

**CURRICULUM  
OF  
BIOCHEMISTRY**

**BACHELOR & MASTER DEGREE PROGRAMME**

**(REVISED 2018)**



**HIGHER EDUCATION COMMISSION  
ISLAMABAD**

## **CURRICULUM DIVISION, HEC**

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## PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo to achieve some specific objectives. It includes scheme of studies, objectives & learning outcomes, course contents, teaching methodologies and assessment/ evaluation. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula regularly through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

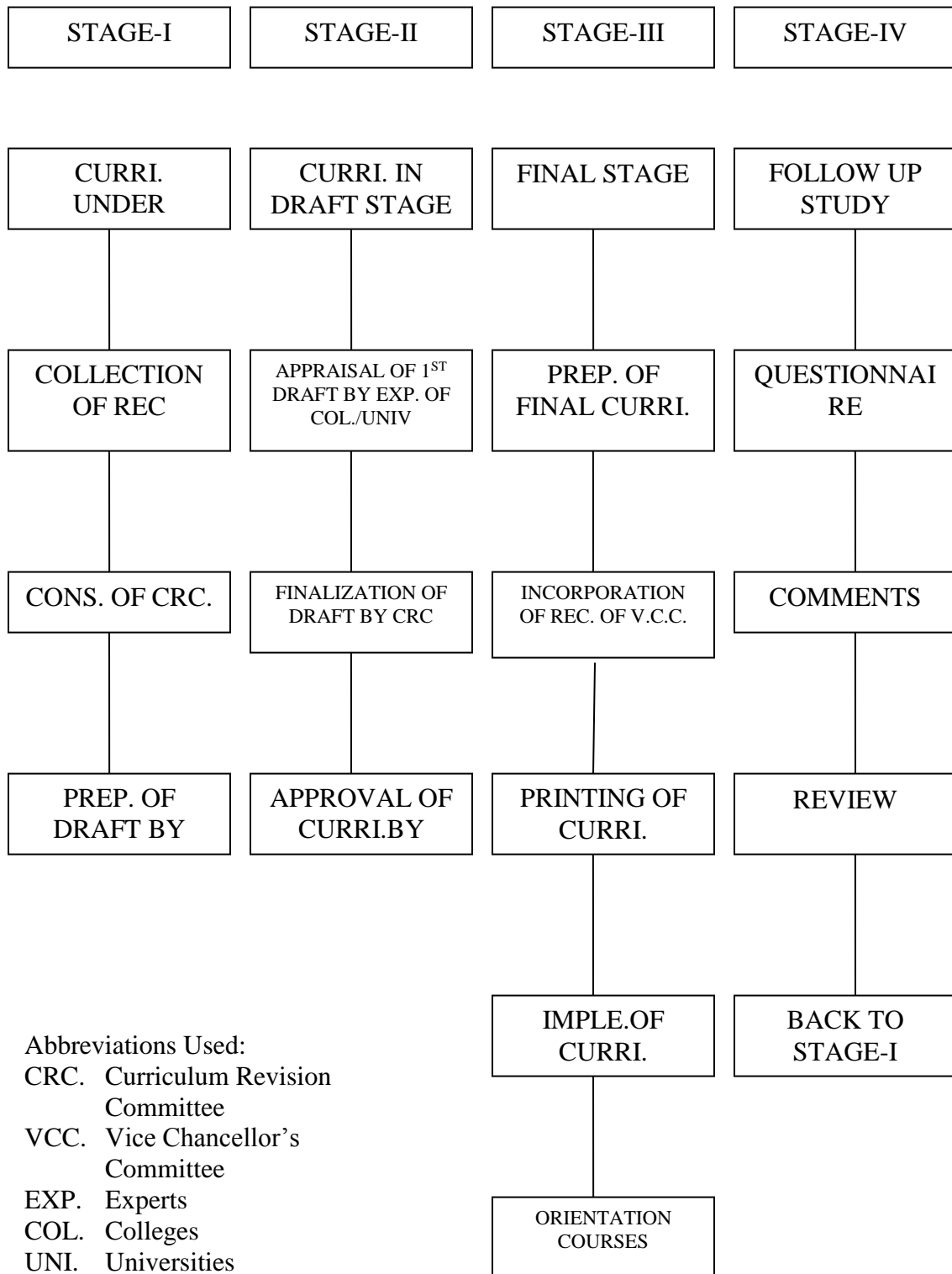
In order to impart quality education which is at par with indigenous needs and international standards, HEC NCRCs have developed unified framework/templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering.

It is hoped that this curriculum document, prepared by the respective NCRC's, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC

<http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx>

**(Muhammad Raza Chohan)**  
**Director General (Academics)**

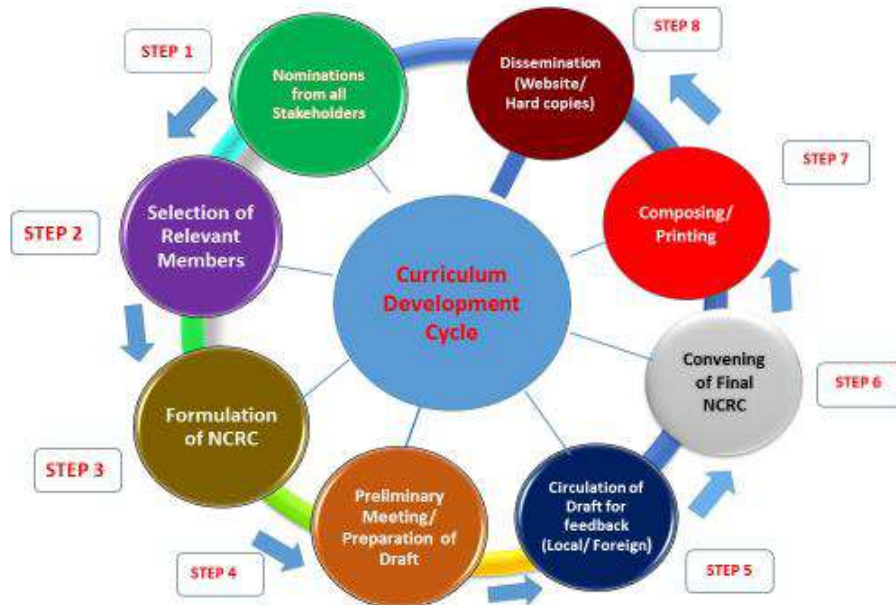
# CURRICULUM DEVELOPMENT PROCESS



**Abbreviations Used:**

- CRC. Curriculum Revision Committee
- VCC. Vice Chancellor's Committee
- EXP. Experts
- COL. Colleges
- UNI. Universities
- PREP. Preparation

# CURRICULUM DEVELOPMENT CYCLE



**MINUTES OF THE FINAL MEETING OF HEC NATIONAL CURRICULUM  
REVISION COMMITTEE ON BIOCHEMISTRY HELD AT HEC REGIONAL  
CENTRE, PESHAWAR FROM FEBRUARY 26<sup>th</sup> to 27<sup>th</sup>, 2018.**

1. The preliminary meeting of National Curriculum Revision Committee (NCRC) in the discipline of Biochemistry for Bachelor (BS), Master (MS/MPhil) and PhD degree programs was held from February 26-28, 2018 (03 days) at HEC Regional Center, Peshawar. Experts from academia, research and development organizations participated in the meeting. Dr. Muhammad Idrees (Director, Academics Division, HEC, Pakistan) coordinated the NCRC meeting. The list of the participants is as below:

<b>S. No</b>	<b>Name &amp; Institution</b>	<b>STATUS</b>
<b>1.</b>	<b>Dr. Muhammad Hassan Khaskeli</b> Professor, Department of Biochemistry, Shah Adbul Latif University, Khairpur.	<b>Convener</b>
<b>2.</b>	<b>Dr. Seyyedha Abbas</b> Associate Professor, Department of Biochemistry & Co-opted faculty in Medical Education Department. Foundation University Medical College DHA 1 Jinnah Avenue, Islamabad.	<b>Secretary</b>
<b>3.</b>	<b>Prof. Dr. M. Kamran Azim</b> Dean / Professor, Faculty of Life Science, Mohammad Ali Jinnah University, 22-E, Block-6, PECHS, Karachi.	<b>Member</b>
<b>4.</b>	<b>Prof. Dr. Saeeda Baig</b> HoD / Professor, Department of Biochemistry, Ziauddin University, 4/B, Shahrach-e-Ghalib, Block-06, Clifton, Karachi.	<b>Member</b>
<b>5.</b>	<b>Prof. Dr. Muhammad Asgher</b> Professor of Biochemistry, Dean Faculty of Sciences, University of Agriculture, Faisalabad.	<b>Member</b>
<b>6.</b>	<b>Prof. Dr. Nakhshab Choudhry</b> Professor, Department of Biochemistry, King Edward Medical University, Nila Gumbad, Lahore.	<b>Member</b>

7.	<b>Dr. Muhammad Ansar</b> Professor, Faculty of Biological Sciences, Department of Biochemistry, Quaid-i-Azam University, Islamabad.	<b>Member</b>
8.	<b>Prof. Dr. Muhammad Zahid Qureshi</b> Professor, Department of Chemistry, GC University, Lahore.	<b>Member</b>
9.	<b>Prof. Dr. Naheed Qadir</b> Professor, Department of Biochemistry, People University of Medical & Health Sciences, Shaheed Benazirabad, Nawabshah.	<b>Member</b>
10.	<b>Prof. Dr. Wasim Shehzad</b> Director, Institute of Biochemistry & Biotechnology, University of Veterinary & Animal Sciences, Out fall Road, Lahore.	<b>Member</b>
11.	<b>Dr. Sumbul Khalid</b> Associate Professor, Department of Bioinformatics & Biotechnology, Room # 13, Hazrat Maryam Block, Female Campus, International Islamic University, Islamabad.	<b>Member</b>
12.	<b>Dr. Ghazala Kaukab Raja</b> Associate Professor / Director, University Institute of Biochemistry & Biotechnology, PMAS Arid Agriculture University, Murree Road, Rawalpindi.	<b>Member</b>
13.	<b>Dr. Muhammad Ayub</b> Associate Professor / Director, Institute of Biochemistry, University of Baluchistan, Quetta.	<b>Member</b>
14.	<b>Dr. Darakhshan Mehboob Saleem</b> Associate Professor, Department of Biomedical Engineering, Sir Syed University of Engineering & Technology, University Road, Karachi.	<b>Member</b>
15.	<b>Dr. Tahir Mehmood</b> Head of Biochemistry Section, Department of Chemistry University of Sargodha, Sargodha.	<b>Member</b>



<b>16.</b>	<b>Dr. Sajjad Ali</b> Assistant Professor /HoD, Department of Chemistry, Room # 323, Food Technology Building, Karakoram International University, Gilgit.	<b>Member</b>
<b>17.</b>	<b>Dr. Faheem Tahir</b> Chief Scientific Officer, Public Health Laboratories Division, National Institute of Health, Park Road, Chak Shahzad, Islamabad.	<b>Member</b>
<b>18.</b>	<b>Dr. Nouman Rasool</b> Assistant Professor, Department of Life Sciences, University of Management & Technology, C-II, Johar Town, Lahore.	<b>Member</b>
<b>19.</b>	<b>Dr. Dilawar Khan</b> Assistant Professor, Atta-ur-Rahman School of Applied Biosciences (ASAB), Department of Healthcare Biotechnology, NUST, H-12, Islamabad.	<b>Member</b>
<b>20.</b>	<b>Dr. Salma Shahid</b> Assistant Professor, Faculty of Science & Technology, Department of Biochemistry, Government College Women University, Faisalabad.	<b>Member</b>
<b>21.</b>	<b>Dr. Hooria Younas</b> Assistant Professor, Department of Biochemistry, Kinnaird College for Women, 93-Jail Road, Lahore.	<b>Member</b>
<b>22.</b>	<b>Dr. Muhammad Ateeq</b> Assistant Professor, Department of Chemistry, Sarhad University of Science & Information Tech, Peshawar.	<b>Member</b>
<b>23.</b>	<b>Dr. Abdul Aziz</b> Assistant Professor, Department of Computer Science & Bioinformatics, Khushal Khan Khattak University, Karak, KPK.	<b>Member</b>

<b>24.</b>	<b>Dr. Naeem Khan</b> Assistant Professor, Department of Chemistry, Kohat University of Science & Technology, Kohat.	<b>Member</b>
<b>25.</b>	<b>Dr. Aisha Siddiqua</b> Assistant Professor, Center of Biochemistry & Biotechnology, Gomal University, Dera Ismail Khan, KPK.	<b>Member</b>
<b>26.</b>	<b>Dr. Asma Saeed</b> Assistant Professor, Department of Biological Sciences, Gomal University, Dera Ismail Khan, KPK.	<b>Member</b>
<b>27.</b>	<b>Dr. Muhammad Shahzad</b> Assistant Professor, Department of Biochemistry, IBMS, Khyber Medical University, Block-IV, PDA Building, Phase-V, Peshawar.	<b>Member</b>
<b>28.</b>	<b>Dr. Umer Rashid</b> Assistant Professor, University of Gujrat, Gujrat.	<b>Member</b>
<b>29.</b>	<b>Dr. Naseebullah Kakar</b> Chairperson / Associate Professor, Faculty of Life Sciences & Informatics, BUIEMS, Takatu Campus, Airport Road, Quetta.	<b>Member</b>
<b>30.</b>	<b>Dr. Muhammad Idrees</b> Director (Curriculum), Higher Education Commission, Islamabad.	<b>Coordinator</b>
<b>31.</b>	<b>Hidayatullah kasi</b> Deputy Director Academics. Higher Education Commission, Peshawar.	<b>Coordinator</b>

### **NCRC Agenda**

The agenda of NCRC for Biochemistry was as follows:

- a. To revise the Biochemistry curriculum (2013) for Bachelor and Master Programs according to indigenous needs and to bring it at par with international standards on Outcomes Based Education (OBE).
- b. To revise/update/ preface/ preamble and rationale of the subject.
- c. To revise program objectives, program learning outcomes (PLOs), teaching methods and assessment criteria (formative & summative).

- d. To incorporate/suggest latest reading materials/references (local & international) for every course.
  - e. To revise course contents keeping in view the uniformity across other disciplines and avoiding overlapping.
  - f. To recommend suggestions for promotion/development of the discipline, keeping in view the futuristic needs of the society and international trends.
2. The meeting started with recitation of verses from the Holy Quran by Dr. Muhammad Hassan Khaskheli. **Muhammad Idrees, Director (Curriculum)**, HEC Islamabad welcomed the members on behalf of Chairman HEC.
  3. All the participants introduced themselves highlighting their qualification, experience and area of expertise. The members of the Committee unanimously selected **Dr. Muhammad Hassan Khaskheli**, Professor, Department of Biochemistry Shah Abdul Latif University, Khairpur, as Convener and **Dr. Seyyedha Abbas**, Associate Professor of Biochemistry as Secretary. The Convener thanked the participants for his selection and started proceedings of the meeting in accordance with the agenda.
  4. In first session, Dr. Muhammad Idrees presented the agenda and objectives of the NCRC. He highlighted the importance of this meeting and emphasized for adaptation of general rules of curriculum development and revision like scope of the subject/programme, horizontal & vertical alignment, rule of flexibility and adaptability keeping in view the futuristic approach, market value/job market and social parity. He also shared a template for finalizing the curricula according to paradigm shift of including learning outcomes (Bloom's Taxonomy), teaching methods and assessment. The template was unanimously accepted to be followed. It was also agreed to add preamble, programme objectives, programme learning outcomes, teaching methodology and assessment segments in the curricula.
  5. Prof. Dr. Muhammad Hassan Khaskheli briefed the participants about outcome of preliminary NCRC meeting. He informed the participants that in preliminary NCRC meeting, a draft regarding the outline of curriculum was prepared after thorough discussion according to the unified framework (guidelines) to institutions offering degrees under the subject of Biochemistry.
  6. In next session the house openly discussed the nomenclature of the discipline, preface, objectives of the programme, learning outcomes, methods of instruction and learning environment, assessment and operational framework. After long deliberations, the committee also finalized such aspects of the degree as framework/scheme of studies, the duration of the programme, number of semesters, number of weeks per semester, total number of credit hours, number of credit hours per semester, weightage of breadth and depth courses and weightage of theory and practical of undergraduate 4-years programme for

- Biochemistry. Furthermore, list of courses (core & elective) and semester wise breakup of courses were also discussed and finalized unanimously.
7. On second day, each course was discussed and the course objectives, learning outcomes, contents, teaching methods, assessment and reference books were reviewed, revised and finalized. After an in-depth discussion draft curriculum of the undergraduate (4-years) programme for Biochemistry was finalized.
  8. On third day, the convener briefed the house about the deliberations and progress made during two days exercise of the meeting. The decision regarding the subject's allocation in the two semesters for MS/M Phil, list of courses revised, and new courses were added (core & elective) and semester wise breakup of courses were also discussed and finalized unanimously.
  9. In the end, Dr. Muhammad Idrees thanked the Convener, Secretary and all members of the NCRC Biochemistry for sparing their precious time and taking pain to travel a long way from across the country for the noble cause of finalizing the curriculum. He further stated that their efforts will go a long way in developing workable, useful and market oriented comprehensive degree in Biochemistry.
  10. The Convener of the NCRC thanked the members for their keen interest and valuable input in finalizing the curriculum to make it more feasible, competitive, efficient and realistic. The Committee highly appreciated the efforts made by the officials of HEC Regional Centre, Peshawar for making arrangements to facilitate their comfortable stay. The members extended their heartfelt felicitations to the Convener and Secretary of the Committee. The meeting ended with the vote of thanks to Dr. Muhammad Idrees and his team from HEC for providing the academic and professional opportunity for national cause.

### **Recommendations:**

After thorough discussion, the participants of the National Curriculum Revision Committee in Biochemistry 2018 formulated the following recommendations for uniform and effective implementation of the HEC policies at national level.

- The committee appreciates the role of HEC in improvement of Higher Education in the country and recommends uniform implementation of its policies including work load and financial matters in all public-sector universities.
- Prior division/distribution of courses as per specialty of members will be fruitful.
- Subject specialist and other academicians should be involved to obtain a genuine curriculum for undergraduate program.
- Biochemistry is a major subject, but degree of this field is not being offered by all universities. But it is recommended that HEC should issue a

notification to promote education and research in Biochemistry and establishing Biochemistry department.

- It is requested to give liberty and freedom to all institutions to choose the courses for MS/M Phil from the approved list of HEC.
- Introduce integrative approach between different subjects of all programs
- Funding may be advanced for the purchase of equipment to be used for research and training regarding biochemical studies in Biochemistry.
- To HEC is requested to expedite the processes related to degree attestation specially of high level i.e Ph.D
- Eligibility conditions for MS/M Phil Biochemistry:
  - ◆ Bs Biochemistry/ BSc Hons Biochemistry, Molecular Biology and Biotechnology (4 Year) or MSc Biochemistry, Molecular Biology and Biotechnology (2 Year). No other discipline should be eligible to get admission in MS/M Phil Biochemistry.
- NCRC recommends that the HEC should pursue the matter with all provincial Public Service Commission's regarding creation of independent posts of lecturers, Assistant Professor, Associate Professor and Professor for recruitment in colleges to teach the specialized Biochemistry courses.
- NCRC recommends to regularly hold meetings of all experts in Biochemistry.

