the basis of immunity, cells and organs involved in immunity.
2. To understand the role of blood group and MHC in transplantation.
3. To know about cancer immunology.
4. To understand different disorders of immune system.

Course Detail

Introduction: chronological development and scope of immunology. Immunity and immune responses: Definitions and types (specific and non-specific). Humoral and cellular immunity. Introduction to complement system. Cells and tissues of immune system. The antigens: structure (simple and complex molecules, proteins and polysaccharides) and immunogenicity. Tissue

antigens: the Allo- and heterophile antigens. The ABO and Rh blood group systems, their chemical basis, inheritance & clinical significance. Immunoglobulin: structure and function; classes, subclasses, types and subtypes. Introduction to antigen-antibody reactions: methods for detecting antigens and antibodies (agglutination, precipitation, complement fixation, EIA, etc.). Introduction to HLA & MHC and its role in immune response, disease and its significance in tissue transplantation. Immune-regulation and tolerance. Introduction to Cancer immunology. Autoimmune diseases and immune-deficiencies, immunization.

Practical

1. Differential leukocyte count.
2. Blood grouping (ABO & Rh).
3. Immuno-diagnostic Methods.
4. Agglutination test (Widal test).
5. Precipitation tests.
6. Gel diffusion test.
7. ICT Test.

Recommended Books

1. Chen, E. R. 2019. Deja Review: Microbiology and Immunology, McGraw-Hill Companies, N.Y.
2. Van Emon, V. M. 2006. Immunoassay and Other Bioanalytical Techniques, CRC Press, F.L.
3. Abbas, A. K., Lichtman, A. H. and Pillai, S. 2019. Cellular and Molecular Immunology, 9th edition, Elsevier Health Sciences, N.Y.
4. Johnson, A. G. G., Ziegler, R. J., Lukasewycz, O. A. and Lukasewycz, O. A. 6th edition, 2014. Microbiology and Immunology: Board Review Series, Lippincot Williams and Wilkins, M.D.
5. Lichtman, A. H. 2019. Basic Immunology Function and disorders of the immune system. Elsevier Health Sciences, N.Y.
6. Kenneth M Murphy; Casey Weaver; Allan Mowat; Leslie Berg; David Chaplin; Charles A Janeway; Paul Travers; Mark Walport 2017. Janeway's Immunobiology (Immunobiology: The Immune System, 9th Edition. Garland Science Publishers.
7. Punt, Jenni, Jones, Patricia P. Owen, Judith A, Stranford, Sharon A.2019, 10th edition, Kuby Immunology, Macmillan Education, New York, 2019.

Course Name: Methods in Molecular Biology	**Course Code: BCHM-643**
Course structure: Lectures: 1, Lab :2	**Credit Hours:3 (1+2)**
Prerequisites: None	
COURSE OBJECTIVES: 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 OUTCOMES:**	

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

COURSE OUTLINE:

Introduction to recombinant DNA technology; Restriction enzymes; Cloning and expression vectors and their types; Expression of recombinant proteins and their purification by affinity chromatography; Polymerase chain reaction (PCR) - types; (inverse, touchdown, 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; Generation of antibodies and their uses; enzyme-linked immunosorbent assay; DNA sequencing technologies

PRACTICLES:

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. Donald, B. R. (2023). Algorithms in structural molecular biology. MIT Press.
2. Shen, C. H. (2023). Diagnostic molecular biology. Elsevier.
3. Seymour, G. J., Cullinan, M. P., Heng, N. C., & Cooper, P. R. (Eds.). (2022). Oral biology: molecular techniques and applications (Vol. 2588). Springer Nature.
4. Pecorino, L. (2021). Molecular biology of cancer: mechanisms, targets, and therapeutics. Oxford university press. Benjamin Lewin, 2017. Gene XII, 12th edition, Jones & Bartlett Learning
5. T. A. Brown. 2016. Gene Cloning and DNA Analysis: An Introduction,7th Edition. Wiley-Blackwell.
6. Green MR and Sambrook J, 2014. Molecular Cloning: A Laboratory Manual.4th Edition; Cold Spring Harbor Laboratory Press.
7. Recombinant DNA technology paper – July 19, 2013, by Keya Chaudary
8. Wilson K and Walker J, 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition; Cambridge University Press.

6. Walker JM and Rapley, 2008. Molecular Biomethods Handbook (Methods in Molecular Biology). 2nd Edition; Humana Press.
7. Primrose SB and Twyman R, 2006. Principles of Gene Manipulation and Genomics. 7th Edition; Wiley-Blackwell.
8. Ausubel FM, 2005. Short Protocols in Molecular Biology (2 volume set). 5th Edition; John Wiley and Son.

Course Name: Cancer Biology	**Course Code:** BCHM- 616

Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3(3+0)

Prerequisites: None

COURSE OBJECTIVES:
This course will teach the students to be conversant on issues related tocancer, its etiology, development, carcinogenic agents, treatment and prevention. The main aim and objective of this course is to educate the students on various genetic and molecular changes in normal cells that undergo during transformation into malignant cells.

COURSE OUTLINES:
Overview of Cell cycle, Stages of cell cycle and its regulation. Check Point: S Phase Inducer, M Phase Kinase, Regulatory activities in S and M. Phase (Heterokaryon experiments). Use of Cell culture in cancer research, Cell strain, Cell lines, Conversion of cell lines into transformed cells, Properties of Transformed cells, Oncogene and its types. Growth factors, Receptors, Signal Transducer, Transcriptional Factors and Cell Cycle Genes. Tumor Suppressing genes: (Rb and P53 etc.). Tumor inducing DNA and RNA Viruses. Cancer staging, Types of Cancer: Human Colon Cancer, Breast Cancer, cervical Cancer, Lung cancer, Hepatic carcinoma. Cancer Epidemiology and Prevention Risk factors and Carcinogenic agent: Chemicals and Radiations. Tumor Invasion and Metastasis. Role of Nutrients, Hormones and Gene Interaction in Carcinogenesis. Cancer Therapy.

RECOMMENDED BOOKS:

1. Hesketh, R. (2023). Introduction to cancer biology. Cambridge University Press.
2. Pecorino, L. (2021). Molecular biology of cancer: mechanisms, targets, and therapeutics. Oxford university press.
3. Barzaman, K., Karami, J., Zarei, Z., Hosseinzadeh, A., Kazemi, M. H., Moradi-Kalbolandi, S., ... & Farahmand, L. (2020). Breast cancer: Biology, biomarkers, and treatments. International immunopharmacology, 84, 106535.The Biology of Cancer by Robert A Weinberg.
4. Cancer Biology by Raymond W. Ruddon, latest edition (2021), Oxford University Press.
5. Wintrobe's Clinical Haematology by Maxwell, M. Wintrobe, G. Richard Lee, (2020). Williams and Wilking Publishers, New York.

Course Name: Cell and Tissue culture	**Course Code:** BCHM- 620
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3(3+0)

Prerequisites: None

COURSE OBJECTIVES;
The main objectives of this course are:

- To provide a thorough understanding of the importance of cell, tissue and organ cultures

- To strength the concepts of its application in life sciences

COURSE OUTLINES:

Plant cell and tissue culture:
Requirements for in vitro 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; 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;
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animal cells for bioassays and bio-products; design and operation of animal cell culture bioreactors for therapeutic protein production; growth environment; Stem cell culture

Learning outcomes:

After completing this course, the students will be able to:
 Understand the basics of cell, tissue and organ culture
 Grow and handle different cell cultures
 Prepare bioassays specific tissue culture

RECOMMENDED BOOKS:

1. Brar, D. S., & Khush, G. S. (2021). Cell and tissue culture for plant improvement. In Mechanisms of Plant Growth and Improved Productivity Modern Approaches (pp. 229-278). CRC Press.
2. Tripathi, M. K., Tiwari, S., Tripathi, N., Tiwari, G., Bhatt, D., Vibhute, M., ... & Tiwari, S. (2021). Plant Tissue Culture Techniques for Conservation of Biodiversity of Some Plants Appropriate for Propgation in Degraded and Temperate Areas. Current Topics in Agricultural Sciences; BP International Publisher: Bhanjipur, India.
3. Chandran, H., Meena, M., Barupal, T., & Sharma, K. (2020). Plant tissue culture as a perpetual source for production of industrially important bioactive compounds. Biotechnology reports, 26, e00450.
4. Setlow JK, 2000. Genetic Engineering: Principles and Methods. Kluwer Academic Publishers.
5. Nicholl DST, 2002. An Introduction to Genetic Engineering. 2nd Edition; Cambridge University Press.
6. Razdan MK, 2003. Introduction to Plant Tissue Culture. 2nd Edition; Intercept, New York, USA.