### **Rationale:**

The Curriculum of Biochemistry has vertical and horizontal alignments. The vertical alignments include placing/offering of basic and/or prerequisite courses in the initial semesters of a degree and those comprising advanced contents in the senior level semesters. The vertical alignments also address the issues of flow or linear advancement of knowledge from intermediate, undergraduate and graduate level degrees. The horizontal alignments include coherence of Biochemistry with other related disciplines.

Evaluation of students' performance will be based on Bloom's Taxonomy of Learning Domains comprising Cognitive, Affective, and Psychomotor. Evaluation scores of a course are proposed to carry 50% of the total marks in Final, 30% of the total theory marks in Mid, and 20% of the total theory marks in Semester work (including quiz, assignment, presentation etc...). The lab part of the course will be evaluated based on RUBRICS for Lab that will include i) Lab Reports, ii) Lab Demonstration, and iii) Viva Voce. The lab part of the course will be assessed as a total of 100 to be converted to the ratio of actual lab score for the number of specified credit hours.

Field visits may be made part of sessional marks wherever it deemed fit.

### **Mission Statement:**

Producing competent Biochemists to effectively deliver real products and services for benefit to society, is a responsibility of universities/DAIs. The Biochemistry

Curriculum is designed to provide necessary knowledge, analytical and leadership abilities, critical thinking, and ethical values to the graduates to cope up with the technological challenges.

**Preamble:**

**Program Educational Objectives (PEOs)**

The program offered by the institution should also have well defined program objectives. Program educational objectives (PEO) are broad statements that describe what graduates are expected to achieve a few years after graduation. It should be ensured that the program objectives are aligned with the vision/mission of the institution. Program objectives should be articulated and made known to everyone in the institution through institutional publications and websites.

The successful pursuit and realization of the mission and objectives, and the means adopted to accomplish them bring out the quality of the institution and its programs. Program educational objectives are based on the needs of the program's constituencies and are linked to student learning outcomes and assessment process.

The objectives should be clear, concise, realistic and measurable within the context of the committed resources. A process should be developed to assess the level of attainment of the program objectives to evaluate effectiveness of the academic programs. It should include feedback from faculty, employers, alumni and other stakeholders. The evaluation results should be utilized for redefining/improving the program objectives.

The program must demonstrate that following are in place:

- a) Well-defined and published Program Mission
- b) Program's educational objectives defined and consistent with the mission
- c) Program's educational objectives based on the stakeholder's needs on program
- d) A process in place to evaluate the attainment of educational objectives
- e) Evaluation results used for continual improvement of the program

**Program Educational Objectives (PEOs)**

The program of Biochemistry will achieve the following Program Educational Objectives (PEOs)

**PEO-1:** Able to understand the basic concepts about structure and chemistry of biomolecules.

**PEO-2:** The objective of the Bachelor and Master's Programme in Biochemistry is to prepare students for future careers in the various fields in which a core understanding of the biochemistry of biological processes is important. Scientific

disciplines such as human biochemistry, medical biochemistry and biotechnology will enhance the understanding of human health.

**PEO-3:** The Biochemistry Programme will benefit the society on the whole by adding to the highly skilled scientific workforce, particularly for the biomedical research sectors, in the academic, industry as well as for research laboratories across the country and the globe.

**PEO-4:** The students opting for the Biochemistry programme will have an advanced in depth understanding on all the human biochemical aspects pertaining to the well being and in the pathological state.

### **Program Learning Outcomes (PLOs)**

The students graduating from the Biochemistry program will have

- a better understanding of the key principles of biochemical functioning at an advanced level
- better awareness of the major issues at the forefront of the discipline
- will possess an in-depth understanding of the area of biochemistry chosen for research emphasis
- ability to design and carry out experiments (safely) and to interpret experimental data
- production of substantial original research of significance and quality sufficient for publication
- ability to present their work through written, oral, and visual presentations, including an original research proposal
- awareness of ethical issues in biochemical research and careers option
- Students will construct a research thesis, and present the results of that thesis to an audience of peers and faculty at regional or all college events, and be able to defend their results to other students and faculty.
- Students will explain/describe the synthesis of proteins, lipids, nucleic acids, and carbohydrates and their role in metabolic pathways
- Students will use current biochemical and molecular techniques to plan and carry out experiments. They will generate and test hypotheses, analyze data using statistical methods where appropriate, and appreciate the limitations of conclusions drawn from experimental data.

### **Scope:**

Biochemistry is the branch of science. It refers to study of chemical processes within living organism. It is called Biological Chemistry. There is a huge scope and demand of Biochemistry in Pakistan. There are numbers of universities which are offering Biochemistry at both Bachelor and Master level in Pakistan.

- They can work in provincial and also in federal government departments
- They can serve in biochemical industries
- They can have jobs in hospitals
- They can look for jobs in agricultural firms
- Work in food production companies

- Serve in the research institutes
- They can have jobs in education and also in some linked sectors
- Have jobs in the pharmaceutical industries
- Have your career in the research related kind of agricultural industries and also in institutions

### **Curriculum and Learning Process:**

The academic curriculum of the program is designed to facilitate / ensure the achievement of program outcomes by all students. This is achieved by offering a balanced combination of technical and non-technical contents coupled with appropriate assessment and evaluation methods. This has a well-defined core of essential subjects supported by requisite compulsory as well as elective courses. It also invokes awareness and comprehension of societal problems amongst the students and motivating them to seek solutions for improving the quality of life. The theory content of the curriculum is supplemented with appropriate experimentation / laboratory work.

The program structure is covering the essential fundamental principles at the initial stages, leading to integrated studies in the final year of the program, in consonance with the approach and levels defined in Bloom's taxonomy, particularly in breadth & depth courses.

The hallmark of a curriculum is to infuse original thinking, resourcefulness and entrepreneurial spirits among students. This program is embodying foundation courses as well as the general and specialized professional content of adequate Breadth and Depth, including appropriate Humanities and Science components. The program scheme is designed to ensure acquisition of knowledge and skills, encouraging necessary exposure to inter-disciplinary areas.

The contents of each constituent courses of the curriculum has been updated to absorb recent technological and knowledge developments as per international practices and to meet the national needs. Efforts are also made that there should also be an effective relationship between the curricular content and practice in the field of specialization.

It is expected that the graduates are able to demonstrate professional ethics and competence in oral communication, scientific & quantitative reasoning, critical analysis, system design, logical thinking, creativity and capacity for life-long learning.

The delivery of subject matter and the assessment process employed is expected enabling the students to develop intellectual and practical skills effectively, as deemed essential in program outcomes assessment. Complex engineering problems which are not easily quantifiable, e.g. communication skills (oral / written), critical thinking, ethics, team work, etc. often require rubrics as a tool for their assessment (both in direct or indirect methods).



In addition to regular teaching / learning activities such as classroom interaction, problem based learning (PBL) assignments, lab experimentation and faculty consultation, other aspects of student learning such as tutorial system, research / design projects, seminar / workshops and exposure to industrial practice should form an integral part of curriculum. Internal reviews of quality assurance procedures should be carried out periodically.

**ELIGIBILITY CRITERIA:**

**For undergraduate level**

**Eligibility for BS Biochemistry:** FSc. PreMedical or O/A level with Biology and at least secure 60% marks or equivalent.

**STANDARDIZED FORMAT  
FOR BS (4-YEAR) IN BIOCHEMISTRY**

**STRUCTURE**

<b>Sr.</b>	<b>Categories</b>	<b>No. of courses</b>	<b>Credit Hours</b>
1.	Compulsory courses	9	25
2.	General courses (to be chosen from other Departments)	8	24
3.	Discipline specific foundation courses	10	30
4.	Major courses (including Research Project/Internship)	15	45
5.	Electives within the major	4	12
	<b>Total</b>	<b>45</b>	<b>136</b>

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

## LAYOUT FOR BS (4 YEAR) IN BIOCHEMISTRY

<b>Compulsory Courses</b> (student has no choice)		<b>General Courses</b> (to be chosen from other Departments)	
<b>9 courses</b>		<b>8 courses</b>	
<b>25 Credit hours</b>		<b>24 Credit hours</b>	
<b>Subject</b>	<b>Cr. hr</b>	<b>Subject</b>	<b>Cr. hr</b>
1. English I	3+0	1. Social Science	3+0
2. English II	3+0	2. Marketing &	3+0
3. English III (Writing & Comm)	3+0	Management	2+1
4. English IV/University optional	2+0	3. Organic Chemistry	2+1
5. Pakistan studies	3+0	4. Inorganic Chemistry	2+1
6. Islamic studies/Ethics	3+0	5. Physical Chemistry	2+1
7. Mathematics I	3+0	6. Analytical Chemistry	
8. Mathematics II/Biostatistics*		7. Genetics	3+0
9. Intro. to Computer Science		8. Microbiology	2+1
	<b>25</b>		<b>24</b>

TOTAL CREDIT HOURS=136

Discipline-Specific Foundation Courses		Major Courses		Elective Courses within the Major	
10 courses		15 courses		4 courses	
30 Credit hours		45 Credit hours		12 Credit Hours	
Subject	Cr hr	Subject	Cr hr	Subject	Cr hr
1. Introductory Biochemistry	2+1	1. Biosafety & Ethics	2+1	1. Elective-I	3+0
2. Carbohydrates & Lipids	2+1	2. Plant Biochemistry	2+1	2. Elective-II	3+0
3. Amino Acids & Proteins	2+1	3. Clinical Biochemistry	2+1	3. Elective-III	3+0
4. Human Physiology	3+0	4. Bio membranes & Cell Signaling	3+0	4. Elective-IV	3+0
5. Enzymology	2+1	5. Bioenergetics	3+0	<b>Note:</b> Elective courses are to be chosen from the given list.  OR Any other course depending upon the expertise available.	
6. Molecular Biology	3+0	6. Research Planning & Scientific Writing	2+1		
7. Metabolism I	3+0	7. Nutritional Biochemistry	2+1		
8. Metabolism II	3+0	8. Bioinformatics	2+1		
9. Cell Biology	2+1	9. Industrial Biochemistry	2+1		
10. Biochemical Techniques	1+2	10. Immunology	3+0		
		11. Current Trends in Biochemistry	3+0		
		12. Biotechnology	2+1		
		13. Environmental Biochemistry	2+1		
		14. Methods in Molecular Biology	1+2		
		15. Research Project/Internship	0+3		
	<b>30</b>		<b>45</b>		<b>12</b>

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

SEMESTER	NAME OF SUBJECT	THEORY	PRACTICAL	CREDITS
<b>First</b>	English-I	3	0	3
	Pakistan Studies	2	0	2
	Mathematics I	3	0	3
	Social Science	3	0	3
	Organic Chemistry	2	1	3
	Introductory Biochemistry	2	1	3
			<b>15</b>	<b>2</b>
<b>Second</b>	English-II	3	0	3
	Islamic studies/Ethics	2	0	2
	Inorganic Chemistry	2	1	3
	Mathematics-II/Biostatistics	3	0	3
	Microbiology	2	1	3
	Carbohydrates & Lipids	2	1	3
			<b>14</b>	<b>3</b>
<b>Third</b>	English-III	3	0	3
	Introduction to Computers	2	1	3
	Physical Chemistry	2	1	3
	Genetics	3	0	3
	Proteins & Nucleic Acids	2	1	3
	Cell Biology	2	1	3
			<b>14</b>	<b>4</b>
<b>Fourth</b>	English IV/University optional	3	0	3
	Marketing & Management	3	0	3
	Analytical chemistry	2	1	3
	Human Physiology	2	1	3
	Enzymology	2	1	3
	Biosafety & Bioethics	2	1	3
			<b>14</b>	<b>4</b>
<b>Fifth</b>	Metabolism I	3	0	3
	Molecular Biology	3	0	3
	Nutritional Biochemistry	2	1	3
	Immunology	3	0	3
	Plant Biochemistry	2	1	3
	Environmental	2	1	3

	Biochemistry			
		<b>15</b>	<b>3</b>	<b>18</b>
<b>Sixth</b>	Metabolism II	3	0	3
	Biochemical Techniques	1	2	3
	Biotechnology	3	0	3
	Bioinformatics	2	1	3
	Bioenergetics	3	0	3
	Industrial Biochemistry	2	1	3
		<b>14</b>	<b>4</b>	<b>18</b>
<b>Seventh</b>	Research Planning & Scientific Writing	3	0	3
	Biomembranes & Cell Signaling	3	0	3
	Clinical Biochemistry	2	1	3
	Elective-I	3	0	3
	Elective-II	3	0	3
		<b>14</b>	<b>1</b>	<b>15</b>
<b>Eight</b>	Current in Trends Biochemistry	3	0	3
	Research Project/Internship	0	3	3
	Methods in Molecular Biology	1	2	3
	Elective-III	3	0	3
	Elective-IV	3	0	3
		<b>11</b>	<b>4</b>	<b>15</b>
	<b>TOTAL</b>	<b>113</b>	<b>23</b>	<b>136</b>

## DETAIL OF GENERAL COURSES

### Organic Chemistry

#### Contact Hours:

Theory = 32  
Practical = 32  
Total = 64

#### Credit Hours:

Theory = 2.0  
Practical = 1.0  
Total = 3.0

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#### **Course Objective:**

The specific objectives are as follow;

- To offer basic concepts of organic chemistry
- To develop understanding of hydrocarbons, reactivity of functional groups and stereochemistry
- To impart practical skills

#### **Learning Outcome:**

Students completing this course will be able to;

- a. Explain basic concepts of organic chemistry
- b. Understand the mechanistic pathways for synthesis of molecules
- c. Apply acquired knowledge in the allied fields of chemistry
- d. Perform any laboratory related task within the scope of course independently

#### **Course Outline:**

- Bonding and hybridization, localized and delocalized bonding, aromaticity, inductive effect, dipole moment, resonance and its rules, hyper-conjugation, classification and nomenclature of organic compounds.
- Different types of organic reactions and mechanism.
- Saturated, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and substitution reactions.
- Hydroxyl, ether and amino groups, preparation and properties of alcohols, phenols, ethers, and amines.
- Reaction mechanism and applications.
- Carbonyl compounds, preparations and reaction mechanism of aldehydes and ketones and their applications.
- Carboxylic acids and their derivatives, acidity of carboxylic acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including; esters, amides, acid halides and acid.
- Types of stereoisomers, RS and EZ notation, optical activity, stereoselectivity and stereospecificity, conformational analysis.

**Practicals:**

- Qualitative analysis of compounds with different functional groups.
- Synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation.
- Preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol, etc.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:****Theory 70%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Clayden J., Greeves N., and Warren S., Organic Chemistry, Paperback Edition, Oxford University Press, 2012.
2. Brown W., and Poon, T., Introduction to Organic Chemistry, 3rd ed., John-Wiley & Sons, Inc., (2005).
3. John, E. M. Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
4. Younus M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).
5. Solomons T. W. G. and Fryhle C. B., Organic Chemistry, 10th ed., John-Wiley & Sons, Inc., (2011).



6. Mayo D. W., Pike, R. M. and Forbes, D. C., *Microscale Organic to Laboratory with Multistep and Multisacle Syntheses*, 5th ed., John-Wiley & Sons, Inc., (2011).

### Inorganic Chemistry

**Contact Hours:**

Theory = 32  
Practical = 32  
Total = 64

**Credit Hours:**

Theory = 2.0  
Practical = 1.0  
Total = 3.0

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**Course Objective:**

The specific objectives are:

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

**Learning Outcome:**

Students completing this course will be able to;

- a. Acquire the basic knowledge of inorganic chemistry
- b. Identify the scope in related fields
- c. Take on laboratory tasks relevant to inorganic chemistry

**Course Outline:**

Chemical Bonding:

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

Acids and Bases:

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

P-Block Elements:

- Physical and chemical properties of p-block elements
- Representative compounds, inter-halogens, pseudo-halogens and polyhalides.

### Stoichiometry:

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

### **Practicals:**

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

### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

### **Assessment:**

#### **Theory 70%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

#### **Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6<sup>th</sup> ed., John-Wiley & Sons, New York, (2007).
2. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 3<sup>rd</sup> ed., Harper International SI Edition, (2006).
3. House, J. E., Inorganic Chemistry, Academic Press. USA, (2008).
4. Lee, J. D., Concise Inorganic Chemistry, 5<sup>th</sup> ed., Chapman and Hall, (1996).
5. Miessler, G. L., Tarr, D. A., Inorganic Chemistry, 3<sup>rd</sup> ed., Pearson Education, India, (2008).
6. Huheey, J. E., Keiter E. A., Keiter L. R., Inorganic Chemistry: Principles of Structure and Reactivity, 4<sup>th</sup> ed., Benjamin-Cummings Pub Co., (1993).
7. Sharpe, A. G., Inorganic chemistry, 3<sup>rd</sup> ed., Pearson Education India, (1981).
8. Chaudhary S. U., IImi Textbook of Inorganic Chemistry, IImi Kitab Khana, Lahore, (2013).

**Physical Chemistry****Contact Hours:**

Theory = 32

Practical = 32

Total = 64

**Credit Hours:**Theory = **2.0**Practical = **1.0**Total = **3.0**

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**Course Objective:**

The specific objectives are:

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

**Learning Outcome:**

Students completing this course will be able to;

- a. Elaborate the fundamental principles of physical chemistry
- b. Analyze physical chemistry related matters
- c. Apply the obtained knowledge of physical chemistry in biochemical sciences

**Course Outline:**

Chemical Thermodynamics:

- Equation of states, ideal and real gases, the real gas equation.
- Van der Waals equation for real gases, critical phenomena and critical constants.
- Laws of thermodynamics and their applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and non-reversible processes.

- Spontaneous and non-spontaneous processes, relations of entropy and Gibbs free energy with equilibrium constant.
- Gibbs Helmholtz equation, fugacity and activity.

#### Chemical Equilibrium:

- General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants.
- Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, van't Hoff equation, Le-Chatelier's principle.

#### Solution Chemistry:

- Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment and their applications.
- Interactions among the molecules in liquids, ideal and non-ideal solutions.
- Raoult's law and its applications, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, vapor pressure of non-ideal solutions.
- Henry's law, abnormal colligative properties, degrees of association and dissociation of solutes, osmotic pressure and its measurement, fractional distillation and concept of azeotropic mixtures.

#### Chemical Kinetics:

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

#### Practicals:

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:****Theory 70%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1<sup>st</sup>ed., University Science Books, (1997).
2. Atkins P. and Paula J.D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).
3. Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill Publishing Company Limited, (2003).
4. Silbey R., Alberty R. and Bawendi M., Physical Chemistry, 4th ed., (2005).
5. Glasstone S., Textbook of Physical Chemistry, Macmillan London (1960).
6. Chaudhary S. U., IImi Textbook of Physical Chemistry, 2nd ed., IImiKitabKhana Lahore, (2013).
7. Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Pvt. Ltd., (2011).
8. Davis, W. M., Dykstra, C. E., Physical Chemistry: A Modern Introduction, 2nd ed., CRC Press, (2011).

**Analytical Chemistry****Contact Hours:**

Theory = 32  
Practical = 32  
Total = 64

**Credit Hours:**

Theory =2.0  
Practical= 1.0  
Total = 3.0

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**Course Objective:**

The specific objectives are:

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

**Learning Outcomes:**

Students completing this course will be able to;

- a. Explain the fundamentals of analytical chemistry
- b. Demonstrate understanding on the working principles of different analytical techniques.
- c. Analyze the chemical problems through a thought process and come up with solution
- d. Apply the learnt techniques in the laboratory for analysis of samples

**Course Outline:**

Separation Methods:

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

Analytical Spectrophotometry:

- Properties of light and its interaction with matter, relation between frequency, velocity and wave number.
- Lambert-Beer's law and its limitations, single beam and double beam spectrophotometers, lamps and lasers as sources of light, monochromators, detectors, photomultiplier tube, photodiode array, charged coupled device
- FT-IR spectroscopy, Fourier analysis, interferometry, noise and its control.

Classical Analytical Methods:

- Acid-base, complexometric and redox titrations, gravimetric analysis.

**Practicals:**

- Calibration of volumetric glassware, electronic and analytical equipment.
- Determination of hardness of water using EDTA.
- Determination of chloride in tap water sample.
- Estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry.
- Gravimetric analysis, determination of cation in a mixture by complexometric titration, studying the effect of common ions on solubility of sparingly soluble salts.
- Separation of phenol from given organic mixture by using solvent extraction.

- Separation of given mixture of cations using paper chromatography.
- Analysis of the composition of a mixture of nitro anilines by TLC.
- Separation of sugars using paper chromatography.
- Deionization and softening of water using ion exchange chromatography. Determination of  $\lambda_{\text{max}}$  of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  solutions and verification of Beer-Lambert's law.
- Determination of stoichiometry of a metal complex by visible spectrometry.
- Determination of aspirin and caffeine in a proprietary analgesic by double beam UV-Vis. spectrometer.
- Quantification of iron in a given sample by using single beam spectrophotometer.

#### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

#### **Assessment:**

##### **Theory 70%**

##### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

##### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

##### **Practical 30 %**

- Written
- Practical performance
- Note book and Viva

#### **Recommended Books:**

1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Brooks Cole Publishing Company, (2013).
2. Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, USA, (2011).
3. Christian, G. D., Analytical Chemistry, 6th ed., John Wiley and Sons, New York, (2006).
4. Kealey, D. and Haines, P. J., BIOS Instant Notes in Analytical Chemistry, 1st ed., Bios Science Publisher Ltd. Oxford UK. (2002)

5. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. A., Introduction to spectroscopy, 4th ed., Cengage Learning, (2008).
6. Wall, P. E., Thin Layer Chromatography: A Modern Approach (RSC Chromatography Monographs), 1st ed., Royal Society of Chemistry, (2005).
7. Deinstrop, E. H., Applied Thin Layer Chromatography, 2nd ed., Wiley-VCH, (2006).
8. Kellener. R, Mermet. J. M., Otto, M., Valcarcel, M., Widmer, H.M., Analytical Chemistry: A Modern Approach to Analytical Science, Wiley. VCH, (2004)

### Microbiology

#### Contact Hours:

Theory = 32  
 Practical = 32  
 Total = 64

#### Credit Hours:

Theory = **2.0**  
 Practical = **1.0**  
 Total = **3.0**

#### **Course Objective:**

- This course will familiarize students with fundamentals of prokaryotic and eukaryotic microorganisms including viruses.
- This course will impart knowledge about the structure, growth, genetics, metabolism and ecology of microbes.
- This course will demonstrate suitable laboratory skills and techniques required for the isolation, staining, identification, characterization and control of microbes.

#### **Learning Outcome:**

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

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

#### **Course Outline:**

- Overview and history of microbiology
- microbial diversity and ecology (Archaea, bacteria, fungi, algae, protozoa)
- Biophysical and biochemical factors for microbial growth
- Microbial growth kinetics and methods of measurement of microbial growth
- Transformation, transduction and conjugation
- Microbial metabolism
- Carbon, nitrogen, sulfur and phosphorus cycles
- Symbiosis
- Structure and biology of viruses



- Common microbial diseases
- Control of microorganisms: sterilization and disinfection, antimicrobial agents, antibiotics, antibiotic resistance and susceptibility, antifungal and antiviral agents
- Applications of microorganisms

**Practicals:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

- 1 Pommerville CJ. Alcamo's Fundamentals of Microbiology. 9th Ed. Jones and Bartlett Learning Company, 2018.
- 2 Madigan MT and Martinko J, 2010. Brock Biology of Microorganisms. 13th Edition; Pearson College Div.

- 3 Talaro KP. 2015. Foundations in Microbiology Companion. 8th ed. McGraw Hill.
- 4 Black JG, 2007. Microbiology: principles and explorations. 7th Edition; John Wiley and Sons.
- 5 Willey JM, Sherwood LM, Woolverton CJ. 2014. Prescott, Harley AND Kleins's Microbiology, 9th ed., McGraw Hill.
- 6 Cappuccino JG and Sherman N, 2013. Microbiology: a laboratory manual. 10thEdition; Pearson Education.

### Genetics

#### Contact Hours:

Theory =48

Practical = 0

Total = 48

#### Credit Hours:

Theory =**3.0**

Practical= **0**

Total = **3.0**

#### **Course Objective:**

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

#### **Learning Outcome:**

After completing this course, students should be able to:

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

#### **Course Outline:**

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

- Mutations
- Chromosomal aberrations: Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation
- Population genetics; Hardy Weinberg equilibrium

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

- 1 Genetics by Strickberger, M.W. Latest edition, The Macmillan. Co.Ny
- 2 Modern Genetics by Ayala & Kiger. The Benjamin Cummings, Co. Inc. California, USA
- 3 Genetics: From Genes to Genomes by Leland Hartwell, Leroy Hood, Michael Goldberg, and Ann Reynolds Genetics by Levine.
- 4 Genetics by Klug and Cummings; 8th edition.
- 5 Genomes 3 by T. S. Brown: Garland Science; New York
- 6 Human Molecular Genetics 3 by Tom Strachan and Andrew P. Read: Garland Science; New York

## DETAIL OF DISCIPLINE-SPECIFIC FOUNDATION COURSES

### Introductory Biochemistry

#### Contact Hours:

Theory = 32  
Practical = 32  
Total = 64

#### Credit Hours:

Theory = 2.0  
Practical = 1.0  
Total = 3.0

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#### **Course Objective:**

This course will provide:

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

#### **Learning Outcome:**

After completing this course students should be able to:

- Understand the scope of biochemistry
- Understand biochemical basis of life
- Acquire basic knowledge of biomolecules

#### **Course Outline:**

- A general introduction to the science of biochemistry;
- Importance and the scope of biochemistry
- Prebiotic molecular evolution and rise of living systems;
- Review of the variety and ecology of the living world;
- Forms, functions and brief classification of prokaryotes;
- Cellular architecture and diversity of eukaryotes;
- Structure, physical properties and importance of water; pH and buffer
- Unique properties of carbon and other elements found in biological molecules;
- General reactions of different functional groups;
- Biologically important organic compounds
- Composition, properties and functions of proteins, carbohydrates, lipids and nucleic acids
- Brief introduction of vitamins, hormones and enzymes

#### **Practicals:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Fundamentals of Biochemistry. (2008) 3rd Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.
2. Text Book of Biochemistry (1970) by E. West & W. Todd Macmillan
3. Biochemistry. (1999) 3rd Ed. by C. K. Mathews, K. E. Van Holde, & K.G. Ahern. Prentice Hall.
4. Harper's Illustrated Biochemistry, 27th Ed. by R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw-Hill.
5. Lehninger Principles of Biochemistry (2008) 5th Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers

**CARBOHYDERATES AND LIPIDS****Contact Hours:**

Theory = 32  
Practical = 32  
Total = 64

**Credit Hours:**

Theory = **2.0**  
Practical = **1.0**  
Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

At the end of this course the students will be able to:

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

#### **Course Outline:**

- Introduction, historical background, occurrence and biological significance of carbohydrates
- Nomenclature and classification of carbohydrates
- Structures, chemical and physical properties of monosaccharides, oligosaccharides and polysaccharides
- Blood group Oligo and polysaccharides and their importance in blood transfusion, and tissue/organ transplants
- Introduction, classification and biological functions of lipids
- Classification, nomenclature, structures and properties of fatty acids
- Structure and properties of simple and mixed triglycerides and waxes
- Structure, properties and functions of phospholipids, sphingolipids and glycolipids
- Lipoprotein system: Chylomicrons, HDL, LDL, IDL and VLDL and their role in distribution of lipids
- Chemical structures and functions of Prostaglandins, thromboxanes and leukotrienes
- Structure and biological significance of cholesterol, bile salts, bile acids and other steroids

#### **Practicals:**

- Qualitative analysis of glucose, galactose and fructose, maltose, lactose, sucrose, starch glycogen and cellulose.
- Quantitative analysis of carbohydrates in unknown samples
- Extraction of starch from plant sources and its confirmative tests
- Extraction of lipids from animal and plant sources
- Extraction of Glycogen from animal sources & its confirmatory
- Qualitative tests for lipids and fatty acids
- Determination of saponification value, rancidity, acid value, iodine value and Reichert – Meissl number

#### **Teaching Methodology**

- Lecturing using multimedia, white boards and structural models
- Asking the students to read recommended books
- Written Assignments
- Lab work

#### **Teaching Methodology:**

- Lecturing

- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

- 1 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.
- 2 Biochemistry. 7th Ed. By Jeremy M. Berg, John L. Tymoczko and Lubert Stryer. Publisher: Palgrave MacMillan; 7th revised international ed edition (April 1, 2011).
- 3 Fundamentals of Biochemistry (2008) 3rd Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.
- 4 Lehninger Principles of Biochemistry. (2012) 6th Ed. By David L. Nelson , Michael M. Cox . W.H. Freeman; 6th Edition (November 21, 2012).

**PROTEINS AND NUCLEIC ACIDS**

**Contact Hours:**

Theory =32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = 2.0  
 Practical= 1.0  
 Total = 3.0

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**Course Objective:**

The objectives of this course are:

- To understand the basic concepts related to structure and functions of amino-acids and proteins

- To acquire the knowledge of chemistry of nucleic acids
- To understand the differences between RNA & DNA

### **Learning Outcome:**

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

- Describe different levels of protein structure
- Identify the different amino-acids and nucleic acids
- Isolate and analyze the proteins and nucleic acids
- Draw the chemical structure of amino-acids and small peptides
- Explain the double helix structure of DNA
- Evaluate the biological role of proteins and nucleic acids

### **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

### **Practicals:**

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



**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:****Theory 70%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Lehninger Principles of Biochemistry. (2012) 6<sup>th</sup> Ed. By David L. Nelson, Michael M. Cox W.H. Freeman; 6<sup>th</sup> Edition (November 21, 2012).
2. Principles of Biochemistry. (2011) 5<sup>th</sup> Ed. by Laurence A. Moran, Robert A Horton, Gray Scrimgeour and Marc Perry
3. Fundamentals of Biochemistry (2010) 4<sup>th</sup> Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.4. Textbook of Practical Biochemistry. Joshi A. Rashmi. B. Jain Publishers, 2002
4. Introductory Practical Biochemistry. 2005. 2<sup>nd</sup> Ed. By S. K. Sawhney, Randhir Singh. Alpha Science International, Ltd.
5. Harpers Illustrated Biochemistry. (2012). 29<sup>th</sup> Ed. By Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil. McGraw-Hill Medical.
6. Biochemistry. (April 1, 2011).7<sup>th</sup> Ed. By Jeremy M. Berg, John L. Tymoczko and Lubert Stryer. Palgrave MacMillan.
7. Molecular cell Biology (2012) 7<sup>th</sup>ed by Lodish et al., W.H.Freeman, Newyar

## HUMAN PHYSIOLOGY

### **Contact Hours:**

Theory = 32  
Practical = 16  
Total = 48

### **Credit Hours:**

Theory = 2.0  
Practical = 1.0  
Total = 3.0

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### **Course Objective:**

This course is designed to:

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

### **Learning Outcome:**

After completing this course students should be able to;

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

### **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.

**Practicals:**

1. Use of stethoscope & measurement of human arterial blood pressure & Pulse
2. Determination of bleeding time in human body
3. Determination of the coagulation time in human body
4. Determination of Red Blood Cells count of human Blood
5. Determination of White Blood Cells count of human blood
6. Estimation of hemoglobin in human blood
7. Determination of the differential Leukocytes count in blood
8. To observe the shape of RBC in normal saline stem
9. To determine the group of blood sample
10. Physiochemical & microscopic analysis of human urine sample
11. Determination of visual acuity of a human subject by using snellen's eye chart
12. Demonstration of the use of ECG
13. To record normal respiration & effect of exercise on it using spirometer
14. To record normal respiration & effect of exercise on it using power lab
15. To identify various parts of digestive tract & to observe cut mobility in exposed abdomen of dissected rabbit

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Text Book of Medical Physiology (2016) 13<sup>th</sup> Edition by Guyton A.C., John E.H, Human Physiology: An Integrated Approach (2018) 8<sup>th</sup> Edition by Silverthorn D.U, Pearson
2. Fundamentals of Biochemistry (2011) 4<sup>th</sup> Edition by Voet D., Voet J.G., & Pratt C.W., John Wiley and Sons, New York.
3. Principles of Biochemistry (2017), 7<sup>th</sup> Edition by Lehninger A.L., Nelson D.L. and Cox M.M., Worth Publishers, New York
4. Human Physiology (2015) 14<sup>th</sup> Edition by Fox S. I, McGraw-Hill Education
5. Human Biochemistry (2017) 1<sup>st</sup> Edition by Litwack G, Academic Press
6. Human Physiology: From Cells to Systems (2015) 9<sup>th</sup> Edition by Sherwood L, Brooks ColeW. B Saunders Company.

**Enzymology****Contact Hours:**

Theory = 32  
Practical = 16  
Total = 48

**Credit Hours:**

Theory = **2.0**  
Practical = **1.0**  
Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

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

- Understand the catalytic properties and mechanisms of enzyme action
- Understand and analyze kinetics of enzyme catalyzed reactions.
- Evaluate effect of different types of inhibitors on enzyme activity
- Perform enzyme assays

**Course Outline:**

- Introduction to enzymes, nomenclature and classification
- Isoenzymes, coenzymes and role of cofactors
- Structure of enzyme; active site and regulatory sites
- Enzyme specificity and different types
- Kinetics of chemical reactions
- Michaelis-Menten equation and other models used to understand kinetics
- Multienzyme system and two substrate reactions
- Enzyme Inhibition and types of inhibition
- Ribozyme
- Enzyme catalysis; catalytic strategies and mechanisms of different enzymes

- Regulation of enzyme activity
- Effect of various factors on rate of reactions
- Enzyme assays
- Immobilized enzyme
- Applications of enzyme

**Practicals:**

- Extraction and estimation of enzymes from plant and animal sources.
- 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.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Fundamentals of Biochemistry. (2008) 3rd Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.
2. Text Book of Biochemistry (1970) by E. West & W. Todd Macmillan
3. Biochemistry. (1999) 3rd Ed. by C. K. Mathews, K. E. Van Holde, & K.G. Ahern. Prentice Hall.

4. Harper's Illustrated Biochemistry, 27th Ed. by R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw-Hill.
5. Lehninger Principles of Biochemistry (2008) 5th Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers

### Molecular Biology

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = 0  
 Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

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

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

**Course Outline:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

- 1 Nelson D and Cox MM, 2009. Lehninger Principles of Biochemistry. 5<sup>th</sup> Edition; WH Freeman, New York.
- 2 David Clark Nanette Pazdern, 2012, 2<sup>nd</sup> Edition, Molecular Biology 2<sup>nd</sup> Edition
- 3 Lodish et al., 2016. Molecular Cell Biology. 8<sup>th</sup> Edition; WH Freeman, New York
- 4 Berg et al., 2006. Biochemistry. 6<sup>th</sup> Edition; WH Freeman, New York.
- 5 Alberts et al., 2007. Molecular Biology of the Cell. 5<sup>th</sup> Edition; Garland Science
- 6 Weaver R, 2011. Molecular Biology. 5<sup>th</sup> Edition; McGraw-Hill

**Metabolism I****Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

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

- Acquire the knowledge about intermediary biochemical processes

- Demonstrate the metabolic pathways of carbohydrates and lipids - the energy yielding and energy requiring reactions in life.
- Understand the diversity of metabolic regulation of two macromolecules, and how this is specifically achieved in different cells.

### **Course Outline:**

#### Carbohydrate metabolism:

- Digestion and absorption of carbohydrates
- Role of glucose in metabolism of plants, animals and microorganisms
- Glycolysis: reactions of glycolysis and energy calculation, anaerobic fate of pyruvate, fermentation, control of metabolic flux. Regulation of glycolytic pathway. Metabolism of other monosaccharides (Feeder pathways).
- Conversion of Pyruvate to acetyl CoA
- TCA cycle: Overview of TCA, Metabolic sources of Acetyl Coenzyme A, Regulation of TCA Cycle, Reactions of Electron Transport chain, Energetics, Shuttle systems.
- Other pathways of carbohydrate metabolism: Gluconeogenesis, cori cycle, glycogenesis, glycogenolysis, Glyoxalate Cycle reactions, Pentose phosphate Pathway.
- 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 digestion, absorption and transport
- Lipolysis and utilization of glycerol
- $\beta$ -oxidation of fatty acids and various modes of oxidations
- Ketogenesis, ketolysis and regulation
- Biosynthesis of fatty acids, Elongase and Desaturase systems
- Biosynthesis of triacylglycerols, Phospholipids, Cardiolipins, Glycolipids and sphingolipids
- Prostaglandins: Prostacyclins, Thromboxanes and leukotrienes
- Lipoproteins: metabolism of plasma lipoproteins.
- Metabolism of cholesterol, steroid hormones and bile acids.

### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

### **Assessment:**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)



- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

- 1 Lehninger Principles of Biochemistry" by Nelson & Cox, (2017) 7<sup>th</sup> edition ISBN 10: 1-4641-2611-9; ISBN-13: 978-1-4641-2611-6.
- 2 Fundamentals of Biochemistry (2014) 5<sup>th</sup> edition By DJ Voet , GJ Voet and CW Pratt. J Wiley & Sons Inc. ISBN: 9781118918401
- 3 Biochemistry (2007) 6<sup>th</sup> edition by JM Berg, JL Tymoczko & L Stryer WH Freeman &Co
- 4 Biochemistry 6<sup>th</sup> Edition (Lippincott's Illustrated Reviews Series) by Richard A. Harvey (2014).
- 5 Harpers Illustrated Biochemistry 30<sup>th</sup> Edition (LANGE Basic Science) by Robert Murray, D. Bender, Kathleen M. Botham and P.J. Kennelly (2015)

**Metabolism II**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

This course will enable students to:

- understand metabolic pathways of proteins and nucleic acids
- Understand the diversity of metabolic regulations of proteins and nucleic acids
- acquire knowledge about inborn errors associated with these biochemical processes

**Course Outline:**

Metabolism of Proteins and Amino acids:

- Digestion and absorption of proteins;
- General aspects of amino acid metabolism,
- Deamination, transamination, transmethylolation, 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 and liver. Metabolic adaptation under starvation and Diabetes Mellitus
- Metabolism of Nucleic acids:
  - Biosynthesis, degradation and regulation of purine and pyrimidine bases
  - Biosynthesis, degradation and regulation of purine and pyrimidine nucleotides
  - Diseases associated with nucleotides and nucleotide metabolism such as gout, xeroderma pigmentosa, ADA, SCID and skin cancer,
  - Lesch nyhan syndrome and orotic aciduria

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

- 1 Lehninger Principles of Biochemistry" by Nelson & Cox, (2017) 7<sup>th</sup> edition ISBN 10: 1-4641-2611-9; ISBN-13: 978-1-4641-2611-6.
- 2 Fundamentals of Biochemistry (2014) 5<sup>th</sup> edition By DJ Voet , GJ Voet and CW Pratt. J Wiley & Sons Inc. ISBN: 9781118918401
- 3 Biochemistry (2007) 6<sup>th</sup> edition by JM Berg, JL Tymoczko & L Stryer WH Freeman & Co
- 4 Biochemistry 6<sup>th</sup> Edition (Lippincott's Illustrated Reviews Series) by Richard A. Harvey (2014).
- 5 Harpers Illustrated Biochemistry 30<sup>th</sup> Edition (LANGE Basic Science) by Robert Murray, D. Bender, Kathleen M. Botham and P.J. Kennelly (2015)

## DETAIL OF MAJOR COURSES

### CELL BIOLOGY

#### Contact Hours:

Theory = 32  
Practical = 32  
Total = 64

#### Credit Hours:

Theory = 2.0  
Practical = 1.0  
Total = 3.0

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#### **Course Objective:**

- Gain knowledge of cell as a fundamental unit of life emphasizing the chemical basis of life

#### **Learning Outcome:**

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

- Describe features of cell as unit of life
- Describe the salient features of plasma membrane
- Explain the structure and functions of the cytoplasmic organelles and nucleus
- Compare the eukaryotic and prokaryotic cell

#### **Course Outline:**

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

#### **Practicals:**

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

#### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Katherine J Denniston, Joseph J Topping , Dr Danae Quirk Dorr, "General, Organic, and Biochemistry" 7th Edition, 2013,publisherBrooks Cole.
2. Thomas M. Devlin. Wiley-Liss,"Textbook of Biochemistry with clinical correlation", 4<sup>th</sup> edition.
3. Kim E. Barrett; Susan M. Barman; Scott Boitano&Heddwen L. Brooks, "Ganong's Review of Medical Physiology",25<sup>th</sup> edition 2015 lang (Mc Graw Hill)
4. James R.Mckee and Trudy Mekee "Biochemistry an Introduction", 1966
5. James R.Mckee and Trudy Mekee " Biochemistry the molecular basis of life" 6<sup>th</sup> edition 2012 Oxford University Press.
6. James W. Baynes and MH Dominiczak, "Medical Biochemistry 3<sup>rd</sup> Edition 2012.
7. Micheal L. Lieberman, Allan-D .Marks, Colleen M Smith 2007 "Essential Medical Biochemistry (A clinical Approach)" Lippincott William & Wilkins.
8. Clinical Biochemistry E-Book: An Illustrated Colour Text,by Allan Gaw 3<sup>rd</sup> edit 2014 Churchill livinstone

**Biosafety and Bioethics**

**Contact Hours:**

Theory = 32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = 2.0  
 Practical =1.0  
 Total = 3.0

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**Course Objective:**

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

**Learning Outcome:**

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

- Understand the importance of biosafety levels
- Comprehend the use and significance of personal protective equipment
- Handle samples and animals in laboratories
- Apply bioethics to plan and conduct research
- Analyze and assess current bioethical controversies and discourses

**Course Outline:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Altman A and Hasegawa PM, 2012. Plant Biotechnology and Agriculture: Prospects for 21st Century. 1st Edition; Academic Press.
2. Laboratory Biosafety Manual, WHO, 2006. 3rd Edition; AITBS Publishers and Distributors, India. (Available online).
3. Furr AK, 2000. CRC Handbook of Laboratory Safety. 5th Edition; CRC Press.
4. Jose Maria A, 2003. Genes Technology and Policy. Available online at: <http://www.apdip.net/publications/iespprimers/eprimer-genes.pdf>
5. Krishna VS, 2007. Bioethics and Biosafety in Biotechnology. New Age International Publishers.
6. National Biosafety Guidelines, 2005. Pakistan Environmental protection Agency (Available online)

**Bioinformatics**

**Contact Hours:**

Theory = 32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory =2.0  
 Practical =1.0  
 Total = 3.0

**Course Objective:**

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

**Learning Outcome:**

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

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

**Course Outline:**

- Basic concepts in bioinformatics.
- Biological Sequence Databases (including Genomic Databases).
- Information Retrieval from Biological Databases.
- Predictive Methods Using DNA Sequences.
- Sequence Polymorphisms.
- Predictive Methods Using Protein Sequences.

- Assessing Pairwise Sequence Similarity: BLAST and FASTA.
- Creation and Analysis of Protein Multiple Sequence Alignments.
- Phylogenetic Analysis.
- Computational Approaches in Comparative Genomics.
- Proteomics and Protein Identification.
- Molecular modeling and visualization.
- Protein Structure Prediction and Analysis.
- Using Programming Language (e.g. Python) to Facilitate Biological Analysis.

**Practicals:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3<sup>rd</sup> Edition, Andreas D. Baxevanis (Editor), B.F. Francis Oullette (Editor), ISBN: 978-0-471-47878-2.

2. Arthur M. Lesk, Introduction to Bioinformatics Oxford University Press.
3. Introduction to Bioinformatics: A Theoretical and Practical Approach, Humana Press.
4. DW Mount, Bioinformatics: Sequence and Genome Analysis, Second Edition, CSHL Press, USA.

### Immunology

**Contact Hours:**

Theory = 48  
 Practical = ---  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0.0**  
 Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

After completing this course the students should be able to:

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

**Course Outline:**

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



- Autoimmunity and immunological tolerance;
- Immune responses against cancer and transplants;
- Hypersensitivity; Immunodeficiencies.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

- 1 Immunobiology. (2001) 5th Ed. by Charles A. Janeway, Mark Walport, Paul Travers, and Mark J. Shlomchik. Published by Taylor and Francis.
- 2 Kuby Immunology. (2007) 7th Ed. by Richard A. Goldsby, Barbara A. Osborne, Thomas J. Kindt, and Janis Kuby. Macmillan Inc.
- 3 Atlas of Immunology. (2010) 3rd Ed. by Robert E. Lewis and Julius M. Cruse. CRC Press.
- 4 Basic Immunology. (2014). 4th Ed. by Abbas, Lichtman and Pillai. Elsevier.

**BIOTECHNOLOGY**

**Contact Hours:**

Theory =32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = **2.0**  
 Practical = **1.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

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

**Course Outline:**

- Biotechnology definition and history
- foundations of biotechnology and interdisciplinary pursuit
- branches and/or applications of biotechnology in medicine, agriculture, food, livestock, fisheries, algae, fungi, etc
- Plant growth promoting bacteria: nitrogen fixation and nodulation
- biocontrol of pathogens growth promotion by free-living bacteria
- Microbial insecticides: Insecticidal toxins of *Bacillus thuringiensis*, baculovirus as biocontrol agents Large scale production of proteins from recombinant microorganisms
- Microbial production of therapeutic agents pharmaceuticals, enzymes, monoclonal
- antibodies as therapeutic agents production of antibodies and vaccine by using microbes
- Synthesis of commercial products by recombinant microorganisms: antibiotics and biopolymers
- Bioremediation and biomass utilization: microbial degradation of xenobiotics
- Production of biofuels by using different biotechnological strategies
- Transgenic organisms: GMOs
- Gene therapy
- Introduction of Stem cells

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:****Theory 70%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Ramawat, K. G. and Goyal, S. (2009). Comprehensive Biotechnology. 4<sup>th</sup> Edition. S. Chand and Company Limited, New Delhi, India.
2. Barnum S. R. (2005). Biotechnology: An Introduction. Brooks/Cole Cengage Learning Course, Belmont, CA, USA.
3. Baltz, R. H., Demain, A. L. and Davies, J. E. (2010). Manual of Industrial Microbiology and Biotechnology.
4. 3<sup>rd</sup> Edition. American Society for Microbiology (ASM) Press, Washington, DC, USA.
5. Hou C. T. and Shaw, J-F. (2008). Biocatalysis and Bioenergy. Published by John Wiley & Sons, Inc., New Jersey, USA.
6. Smith J. E., Biotechnology, 3<sup>rd</sup> Edition, Cambridge University Press (2006)
7. Dhama, P.S., Srivastava, H.N. and Chopra, G., A Textbook of Biology, Pradeep Publications (2008).

**METHODS IN MOLECULAR BIOLOGY****Contact Hours:**

Theory = 16

Practical = 64

Total = 80

**Credit Hours:**Theory = **1.0**Practical = **2.0**Total = **3.0****Course Objective:**

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

**Learning Outcome:**

- 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 molecular biology

**Course Outline:**

- Introduction to recombinant DNA technology;

- Restriction and modifying enzymes;
- Cloning and expression vectors and their types;
- Expression of recombinant proteins and their purification by affinity chromatography;
- Polymerase chain reaction (PCR) - types; (inverse, touch-down, nested, hemi-nested, pit stop, multiplex, reverse transcriptase, RACE, real-time) and its applications;
- Detection of mutations and/or SNPs;;
- Analysis of nucleic acids by gel electrophoresis – horizontal, vertical, pulse field, denaturing gradient gel electrophoresis;
- Generation of antibodies and their uses;
- enzyme-linked immunosorbent assay;
- Blotting: Southern, Western and Northern;
- DNA sequencing technologies

#### **Practicals:**

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

#### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

#### **Assessment:**

##### **Theory 70%**

##### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

##### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Benjamin Lewin, 2017. GeneXII, 12th edition, Jones & Bartlett Learning
2. T. A. Brown. 2016. Gene Cloning and DNA Analysis: An Introduction, 7th Edition.. Wiley-Blackwell.
3. Green MR and Sambrook J, 2014. Molecular Cloning: A Laboratory Manual. 4th Edition; Cold Spring Harbor Laboratory Press.
4. Recombinant DNA technology paper – July 19, 2013, by Keya Chaudary
5. 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.

**BIOCHEMICAL TECHNIQUES****Contact Hours:**

Theory = 16  
Practical = 64  
Total = 80

**Credit Hours:**

Theory = **1.0**  
Practical = **2.0**  
Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

After completing this course students will be able to:

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

**Course Outline:**

- Introduction and principles of centrifugation and ultracentrifugation

- methods and their applications
- Ultrafiltration, dialysis and lyophilization
- Chromatography; principles, methods and applications of paper and thin layer chromatography
- Column chromatography (ion exchange and gel filtration)
- Gas chromatography (GC), GC-MS/LC-MS
- Hydrophobic interaction chromatography
- Affinity chromatography
- Electrophoresis, capillary electrophoresis
- Introduction to spectroscopy and spectrophotometry – Principles, methods and applications of infrared spectroscopy, FTIR
- Visible and ultraviolet absorption spectrophotometry and MALDI.
- Flamephotometer
- Atomic absorption spectro-photometry (AAS)
- Amino acids analyzer
- Electron microscopy
- X – ray diffraction
- Nuclear magnetic resonance

#### **Practicals:**

- Centrifugation of fresh milk and Acetic Acid
- Fractionation of cells by density gradient centrifugation
- Separation of biomolecules by using TLC
- Separation of crud plants extracts by using TLC
- Separation of Biomolecules by affinity chromatography identification of sugars, proteins etc.
- Separation of mixture proteins by using Ion-Exchange chromatography
- Separation of biomolecules using size exclusion chromatography
- Agarose Gel Electrophoresis for the Separation of DNA Fragments
- Protein Separation by Protein Electrophoresis
- Analysis of drugs and related compounds by using Capillary Electrophoresis
- Purification of proteins or biomolecules by using hydrophobic interaction chromatography
- Preparation of sample for mineral analysis by ashing method and Wet digestion procedure of sample preparation for mineral analysis
- Determination of sodium and potassium content in blood serum by flamephotometer
- Separation of amino acids by amino acid analyzer
- Structural elucidation of biomolecules

#### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Modern Experimental Biochemistry 3d Ed - Rodney F. Boyer
2. Principles and Techniques of Biochemistry and Molecular Biology 6th Edition. Edited by K. Wilson & J. Walker.
3. Introduction to Modern liquid chromatography (1979) by L.L.Snyder & J.J Kirkland. John Wiley & Sons
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) by David Freifelder, W. H. Freeman.

**Clinical Biochemistry**

**Contact Hours:**

Theory = 16  
 Practical = 64  
 Total = 80

**Credit Hours:**

Theory = 1.0  
 Practical = 2.0  
 Total = 3.0

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**Course Objective:**

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

**Learning Outcome:**

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

- Identify, interpret and perform the role of plasma enzymes in the diagnosis of various clinical disorders
- Assess the severity of disorder/cell damage

- Correlate the enzymes deficiencies with inborn errors of metabolism
- Determine the role of enzymes as prognostic indicator

### **Course Outline:**

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

### **Practicals:**

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

### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

### **Assessment:**

**Theory 70%**



**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

- 1 Clinical Chemistry: Principles, Procedures, Correlations by Michael L. Bishop, Edward P. Fody, Larry E. Schoeff Publisher: Lippincott Williams & Wilkins; 6th Edition (July 6, 2004)
- 2 Carl Burtis Edward AshwoodDavidBruns2011. "Tietz Textbook of Clinical Chemistry and Molecular Diagnostics", ELSEVIER
- 3 Lecture Notes on Clinical Biochemistry, Alistaire F Smith, Geoffrey Beckett, Simon Walker, Peter Rae 6 th Edition, John Wiley & Sons, 1998
- 4 Alan H Gowenlock; Janet R Mc Murray. Varley Clinical Biochemistry 6th edition 2006. Heinemann medical books, New Dehli
- 5 Donald Voet; Judith G Voet. Biochemistry 3rd edition, 2004. John Wiley & Sons
- 6 Clinical Biochemistry E-Book: An Illustrated Colour Text, by Allan Gaw 3rd edit 2014 Churchill livin stone

**Environmental Biochemistry****Contact Hours:**

Theory = 32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = **2.0**  
 Practical = **1.0**  
 Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

After completing this course students should be able to:

- Acknowledge the importance of pollutants
- Understand the chemistry of pollutants in air, land and water

- Understand the pathways in bioremediation
- Apply the acquired knowledge to design ways for the eradication of pollutants

#### **Course Outline:**

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

#### **Practicals:**

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

#### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

#### **Assessment:**

##### **Theory 70%**

##### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

##### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

##### **Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Environmental Biochemistry Vol-3 NeelimaRajvaidya, Dilip Kumar Markandey, APH Publishing, 2005.
2. Environmental Biochemistry Eric Hamilton, 2013.
3. Understanding Environmental Pollution, Hill, M.K., 2<sup>nd</sup> Edition. Cambridge University Press, 2005.
4. Environmental Pollution and Control. Peiece, J.J., Weiner, R. F., and Vesilaind, P.A. 4<sup>th</sup> Edition, Butterworth-Heinemann, (Elsevier) USA, 1998.
5. Environmental Contaminants: Assessment & Control, Dairel, A.V., Academic Press, USA, 2005.
6. Standard Methods for the Examination of Water & Wastewater. American Public Health Association (APHA), 2003.
7. An Air That Kills Andrew Schneider and David McCumber Berkley Publishing (Penguin Group) January 2005

**PLANT BIOCHEMISTRY**

**Contact Hours:**

Theory = 32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = **2.0**  
 Practical = **1.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

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

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

**Course Outline:**

- Structure and functions of plant cell
- Photosynthesis; structure of chlorophyll, absorption of light energy, photosynthetic pigments
- Photosynthetic reaction center, photosystem-I, photosystem-II
- Hill's reaction, electron transport chain, ATP C3 and C4 pathways
- CAM photosynthetic pathways
- CO<sub>2</sub> fixation (Calvin Benson cycle)
- Hatch Slack pathway and photorespiration
- Conversion of nitrogen into ammonia and other nitrogenous compounds

- Biosynthesis of Alkaloids, Flavonoids, Terpenes, Terpenoids, Phenolics and other secondary plant metabolites and their biological functions
- Phytohormones and related compounds
- Signal transduction in plant cells

**Practicals:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Biochemistry and Molecular Biology of Plant Hormones (1999). Edited by P. J. J., Haykaas, M. A. Hall, & K.R. Libbenga, Science Pub. Co.
2. Lehninger, A. L., Nelson, D.L. and Co. N.M., (2008). Principles of Biochemistry. W. H. Freeman; 5th Edition. 3. Plant Biochemistry by T. Wood & Mercer

## BIOENERGETICS

### Contact Hours:

Theory = 48

Total = 48

### Credit Hours:

Theory = 3.0

Total = 3.0

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### **Course Objective:**

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

### **Learning Outcome:**

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

- Understand the bioenergetic principles
- Demonstrate the detailed understanding of electron transport chain
- Acquire in-depth understanding of the mechanism of ATP synthesis and its regulation

### **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
- 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
- Uncouplers and inhibitors of electron transport chain

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:****Theory 70%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

- 1 Text Book of Biochemistry (1971) by B. Harrow and A. Mazur W.B. Saunders Company.
- 2 Harper's Illustrated Biochemistry, 27th Ed. By R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw Hill.
- 3 Physical Chemistry (2002) 7th Edition by P.W. Atkin Oxford University Press
- 4 Physical Chemistry (2004) 4th Edition by R.J. Sibley, R.A. Alberty & M.G. BawendiJ. Wiley& Sons

**Biomembranes and Cell Signaling****Contact Hours:**

Theory =48  
Practical = 0  
Total = 48

**Credit Hours:**

Theory = **3.0**  
Practical = **0.0**  
Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

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

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

**Course Outline:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:****Theory 70%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Molecular Cell Biology. (2013) 7th Ed. by Lodish et al. Published by W H Freeman and Company.
2. Molecular Biology of the Cell. (2008). by Alberts et al. Garland Sciences, Taylor & Francis Group.
3. Cell and Molecular Biology. (2013) 7th Ed. by Gerald Karp. Wiley.