Course Name: Capstone Research project	**Course Code:** BCHM-699
Course Structure: 3 Cr. hrs. Research	**Credit Hours: 3**

Course Name: Capstone project	**Course Code:** BCHM-697
Course Structure: 3 Cr. Hrs Elective Course	**Credit Hours: 3**

CURRICULUM FOR MS /PHD BIOCHEMISTRY

Ex-post Facto approval for MS program session 2021-2022 and session 2022-2023 in Biochemistry, Course Codes, and scheme of studies for program are classified as:

1st Semester

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	CREDIT HOURS
1.	1st	Advanced Biochemistry	BCHM-721	3	3
2.		Statistical analysis in Biochemistry	STAT-705	3	3
3.		Elective I:	BCHM-	3	3
4.		Advanced Molecular Biology	BCHM-723	3	3
			Total Credit Hours	**12**	**12**

2nd Semester

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	CREDIT HOURS
1.	2nd	Advanced Molecular Genetics	BCHM-724	3	3
2.		Elective II	BCHM-	3	3
3.		Advanced Research Methodology/ Advanced Bioinformatics	BCHM-725/ BCHM726	3	3
4.		Elective III	BCHM-	3	3
			Total Credit Hours	**12**	**12**

3rd and 4th semester will comprise of Research Project and Thesis of 06 credit hours with course code BCHM799.

For MS program session 2023 onwards in Biochemistry, Course Codes, and scheme of studies for program are classified as:

1st Semester

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	Practical	CREDIT HOURS
1.	1st	Core I	BCHM-	3	0	3
2.		Core II	BCHM-	3	0	3
3.		Elective I	BCHM-	3	0	3
4.		Elective II	BCHM-	3	0	3
Total Credit Hours				**12**		**12**

2nd Semester

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	Practical	CREDIT HOURS
1.	2nd	Core III	BCHM-	3	0	3
2.		Core IV	BCHM-	3	0	3
3.		Elective III	BCHM-	3	0	3
4.		Elective IV	BCHM-	3	0	3
	Total Credit Hours			**12**	**0**	**12**

3rd and 4th semester will comprise of Research Project and Thesis of 06 credit hours with course code BCHM799.

List of Core courses for MS/M.Phil

Advanced Biochemistry	BCHM-721
Statistical analysis in Biochemistry	STAT-705
Advanced Molecular Biology	BCHM-723
Advanced Molecular Genetics	BCHM-724
Advanced Research methods in Biochemistry	BCHM-725

Advanced Bioinformatics	BCHM-726
Advanced Biochemical Techniques	BCHM-727
Advanced Neurochemistry	BCHM-728
Advanced Human Physiology	BCHM-729

Details of Core Courses

Course Title: Advanced Biochemistry	**Course Code: BCHM-721**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Rehana Masood	
Course Objectives: This course will cover the details of macromolecules such as carbohydrates, proteins, nucleic acids and lipids, their structures and functions. It will describe the physical-chemical properties of amino-acids, lipids, nucleotides and sugars and will give the concept of physical-chemical factors that influence the activity of macromolecules.	
Course Outline: Introduction, foundation of Biochemistry, water, buffer, pH and solution. Protein Structure and Function A detailed study of protein structure, including primary, secondary, tertiary, and quaternary structures. Protein folding, stability, and conformational changes. Enzyme kinetics and mechanisms. Nucleic Acids and Genetic Information. Structure and function of DNA and RNA. DNA replication, transcription, and translation. Regulation of gene expression. Metabolism and Bioenergetics Overview of central metabolic pathways, including glycolysis, citric acid cycle, and oxidative phosphorylation. Energy production and utilization in cells. Regulation of metabolism and metabolic integration. Biochemical Signalling and Cell Communication Cellular signalling pathways and signal transduction mechanisms. Role of second messengers, receptors, and protein kinases. Communication between cells and the regulation of cellular processes. Carbohydrate Metabolism Glycolysis, gluconeogenesis, and glycogen metabolism. Regulation of blood glucose levels. Disorders related to carbohydrate metabolism. Lipid	

Metabolism Fatty acid synthesis, β-oxidation, and lipid degradation. Cholesterol biosynthesis and metabolism. Lipid transport and storage. Biochemical Techniques and Instrumentation. Genetic disorders and metabolic diseases. Therapeutic approaches targeting biochemical pathways. Current Advances in Biochemistry.
Recommended Books & Readings: 1. Stryer, L. 2012. Biochemistry, 7th Edition, W. H. Freeman and C0. 2. Nelson, D.L and M.M. Cox. 2017. Lehninger Principles of Biochemistry. 7th ed. Worth Publishers, New York, NY, USA. 3. Lehninger, A.L. 1982. Principles of Biochemistry. Worth Publishers, Inc. New York, NY, USA. 4. Cornish, B. A. 2004. Fundamentals of Enzyme Kinetics. Portland Press, UK. 5. Lesakovac, L. 2003. Comprehensive Enzyme Kinetics. Kluwer Academic/ Plenum Publishers, New York, NY, USA. 6. Neale Ridgway (ed.); Roger McLeod (ed.) 2021. Biochemistry of lipids, Lipoproteins and membranes 7th ed. Publisher, Elsevier Science.

Course Title: Statistical analysis in Biochemistry	**Course Code: STAT-705**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Asma Gul	
Course Objectives: • To discuss and explain biostatistics and its utilization in Biological Sciences	

- To know the data and apply appropriate measure for description and inferences.
- To use statistical techniques to summarize the Biological data

Course Outline: Definition of Biostatistics, type of variables, scale of measurements and observations in biological, health and medical sciences. behavior of variables their domain, and units. Censored data. Data presentation. Measure of central tendency and dispersion. Population, Target populations, sample and sample size. Role of sampling in biostatistics. Hypothesis testing.
Proportions, rates and ratios; incidence, prevalence and odds. Probability and odd ratio. Simple linear regression; model fitting. Correlation; correlation co-efficient, co-efficient of determination. Logistic regression; Logit transformations and their analysis. P- values, its importance and role. Distributional behavior of biological variables (Binomial, Poisson and Normal).

Recommended Books & Readings:

1. Alfassi Z. B., Boger, Z. and Ronen, Y. (2005): Statistical Treatment of Analytical Data. Blackwell Science, USA.

2. Antonisamy, B. Premkumar, P. and Christopher, S. (2017). Principles and Practice of Biostatistics. 1st edition. Elsevier, India.

3. Daniel, W.W. (2010). Biostatistics: A Foundation for the Health Sciences. 6th edition. John Wiley, New York. NY, USA.

4. Dunn, G. and Everit, B. (1995). Clinical Biostatistics. Edward Arnold, London, UK.

5. Sullivan, M.L. (2018). Essentials of Biostatistics in Public Health. 3rd edition. Jones and Bartlett Learning, Burlington, MA, USA.

6. Zar, J. (2000). Biostatistical Analysis. 5th Edition. John Wiley & Sons, New York, NY, USA.

Course Title: Advanced Molecular Biology	**Course Code: BCHM-723**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Bushra Ahmad	
Course Objectives: Students will be able to understand the mechanisms of molecular biology at advanced levels. Student will be able to understand the conceptual approach underlie in central dogma of Molecular Biology.	
Course Outline: Replication: Models of DNA Synthesis, Conservative and dispersive models, Semiconservative synthesis of DNA, mechanism of replication, in prokaryotes and eukaryotes. DNA repair systems, epigenetics DNA methylation, Histone acetylation and methylation, genomic imprinting, noncoding RNA. Transcription: Transcription of protein coding, and non-protein coding genes, Mechanism of transcription in Prokaryotes and Eukaryotes, Differences Between Replication and Transcription, Reverse transcription, post transcriptional modifications and RNA processing. Translation: Protein synthesis in Prokaryotes and eukaryotes, Open Reading Frame, Genetic code and its degeneracy, Wobble Hypothesis, Post-Translational Modifications. Mechanism of Genetic Drifts: Transposable Genetic Elements, rearrangements mediated by transposable elements, Types and mechanism of transposable elements in Prokaryotes and eukaryotes, Gene Regulation: Regulation of gene expression in Prokaryote, Constitutive, Inducible, and Repressible genes, Induction of Genes for Lactose Utilization, Repression of Genes for Tryptophan Biosynthesis, Organization of a bacterial operon, Positive and Negative Control Mechanisms, Components of the Operon Model.	
Recommended Books & Readings: 1. Pearson Essentials of Molecular Biology, 4th edition, 2015. 2. Watson, J.D. 2004. Molecular Biology of Gene. Pearson Education, Singapore. 3. Weaver, R.F. 2005. Molecular Biology. Mc Graw Hill St. Louis. 4. Gibson, G. and S.V. Muse, 2002. A Premier of Genome Science, Sinauer Associates Inc. Massachuett Lodish, H. 2004. Molecular Cell Biology, 4th Edition, W.h. freeman & Co. New York	

V.Malathi 2013, Ethiraj Pearson Essentials of Molecular Biology

Course Title: Advanced Molecular genetics	**Course Code: BCHM-724**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Bushra Ahmad	
Course Objectives: This course will cover the various concepts of genetics at advanced level. This will provide a deep understanding about the genetic principles inherited. Students will learn about the conceptual approach to the genetics of various traits. Students will be able to identify the patterns of inheritance in various families through the concept of pedigree.	
Course Outline: Extensions and modifications of basic principles of mendalian genetics, concept and types of dominance, lethal alleles, penetrance and expressivity, multiple alleles with examples of duck feather patterns and abo blood groups, gene interaction in capsicum annuam. Pedigree analysis, types of pedigrees: autosomal recessive traits, autosomal dominant traits, x-linked recessive traits, x-linked dominant traits, y-linked traits. Linkage and recombination: linked genes and crossing over, notation of linkage, linked genes segregate independently, calculating recombination frequency, gene mapping with recombination frequencies, constructing a genetic map with the use of two and three-point testcross to map three linked genes, determination of gene order, determination of cross over. twins and adoption studies to consider genetics and environmental factors: types of twins, concordance in twins, adoption studies. Genetic counselling, genetic testing including ultrasonography, amniocentesis, chorionic villus sampling, maternal blood screening	

tests, noninvasive fetal diagnosis, preimplantation genetic diagnosis, newborn screening, interpreting genetic tests.
Recommended Books & Readings: 1. Benjamin A. Pierce, Genetics: A conceptual approach: 4th edition, southwestern university, 2. Pearson Essentials of Molecular Biology, 4th edition, 2015. 3. Molecular Cell Biology. 8th Edition. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., and Darnell, J. E. W. H. Freeman, USA. 2016.

Course Title: Advanced research methods in Biochemistry	**Course Code: BCHM-725**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Rehana Masood	
Course Objectives: To Combine different biochemical methods to address a complex biological question. Troubleshoot biochemical methods based on their scientific principles. Impart knowledge regarding literature survey and review. Develop/structure research synopsis for thesis and research grants. Develop technical skills for writing research reports, articles, and thesis.	

Course Outline:

Introduction to research methods, types of research methods, qualitative and quantitative research methods and its types. Instrumentation in biochemistry research. Biochemistry research philosophy: Types of research in Biochemistry; Laboratory safety and management in biochemistry; Ethics in biochemistry and role of ethical committee in research; Survey of literature; Research hypothesis, Gap in literature; Selection of a research topic; Data interpretation; Software use for data interpretation with special contexts of biochemistry; Writing a research proposal of Biochemistry; Plagiarism, its types and how to avoid it; Use of plagiarism detection software's; Writing synopsis; Writing of a research paper; Journal selection for biochemistry and submission of a manuscript; Review article; Short communication; Conference presentation, Referencing software's used in biochemistry; Peer review process; How to address editor and reviewers comments with practical examples; Thesis writing; Journal article discussion. Patent; Importance of patent; Need of patent. Preparing and delivering effective scientific oral presentation, Poster preparation and presentation in biochemistry.

Recommended Books & Readings:

1. E. A. Godwill. 2015. Fundamentals of Research Methodology: A Holistic Guide for Research Completion, Management, Validation and Ethics, Nova Science Publishers Hauppauge, New York, United States.

2. R. P. Singh. 2014. Research Methodology in Biochemistry, 1st. ed ALP Books.

3. A. S. Sharma. 2012. Research Methodology and Techniques in Biochemistry Anmol Publication, India.

4. S. B. Mishra and S. Alok. 2017. Handbook of Research Methodology Edu creation Publishing.

Course Title: Advanced Bioinformatics	**Course Code: BCHM-726**

Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Rehana Masood	
Course Objectives: To understand the concepts of basic computational tools in the field of Biochemistry. To train the students about using different software for visualizing and analyzing various types of structural data. Build students' background about protein-ligand interactions and develop their skills to explore the important features involved in these interactions and the basic pharmacophore concept and methods for generating them.	
Course Outline: Introducing fundamental biological bioinformatics repositories and retrieval of database entries. Introduction to biological sequences alignment, Phylogenetics. Multiple sequence alignment, Evolutionary Alignment. Amino acids substitution scoring schemes, including Pint Accepted Mutation (PAM) and Blocks Substitution Matrix (BLOSUM) matrices. Position-specific scoring matrices. Hidden Markov models. Protein structure modeling and prediction. Homology modeling. Ramachandran Plot analysis. Computational methods for structure-based drug designing. Molecular Docking and Virtual Screening. Rational Drug Designing. Proteins structural informatics. Computer-Aided Drug Designing and Application. Introduction and overview of pharmacophore searching applications. Pharmacophore generating programs. Generation of pharmacophores by using Discovery Studio Visualizer. Receptor-based pharmacophore. Ligand-based pharmacophores. Significance of Hydrogen bond interactions. Protein-ligand interactions. Pharmacophore database searches. Pharmacophore searching versus docking. Quantitative structure-activity relationships (QSAR) methods. Introducing Searching Algorithms for screening huge virtual combinatorial libraries of diverse compounds. Vector method. Query atom method.	
Recommended Books & Readings: 1. Computational Molecular Biology: AN INTRODUCTION, Clote Peter Et., al 2014, Wiley India Pvt Ltd. 2. Computational Biology: Introduction to Proteins: Structure, Function, and Motion, Amit Kessel & Nir Ben-Tal, 2nd Edition, 2018, Chapman & Hall/CRC Series. 3. Bioinformatics, Volume II: Structure, Function, and Applications, Jonathan M. Keith (Edited), 2017, Humana Press. 4. Computer-Aided Drug Designing: D. B. Singh (Ed), 2020, Springer Nature Singapore Pte Ltd.	

5. An Introduction to Computational Systems Biology: Systems-Level Modelling of Cellular Networks, Karthik Raman, Kindle Edition, 2021, Chapman & Hall/CRC Computational Biology Series.

6. Bioinformatics with Python Cookbook: Use modern Python libraries and applications to solve real-world computational biology problems, Tiago Antao (Ed), 3rd Edition, 2022, Packt publishing.

Course Title: Advanced Biochemical Techniques	**Course Code: BCHM-727**
Course Structure: Lectures, 2 Hours	**Credit Hours:**
Course Designed by: Dr. Sidra Pervez	
Course Objectives: The objective of this course is to provide information of principles & mechanism of different techniques used for analysis of biological samples and to Provide students with a "snapshot" of a career in research by transmitting student's knowledge to practical applications.	
COURSE OUTLINES: Isolation and separation of nucleic acids, Polymerase chain reaction, Cell culture techniques including stem cell culture and bacterial cell culture, Microscopic techniques including light, electron and immuno microscopy, One and two dimensional electrophoresis, Staining techniques in electrophoresis and cytometry, chromosome staining, Cell and tissue staining techniques, Western, Southern, Northern and Immuno Blotting, Immunoaffinity chromatography, Enzyme linked immunosorbent assay (ELISA), Nuclear magnetic resonance (NMR), Mass spectrometry, atomic absorption spectrophotometry	
Recommended Books & Readings: 1. . Bhatia, R., and Kumar, B. (2023). Modern Approaches in Fluid Chromatography: Impact and Applications, NY. 2. Polenova, T., Quinn, C.M. Gronenborn, A.M. (2023). Integrated structural biology. 3. Sripathi, S. S., and Pandey, P. (2020). Overview of blotting techniques. Cambridge.	

4. Jain, A., Jain, R., and Jain, S. (2020). Basic Techniques in Biochemistry, Microbiology and Molecular Biology. Humana New York, NY.

5. Hofmann, A., & Clokie, S. (Eds.). (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge: Cambridge University Press. doi:10.1017/9781316677056.

6. Katoch, R., (2014). Analytical Techniques in Biochemistry and Molecular Biology, Springer, New York. Springer, New York.