**Nutritional Biochemistry****Contact Hours:**

Theory = 32  
Practical = 32  
Total = 64

**Credit Hours:**

Theory = **2.0**  
Practical = **1.0**  
Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

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

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

**Course Outline:**

- Nutrients structure & functional characteristics
- Role of nutrients in metabolism
- Healthy diet: types and constituents
- Recommended dietary allowance (RDA), adequate intake (AI), tolerable upper intake level, dietary reference intakes for macronutrients and micronutrients



- Estimation of dietary intake (FFQ, 24 hour dietary recall, questionnaires etc)
- Nutritional status biomarkers
- Basic metabolic rate (BMR), body mass index calculations (BMI)
- Respiratory quotient calculations
- Nutritional disorders

**Practicals:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:**

**Theory 70%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

- Krause's Food, Nutrition and Diet Therapy L. Kathleen Mahan Sylvia Escott-Stump (latest edition). Saunders
- Understanding Nutrition. E. N. Whitney & S. R. Rolfes (latest edition) Thomson learning: New York
- Nutritional Biochemistry, Tom Brody (latest edition) Academic Press: New York.

## RESEARCH PLANNING & SCIENTIFIC WRITING

### Contact Hours:

Theory = 48  
Total = 48

### Credit Hours:

Theory = 3.0  
Total = **3.0**

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### **Course Objective:**

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

### **Learning Outcome:**

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

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

### **Course Outline:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Graduate research: A guide for students in the science (1998) 3 Rev Sub edition by Robert V. Smith University of Washington Press.
2. Writing, Reading & Research Clifford (1985) by R. Veit, and J. Clifford Bobbs-Merrill Educational Publications.
3. Practical Research: Planning & Design (2009) by P.D. Leedy and J.F., Ormrod Publishers: Merrill.
4. Research methods: A process of Inquiry by Grazinao & Ranlin (2006)
5. Conducting Research Literature Reviews: From the Internet to Paper (2004) by A. G. Fink. Saga Publications.

**CURRENT TRENDS IN BIOCHEMISTRY****Contact Hours:**

Theory = 48

Practical = 0

Total = 48

**Credit Hours:**Theory = **3.0**Practical = **0.0**Total = **3.0****Course Objective:**

The main objective of this course are:

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

**Learning Outcome:**

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

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

**Course Outline:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Industrial Biochemistry****Contact Hours:**

Theory = 32  
Practical = 32  
Total = 64

**Credit Hours:**

Theory = 2  
Practical = 1  
Total = 3

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**Course Objective:**

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

**Learning Outcome:**

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

1. Understand metabolites with respect to their industrial importance.

2. Evaluate bioprocesses to manipulate for large scale production of a chosen material/ metabolite.
3. Analyze limitations of industrial biological processes.

**Course Outline:**

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

**Practicals:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion
- Lab demonstrations

**Assessment:****Theory 70%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments

- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Practical 30 %**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

1. Principles of Shreve's chemical process industries (1998) 5<sup>th</sup> Edition by G.T. Austin Publishers: McGraw-Hill.
2. Kent and Riegel's Hand Book of Industrial Chemistry and Biotechnology (2007) 11<sup>th</sup> Edition by J.A. Kent. Springer.
3. Introduction to Cane Sugar Technology. by G.H. Jenkins Elsevier
4. British pharmacopoeia.
5. Comprehensive Biotechnology (1985) Edited by M. Moo-Yong& C.L. Cooney, Pergamon Press.
6. Principles of Fermentation Technology (1995) 2nd Edition by Peter F. Stanbury, Allan Whitaker and Stephen Hall

## **DETAIL OF ELECTIVE COURSES**

### **LIST OF ELECTIVE COURSES:**

- Cancer Biology
- Genomics
- Proteomics
- General Virology
- Cell and tissue culture
- Pharmacology
- Antimicrobials and Chemotherapeutics
- Functional Genomics
- Structural Biology
- Drug Development
- Fermentation Biotechnology
- Neurochemistry
- Toxicology
- Biodiversity
- Water and Mineral Metabolism
- Research Projects
- Any other course(s) recommended by an Institution's Board of Studies

## CANCER BIOLOGY

### Contact Hours:

Theory = 48  
Practical = 0  
Total = 48

### Credit Hours:

Theory = 2.0  
Practical = 0.0  
Total = 3.0

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### **Course Objective:**

The specific objects are as follow:

- To increase the awareness of various aspects of cancers, etiology, development, carcinogenic agents, treatment and prevention.
- To educate genetic and molecular changes responsible for the transformation of normal cells into malignant cells.

### **Learning Outcome:**

By the end of course, students should be able to;

- Understand the concepts of cell cycle and its phenomena
- Discuss the process of oncogenesis and its various types
- Analyze the use of cell culture in cancer research.
- Explain the various risk factors of carcinogenesis
- Perform any laboratory related task within the scope of course independently

### **Course Outline:**

- 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
- 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



**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

- 1 The Biology of Cancer by Robert A Weinberg, 2<sup>nd</sup> edition, 2012
- 2 Cancer Biology by Raymond W. Ruddon, 4<sup>th</sup> edition, 2007 Oxford University Press.
- 3 Wintrobe's Clinical Haematology by Maxwell, M. Wintrobe, G. Richard Lee, 13<sup>TH</sup> Edition, 2012, Williams and Wilking Publishers, New York.

**GENOMICS****Contact Hours:**

Theory = 48

Practical = 0

**Total = 48****Credit Hours:**

Theory = 03

Practical = 0

**Total = 3**

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**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.

**Learning Outcome:**

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.

**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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Strachan T and Read AP, 2010. Human Molecular Genetics. 4<sup>th</sup> Edition; Garland Science.
2. Saccone C and Pesole G, 2003. Handbook of Comparative Genomics: Principles and Methodology. 1<sup>st</sup> Edition; Wiley-Liss.
3. Town C, 2002. Functional Genomics. 1<sup>st</sup> Edition; Springer.
4. Krebs et al., 2010. Lewin Genes X. 10<sup>th</sup> Edition; Jones and Bartlett Publishers.
5. Al-Rubeai M and Fussenegger M, 2010. Systems Biology (Cell Engineering). 1<sup>st</sup> Edition; Springer

## PROTEOMICS

### Contact Hours:

Theory = 48  
Practical = 00  
Total = 48

### Credit Hours:

Theory = 03  
Practical = 0  
Total = 3.0

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### **Course Objective:**

The course will provide

- Fundamental information about Proteins, Posttranslational modifications and protein-protein interactions
- Knowledge about bioinformatics tools and data bases involved in proteomics
- An introduction to basic proteomics techniques.

### **Learning Outcome:**

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

- Acquire knowledge about the proteins and proteome
- Understand the methodology used to analyze and identify proteins.
- evaluate results from proteomic studies
- Insight into the analysis of post-translational modifications and protein-protein interactions.
- Understand how to identify proteins from mass spectrometry data using data bases.

### **Course Outline:**

- Molecular Biology of Proteins (types, structure, synthesis, translation)
- Posttranslational modifications (glycosylation, phosphorylation, methylation, etc.)
- Molecular mechanisms of cellular communication/signaling pathways
- Bioinformatics tools
- Protein-Protein Interactions
- Receptor identification and characterization
- Integral Membrane Proteins and Ion Channels
- Peptide Models of Transmembrane Domains
- Membrane Fusion and Membrane Binding Proteins
- Apolipoproteins
- Protein sequencing
- Proteomics Strategy
- Protein extraction and sample preparation
- Advance techniques used in proteomics including capillary and 2D Gel Electrophoresis
- Mass Spectrometry; MALDI TOF, MS/MS, LC/MSMS
- Protein arrays
- Protein data bases

- Online search engines for data analysis.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Twyman RM. Principles of Proteomics (2004). BIOS Scientific Publishers
2. Westermeier R., Naven T. and Hans-Rudolf. Proteomics in Practice: A Guide to Successful Experimental Design (2008) 2<sup>nd</sup> Edition. J.Wiley & Sons
3. Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P. Molecular Biology of the Cell (2008) 5<sup>th</sup> Edition . Garland Sciences, Taylor and Francis
4. Berg JM, Tymoczko JL & Stryer L. Biochemistry (2007) 6<sup>th</sup> Edition by W.H. Freeman & Co.
5. Introduction to Proteomics. Edited by Daniel C. Liebler (2002). Humana Press. ISBN 0-8960-3992-7.
6. Westermeier R and Naven T. Proteomics in Practice – A Lab Manual of Proteome Analysis. (2002). Wiley-VCH Verlag. ISBN 3-527-30354-5
7. Liebler DC. Introduction to Proteomics: Tools for the New Biology (2001)
8. Mishra NC (2010) Introduction to Proteomics: Principles and Applications. 1st Edition. John Wiley and Sons.

**GENERAL VIROLOGY**

**Contact Hours:**

Theory =48  
 Practical = 0  
 Total = 48  
 Total = 3.0

**Credit Hours:**

Theory = 3.0  
 Practical = 0



**Course Objective:**

The main objectives of this course are:

- To provide fundamental concepts of viruses, their diversity and classification.
- To give understanding of the replication, infections and diseases caused by viruses

**Learning Outcome:**

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

- Understand the classification and nomenclature and molecular basis of viruses
- Acquire knowledge about infections caused by viruses
- Identify the health risks due to viruses and measures of preventions

**Course Outline:**

- General concepts of virus, history, diversity, shapes, sizes and components of genomes.
- Isolation and purification of viruses and components.
- Classification of viruses and their nomenclature
- positive strand RNA viruses - Picornavirus, Flavivirus, West Nile virus, Dengue virus, Coronavirus and SARS pathogenesis.
- Negative strand RNA viruses: Paramyxovirus, Orthomyxovirus, Influenza pathogenesis and Bird flu. Rabies pathogenesis;
- Double-stranded RNA viruses: Reoviruses, Retroviruses.
- Structure, classification, life cycle, Reverse transcription, HIV, Viral pathogenesis and AIDS.
- Small DNA viruses: Parvo and polyomaviruses
- Large DNA viruses: Herpes-ado and poxviruses, Nanoviruses,
- Miscellaneous viruses.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs)

### Recommended Books:

- 1 Principles of Virology; Molecular Biology, Pathogenesis, by Krug, R., Racaniello, V., and Lynn, W. E, 1999, ASM Press.
- 2 Principles of Molecular Virology by Cann, A. J. 2001, Academic Press.
- 3 Basic Virology by Wanger, E. K and Hewlett, M., 1999, Blackwell Science, Inc.
- 4 Medical Virology 4<sup>th</sup> Edition by David, O. White and Frank. J. Fenner, 1994 Academic Press USA.
- 5 Fields Virology 6<sup>nd</sup> Edition, by Bernard Fields Knipe and Peter Howley, 2013, Walters USA.

## CELL AND TISSUE CULTURE

### Contact Hours:

Theory = 48  
Practical = 0  
Total = 48

### Credit Hours:

Theory = 3.0  
Practical = 0  
Total = 3.0

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### Course Objective:

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

### Learning Outcome:

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

### Course Outline:

- 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 micro-propagation; 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;

animal cells for bioassays and bio-products; design and operation of animal cell culture bioreactors for therapeutic protein production; growth environment; Stem cell culture

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Setlow JK, 2000. Genetic Engineering: Principles and Methods. Kluwer Academic Publishers.
2. Nicholl DST, 2002. An Introduction to Genetic Engineering. 2<sup>nd</sup> Edition; Cambridge University Press.
3. Gale YL, 2002. Genetic Engineering.
4. Razdan MK, 2003. Introduction to Plant Tissue Culture. 2<sup>nd</sup> Edition; Intercept, New York, USA.
5. Lanza et al., 2000. Principles of Tissue Engineering. 2<sup>nd</sup> Edition; Academic Press, California.
6. Ignacimutu S, 1997. Plant Biotechnology. Oxford IBH Publisher.
7. Punia MS, 1999. Plant Biotechnology and Molecular Biology: A Laboratory Manual. Scientific Publishers.

**PHARMACOLOGY**

**Contact Hours:**

Theory = 48  
Practical = 00  
Total = 64

**Credit Hours:**

Theory = 3.0  
Practical = 0.0  
Total = 3.0

**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

**Learning Outcome:**

- 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

**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).

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)



- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Goodman Gilman, Pharmacological basis of Therapeutics. 11<sup>th</sup> Ed McGraw-Hill Book Company, New York, 2008.
2. Winguard and Brody's, Human Pharmacology, Mosby Year Book, Boston, 1991.
3. James M Ritter and Lionel De Levis, A Text book of Clinical Pharmacology, 5<sup>th</sup> Ed Oxford University Press, New York, 2008.
4. R S Satorkar and S D Bhandarkar, Pharmacology and Pharmacotherapeutics, 19<sup>th</sup> Ed, Popular Prakashan, Bomby, 1998.
5. J D Tripathy, Essential of Medical Pharmacology, Japees Brother, New Delhi, 6<sup>th</sup> Ed., 2008.
7. Katzung B G, Basic and Clinical Pharmacology, McGraw-Hill Medical Publishers, New York, 11<sup>th</sup> Ed., 2009.
8. Lippincott, Pharmacology, 4<sup>th</sup> Ed, Lippincott William & Wilkins, USA, 2008.
9. Manuchair Ebadi, Pharmacology, Little Brown & Company, London, 1993
10. Prof Dr A Qayum, Fundamentals of Experimental Pharmacology.
11. Bertram G K, Basic and Clinical Pharmacology, Paramount Publishing Business & Professional Group, USA, 10<sup>th</sup> Ed., 2007.
12. William F Ganong, W F, Review of Medical physiology, 22<sup>nd</sup> Ed, 2005 Prentice Hall International Inc, New Jersey.
13. Qayum A, Fundamentals of Experimental Pharmacology. Ghandhara University, Peshawar, 2004.
14. Humphrey P. Rang, Rang & Dale's Pharmacology, 6<sup>th</sup> Ed, 2007.

**ANTIMICROBIALS AND CHEMOTHERAPEUTICS**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

**Course Objective:**

- This course will provide the basic principles of chemotherapy of cancer and infectious disease
- This course will provide the basic concepts of selective toxicity and resistance;
- This course will also provide an understanding of the molecular mechanisms behind the action of anticancer and anti-infective drugs.

**Learning Outcome:**

After completing this course student should be able to;

- a. Understand the basic principles of chemotherapy of cancer and infectious disease
- b. Acquire basic knowledge of selective toxicity and resistance.
- c. Understand the molecular mechanism of anti-cancer and anti-infective drugs

**Course Outline:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs)

### Recommended Books:

1. Bertram G. Katzung, Susan B. Masters, Anthony J. Trevor, Basic & Clinical Pharmacology. The McGraw-Hill Companies, 12<sup>th</sup> Ed. 2012.
2. Michelle A. Clark. et al. Lippincott's Illustrated Reviews: Pharmacology. Lippincott Williams & Wilkins China, 5<sup>th</sup> Ed. 2012.
3. Laurence L. Brunton, John S Lazo, Keith L. Parker. Goodman & Gilman's The Pharmacological basis of Therapeutics. The McGraw-Hill Companies, Inc. 11<sup>th</sup> Ed. (2006).
4. P. N. Bennett, M. J. Brown, Clinical Pharmacology. Churchill livingstone. Edinburgh London. 9<sup>th</sup> Ed. 2003.

## FUNCTIONAL GENOMICS

### Contact Hours:

Theory = 48  
Practical = 0  
Total = 48

### Credit Hours:

Theory = **3.0**  
Practical = 0  
Total = **3.0**

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### Course Objective:

- The course objective is to enable the students with an in-depth understanding of new and emerging genomics technologies and their applications in the life sciences.
- To Know what functional genomics is and the questions that can be addressed in this field of study
- Students will be able to know the main technologies used in functional genomics experiments

### Learning Outcome:

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

- Understand various functional genomics tools and approaches
- Apply functional genomics tools when integrated with other research disciplines (e.g., genetics physiology, biochemistry, ecology)
- Understand techniques used in functional genomics such as microarrays, next generation sequencing technology, mRNA expression and miRNA expression
- Interpret data obtained through high throughput expression studies

### Course Outline:

- Course introduction & Objectives,
- A large-scale analysis of the function of different gene products within an organism

- Bioinformatics, working with single genes and annotation work flow, Gene annotation with Artemis
- DNA microarray overview and principles
- Functional vs Comparative Genomics
- Genome Mapping and organization
- Genome Sequencing projects; Assembling genome sequences, Sequence polymorphisms in genomes and SNPs
- Differential Display, Gene Discovery - Expressed Sequencing Tags (ESTs); Serial Analysis of Gene Expression (SAGE),
- Transcriptome analysis: cDNA microarrays, oligonucleotide microarrays,
- Metabolomics, Forward and Reverse Genetics,
- RNAi-mediated Gene Silencing,
- Gene Knockouts,
- Micro-RNAs and Small RNAs,
- Site-directed mutagenesis,
- Genomics as a systems biology,
- two-hybrid systems;
- Applications of genomics to: medicine, agriculture, forensics and population studies.
- In vivo technologies for assessing gene expression; analysis/ visualization and issues with imaging.
- Quantitative RT-PCR analysis,
- Integration of proteomic, microarray, and other functional genomics techniques.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Functional Genomics (Methods in Molecular Biology). (2010) by Michael J. Brownstein and Arkady Khodursky. Humana Press; Soft cover reprint of

- hardcover.
2. Functional Genomics: Methods and Protocols (Methods in Molecular Biology). (2011). 2<sup>nd</sup> Ed. Humana Press.
  3. Functional Genomics. (2002) by Chris Town. Springer.
  4. Functional Genomics of Human Ion Channels. (2010). 1<sup>st</sup> Ed. by Edited by Zhiguo Wang and Zhiguo Wang (Jun 1, 2010). Transworld Research Network.
  5. Plant Functional Genomics: Methods and Protocols (Methods in Molecular Biology). (2010). 1<sup>st</sup> Ed. by Erich Grotewold (Dec 1, 2010), Publisher: Humana Press.

## STRUCTURAL BIOLOGY

### **Contact Hours:**

Theory =48  
 Practical = 0  
 Total = 48

### **Credit Hours:**

Theory =**3.0**  
 Practical = **0.0**  
 Total = **3.0**

### **Course Objective:**

- To understand structural biology as a foundation of Biochemistry and Molecular Biology.
- To determine structural aspects of proteins, nucleic acids, carbohydrates and lipids.
- To understand and elucidate published knowledge.

### **Learning Outcome:**

- Recognize the role of structural biology in Biochemistry and Molecular Biology.
- Understand the gene expression during development
- Compare the interaction between macromolecules.
- Realize the sequence structure relation.
- Apply the knowledge in designing basic projects.