Course Title: Advanced Neurochemistry	**Course Code: BCHM-728**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Riffat Jehan	
Course Objectives To provide basic and fundamental concepts of nervous system, comprehend the role of neurotransmitters in the modulation of brain function and to understand mechanism and signaling pathways in the brain in health and diseases.	
Course Outline: Introduction to neuroscience: Nervous system, Sympathetic, Parasympathetic and motor nervous system and their functions, Brain and its functions, Neuron and glia, structure of a neuronal cell, types of glia, Blood brain barriers. Neuronal Circuits: Neuronal circuit in emotional control, Neuronal circuit in reward and addiction, Neuronal regulation of stress. Receptors: Ionotropic and metabotropic receptors, signal transduction pathways, G proteins, protein phosphorylation, Signaling to the nucleus. regulation of gene expression. Neurotransmitters: Excitatory and inhibitory amino acid neurotransmitters, Functions in the brain, Pain pathways in brain, Role of excitatory neurotransmitter in learning and memory, Diseases associated with the malfunctioning of	

these neurotransmitters, Neuronal degeneration. Catecholamines: Functions in the brain, Diseases associated with the malfunctioning. Neuroendocrine and motivational systems: Endocrine systems, Feeding behavior, Stress. Diseases of the nervous system: Addiction, Depression, Schizophrenia, Epilepsy, Alzheimer, Parkinson, Prion, Motor Neuron Disease.
Recommended Books & Readings: 1. 1. Christophe Habas, The Neuroimaging of Brain Diseases: Structural and Functional Advances (Contemporary Clinical Neuroscience) 1st ed. 2018. 2. Lola Thompson, Advances in Neurochemistry Research, Neuroscience Research Progress, 2016. 3. Eric R. Kandel, John D. Koester, Sarah H. Mack, Steven A. Siegelbaum, Principles of Neural Science, Sixth Edition, 2021. 4. Scott Brady, George Siegel, Basic Neurochemistry: Molecular, Cellular and Medical Aspects, 9th Edition 2024. 5. Darakhshan Haleem, Neurochemistry, Neuropharmacology and Behavior: Outlines on the mechanism of brain function, 2010.

Course Title: Advanced Human Physiology	**Course Code: BCHM-729**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Bushra Ahmad	
Course Objectives: By the end of the course the students will be able to Develop an advanced understanding of the principles and mechanisms underlying human physiological processes. They will learn how to explore integrative physiological mechanisms that coordinate the function of multiple organ systems. They will be able	

to analyze physiological adaptations to environmental challenges, stressors, and disease states.

Course Outline: Cellular Physiology, Cell membrane transport mechanisms, Cell signaling pathways and signal transduction, Cellular metabolism and energy production. Nervous System, Anatomy and function of the nervous system, Neuronal communication: neurotransmitters, synapses, and action potentials, Central and peripheral nervous system integration and regulation, Nervous system disorders. Cardiovascular System, Structure and function of the heart and blood vessels, Cardiac electrophysiology and regulation of cardiac output, Blood pressure regulation and cardiovascular reflexes and cardiac disorders, Respiratory System, Pulmonary ventilation and gas exchange. Oxygen transport and carbon dioxide transport in the blood, Regulation of respiration and respiratory reflexes and respiratory disorders. Renal System, Anatomy and function of the kidneys and urinary tract, Glomerular filtration, tubular reabsorption, and secretion, Regulation of water and electrolyte balance, acid-base balance, renal disorders. Gastrointestinal System. Structure and function of the gastrointestinal tract, Digestion, absorption, and metabolism of nutrients, Regulation of gastrointestinal motility and secretion. Endocrine System, Endocrine glands and hormone synthesis, Mechanisms of hormone action and regulation, Integration of endocrine signaling with other physiological systems. Integration and Homeostasis, Physiological integration and coordination of organ systems, Homeostatic mechanisms and adaptive responses to environmental challenges, Physiological responses to stress, exercise, and disease

Recommended Books & Readings:

1. Guyton and Hall Textbook of Medical Physiology By John E. Hall and Micheal E. Hall, 2020, Elsevier, 1152 Pages

2. The Human Body in Health and Illness, By Barbara Herlihy, 2021, Elsevier, 584 Pages.

3. Anatomy & Physiology Made Easy: An Illustrated Study Guide for Students To Easily Learn Anatomy and Physiology Paperback – October 25, 2021, by NEDU Publisher.

4. Updated research articles and review articles.

For PHD program session 2023 onwards in Biochemistry, Course Codes, and scheme of studies for program are classified as:

1st Semester

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	CREDIT HOURS
1.	1st	Core 1	BCHM-	3	3
2.		Elective I	BCHM-	3	3
3.		Elective II	BCHM-	3	3
		Total Credit Hours		**09**	**09**

2nd Semester

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	CREDIT HOURS
1.	2nd	Core II	BCHM	3	3
2.		Elective III	BCHM	3	3
3.		Elective IV	BCHM	3	3
		Total Credit Hours		**09**	**09**

List of Core Courses for PhD

Course Title	Course Code
Recent trends in biochemistry	BCHM-821
Advanced Clinical Biochemistry	BCHM-822
Advanced Proteomics	BCHM-823
Advanced endocrinology	BCHM-831

List of Core Courses for PhD

Course Title: Advanced Clinical Biochemistry	**Course Code: BCHM-822**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Rehana Masood	
Course Objectives: This course aims to improve the fundamental concepts of the students in clinical Biochemistry which particular focus upon various diseases and its diagnostics. The students will be able to know the about the causes and different methods of diagnosis of liver, kidney, blood, gastrointestinal tract and cerebrospinal fluid diseases.	
Course Outline: Introduction to clinical Biochemistry. Water and electrolyte balance and imbalance. Role of clinical Biochemistry, Factors causing disease. Research methods in clinical Biochemistry, hormonal disorders, associated disorders and diagnosis. Liver disease and associated disorders. Liver function tests and diagnostics value. Gastrointestinal tract diseases and related disorders. Acid-base balance and oxygen transport. Blood and urine chemistry: related disorders and tests. Glucose metabolism and diabetes. Haematology: bleeding time, clotting time, blood CP. Cerebrovascular fluid (CSF): related disorders and clinical significance. PCR based diagnostic tests.	
Recommended Books & Readings: 1. All recent literature in the form of scientific journals, articles etc.	

2. Beckett, G. J., Walker, S. W., Rae, P. and Ashby, P. (2005). Lecture Notes: Clinical

Biochemistry 7th edition. Wiley-Blackwell.

3. Cameron, A. T. (2007). A Course in Practical Biochemistry - For Students of Medicine,

Cameron Press.

4. Hoffbrand, V., Moss, P. and Pettit, J. (2006). Essential Hematology (Essential) 5th Rev.

Edition. Blackwell Publishing.

5. Marshall, W. J and Bangert, S. K. (2008). Clinical Biochemistry 2nd Rev.Edition.

6. Mohanty, B. (2006). Fundamentals of Practical Clinical Biochemistry. B.I.

Publications

Course Title: Advanced Proteomics	**Course Code: BCHM-823**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr.	

Course Objectives:

This course will provide fundamental concepts about proteins and proteomics. This course will introduce students to the major concepts, approaches and capacities of the field of proteomics and protein mass spectrometry and to provide an understanding of the types of problems that can be addressed by proteomics.

Course Outline:

Introduction to proteomics, its tasks, challenges and application, protein extraction, preparing cellular and subcellular extracts and their quantification, fractionation of

complex samples of proteins by chromatographic and electrophoretic techniques, identification and characterization of post-translation modifications, types, importance, favorable sites (consensus sequences) for these modifications, electrophoresis (1D-PAGE & 2D-PAGE), gel and membranes staining and their computability with subsequent analytical techniques, analyzing gel images,

preparation of samples and identification of proteins by mass spectrometry and Nterminal sequencing, colleting, processing of MADI-TOF MS spectral data, protein quantification by MS, protein NMR, Protein microarray. X-Ray, IR. Bioinformatics for proteomics.
Recommended Books & Readings: 1. All recent literature in the form of scientific journals, articles etc. Plants proteomics (2007). J. Samaj and .J. Thelen Eds. 2. Proteome Research: new frontiers in functional genomics (1997).M.R Wilkins et al, Eds. 3. Essential of Genomics and Bioinformatics (2002)C.W.Sense, Ed. 4. Proteins and Proteomics:A Laboratory Manual (2003).R.J.Simpson 5. Purifying Proteins for Proteomics: A Laboratory Manual (2004).R.J.Simpson,Ed. 6. Liningers Principles of Biochemistry, 4th Ed DV Nilsson, MMCox, WH Freeman and company 2005.

Course Title: Advanced Endocrinology	**Course Code: BCHM-831**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Bushra Ahmad	
Course Objectives: By the end of the course the students will be able to: 1. Understand the molecular and cellular mechanisms of hormone synthesis, secretion, and action. 2. Explore the regulation of endocrine systems and their interactions with other physiological processes. 3. Analyze the pathophysiology of endocrine disorders and their clinical manifestations.	