### **Course Outline:**

- Macromolecular Crystallography and X-ray diffraction, Nuclear magnetic resonance spectroscopy of proteins, Mass spectrometry, Electron paramagnetic resonance.
- Cryo-electron microscopy, Multiangle light scattering, Small angle scattering, Ultrafast laser spectroscopy, Dual-polarization interferometry and circular dichroism
- The structural mechanism of enzymes and catalysis.
- protein-nucleic acid interactions.
- Structural Genomics
- Structural Proteomics
- Gene Regulation of development
- Macromolecular assemblies and higher order structures include oligomers, viruses, molecular machines, metalloproteins, membrane

- proteins and biological complexity.
- Homology modeling and molecular docking
- Bioinformatics in Structural Biology
- Interpretation and assessment of published research in structural biology.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Foundations of Structural Biology. (2000). 1<sup>st</sup> Ed. by Leonard J. Banaszak. Academic Press.
2. Structural Biology: Practical NMR Applications. (2012). 2<sup>nd</sup> Ed. by Quincy Teng. Springer.
3. Textbook of Structural Biology. (2009). Pap/Cdr edition. by Anders Liljas, Lars Liljas, Jure Piskur and GÅran Lindblom. World Scientific Publishing Company.
4. Membrane Structural Biology: With Biochemical and Biophysical Foundations. (2008). 1<sup>st</sup> Ed. by Mary Luckey, Publisher: Cambridge University Press.
5. Structural Biology of Bacterial Pathogenesis. (2005). 1<sup>st</sup> Ed. by Gabriel Waksman, Michael Caparon and Scott Hultgren Amer Society for Microbiology.
6. Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology. (2009). 1<sup>st</sup> Ed. by Bernhard Rupp. Garland Science.

**DRUG DEVELOPMENT**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

After completing this course student should be able to;

- Understand the basic concept of drug development
- Acquire basic knowledge of drug discovery.
- Apply the knowledge to plan and evaluate drug development.

**Course Outline:**

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

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments

- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. New drug development by J. Rick Turner
2. Drug discovery and development by R. Hill
3. The drug development process by Peter.g.welling

**FERMENTATION BIOTECHNOLOGY**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

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**Course Objective:**

This course will cover

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

**Learning Outcome:**

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

- Understand the rules of fermentation biotechnology
- Describe the types and operation of bioreactors, equipment and tools used in the control of fermentation
- Explain relationship of microbiology to Industrial fermentation.
- Know the different phases in relation to the production of biomass or different microbial metabolites

**Course Outline:**

- Fermentation and Microorganisms
- Different types of fermentation: alcoholic & lactic acid fermentation
- Industrial fermentation
- Chronological review and perspectives in fermentation biotechnology
- Microbial metabolism
- Respiro-fermentative metabolism of yeasts
- Screening and selection of industrial cultures
- Genetic manipulations of industrial strains
- The maintenance of the cultures
- Raw materials and the composition of substrate of fermentation.



- Fermentation processes, batch, extended batch, batch with cell recycle, continuous process
- Kinetic of microbial growth and fermentation products
- Principal parameters of fermentation process. measurements and regulations of principal fermentation parameters
- Fermentation technology upscaling,
- Bioreactors: agitation and aeration technology, fermentation plant (fundamental and auxiliary equipment, modality of sterilization and product recovery).
- Downstream processing

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:  
Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Microbiology: An Introduction. By Gerard J. Tortora, Berdell R. Funke, Christine L. Case. Publisher: Benjamin Cummings; 11<sup>th</sup> Edition (January 6, 2012)
2. Prescott's Microbiology by Joanne Willey, Linda Sherwood, Chris Woolverton, Publisher: McGraw-Hill Science/Engineering/Math; 8<sup>th</sup> Edition (February 3, 2010).
3. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain and A.R. Allman. Publisher: CRC Press; 3<sup>rd</sup> Edition (December 12, 2011).
4. Yeast: The Practical Guide to Beer Fermentation (Brewing Elements Series) by Jamil Zainasheff and Chris White. Publisher: Brewers Publications (October 16, 2010)
5. Fermentation and Biochemical Engineering Handbook, 2<sup>nd</sup> Ed., Principles, Process Design and Equipment by Henry C. Vogel, Celeste C. Todaro. Publisher: William Andrew; 2<sup>nd</sup> Edition (December 17, 2007).
6. Fermentation Biotechnology. By Achrekar Jayanto. Publisher: Wisdom Press/Dominant Publishers & Distributors Pvt Ltd India (2012).

## NEUROCHEMISTRY

### Contact Hours:

Theory = 48  
Practical = 0.0  
Total = 48

### Credit Hours:

Theory = 3.0  
Practical = 0.0  
Total = 3.0

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### **Course Objective:**

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

### **Learning Outcome:**

After completing this course, students should be able to;

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

### **Course Outline:**

- Neuroanatomy: Gross appearance, Fluid compartments, Microscopic appearance, Neurons, Glial cells. The synapses.
- Brain composition: Central and peripheral nervous system, Lipids, Myelin and membranes, structure of Myelin, Function of Myelin, Electrolytes, Proteins (structure and Properties).
- Neurotransmission: Resting potential, sodium pump, Action potential and nerve conduction, Chemical events at synapses, Identification and occurrence of neurotransmitters, Quantum hypothesis, Origin of synaptic vesicles, postsynaptic events, involvement of C-AMP Receptors, Neuron-axonal transport in exoplasmic flow, Mechanism of transport in exoplasmic flow, Neurotransmitters and Neuropeptides, Inhibitory and excitatory synapse, GABA and other inhibitory transmitters, Mechanism of action of dopamine, Enkephlines and endorphins, Opiate receptors, cyclic nucleotides.
- Nourishment of the brain: Nutritional factors and the CNS, Development of the brain and nutritional effects on maturation, Chemical and enzymatic make-up of the brain during development, cerebral metabolism.
- Brain Functions: Adaptive processes in the brain, inducible enzymes, Adaptation to specific substrates, Adaptation to product of an alternate pathway, Adaptation involving coenzymes, Adaptation in response to hormone.
- Adaptation to Environment: Light, The pineal gland, Learning and memory as adaptive processes.
- Biochemistry of Neurological disorders: Genetic and metabolic disorders, Metabolic basis of Tay-sachs, Lesch-Nyhan, Schizophrenia, Epilepsy, Other psychiatric disorders including Dyskinesia, Myelin diseases, Multiple Sclerosis, Parkinsons disease, Myasthenia Gravis.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Basic Neurochemistry, Molecular, Cellular, and Medical Aspects by George J. Siegel 6<sup>th</sup> Edition, 2005.
2. Handbook of Neurochemistry and Molecular Neurobiology Editor-in-chief: Lajtha, Abel, 2010.
3. Essentials of Neurochemistry, Gaynor C. Wild, Edward C. Benzel, Jones and Bartlett Publishers, 1994.

**TOXICOLOGY****Contact Hours:**

Theory = 48

Practical = 0

Total = 48

**Credit Hours:**Theory = **3.0**Practical = **0**Total = **3****Course Objective:**

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

**Learning Outcome:**

- Up on successful completion of the course, the student will be able to
- To interpret and integrate a broad range of toxicological information.
- To tackle with Toxicological assessment of poisons including heavy metals & pesticides.

**Course Outline:**

- Introduction to toxicology and toxicological substances, Metabolism of Xenobiotics, Absorption, Distribution, and Excretion of Toxicants.
- Air Toxicants: Effects of ozone and benzene, NO, CO, aldehyde exposure in humans, sources of benzene exposure, toxicokinetics and toxicodynamics of benzene. Toxic effects of radiation and radioactive materials, pesticides, hydrocarbons and alcohols.
- Food-Borne Toxicants and Prevention in Toxicology, Role of mycotoxins as environmental toxins impact on human health, role of metabolism in the toxicity of the mycotoxin aflatoxin, Proposed means to prevent aflatoxin-induced liver cancer in high-risk populations and apply knowledge to other environmental carcinogens.
- Metal & Drugs Toxicology: Overview of metals in the environment and heavy metal toxicity, Ways in which we can protect ourselves from metal poisoning, both through man-made agents and natural chelates of heavy metals, Heavy metals that have an important impact on human health e.g. mercury and cadmium, lead and arsenic. Therapeutic drug monitoring, poisonous plants and herbal medicines.

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:  
Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. HODGSON, E. and SMART, R.C: Introduction to Biochemical Toxicology. Wiley and Sons, New York, Hardcover: 902 pages, Publisher: Wiley; 4<sup>th</sup> Edition (August 18, 2008)
2. CASARETT AND DOULL's Toxicology: The Basic Science of Poisons. 7<sup>th</sup> edition (November 20, 2007), McGraw-Hill, New York, pp. 1280. Edited by Curtis D. Klaassen.

## Biodiversity

### Contact Hours:

Theory = 36  
Practical = 0  
Total = 36

### Credit Hours:

Theory = **3.0**  
Practical = **0**  
Total = **3.0**

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### **Course Objective:**

- To learn the basics of plant and animal diversity
- To develop a scientific way of thinking about biological diversity

### **Learning Outcome:**

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

- Understand the nature of diversity of plants and animals
- Learn the impact of environment on the ecological changes
- Understand different taxonomic systems

### **Course Outline:**

- Biosphere and biological resources.
- Evolution of biosphere: Origin, concept and chemical basis of life
- Protocell formation, unicellularity, multicellularity and tissue levels of organization
- Evolutionary perspective: relationship to other animals, metamerism and tagmatization
- Origin of metabolism.
- Classification of organisms, evolutionary relationships and tree diagrams,
- Patterns of organization, life within a single plasma membrane,
- Symbiotic life styles
- Life in sea, invasion of life on land
- Geological time chart with biodiversity
- Origin of taxonomy: Origin of species
- Taxonomic categories and modern criteria of classification, different classification systems.
- Protozoan taxonomy
- Structural, chemical and functional diversity of carbohydrates, lipids, proteins and nucleic acids

### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

### **Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Singapore: McGraw Hill, Miller SA and Harley, JB Zoology, Latest Edition (International), 2012, Singapore; McGraw-Hill.
2. Kent, GC and Miller S. Comparative Anatomy of Vertebrates, 9<sup>th</sup> edition, 2015. New York: Mc Graw-Hill,
3. Campbell, NA, Biology, 11<sup>th</sup> Edition, 2016, Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
4. The Biosphere, Bradbury, I. K., John Wiley and Sons. Inc. UK, 2009.
5. Biodiversity: An introduction. by Kevin J. Gaston and John I. Spicer, 2<sup>nd</sup> edition, 2004, Wiley-Blackwell.

**Water and Mineral Metabolism****Contact Hours:**

Theory = 48  
 Practical = 00  
 Total = 48

**Credit Hours:**

Theory =3.0  
 Practical = 0.0  
 Total = 3.0

**Course Objective:**

The course is focused on:

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

**Learning Outcome:**

After completing this course the students are expected to:

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

**Course Outline:**

Minerals:

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

#### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

#### **Assessment:**

**Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

#### **Recommended Books:**

1. Barret, K.E., S.M. Barman, S. Boitano and H. Brooks. 2012. Ganong's Review of Medical Physiology. 24<sup>th</sup> Ed. McGraw Hill, New York, USA.
2. Chatterjea, M. N. and R. Shinde. 2012. Textbook of Medical Biochemistry. 8<sup>th</sup> Ed. Jaypee Brothers, Medical Publishers (P) Ltd, New Delhi, **India**.
3. Murray, R.K., D.A. Bender, K. M. Botham, P.J. Kennelly, V.W. Rodwell and P.A. Weil. 2012. Harper's Illustrated Biochemistry. 29<sup>th</sup> Ed. McGraw Hill. New York, USA.
4. Nelson, D.L. and M.M. Cox. 2012. Lehninger Principles of Biochemistry. 6<sup>th</sup> Ed. Worth Publishers, New York, USA.
5. Rodwell, V and D. Bender. 2015. Harpers Illustrated Biochemistry. 30<sup>th</sup>

- Ed. McGra Bender, D.A. 2003. Nutritional Biochemistry of the Vitamins. Cambridge University Press, London, UK.
6. Chatterjea, M. N. and R. Shinde. 2012. Textbook of Medical Biochemistry. 8<sup>th</sup> Ed. Jaypee Brothers, Medical Publishers (P) Ltd, New Delhi, **India**.
  7. Combs, G.F. 2012. The Vitamins. Elsevier Inc., New York, USA.

**COMPULSORY COURSES**  
**BS (4 YEARS) IN BASIC & SOCIAL SCIENCES**  
**English I (Functional English)**

**Contact Hours:**

Theory = 48

Practical = 0

Total = 48

**Credit Hours:**

Theory = **3.0**

Practical = **0**

Total = **3.0**

**Course Objective:**

- To enhance language skills
- To develop critical thinking

**Course Outline:**

- Basics of Grammar
- Parts of speech and use of articles
- Sentence structure, active and passive voice
- Practice in unified sentence, Analysis of phrase, clause and sentence structure
- Transitive and intransitive verbs
- Punctuation and spelling
- Comprehension:
- Answers to questions on a given text, Discussion
- General topics and every-day conversation
- Listening
- Translation skills
- Urdu to English
- Paragraph writing

Topics to be chosen at the discretion of the teacher

Presentation skills

Introduction

Note: Extensive reading is required for vocabulary building

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion



**Assessment:  
Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Practical English Grammar by A. J. Thomson and A.V. Martinet. Exercises 1. 3<sup>rd</sup> Edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. 3<sup>rd</sup> Edition. Oxford University Press. 1997. ISBN 0194313506
3. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
4. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

**ENGLISH II (Communication Skills)**

**Contact Hours:**

Theory = 48  
Practical = 0  
Total = 48

**Credit Hours:**

Theory = **3.0**  
Practical = **0**  
Total = **3.0**

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**Course Objective:**

Enable the students to meet their real-life communication needs.

**Course Outline:**

- Paragraph writing
- Practice in writing a good, unified and coherent paragraph
- Essay writing
- Introduction
- CV and job application
- Translation skills
- Urdu to English
- Study skills
- Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension
- Academic skills
- Letter/memo writing, minutes of meetings, use of library and internet

- Presentation skills
- Personality development (emphasis on content, style and pronunciation)

**Note:** Documentaries to be shown for discussion and review

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. 3<sup>rd</sup> Edition. Oxford University Press 1986. ISBN 0 19 431350 6.
1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 4534030.
2. Reading and Study Skills by John Langan
3. Study Skills by Richard York.

**ENGLISH III (Technical Writing and Presentation Skills)**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**



**Course Objective:**

Enhance language skills and develop critical thinking

**Course Outline:**

Presentation skills

Essay writing

Descriptive, narrative, discursive, argumentative

Academic writing

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing

Progress report writing

*Note: Extensive reading is required for vocabulary building*

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3
2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
4. The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton.

## PAKISTAN STUDIES

### **Contact Hours:**

Theory = 32  
Practical = 0  
Total = 32

### **Credit Hours:**

Theory = **2.0**  
Practical = **0**  
Total = **2.0**

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### **Course Objective:**

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

### **Course Outline:**

#### Historical Perspective

- Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam M. Ali Jinnah.
- Factors leading to Muslim separatism
- People and Land
  - Indus Civilization
  - Muslim advent
  - Location and geo-physical features.

#### Government and Politics in Pakistan

##### Political and constitutional phases:

- 1947-58
- 1958-71
- 1971-77
- 1977-88
- 1988-99
- 1999 onward
  - Contemporary Pakistan
- Economic institutions and issues
- Society and social structure
- Ethnicity
- Foreign policy of Pakistan and challenges
- Futuristic outlook of Pakistan

### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

### **Assessment:**

**Theory 100%**

### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)

- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Burki, Shahid Javed. *State & Society in Pakistan*, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

**ISLAMIC STUDIES**

**Contact Hours:**

Theory = 32  
 Practical = 0  
 Total = 32

**Credit Hours:**

Theory = 2.0  
 Practical = 0  
 Total = 2.0

**Course Objective:**

This course is aimed at:

- To provide Basic information about Islamic Studies

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

### **Course Outline:**

#### Introduction to Quranic Studies

- Basic Concepts of Quran
- History of Quran
- Uloom-ul -Quran
- Study of Selected Text of Holly Quran
- Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
- Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)
- Study of Selected Text of Holly Quran
- Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)
- Seerat of Holy Prophet (S.A.W) I
- Life of Muhammad Bin Abdullah ( Before Prophet Hood)
- Life of Holy Prophet (S.A.W) in Makkah
- Important Lessons Derived from the life of Holy Prophet in Makkah
- Seerat of Holy Prophet (S.A.W) II
- Life of Holy Prophet (S.A.W) in Madina
- Important Events of Life Holy Prophet in Madina
- Important Lessons Derived from the life of Holy Prophet in Madina
- Introduction To Sunnah
- Basic Concepts of Hadith
  - History of Hadith
  - Kinds of Hadith
  - Uloom-ul-Hadith
  - Sunnah & Hadith
  - Legal Position of Sunnah

### **Selected Study from Text of Hadith**

#### **Introduction To Islamic Law & Jurisprudence**

1. Basic Concepts of Islamic Law & Jurisprudence
2. History & Importance of Islamic Law & Jurisprudence
3. Sources of Islamic Law & Jurisprudence

4. Nature of Differences in Islamic Law
5. Islam and Sectarianism

### **Islamic Culture & Civilization**

1. Basic Concepts of Islamic Culture & Civilization
2. Historical Development of Islamic Culture & Civilization
3. Characteristics of Islamic Culture & Civilization
4. Islamic Culture & Civilization and Contemporary Issues

### **Islam & Science**

1. Basic Concepts of Islam & Science
2. Contributions of Muslims in the Development of Science
3. Quranic & Science

### **Islamic Economic System**

1. Basic Concepts of Islamic Economic System
2. Means of Distribution of wealth in Islamic Economics
3. Islamic Concept of Riba
4. Islamic Ways of Trade & Commerce

### **Political System of Islam**

1. Basic Concepts of Islamic Political System
2. Islamic Concept of Sovereignty
3. Basic Institutions of Govt. in Islam

### **Islamic History**

1. Period of Khlaft-E-Rashida
2. Period of Ummayyads
3. Period of Abbasids

### **Social System of Islam**

1. Basic Concepts of Social System of Islam
2. Elements of Family
3. Ethical Values of Islam

### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

### **Assessment:**

**Theory 100%**

### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation

- Assignments
- Tests/Quiz

### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs)

### Recommended Books:

- 1 Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2 Hameed ullah Muhammad, "Muslim Conduct of State"
- 3 Hameed ullah Muhammad, "Introduction to Islam"
- 4 Mulana Muhammad Yousaf Islahi,"
- 5 Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6 Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7 Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes"
- 8 Islamic Book Service (1982)
- 9 H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 10 Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

## MATHEMATICS COURSES FOR BS (4 YEAR) (FOR STUDENTS NOT MAJORING IN MATHEMATICS)

### 1. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

Title of subject:	MATHEMATICS
Discipline	BS (Social Sciences).
Pre-requisites:	SSC (Metric) level Mathematics
Credit Hours	03 + 00
Minimum Contact Hours:	40
Assessment	Written examination;
Effective	: 2008 and onward

#### Course Objective:

To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

#### Learning Outcome:

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

- Understand the use of the essential tools of basic mathematics
- Apply the concepts and the techniques in their respective disciplines



- Model the effects non-isothermal problems through different domains

### **Course Outline:**

#### **Algebra:**

Preliminaries: Real and complex numbers, Introduction to sets, set operations, functions, types of functions. Matrices: Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. Quadratic equations: Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. Sequence and Series: Arithmetic, geometric and harmonic progressions. Permutation and combinations: Introduction to permutation and combinations, Binomial Theorem: Introduction to binomial theorem. Trigonometry: Fundamentals of trigonometry, trigonometric identities. Graphs: Graph of straight line, circle and trigonometric functions.

Statistics: Introduction: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution*: Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean medium and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

#### **Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

#### **Assessment:**

##### **Theory 100%**

##### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

##### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

#### **Recommended Books:**

1. Swokowski. E. W., 'Fundamentals of Algebra and Trigonometry', Latest Edition.

2. Kaufmann. J. E., 'College Algebra and Trigonometry', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., 'Introduction of Statistics', Prentice Hall, Latest Edition.
4. Wilcox, R. R., 'Statistics for The Social Sciences'.

## **INTRODUCTION TO STATISTICS      3 (3-0)**

### **Course Objective:**

### **Learning Outcome:**

### **Course Outline:**

#### **Unit 1.    What is Statistics?**

Definition of Statistics, Population, sample Descriptive and inferential Statistics, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, Rounding of a Number, Collection of primary and secondary data, Sources, Editing of Data. Exercises.

#### **Unit 2.    Presentation of Data**

Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Histogram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

#### **Unit 3.    Measures of Central Tendency**

Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

#### **Unit 4.    Measures of Dispersion**

Introduction, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios. Exercises.

#### **Unit 5.    Probability and Probability Distributions.**

Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

#### **Unit 6.    Sampling and Sampling Distributions**

Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and non-

probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions. Exercises.

**Unit 7. Hypothesis Testing**

Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis. Exercises.

**Unit 8. Testing of Hypothesis- Single Population**

Introduction, testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

**Unit 9. Testing of Hypotheses-Two or more Populations**

Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table. Exercises

**Unit 10. Testing of Hypothesis-Independence of Attributes**

Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes. Exercises.

**Unit 11. Regression and Correlation**

Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation.  $r$  and  $R_2$ . Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

**Teaching Methodology:**

- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs)
- Project/case study/Presentation
- Assignments
- Tests/Quiz

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs)

**Recommended Books:**

1. Walpole, R. E. 1982. "Introduction to Statistics", 3<sup>rd</sup> Ed., Macmillan Publishing Co., Inc. New York.
2. Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar Faisalabad.

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**Note: *General Courses from other Departments***

Details of courses may be developed by the concerned universities according to their Selection of Courses as recommended by their Board of Studies.

## SCHEME OF STUDIES (2-Year) MS/MPhil-BIOCHEMISTRY

Semester	Course Code	Subjects	Credits
First		Course I	3
		Course II	3
		Course III	3
		Course IV	3
		<b>Total</b>	<b>12</b>
Second		Course V	3
		Course VI	3
		Course VII	3
		Course VIII	3
		<b>Total</b>	<b>12</b>
Third-Fourth		Master Thesis	6
		<b>Total</b>	<b>30</b>

Department may offer core/elective courses from the given list (but not limited to) according to the availability of resources.

### LIST OF MS/MPhil Biochemistry Courses

1. Advances in Molecular Genetics
2. Advances in Biochemistry
3. Advances in Clinical Biochemistry
4. Advances in Molecular Biology
5. Advances in Endocrinology
6. Advances in Biotechnology
7. Advanced Biostatistics
8. Advanced Bioinformatics
9. Recent Trends in Immunology
11. Advanced Fermentation Biotechnology
12. Community Nutrition
13. Protein Structure, Function and Engineering
14. Enzymes - Mechanism & Kinetics
15. Advances in Cell Biology
16. DNA Techniques and Clinical Applications
17. Good Laboratory Practices and Quality Control
18. Signal Transduction
19. Biochemistry of Metabolic Disorders
20. Biochemistry of Natural Products
21. Recombinant DNA Technology

23. Research Methodology
25. Advanced Biochemical Techniques
27. Genomics, Proteomics and Metabolomics
29. Gene Expression and Regulation
30. Food Biochemistry
31. Renewable bioenergy Resources
32. Molecular Mechanism of Diseases
33. Molecular Evolution
34. Seminar
36. Special Problem/ Specific assignment
37. Drug Designing and Metabolism
38. Forensic Serology and DNA Analysis
40. Application of Nanomaterials in Biosciences
41. Stem Cell and Therapeutics
42. Neuroscience
43. Structural Bioinformatics
44. Plant Genomics
45. Biochemistry of Drugs and their Resistance

**Note:** University may opt any other course(s) depending upon the facilities and expertise of faculty available subjected to the approval of concerned academic forum.

### **Advances in Molecular Genetics**

**Contact Hours:**

Theory = 48  
 Practical = 00  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0.0**  
 Total = **3.0**

**Course Objective:**

- To provide a deep insight about the recent advances in molecular genetics
- To understand mechanisms underlying different genetic disorders

**Learning Outcome:**

After completing this course students should be able to;

- Understand the role of genetics to address various problems
- Liaison between classical and modern genetics

**Course Outline:**

- Genes in Pedigrees.
- Organization of the human genome:
- The limited autonomy of the mitochondrial genome,
- Human gene Expression,
- Pseudogenes and genes fragments,
- Transposition through an RNA intermediate.

- Human Genome Expression.
- Instability of the human genome: mutations.
- Physical and transcript mapping: the importance of sequence tagged sites.
- Identifying human and animal disease genes.
- Molecular pathology.
- Genetic testing in individuals and population.
- Cancer Genetics.
- Complex Disease theories and results.
- Genetic manipulation of animals.
- General gene therapy strategies.
- Treatment using conventional animals or human products.

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### **Recommended Books:**

1. Miller J. H (1996) Discovering molecular genetics: a case study course with problems & scenarios. 1<sup>st</sup> edition. Cold Spring Harbor Laboratory Press, USA
2. Pasternak J. J (2005) An introduction to human molecular genetics. 2nd edition. Wiley-Liss, Canada
3. Lewis R (2007) Human genetics: concepts and applications. 7th edition. McGraw Hill
4. Jorde L. B, Cary J. C, Bamshad M. J & White R. L (2006) Medical genetics. 3<sup>rd</sup> edition. Mosby, Elsevier

5. Klug W. S & Cummings M (2005). Essentials of Genetics. 5<sup>th</sup> edition. Pearson/ prentice Hall.

### **Advances in Biochemistry**

#### **Contact Hours:**

Theory = 48  
Practical = 0  
Total = 48

#### **Credit Hours:**

Theory = **3.0**  
Practical = 0  
Total = **3.0**

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#### **Course Objective:**

- This course will provide a deep insight about the advances in Biochemistry.

#### **Learning Outcome:**

After completing this course students should be able to;

- Liaison between classical and advances biochemistry.

#### **Course Outline:**

- Recent advances in biochemistry will be discussed in detail by following review articles and research papers.

#### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

#### **Assessment**

**Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Recommended Books:**

1. Keith Wilson, John walker 2000, Principles and Techniques of practical biochemistry, Cambridge university press, UK
2. John F. Robyt, BernardJ. White 1994 4rth edition Biochemical techniques: theory



- and Practice Waveland press Illsioness
3. Sowbney, S.K; and r. singh 2000. Introductory practical Biochemistry. Norosa Publishing house, New delhi.
  4. Levinson, Wand E Jawetz. 1996. Meldical Microbiology and Immunology, 4th Ed. Appleton &Lange, Stanford, Connecticut, USA.
  5. Murray, R.K; O.K. Granner, P.A. Mayes and V.W. Redwell. 2000, Harper's Biochemistry, 25th Ed. Appleton &Lange Inc. USA.

### **Advances in Clinical Biochemistry**

**Contact Hours:**

Theory = 32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = **2.0**  
 Practical = **1.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

After completing this course, students should be able to;

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

**Course Outline:**

- Biochemical investigation and quality control
- Use, acquisition and interpretation of biochemical data in clinical medicine
- Use of chemistry analyzer in clinical diagnostics
- Fluid and electrolyte disorders
- Acid-base disorders
- Disorders of calcium, magnesium and phosphorus
- Renal disorders: Proteinuria, Renal tubular disorders and renal calculi
- Hepatic disorders: Acute and chronic liver disease
- Clinical enzymology and biomarkers
- Abnormalities of lipid metabolism
- Thyroid diseases
- Diabetes mellitus
- Reproduction endocrinology
- Biochemical nutrition

- Specific protein markers
- Cancer biochemistry and tumour markers
- Use of isotopes in medical diagnosis
- Autoimmune and immunodeficiency disorders
- Literature / leaflet review of concerned practical and instruments

**PRACTICAL:**

1. Basic Clinical Laboratory tests
  - i. Total Serum Protein
  - ii. Total Serum Albumin
  - iii. Total Serum Globulin
  - iv. Serum Calcium
  - v. Blood Glucose Level
  - vi. Blood Iron level
  - vii. Blood Uric Acid level
  - viii. Ion Selective Electrode
    - i. Sodium
    - ii. Potassium
    - iii. Chloride
2. Renal function tests
  - i. Blood Urea level
  - ii. Serum Creatinine
3. Liver function tests
  - i. AST level
  - ii. ALT level
  - iii. Alkaline Phosphatase level
  - iv. Bilirubin test
4. Clinical Enzymology
  - i. Serum amylase
  - ii. Serum lipase
  - iii. Serum LDH
  - iv. CK –MB
  - v. CPK

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%

- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Assessment**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

**Recommended Books:**

- Devlin T. Textbook of Biochemistry with Clinical Correlations. 7 th ed.Wiley; 2010.
- Ahmed N. Clinical Biochemistry (Fundamentals of Biomedical Science). Oxford University Press; 2011.
- Marshall W, Bangert S. Clinical Biochemistry: Metabolic and Clinical Aspect. 2 nd ed. Churchill Livingstone; 2008.
- Coico R, Sunshine G. Immunology: A Short Course.6 th ed. Wiley-Blackwell; 2009.
- Varcoe SJ. Clinical Biochemistry: Techniques and Instrumentation - A Practical Course. World Scientific Pub Co Inc; 2001.

**Advances in Molecular Biology**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory =**3.0**  
 Practical = 0  
 Total = **3.0**

**Course Objective:**

- To impart advance knowledge of life processes at molecular level
- To motivate students for using advanced molecular biology techniques

- To understand the theory behind the new technologies

### **Learning Outcome:**

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

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

### **Course Outline:**

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

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

**Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

## Recommended Books:

1. Review articles

### Advances in Endocrinology

#### Contact Hours:

Theory = 48  
Practical = ---  
Total = 48

#### Credit Hours:

Theory = **3.0**  
Practical = **0.0**  
Total = **3.0**

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#### **Course Objective:**

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

#### **Learning Outcome:**

After completing this course, students should be able to:

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

#### **Course Outline:**

- Molecular basis of hormones
- Endocrinology methodologies
- Hypothalamus-Pituitary Feedback
- Mechanisms of hormone secretions
- Pituitary diseases
- Sex hormones; Puberty; Hormonal contraception; Pregnancy; Lactation
- Adrenal Cortex; Adrenal Medullary hormones
- Thyroid hormones
- Parathyroid; Hormonal regulation of Calcium
- Pancreas as endocrine organ
- Endocrine tumors
- Nongenomic Steroid actions
- Endocrine disrupters

#### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment  
Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

Written (Long Questions, Short Questions, MCQs) 50%

- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Integrated Endocrinology. (2013). Latest Edition. John Laycock and Karim Meeran. Wiley-Blackwell.
2. Hormones and the Endocrine System. (2016). Latest Edition. Kleine et al. Springer.
3. Williams Textbook of Endocrinology. (2015). Latest Edition. Melmed et al. Elsevier.

**Advances in Biotechnology**

**Contact Hours:**

Theory = 32  
Practical = 32  
Total = 64

**Credit Hours:**

Theory = **2.0**  
Practical = **1.0**  
Total = **3.0**

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**Course Objective:**

- Develop understanding of recent advances in biotechnology and its ethical and social implications
- Provide students opportunities to conduct hands on experiments and projects in different areas of biotechnology

**Learning Outcome:**

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

- Understand principles and applications of various aspects of biotechnology
- Critically appraise recent research areas in the field of biotechnology
- Recognize and evaluate the methods and applications of biotechnology in animal, plants and biomedical sciences

**Course Outline:**

Scope and Current applications of Biotechnology  
Gene Technology, Genomics and the Human Genome Project  
Gene editing, animal cloning, transgenesis, and gene therapy

- Microbial Metabolism
- Fermentation, Biosynthesis of Metabolites, Primary and Secondary metabolites
- Biotechnological Process
- Upstream and Downstream processing
- Industrial Applications of Fermentation Products
  - Pharmaceutical Industry
  - Antibiotics
  - Vitamins
  - Food/Textiles/Pulp/Detergent Industry
  - Amino Acids
  - Enzymes
- Intellectual Property Rights in Biotechnology
  - Patents
  - Patentable subject matter
  - The novelty requirement

#### **Practicals:**

- Biotechnology laboratory security and safety
- Current good manufacturing practices.
- Plasmid isolation
- Restriction enzyme mapping
- Inoculum preparation and development of inoculum for industrial fermentation.
- Improvement of selected microorganism with increased productivity of the fermented products.
- DNA fingerprinting by southern blot analysis
- 2-D Electrophoresis
- Production of antibiotics through microbial fermentation

#### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

#### **Assessment**

##### **Theory100%**

##### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Comprehensive Biotechnology.4<sup>th</sup> Edition. By Ramawat, K. G. and Goyal, S. S. Published by Chand and Company Limited, New Delhi, India. (2009).
2. Biotechnology: An Introduction.By Barnum S. R. Brooks/Cole Cengage Learning Course, Belmont, CA, USA. (2005).
3. Manual of Industrial Microbiology and Biotechnology By Baltz, R. H., Demain, A. L. and Davies, J. E. (2010).
4. Biocatalysis and Bioenergy.By Hou C. T.and Shaw,J-F. Published by John Wiley & Sons, Inc., New Jersey, USA. (2008).
5. Biotechnology, 3<sup>rd</sup> Edition, By Smith J. E., Published by Cambridge University Press (2006 )
6. A Textbook of Biology By Dhami, P.S., Srivastava, H.N. and Chopra, G., Pradeep Publications (2008).

**Advanced Biostatistics****Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

After completing this course students should be able to;

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

**Course Outline:**

- Statistics of repeated measurements, Significance tests and the quality of analytical measurements.
- Modern Regression Analysis
- Theory and Quantitative Methods in Epidemiology
- Applied Epidemiologic Methods in Regression.



- Binary Data, Quantitative Methods and Measurements, Clinical Trials, Decision Analysis and Cost Effectiveness, Molecular Techniques for Public Health Research.
- Methods for Accommodating Missing Data.
- Event surveillance and mathematical modeling of dispersion.
- Advanced Probabilistic Concepts
- Advanced Predictive Modeling and Simulation
- Response surface methodology. this include the planned analytical techniques the analysis of correlated data (i.e., clustered data, longitudinal data), survival analysis using the proportional hazards (Cox) regression model, and linear models.
- Experimental Design, Multivariate Data analysis, Exploratory Factor Analysis, Confirmatory Factor Analysis, Principle components analysis (PCA), Support Vector Machine (SVM) Analysis for Multivariate Data, Canonical Correlation Analysis, Discriminate Analysis, Neutral Network Models and MANOVA.
- A semester-long project may be included, the creation of a Protocol, Case Report Forms, and Informed Consent. Midterm/ final term may be based on practical exercises as well as written paper.

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### **Recommended Books:**

- Statistics and Chemo metrics for Analytical Chemistry, Sixth Edition by by James Miller and Jane C Miller (2006)

- Daniel, W.W. "Biostatistics: A Foundation for Analysis in the Health Sciences" John Wiley and sons, lin, New York, 1995.
- Dawson, B. and Trapp, R.G., "Basic and Clinical Biostatistics." McGraw Hill, 2004.
- Zar, J. (2000). "Biostatistical Analysis", 5th Edition, John Wiley and Sons.
- Shoukri, M. M. & Pause, C. A. (1998). "Statistical Methods for Health Sciences". 2nd Edition, CRC Press, Florida.
- Geoffery, R. Norman, David L. Streiner BIostatISTICS: THE BARE ESSENTIALS. 2000. B.C. DeckerInc
- Gerry, P. Quinn, Micheal J. Kenough, EXPERIMENTAL DESIGN AND DATA ANYSIS FOR BIOLOGISTS. 2002. Cambridge University Press.
- Campbell, R. C. STATISTICS FOR BIOLOGISTS. 1989. Cambridge University Press.
- Harvey Motulsky, Intuitive Biostatistics, by New York, Oxford University Press, 1995.
- Heath, D. *An Introduction to Experimental Design and Statistics for Biology*, London, UCL Press, 1995.

### **Advanced Bioinformatics**

**Contact Hours:**

Theory = 48  
 Practical = 00  
 Total = 48

**Credit Hours:**

Theory = 3.0  
 Practical = 0.0  
 Total = 3.0

**Course Objective:**

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

**Learning Outcome:**

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

- Search databases accessible on the internet for literature relating to molecular biology and biotechnology
- Manipulate DNA and protein sequences using stand-alone PC programs and Webservers
- Find homologues, analyse sequences, construct and interpret evolutionary trees
- Analyse protein sequences, identify proteins, and retrieve protein structures from databases.

- Understand structure determination, homology modelling and computational drug design.
- Process biological data, interpret and model biological information and apply this to the solution of biological problems in any arena involving molecular data.

### **Course Outline:**

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

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%

- Tests/Quiz 10%

**Recommended Books:**

- 1 Christianini, N. and Hahn, M. W. Introduction to Computational Genomics: A Case Studies Approach, Cambridge University Press, 2007. UK.
- 2 Durbin, R., Eddy, S., Krogh, A. and Mitchison, G., Biological Sequence Analysis: Probabilistic models of proteins and nucleic acids, Cambridge University Press, 1998. UK.
- 3 Jones, N. C. and Pevzner, P. A. An Introduction to Bioinformatics Algorithms, MIT Press, 2004. USA.
- 4 Xiong, J., Essential Bioinformatics, Cambridge University Press, 2006. UK.