4. Critically evaluate current research literature in endocrinology and its implications for clinical practice.

Course Outline: Overview of endocrine glands and hormone classification. Endocrine regulation and feedback mechanisms. Hormone Synthesis and Secretion, Biosynthesis and processing of peptide, steroid, and amine hormones, Mechanisms of hormone secretion and regulation, Endocrine disorders related to hormone synthesis and secretion. Hormone Receptors and Signaling: Mechanisms of hormone-receptor interactions, Signal transduction pathways and second messenger systems, Intracellular signaling cascades and gene expression regulation. Hypothalamic-Pituitary Axis, Anatomy and function of the hypothalamus and pituitary gland, Regulation of anterior and posterior pituitary hormone secretion, Pituitary gland Disorders. Thyroid hormone synthesis and metabolism, Regulation of thyroid hormone secretion and action, Parathyroid hormone and calcium homeostasis. Adrenal cortex and medulla anatomy and function, Regulation of adrenal steroidogenesis and catecholamine synthesis, Role of the adrenal glands in the stress response and adaptation. Reproductive Endocrinology, Male and female reproductive hormone synthesis and regulation, Reproductive cycle regulation and fertility. Endocrine disorders affecting reproductive health. Endocrine Disorders and Clinical Management. Diabetes mellitus: pathophysiology and treatment, Obesity and metabolic syndrome, Hormone replacement therapy and endocrine disruptors, Hormones and malignancy.

Recommended Books & Readings:

1. Oxford Textbook of Endocrinology and Diabetes 3e (3 edn), John Wass (ed.), Wiebke Arlt (ed.), Robert Semple (ed.), Published: January 2022, Oxford University Press.
2. Essentials of Endocrinology and Metabolism: A Practical Guide for Medical Students 1st ed. by Fredric E. Wondisford, 2020 Edition, Springer.
3. Williams Textbook of Endocrinology, 14th Edition, Shlomo Melmed, Ronald Koenig, Clifford J. Rosen, Richard J. Auchus, Allison B. Goldfine, November, 2019, ELSEVIER.

List of Elective Courses for MS/M.Phil and PhD

(Credit hour: 03)

S. No	Course title	Course code
1.	Bioanalytical Techniques	BCHM- 733
2.	Enzymes - Mechanism & Kinetics	BCHM- 735
3.	Community Nutrition	BCHM- 737
4.	DNA Techniques and Clinical Applications	BCHM- 739
5.	Food Biochemistry	BCHM- 742
6.	Molecular Evolution	BCHM- 749
7.	Molecular Mechanism of Diseases	BCHM- 750
8.	Renewable bio-energy Resources	BCHM- 756
9.	Recent Trends in Immunology	BCHM- 757
10.	Biological Risk Assessment and Management	BCHM-761
11.	Nutrition for health promotion and disease prevention	BCHM-764
12.	Advanced Bioenergy technologies	BCHM- 829
13.	Biomolecular crystallography	BCHM- 836
14.	Graduate Seminar-I	BCHM- 845
15.	Medicinal Chemistry	BCHM- 847
16.	Herbal medicines	BCHM- 861
17.	Advanced cancer Biology	BCHM-865
18.	Laboratory practical supervision	BCHM-866

Note: 7xx series will be assigned to courses for MS/M.Phil and 8xx series will be assigned to courses offered in PhD with same course content in list approved. In addition to the above, the university can offer any other course according to the availability of expert faculty.

Detail of Elective courses for MS/PhD

Course Title: Bioanalytical Techniques	**Course Code: BCHM-733**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Saira Shams	
Course Objectives: The primary objectives of this course are to develop the skills to understand the theory and practice of bio analytical techniques. To provide scientific understanding of analytical techniques and detail interpretation of results.	
Course Outline: Spectroscopy study of chemical compounds and bio-molecules, Electromagnetic radiations and interactions with matters: Electromagnetic spectrum. Quantisation of energy, Electronic, vibrational and rotational spectroscopy. Absorption of radiation, Beer Lambert's law, deviation of Beer-Lambert's equation and its limitations. Principals, instrumentation, sampling and application of few spectroscopic techniques: UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy. Microscopy: Principals, instrumentation and applications of imaging techniques: Dark-field, Phase contrast, Fluorescence, Confocal microscopy, Atomic force microscopy, and Transmission and Scanning electron microscopy. Crystal geometry and structure: Introduction to lattice and lattice systems, Bragg's plane, miller indices, point groups and space groups. Principle of diffraction and X-ray diffraction: X-rays production, X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law. Chromatography: Classification of chromatographic techniques and their principles, Theory of chromatography, Column chromatography, TLC, Paper chromatography. Liquid Chromatography and HPLC. Electrophoretic Techniques: Principle, equipment and process, Agarose gel Electrophoresis and application of electrophoresis in analysing macromolecules.	
Recommended Books & Readings: 1. 1. All recent literature in the form of scientific journals, articles etc. 2. K. Wilson, J. M. Walker, Eds., *Principles and techniques of biochemistry and molecular biology* (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009). 3. R. F. Boyer, *Biochemistry laboratory: modern theory and techniques* (Prentice Hall, Boston, 2nd ed., 2012). 4. R. Katoch, *Analytical techniques in biochemistry and molecular biology* (Springer, New York, 2011). 5. D. L. Spector, R. D. Goldman, Eds., *Basic methods in microscopy: protocols and concepts from cells: a laboratory manual* (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006).	

6. D. B. Williams, C. B. Carter, *Transmission electron microscopy a textbook for materials science* (Springer, New York, 2009; http://dx.doi.org/10.1007/978-0-387-76501-3).
7. R. M. Silverstein, *Spectrometric identification of organic compounds* (John Wiley & Sons, Hoboken, NJ, 7th ed., 2005).

Course Title: Enzymes- Kinetics and Mechanisms	**Course Code: BCHM-735**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Sidra Pervez	
Course Objectives: This course will cover the details of structures and conformations of enzyme molecules, active sites, reaction mechanisms in enzyme active sites and factors affecting enzyme activity. The contents will provide understanding of biochemical reaction types, derivation of kinetic equations and their transformations for single and multi substrate enzyme catalyzed reactions.	
Course Outline: Introduction, History and Nomenclature of Enzymes, Free energy of activation, transition state and effect of enzymes, Catalytic mechanisms: Lock and Key model and Induced fit model, Mechanism of enzyme catalysis i.e. acid base catalysis, substrate strain, covalent catalysis, entropy effect. Thermodynamics of enzymatic reactions, Enzyme kinetics factors, Effect of temperature, Effect of pH, Effect of Enzyme concentration, Effect of radiations, Effect of activators/ inhibitors, Derivation of Michaelis-Menton equation for one substrate enzyme catalyzed reactions; effect of substrate concentration on rates of enzyme catalysed reactions, Derivation of Lineweaver-Burk plot, Kinetics of enzyme inhibition (Reversible and Irreversible inhibition), Construction of Michaelis-Menton plot of substrate concentration data using Graphpad prism software., Construction of Lineweaver Burk plot of substrate concentration data using Graphpad prism software., Kinetics of two-substrate and multi-substrate reactions , Kinetics of Allosteric and regulatory enzymes, Enzyme assays with examples, Types of enzyme activity units and their relationships , Significance of enzyme kinetics in clinical and industrial applications, Enzyme Immobilization introduction and history, Matrices used for immobilization, methods of immobilization, Kinetics of immobilization, Purification of enzymes (partial and complete purification). Characterization of purified enzymes.	
Recommended Books & Readings:	

1. 1. Stryer, L. 2012. Biochemistry, 7th Edition, W. H. Freeman and C0.

2. Lab Manual in Biochemistry, Immunology and Biotechnology,

3. ArtiNigram, ArchanaAyyagari. Tata McGraw-Hill Publishing

Company Limited, New Delhi.

4. Cornish,, B. A. 2004. Fundamentals of Enzyme Kinetics. Portland Press, UK.

5. Lehninger, A.L. 1982. Principles of Biochemistry. Worth Publishers, Inc. New York,

NY, USA.

6. Lesakovac, L. 2003. Comprehensive Enzyme Kinetics. Kluwer Academic/ Plenum

Publishers, New York, NY, USA.

7. Nelson, D.L and M.M. Cox. 2017. Lehninger Principles of Biochemistry. 7th ed.

Worth Publishers, New York, NY, USA.

8. Voet, D., J. G. Voet and C.W. Pratt. 2013. Fundamentals of Biochemistry, Life at the

Molecular Level. 4th ed. John Wiley & Sons. Inc. New York, NY, USA.

Course Title: Community Nutrition	**Course Code: BCHM-837**
Course Structure: Lectures, 3 Hours	**Credit Hours: 03**
Course Designed By: Dr. Rehana Masood	

Course Objectives: To enable the students to understand the role of food science & technology in ensuring food security. acquaint knowledge about the food constituents, food classification, and spoilage agents. Comprehend the role of food processing and preservation methods in shelf-life extension. Understand and apply dietary guidelines for standard nutrient intake and identification of groups at risk for malnutrition.

Course Outline: Foundations of healthy diet, meal planning, Food guide pyramid and allied approaches, Food constituents and their functions, Eating disorders, Nutritional value of meal, Food processing and preservation, Principles of food preservation– (high temperature: pasteurization, sterilization, canning; low temperature – refrigeration, freezing; removal of moisture – drying, dehydration; use of chemical additives), Food-borne infections: intoxications,

Spoilage agents in food: (enzymes, microorganisms, insects, rodents, birds, and physical factors), Food safety and security; food sources and global food situation, Adult nutrition: Assessment of physical activity, Nutritional assessment at individual and population level, Food and nutrition guidelines, Psychology and nutrition adherence, Psychological influences on appetite; Dietary management in various health disorders: diet in the diseases, Health diets and lifestyles, Food allergy, Harmful effects of vaccinations and antibiotics and nutritional support, Genetically modified foods, Diet based regimen to improve the public health, Dietary management in various health disorders: obesity, leanness and underweight.
Recommended Books & Readings: 1. Textbook of Community Nutrition, 2nd Ed. by Suryatapa Das 2016, Academic Publishers, Kolkata. 2. Community Nutrition for Developing Countries (2016). By Norman J. Temple and Nelia Steyn. AU Press, USA. 3. Public Health Nutrition (2014). Stein. Jones & Bartlett Learning, 2014.

Course Title: DNA Techniques and Clinical Applications	**Course Code: BCHM-739**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Objectives: This course will provide basic concepts of mechanisms of DNA and its replication. This course will give a deep understanding of different DNA techniques used and their clinical application	
Course Outline: Discovery of DNA as genetic material; Double-helix model for DNA structure; DNA extraction from bacterial, plant and blood cells; Discovery of DNA polymerase; Basic concept of PCR; Genotyping; Microsatellite Markers; Investigations of PCR products by gel electrophoresis; Horizontal and vertical gel electrophoresis; RT-PCR and RFLP; DNA restriction nucleases; Sticky and blunt end restriction enzymes; Development of DNA cloning techniques; Selection of DNA of interest; Selection of cloning vectors; Rapid DNA sequencing methods; WES and Next generation Sequencing Approach; Detection of mutations and SNPs, Karyotyping of normal and abnormal human chromosomes; Gene targeting by homologous recombination chromosomes; Basis for nucleic acid hybridization; Southern Blotting Techniques; Fluorescent *in situ* hybridization (FISH); Chromogenic *in situ* hybridization (CISH); DNA fingerprinting.	

Recommended Books & Readings:

1. Updated research Published in Nature Review Cell & Molecular Biology.
2. Articles Published in Nature Review Genetics.
3. Molecular Biology Techniques: An Intensive Laboratory Course by Walt Ream, Katharine G. Field, 2021
4. Molecular Biology Techniques, Third Edition: A Classroom Laboratory Manual 3rd Edition by Heather Miller, D. Scott Witherow, Sue Carson2019
5. Brownstein M. J and Khodursky A, Functional Genomics (Methods in Molecular Biology). Humana Press (2010).
6. Strachan T, Read A. P, Human Molecular Genetics, 4th ed, Garland Science, New York (2010).

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Course Title: Food Biochemistry	**Course Code: BCHM-742**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**

Course Objectives:

Te main objective of this course is to provide students the key concepts of Food, nutrition and human health. Students will be able to describe the role of essential components of a balanced diet. Students will learn to integrate chemistry and biochemistry principles into real-world food science and nutritional problems

Course Outline:

Food selection and meal planning for healthy individuals, Absorption, storage and metabolic function of macro and micronutrients, Balanced diet: recommended dietary allowances for different groups of the human beings, pharmacological and toxic effects nutrients, reference individual, adjustments in dietary allowances. Water's importance in Food Chemistry: Phases of water, water sources, physical properties of water, use of water as a solvent in food industry, the concept of water activity. Measurement of energy of foods and expenditures, Direct and indirect caloric measurement, Basal metabolism, BMR Vs resting metabolic rate (RMR), Obesity, BMR, BMR importance and Factors affecting BMR, Respiratory quotient, Food borne diseases, Nutritious characteristics and dietetic treatment of a few essential primary nutritional and general diseases, prevention of food borne illness, Fasting, Starvation, Food intolerance and food allergies, Physical examinations, Clinical surveys, Dietary surveys, Laboratory examinations, FAO global information and early warning system for food and agriculture. Micronutrients: Sources, Daily allowance, Deficiency diseases; Biological importance of vitamins and minerals. Nutrigenomics (influence of genetic variation on nutrition, effects of nutrition, nourishment or

lack of nutrition on the genetic expression and correlating gene expression or SNPs with a nutrient's absorption.), Preservation of food by UV-radiation / chemical methods.
Recommended Books & Readings: 1. E. N. Whitney and S. R. Rolfes .2022. Understanding Nutrition. 9thedition. Wads worth Thomson learning: New York. J. I. Jain. 2018. Fundamentals of Biochemistry. S. Chand & Co. India L. Kathleen and M. S. Escott-Stump. 2009. Krause's Food, Nutrition and Diet Therapy. 11thEdition. Saunders. S. A. Joshi. 2012. Nutrition & Dietetics. 2ndEdition. Tata McGraw Hill Publishers U. Satayanarayna and U. Chakarapani. 2014. Biochemistry. 4th edition.

Course Title: Molecular Evolution	**Course Code: BCHM-749**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Objectives: This course will provide an introduction to the evolutionary processes at molecular and genomic levels. This course will give a review on the biochemical effects of genomic molecular evolutions. This will encompass discussion on the medical, biotechnological and anthropological effects of molecular evolution	
Course Outline: Molecular Basis of Evolution: how and why DNA sequences and genomes change; Allele Dynamics in Populations; DNA and Amino Acid Sequence Evolution; Rates and Patterns of Molecular Evolution: reconstructing the evolutionary history of genes, genomes, and organisms; Molecular Phylogenetics and Phylogenetic Trees: Molecular Evolution and Molecular Phylogenetics, Anatomy of a Phylogenetic tree; Reticulate Evolution and Phylogenetic Networks: Which species are more related?; Evolution by DNA Duplication:	

Preservation of gene duplicates, Dosage effect or gene amplification, Long-term fate of duplicated genes; Evolution by Molecular Tinkering; Mobile Elements in Evolution; Prokaryotic Genome Evolution: Protein-Level Selection and Microbial Genome Size, Evolution of Distinct Functional Classes of Genes; Eukaryotic Genome Evolution: Genome size, Chromosomal evolution; The Evolution of Gene Regulation: epigenetic, transcriptional, post-transcriptional, translational, and post-translational; Experimental Molecular Evolution

Recommended Books & Readings:

1. Articles Published in Nature Review Molecular Evolution.
2. Molecular and Genome Evolution. (2016). Latest Edition. Dan Graur. Oxford University Press.
3. An Introduction to Molecular Evolution and Phylogenetics. (2015). Lindell Bromham. Oxford University Press.
4. Molecular Evolution. (2021). Latest Edition. Wen Hsiung Li. Oxford
5. University Press. Updated research Published in Nature Review Molecular Biology and Evolution.

Course Title: Molecular Mechanism of Diseases	**Course Code: BCHM-750**
Course Structure: Lectures, 3 Hours	**Credit Hours: 03**
Course Designed By: Dr. Hian Mir	

Course Objectives: This course will provide

- basic concepts of mechanisms of diseases
- Understanding of mechanisms of genomic instability, signal transduction and the networks of cellular responses.

Course Outline: A general introduction to Basic Mechanisms of Disease, Genetic: Pathogenic, Tumor and Cancer, Physical and Chemical Agents, Malnutrition, Autoimmunity, Inflammation. Degeneration; Risk Factors: Stress, Environmental Factors, Microorganisms, Preexisting Condition; Origin and development of the disease: Pathophysiology, symptoms, diagnosis, mechanism, target; Genetic diseases: Types, causes, methods of identification of Genetic diseases; Muscular dystrophy: Introduction, prevalence, types, Symptoms, diagnosis, treatment, management, molecular mechanism of DMD and BMD; Bone deformities, Skin diseases, Microbial Infections: Introduction, mechanism of action, causes, types, symptoms, treatment, management, diagnosis; Fungal Infections: Athlete's Foot, Ring Worm, Yeast infection; Viral

infections and its factors; Immunopathogenesis (Inflammation, Fibrosis); Hypersensitivity, Autoimmunity, Immunodeficiency; Degeneration; Pathogenesis of Cancer
Recommended Books & Readings: 1. Michael A. Lieberman and Dr. Rick Ricer, Molecular Biology, and Genetics (Board Review Series), Part of: Board Review (21 books), Mar 12, 2019. 2. Sterling Education , Molecular Biology & Genetics: Essential Biology Self-Teaching Guide (Essential Biology Self-Teaching Guides), Part of: Essential Biology Self-Teaching Guides (6 books) Jul 18, 2023. 3. Tom Strachan, Human Molecular Genetics, 5th EditioN, Copyright 2019. 4. Updated research Published in Nature Review Cell & Molecular Biology. 5. Articles Published in Nature Review Genetics.

Course Title: Renewable bioenergy Resources	**Course Code: BCHM-756**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Sidra Pervez	
Course Objectives: The objective of this course is to provide students with the basic principles of biofuels and Bioenergy systems design. Students in this course will identify biofuels and bioenergy sources; describe biofuels and bioenergy technologies, applications and efficiency.	
Course Outline: Chemistry of plant materials, Types of renewable resources for bioenergy production, Conversion of biomass into heat and power: Direct combustion, Thermal gasification, Anaerobic digestion, three generations of biofuels, first generation, second generation, third generation, uses and advantages, Bioethanol production, applications and uses, Environmental impact of the bio-economy: Land use, Pollution, Climate change etc, Biomass conversion technologies – Chemical and acid hydrolysis, fermentation, Role of algae as promising resource, Production, use and processes of biodiesel, Transesterification, Production of biogas, plants used for biogas production, bioethanol production from three generations, Double fermentation processes, Role of microbes in production of bioenergy. Current and future prospect of renewable resources for biofuel production.	
Recommended Books & Readings:	

1. Current research papers from reputed journals.

2. Dahiya, A. ed., 2014. Bioenergy: Biomass to Biofuels. Academic Press.

3. Halford, N.G., 2013. An Introduction to Bioenergy. World Scientific Publishing CoInc.

4. Khanal, S.K., 2011. Anaerobic Biotechnology for Bioenergy Production: Principles and 5pplications. John Wiley & Sons.

6. Lee, S. and Shah, Y.T., 2012. Biofuels and Bioenergy: Processes and Technologies. CRC Press.

7. Lund, P., Byrne, J.A., Berndes, G. and Vasalos, I., 2015. Advances in Bioenergy: The Sustainability Challenge. John Wiley & Sons.

Course Title: Recent trends in Immunology	**Course Code: BCHM-757**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Outline: Updated knowledge published in recent articles and reviews in nature and other journals.	
Course Name: Biological Risk Assessment and Management	**Course Code:** BCHM-761
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Sidra Pervez	
Course Objectives The objective of this course is to equip learners with a comprehensive understanding in principles of biorisk (biosafety/biosecurity) management system for containment laboratories, in terms of the AMP (Assessment, Mitigation and Performance) model.	
Course Outline: Biorisk assessment by identifying hazards, determining risk levels and working in BSL1, 2, 3 and 4; Understanding the need of SOPs: SOP evaluation based on language, effectiveness and capabilities, SOP validation based on internal and external verification based on cognition and behaviors; Risk mitigation: need for surveillance programs, occupational health program, incident surveillance program. Donning and Doffing PPEs: Hand washing procedure, hand sanitization, donning of PPEs according to biosafety levels, Safe glove removal methods,	

bootie dance; Waste management procedures: types of biological waste, managing biological waste, liquid waste management, spill cleanup; Laboratory acquired illness: needle stick injury, emergency response, unconscious individual; Working in Biosafety cabinets (BSC 1, 2 and 3).

Recommended Books & Readings:

1. Salerno, R.M., Gaudioso, J., (2021). Laboratory Biorisk Management. 1st edition, CRP press.
2. The Biorisk Management Casebook: Insights into Contemporary Practices (2023). Available online

3. National Biosafety Guidelines, 2005. Pakistan Environmental protection

Agency (Available online)

4. Laboratory biosafety manual. 4th edition by WHO (2020). (Available online)

Course Title: Nutrition for health promotion and disease preventions	**Course Code: BCHM-764**
Course Structure: Lectures, 3 Hours	**Credit Hours: 03**

Course Designed by: Dr. Rehana Masood

Course Objectives: To understand the basic principles of nutrition and its impact on health and disease prevention. Explore the relationship between nutrition and chronic diseases such as cardiovascular disease, diabetes, and cancer. Evaluate dietary guidelines and develop strategies for promoting healthy eating patterns. Analyse cultural and social influences on food choices and develop strategies for promoting healthy eating within diverse populations.

COURSE OUTLINES:

Introduction to Nutrition for Health Promotion and Disease Prevention. Nutrients: Macronutrients: The Role of Carbohydrates, Proteins, and Fats in Health. Micronutrients: Vitamins and Minerals. Water: The Importance of Hydration for Health. Dietary Supplements: Evaluating the Safety and Efficacy of nutritional Supplements. The Digestive System and Absorption of Nutrients. The Role of Fiber in Health and Disease Prevention. Healthy Eating Patterns: Dietary Guidelines and MyPlate Nutrition and Energy Balance: Understanding Metabolism and Body Weight Regulation. Weight Management: Strategies for Maintaining a Healthy Body Weight. Eating Disorders: Recognizing and Treating Anorexia, Bulimia, and Binge

Eating Disorder. Food Allergies, Foodborne Illnesses and Intolerances. The Mediterranean Diet, The DASH Diet, The Flexitarian Diet. Nutrition and Exercise: Understanding the Relationship between Physical Activity and Nutritional Needs. Ergogenic Aids: Evaluating the Safety and Efficacy of Sports Supplements. The Ketogenic Diet, The Paleo Diet, The Whole30 Diet. Diabetes Management: The Role of Nutrition in Diabetes Prevention and Treatment. Heart-Healthy Diets: The Role of Nutrition in Cardiovascular Disease Prevention and Treatment. Cancer Prevention: The Role of Nutrition in Cancer Prevention and Treatment. Nutrition and Mental Health: The Relationship between Nutrition and Mental Health and Well-being. The Gut-Brain Connection: The Role of Gut Health in Mental Health and Well-being Dietary Approaches to Treating Depression and Anxiety. Nutrition and Skin Health: The Role of Nutrition in Skin Health and Aging. Nutrition and Bone Health: The Role. Nutrition and Eye Health: The Role of Nutrition in Maintaining Healthy Eyes. The Role of Nutrition in Immune System Health. Nutritional Approaches to Managing Autoimmune Disorders, Chronic Inflammation. Understanding the Role of Nutrition in Integrative and Functional Medicine. Nutrigenomics. Nutritional Approaches to Managing Chronic Diseases, Digestive Disorders, Neurological Disorders, Hormonal Imbalances, Skin Disorders, Respiratory Disorders and Musculoskeletal Disorders.

Course Title: Advanced Bioenergy Technologies	**Course Code: BCHM-829**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Designed by: Dr. Sidra Pervez	

Course Objectives:

To analyze the main biomass systems that can be used for biomass energy conversion and utilization. To design for biomass energy conversion and utilization. To identify potential biomass feed stocks including energy crops. To evaluate the environmental benefits and consequences of biomass energy production. Determine potential solutions for energy needs and problems by incorporating the bioenergy technologies being explored.

Course Outline:

Introduction Bioenergy Concepts, Need for bioenergy, Environmental issues – Greenhouse effect, pollution, non-renewable resources, Types of renewable resources for bioenergy production, Bioenergy applications - Electricity, heat, motion (Transport fuel), Types of bioenergy - First generation, second generation, third generation, fourth generation. Biobased products, Biochemical methods for bioenergy production – Diesel production, alkane production, butanol production, Biomass feedstock for biofuel production- Biomass for first generation, biomass for second generation, biomass for third generation, Biomass conversion technologies. Chemical and acid

hydrolysis, fermentation, Sustainability & Resilience – Understanding sustainability, environmental sustainability, bioenergy & sustainability.
Recommended Books & Readings: 1. Dahiya, A. ed., 2014. Bioenergy: Biomass to Biofuels. Academic Press. 2. Halford, N.G., 2013. An Introduction to Bioenergy. World Scientific Publishing CoInc. 3. Khanal, S.K., 2011. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. John Wiley & Sons. 4. Lee, S. and Shah, Y.T., 2012. Biofuels and Bioenergy: Processes and Technologies. CRC Press. 5. Lund, P., Byrne, J.A., Berndes, G. and Vasalos, I., 2015. Advances in Bioenergy: The Sustainability Challenge. John Wiley & Sons. 6. United Nations Environment Programme. Biofuels Working Group and United Nations Environment Programme. International Panel for Sustainable Resource Management, 2009. Towards

Course Title: Biomolecular Crystallography	**Course Code: BCHM-836**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Objectives: The aim of this course is to introduce the Biomolecular Crystallography of Proteins to the graduate students (MS/Ph.D). The main objective of proposed course for graduate students is to make in-depth understanding and interpretation of Protein chemistry, purification n from different sources and Crystallography by principle methodologies for determining the three dimensional structure of proteins.	

Course Outline:

Proteins background, Chemistry and Protein structure, Protein Cloning, Expression, Purification and Characterization. Protein homology and sequence alignment. Protein Crystallization through different methods (Hanging Drop Vapor Diffusion Method, Sitting Drop Method, Counter Diffusion Method). Macromolecules, Macromolecular Crystallography, Crystal Diffraction, Diffraction Analysis, Crystallographic software (Mosflm Software, CCP4 Software, COOT Software, Pymol Molecular Graphic Software).

Recommended Books & Readings:

1. Current research papers from reputed journals.
2. Crystallography Made Crystal Clear A Guide for Users of Macromolecular Models A volume in Complementary Science Book • 3rd Edition • 2006
3. Bimolecular Crystallography: Principles, Practice, and Application to Structural Biology Bernhard Rupp, Garland Science (1st Edition) ublished October 20, 2009

4. Textbook - 800 Pages - 448 Color Illustrations, ISBN 9780815340812 - CAT# RT8670.

5. Recent literature in the form of research articles, reviews and related journals such as

Nature, Cell, sciences and Molecules etc.

Course Title: Graduate Seminar-I	**Course Code: BCHM-845**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**

Course Objectives:

Course Outline:

Students will deliver and participate in seminar. They will present various topics related to research.

Recommended Books & Readings:

1. Current research papers and review articles from reputed journals e.g. Nature.

Course Title: Medicinal Chemistry	Course Code: BCHM-847
Course Structure: Lectures, 3 Hours	Credit Hours: 3

Course Designed by: Dr. Bushra Ahmad

Course Objectives: The course focuses on introducing concept about history and significance of medicinal value of plants. Students will be able to acquaint students with features of medicinal chemistry and phytoconstituents having important therapeutic benefits, They will be able to understand the principles and concepts concerning the characterization techniques. This course is designed to provide a holistic overview of the various aspects of important medicinal plants used in Pakistan to treat different diseases.

Course Outline:

Introduction to medicinal plants, historical significance of medicinal plants, important medicinal plants of Pakistan, Introduction and significance of plant based drugs, understanding and description of herbal remedies, herbal medicines and their importance, Chemical constituents/phytochemicals of medicinal plants, including flavonoids, phenolics, alkaloids, tannins, cumarins etc, Methods of identification of active constituents of plants, Extraction and fractionation of medicinal plants, chromatographical separation of active compounds, Bioassay guided separation, Use of Nuclear Magnetic Resonance spectroscopy (NMR), Mass spectrometery (MS) and Infra red (IR) spectrum for characterization. Brief description of some important medicinal plants of Pakistan used to treat different diseases e.g. cancer, diabetes, infections, Liver and kidney disorders, Skin inflammations and sores etc. Recent research trends and future prospects of study in medicinal plants.

Recommended Books & Readings:

1. Recent and updated articles in reputed journals.
2. Medicinal Chemistry, **by** Roland Barret, 1st Edition Fundamentals, ISTE Press – Elsevier, 3rd July 2018,.
3. The Practice of Medicinal Chemistry, 4th Edition, by Camille Wermuth David Aldous Pierre Raboisson Didier Rognan, Hardcover ISBN: 9780124172050, Imprint: Academic Press, 2015, Page
4. Burger's medicinal chemistry and drug discovery, 7th Edition, Edited by Donald J. Abraham, A John Wiley and Sons Inc, Publication, 2010.

Course Title: Herbal Medicines	**Course Code: BCHM-861**
Course Structure: Lectures, 3 Hours	**Credit Hours: 03**
Course Designed By: Dr. Bushra Ahmad	
Course Objectives: This course is designed to gain knowledge about role of botanical medicines, dietary supplements in healthcare. This course will give a deep understanding to identify what makes botanicals unique from pharmaceuticals. This course will help to explain relevant legislation and federal regulations regarding use of botanicals and to discuss your role in protecting patients from misuse of botanicals.	
Course Outline: Introduction to herbalism and botanicals. What is herbal medicine and how it is used. Botanical laws and regulations around the world. Are dietary supplements and natural medicines also botanicals. Differences between herbal medicines and pharmaceuticals. Challenges with recommending botanicals. Third party testing organizations. Contaminants and adulterants. Botanicals interactions with pharmaceuticals. Herb-drug interactions. Botanical product quality measures. Safety guidelines for purchasing botanicals. How do botanical medicines work. Botanical preparations, water-based preparations, types of botanical preparations e.g., infusions, macerations, decoctions, tinctures, standardized extracts. Herbs for mental health, pain and stress. Herbs used for women health, musculoskeletal pain, migraine, Botanicals for upper respiratory problems, for skin diseases, GERD, Liver and Urinary tract infections.	
Recommended Books & Readings: 1. Update research articles from renown journals 2. Southeast Medicinal Plants: Identify, Harvest, and Use 106 Wild Herbs for Health and Wellness (Medicinal Plants Series) by CoreyPine Shane, Kindle, Nov 9, 2021.updated by Aurora Wildroot, Jan 23, 2024. 3. The Encyclopedia of Herbal Medicine & Natural Remedies: [10 in 1] by Hadassah Lewis, 2021.Springer. 4. Herbal Medicine From The Heart Of The Earth Perfect Paperback – December 31, 2020 by Dr. Sharol Marie Tilgner, Tiffany Sanford and D.M. Fratz. Wise Acres LLC, march 2020.	

Course Title: Advanced Cancer Biology	Course Code: BCHM-865
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**

Course Designed by: Dr. Bushra Ahmad

Course Objectives:

This course will provide a deep understanding to grasp the basic principles of cancer biology, including the definitions, types, and epidemiology of cancer.

This will comprehend the historical developments and milestones in cancer research. Students will be able to eexplain the roles of oncogenes, tumor suppressor genes, and genetic mutations in cancer development. Students will be able to understand the impact of epigenetic changes, such as DNA methylation and histone modification, on gene expression and cancer progression.

Course Outline:

Historical Perspectives of Cancer. Key milestones in cancer research, Epidemiology of Cancer, Global and regional cancer statistics, Risk factors and prevention strategies.

Oncogenes and Tumor Suppressor Genes. Mechanisms of oncogene activation, Role of tumor suppressor genes. Epigenetic Modifications in Cancer. DNA methylation, histone modification Non-coding RNA. Cell Cycle Regulation and checkpoints. Apoptosis and Cancer. DNA Repair and Genomic Instability. DNA Repair Mechanisms. Mutations and cancer. Genomic Instability. Chromosomal abnormalities. Tumor Microenvironment, Angiogenesis, Mechanisms of new blood vessel formation, Therapeutic targeting of angiogenesis. Metastasis, Steps of Metastasis. Signaling pathways involved, Role of EMT (Epithelial-Mesenchymal Transition. Cancer Stem Cells. Identification and Characteristics, Markers of cancer stem cells, Functional assays. Role in Tumorigenesis and Therapy Resistance, Cancer stem cells in different cancer types, Targeting cancer stem cells. Cancer Genomics and Epigenomics, Techniques in Cancer Genomics, Next-generation sequencing, Genome-wide association studies (GWAS), Epigenomic Alterations, Epigenome editing, Clinical implications, Cancer Immunology, Immune Surveillance and Evasion, Mechanisms of immune detection, Immune evasion strategies by tumors, Immunotherapy, Checkpoint inhibitors, CAR-T cells, Vaccine strategies. Cancer Metabolism, Metabolic Reprogramming in Cancer, Warburg effect and beyond Metabolic pathways in cancer, Therapeutic Targeting of Metabolism. Signaling Pathways, MAPK, PI3K/AKT, Wnt, Notch, etc. Conventional and Emerging Therapies. Traditional Cancer Therapies, Surgery, radiation, chemotherapy, Personalized and Precision Medicine, Targeted Therapy, Ethical, Social, and Economic Aspects, Ethical Considerations in Cancer Research, Informed consent, patient privacy, Socioeconomic Disparities

Recommended Books & Readings:

1. Update research articles from renown journals

2. The Biology of Cancer Third Edition by Robert A. Weinberg (Author). W. W. Norton & Company, 2023.

3. The Biology of Cancer, 2nd Edition by Robert A. Weinberg, Garland Science, 2018.

4. Oxford Textbook of Cancer Biology Get access Arrow

Francesco Pezzella (ed.), Mahvash Tavassoli (ed.), David J. Kerr (ed.), 2019.

Course Title: Laboratory Practical Supervision	**Course Code: BCHM-866**
Course Structure: Lectures, 3 Hours	**Credit Hours: 3**
Course Objectives:	
Course Outline: This will encompass all the knowledge based on laboratory manual of Biochemistry.	
Recommended Books & Readings: 1. Recent articles and updated knowledge	