**Recent trends in immunology**

**Contact Hours:**

Theory = 32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = **2.0**  
 Practical = **1.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

After completing this course students should be able to;

- Understand recent challenges in the field of immunology
- Describe the principles involved in the immune response

**Course Outline:**

- Overview and elements of the immune system
- Cells and Organs of the Immune System
- Immunogens & Antigens
- Antibody Structure and Function
- Complement System
- Genetic Basis of Ab Structure
- Role of Major Histocompatibility Complex (MHC) in the Immune Response
- The T Cell Receptor: Structure and Genetic Basis
- Adaptive Immune Response
- Antigen-Antibody Interactions - ImmunoAssays
- Antibody and Cell-Mediated Reactions
- Immunology of HIV Infection
- Infection and Immunity
- Immunopathology, Immune Regulation & Tolerance
- Autoimmunity

- Clinical Scenarios
- Transplantation
- Immunoprophylaxis (Vaccines)
- Disorders of the Immune Response
- Immunology of Cancer
- Modern Antibody Therapy

#### **Practicals:**

- Laboratory Safety/ Student Surveys
- ELISA and statistical analysis
- Cell Culture and Cell Counting techniques
- Immunostaining and Flow Cytometry
- Immunoblotting
- Cell Function Assay
- PCR and RT PCR
- Team Based Learning Exercise

#### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

#### **Assessment**

##### **Theory 100%**

##### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

##### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Recommended Books:**

1. Immunology: A Short Course, 6<sup>th</sup> Edition By: R. Coico and Sunshine, G. Published by John Wiley & Sons, Inc., 2009.
2. Studies in Immunology: A Clinical Companion. (6<sup>th</sup> Ed) By: R. S. Geha and Notarangelo, L. Published by Case Garland Publishing, New York, 2012.
3. The Immune System. 3<sup>rd</sup> Edition. By: Parham, P. Garland Publishing, New York, 2009.

4. Basic Immunology – Functions and Disorders of the Immune System 3<sup>rd</sup> Edition (updated edition). By: A. K. Abbas and Lichtman, A. H. Saunders-Elsevier. Philadelphia, PA. 2011. BA. Kuby Immunology (6<sup>th</sup> Ed.) By Kindt, TJ, Goldsby, RA, Osborne, , W.H. Freeman and Company, New York, 2007

### **Advanced Fermentation Biotechnology**

#### **Contact Hours:**

Theory = 16  
Practical = 64  
Total = 80

#### **Credit Hours:**

Theory = 1.0  
Practical = 2.0  
Total = 3.0

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#### **Course Objective:**

The course has been designed to provide:

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

#### **Learning Outcome:**

After studying this course, the students are expected to:

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

#### **Course Outline:**

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

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

**Practicals:**

- Selection and isolation of bacteria and fungi for fermentation experiments;
- Preparation of basal, inoculum and fermentation media for preservation of bacteria and fungi
- Production of single cell protein, its determination and characterization
- Production of industrial enzymes in solid and liquid state cultures and their assays
- Production of organic acids in solid and liquid state fermentation and their determination
- Production of ethanol using molasses and lignocellulosic residues
- Production of lysine and glutamic acid in submerged fermentation
- Decolourization of textile dyes and industrial effluents by bacteria and white rot fungi
- Industrial visits.

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Cino, J. 2007. Fermentation Methods: Methods in Biotechnology. Human Press Inc., New Jersey, USA.
2. Gupta, V.K. and M. Ayyachamy. 2012. Biotechnology of Microbial Enzymes. Nova Science Publishers, Inc., New York, USA.

3. Moo-Young, M. 2011. Comprehensive Biotechnology. 2<sup>nd</sup> Ed. (Vol.3 & 6). Elsevier Inc., New York, USA.
4. Panday, A., C. Lorroche, C.R. Socccol, E. Gnansounou and C.G. Dussap. 2011. Comprehensive Food Fermentation Biotechnology. Vol.1. Asiatech Publishers Inc., New Delhi, India.

### Community Nutrition

**Contact Hours:**

Theory = 32  
 Practical = 32  
 Total = 64

**Credit Hours:**

Theory = **2.0**  
 Practical = **1.0**  
 Total = **3.0**

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**Course Objective:**

Students completing this course will have a broader understanding of

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

**Learning Outcome:**

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

- Demonstrate understanding of community nutrition practices
- Carry out community nutritional assessment.
- Demonstrate understanding of culture, religion, beliefs, values and behaviors on community nutrition status.
- Collect, analyze and critically evaluate data on nutrition problems in communities.
- Manage time and demonstrate skills in written and oral communication.

**Course Outline:**

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



**Practicals:**

- Anthropometric measurements to assess growth in children (length, height, weight and head circumference).
- Body composition analysis (BMI, fat mass, MUAC etc).
- Assessment of wasting and stunting.
- Dietary analysis using Windiets software.

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Text book of Community Nutrition. (2016) 2<sup>nd</sup> Ed. by Suryatapa Das. 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.

**Protein Structure, Functions and Engineering**

**Contact Hours:**

Theory = 48  
Practical = 0  
Total = 48

**Credit Hours:**

Theory = **3.0**  
Practical = **0**  
Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

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

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

**Course Outline:**

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

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment  
Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
2. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.
3. Donald Voet, Charlotte W. Pratt, Judith G. Voet. Principles of Biochemistry, 4/e, Wiley, 2012.
4. David L Nelson, Michael M Cox, Albert L Lehninger. Lehninger Principles of Biochemistry, 6/e New York: W.H. Freeman, 2013.
5. T Palmer, P L Bonner. Enzymes, 2nd Edition Biochemistry, Biotechnology, Clinical Chemistry. 2/e Woodhead Publishing, 2007.
6. Peter Tompa, Alan Fersht. Structure and Function of Intrinsically Disordered Proteins. CRC Press, 2009.

**Enzymes- Kinetics and Mechanisms**

**Contact Hours:**

Theory = 32  
Practical = 32  
Total = 64

**Credit Hours:**

Theory = **2.0**  
Practical = **1.0**  
Total = **3.0**

**Course Objective:**

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

### Learning Outcome:

After completing this course students should be able to;

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

### Course Outline:

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

### Practicals:

- Enzyme activity assays
- Effect of pH on enzyme activity.
- Effect of temperature on enzyme activity
- Effect of cofactors and metal ions on enzyme activity
- Effect of inhibitors on enzyme activity
- Effect of substrate concentration on enzyme activity
- Determination of  $K_m$ ,  $V_{max}$  and  $K_{cat}$  through Reciprocal and Eddie-Hofstee plots
- Determination of thermo-stability and half life

## Teaching Methodology

### Teaching Methodology

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

## Assessment

### Theory 100%

#### Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

## Recommended Books:

1. Stryer, L. 2012. Biochemistry, 7<sup>th</sup> Edition, W. H. Freeman and CO.
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. 7<sup>th</sup> 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. 4<sup>th</sup> ed. John Wiley & Sons. Inc. New York, NY, USA.

## Advances in Cell Biology

### Contact Hours:

Theory =48

Practical = 0

Total = 48

### Credit Hours:

Theory =**3.0**

Practical = **0.0**

Total = **3.0**

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**Course Objective:**

- To provide knowledge about the recent developments in cell biology.

**Learning Outcome:**

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

- Acquire latest knowledge of recent developments in cell biology.
- Ability to understand and analyze research data published in journals on cell biology.

**Course Outline:**

- Introduction of recent developments in cell biology
- Articles published in peer reviewed journals will be discussed

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. Molecular Cell Biology (2016 edition).
2. Cooper, Geoffrey M. The Cell - A Molecular Approach (2015 edition).
3. <http://www.cell.com/cell-reports/home>
4. <http://www.cell.com/cell/home>
5. <http://jcb.rupress.org/>
6. <http://www.cell.com/molecular-cell/home>

## DNA Techniques and Clinical Applications

### Contact Hours:

Theory = 32  
Practical = 32  
Total = 64

### Credit Hours:

Theory = 2.0  
Practical = 1.0  
Total = 2+1

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### **Course Objective:**

- To learn major advanced clinical research techniques employed in the diagnosis of various diseases
- To develop and enhance practical skills in the postgraduate students for the revolutionary progress in human genomics

### **Learning Outcome:**

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

- Understand the theory behind the new technologies related to different areas of biology and how to apply of these technologies to a specific research question.
- Have a clear concept of the primary characteristics of application of quantitative and qualitative research in basic sciences to clinical practice.
- Understand the application of antenatal techniques for the diagnosis and prediction of diseases in the unborn.

### **Course Outline:**

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

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**  
**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommendation Books:**

1. Molecular Biology Techniques: An Intensive Laboratory Course by Walt Ream (Author), Katharine G. Field (Author)
2. Molecular Biology Techniques, Third Edition: A Classroom Laboratory Manual 3rd Edition by Heather Miller (Author), D. Scott Witherow (Author), Sue Carson (Author)

Molecular Diagnostics: Fundamentals, Methods and Clinical Applications 2nd Edition by Lela Buckingham PhD MB DLM(ASCP) (Author)

**Good Laboratory Practices and Quality Control**

**Contact Hours:**

Theory = 48  
Practical = 00  
Total = 48

**Credit Hours:**

Theory = 3.0  
Practical = 0.0  
Total = 3.0

**Course Objective:**

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

**Learning Outcome:**

After completing this course, students should be able to;

- Understand the difference between quality control and quality assurance
- Acquire basic knowledge of laboratory design and management
- Understand pre and post analytical errors
- Technically defend scientific data by its quality and reliability using GLP
- Apply the regulations and standards associated with GLP



- Understand consequences of non-compliance regulated laboratories.

### **Course Outline:**

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

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Good Laboratory Practice: Nonclinical Laboratory Studies Concise Reference (2010) by Mindy J. Allport-Settle, Pharma Logica Inc, NC, USA
2. The Indispensable Guide to Good Laboratory Practice (GLP): Second Edition (2009) by Mark Gregory Slomiany, Pinehurst Press USA
3. Good clinical laboratory practice (2009) World Health Organization on behalf of the Special Programme for Research and Training in Tropical Diseases, Geneva, Switzerland

**Biochemistry of Metabolic Disorders****Contact Hours:**

Theory = 32

Practical = 32

Total = 64

**Credit Hours:**

Theory =2.0

Practical =1.0

Total =3.0

**Course Objective:**

- To identify enzyme defects that produces glycogen storage diseases and lipid storage diseases
- To provide an overview of inborn errors of amino acid metabolism.
- To describe the Lesch- Nyhan Syndrome, Gout and action of allopurinol.
- Characterize the Diabetic Syndrome.
- Explain the basis of laboratory test relevant to diagnosis of inborn- errors of metabolism and glucose homeostasis.

**Learning Outcome:**

After completing this course students should be able to;

- a. Learn the underlying molecular basis of the metabolic disorders.
- b. Relate the cause to the clinical characteristic of the disorder.
- c. Understand how obesity is related to non-insulin dependent Diabetes Mellitus.
- d. Correlate hypercholesterolemia to development of atherosclerosis.
- e. Distinguish Insulin dependent and non-insulin dependent diabetes mellitus.

**Course Outline:**

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

- Disorders leading to primary hypercholesterolemia. Biochemical basis of Tangiers disease

### **Practicals:**

- Blood gas analysis
- Blood glucose estimation
- Estimation of Plasma ammonia
- Liver function tests
- Plasma and urinary Amino-acids & Orotic acid
- Urinary ketones
- Urinary Glycosaminoglycans
- Enzyme analysis i-e Galactose -1-phosphate uridyl transferase
- Lysosomal enzyme screening

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### **Recommended Books:**

1. *Textbook Of Biochemistry With Clinical Correlation.* (1997) 4<sup>th</sup> edition by Thomas M Devlin. Wiley-Liss.
2. *Biochemistry the molecular basis of life.*(2012) 6<sup>th</sup> edition by James R.McKee and Trudy McKee. Oxford University Press.
3. *Medical Biochemistry.*(2012) 3<sup>rd</sup> Edition .by James W. Baynes and MH Dominiczak,
4. *Marks Essential Medical Biochemistry (A clinical Approach).*(2007)2<sup>nd</sup>edition by

5. Micheal L. Lieberman, Allan-D .Marks, Colleen M Smith. Lippincott William & Wilkins.
6. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. (2018) 6<sup>th</sup> Edition by Carl Burtis ,Edward Ashwood ,David Bruns.ELESVIER
7. Clinical Biochemistry An Illustrated Colour Text.(2014) 3<sup>rd</sup>editionby Allan Gaw.Churchill livinstone
8. Clinical Biochemistry Metabolic and Clinical Aspects. (2014)2nd Edition by William J. Marshall, Stephen K-Bengerl. Elsevier Health Sciences
9. Principles of Biochemistry. (2008) 3<sup>rd</sup> Edition by Donald Voet Judith G-Voet. John Wiley & Sons Ins

### **Biochemistry of Natural Products**

**Contact Hours:**

Theory = 48  
Total = 48

**Credit Hours:**

Theory =3.0  
Total =3.0

**Course Objective:**

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

**Learning Outcome:**

Scholars completing this course will be able to;

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

**Course Outline:**

- Introduction to natural products in biological system
- Common mechanisms in biological chemistry for metabolism of natural products
- Biosynthesis of lipids and their catabolic reactions
- Fatty acids, steroids and terpenoids biosynthesis
- Pathways involved in the biosynthesis fatty acids, steroids and terpenoids
- Biosynthesis of thromboxanes, leukotrienes, prostaglandins' biosynthesis and their catabolic mechanism
- Carbohydrates transformation to different natural products
- Biosynthesis of secondary metabolites (alkaloids) using amino acids as starting material
- Synthesis of polyketides in biological systems
- Biosynthesis of some representative natural products; Penicillin, cephalosporins, erythromycin, morphine, coenzyme B<sub>12</sub> and tetrapyrrols

### Teaching Methodology

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### Assessment

#### Theory 100%

#### Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### Recommended Books:

1. McMurry J. E., Begley T. P., The organic chemistry of Biological Pathways, 2nd Ed., (2016).
2. Goncalves R. E., Pinto M. C., Natural Products: Structure, Bioactivity and Applications (Biochemistry Research Trend), 1st Ed., Nova Biomedical, 2012.
3. Dewick P. M., Medicinal Natural Products: A Biosynthetic Approach, 3rd Ed., Wiley, 2009.
4. Talapatra, Sunil K., Talapatra, Bani, Chemistry of Plant Natural Products, Springer, 2015.
5. Newman D. J., Cragg G. M., Grothaus P., Chemical Biology of Natural Products, CRC Press, 2017.

### Recombinant DNA Technology

#### Contact Hours:

Theory = 48  
Practical = 00  
Total = 48

#### Credit Hours:

Theory = 3.0  
Practical = 0.0  
Total = 3.0

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### Course Objective:

- To clarify creative use of modern tools and techniques for manipulation of genomic sequences

- To expose students to application of recombinant DNA technology in biotechnological research

### **Learning Outcome:**

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

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

### **Course Outline:**

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

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

- 1 Principles of Gene Manipulation by Sandy Primose and Richard Twyman
- 2 A text book of Biotechnology by S. Chand
- 3 Gene Biotechnology by Shailendra Singh
- 4 Molecular Biotechnology: Principles & Applications of Recombinant DNA B. R. Glick., et al. by (ASM Press, 2009)
- 5 An Introduction to Genetic Engineering by Dr. Desmond S. T. Nicholl

**RESEARCH METHODOLOGY****Contact Hours:**

Theory	= 48
Practical	= 0
Total	= 48

**Credit Hours:**

Theory	= 3.0
Practical	= 0
Total	= 3.0

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**Course Objective:**

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

**Learning Outcome:**

After completing this course students should be able to;

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

**Course Outline:**

- Introduction to Research
- Role of Research and Types of Research
- Epidemiological Studies, Basic Studies; Descriptive & Analytical Studies
- Research Methods, Samples and Population, Probability and Nonprobability Sampling Problems and Hypotheses
- Formulation of Research Hypotheses, Importance of Problems and Hypotheses
- Study Design
- Selection of Research Topic and Research Supervisor
- Variable; Independent & Dependent Variables
- Methods of Data Collection
- Review of Literature and Literature Citations

- Bibliography/ References, Research Ethics, Plagiarism and its Consequences
- Writing of Research Grant Application
- Writing of Synopsis, Research Thesis, Writing of Manuscript and Research Report

### Teaching Methodology

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### Assessment

#### Theory 100%

#### Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### Recommended Books:

1. Dawson, Catherine, 2002, Practical Research methods, New Delhi, UBS Publishers' Distributors.
2. Kothari CR, 1985, Research Methodology Methods and Techniques, New Delhi, Wiley Eastern Limited. Kumar, Ranjit, 2015. Research Methodology: A step-by-step guide for beginners. (2nd .ed), Singapore, Pearson Education.

### Advanced Biochemical Techniques

#### Contact Hours:

Theory = 32  
 Practical = 32  
 Total = 64

#### Credit Hours:

Theory = 2.0  
 Practical = 1.0  
 Total = 3.0

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### Course Objective:

- To provide information of principles & mechanism of different equipments and analysis of advance Biochemical techniques and Biological sampling



- To Provide students with a “snapshot” of a career in research
- To Improve problem solving and deductive reasoning skills
- Transition student’s knowledge to practical applications

**Learning Outcome:**

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

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

**Course Outline:**

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

**Practicals:**

- One dimensional electrophoresis
- Two-dimensional electrophoresis basic protocols
- DNA isolation
- Basic protocol PCR
- Protein blotting basic and alternate protocols
- Desalting
- Protein fractionation
- Determination of molecular size
- Spectrophotometric and colorimetric estimation of protein concentration.

- Immunization of mice
- Preparation of nuclear and cytoplasmic extracts from mammalian cells
- Staining techniques
- Chromosomes staining
- Preparation of standard curve and estimation of various Solutions
- Using A280 for protein estimation
- Fiber analysis
- Estimation of carbohydrate/ soluble and insoluble, cellulose, hemicellulose and lignin.
- Properties of peptides and protein and their implications for HPLC method development
- Detection and quantitation of radio-labelled proteins and DNA in gels and blots

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### **Recommended Books:**

- D. L. Nelson and M. M. Cox. 2012. Lehninger Principles of Biochemistry. 6<sup>th</sup> edition. Worth Publishers, New York.
- D. J. G. Voet and C. W. Pratt. 2014. Fundamentals of Biochemistry. 5<sup>th</sup> edition. John Wiley and Sons. Inc. NY.
- L. Taiz and E. Zeiger. 2015. Plant Physiology. 6<sup>th</sup> edition. Sinauer Associates Inc. USA.
- P. C. Champe., R. A. Harvey and D. R. Ferrier. 2008. Biochemistry: Lippincott's Illustrated Reviews. 4<sup>th</sup> edition. Lippincott Williams and Wilkins. U.S.A.

- T. W. Goodwin and E. I. Mercer. 2003. Introduction to Plant Biochemistry. 2<sup>nd</sup> edition. CBS publishers and distributors. New Delhi.
- D.A Skooge, Wert. P.M. Holler F.J and Crouch's. R. 2013. Fundamentals of Analytical Chemistry. 9<sup>th</sup> edition Brooks Publishers.
- K. Wilson and J. Walker. 2005. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. UK. 6<sup>th</sup>edition.

### **Genomics, Proteomics and Metabolomics**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

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

- Understand the complex terms used in 'omics'
- Acquire the basic knowledge about the technologies involved in genomics, proteomics and metabolomics.
- Evaluate that how these technologies provide a better understanding of the complexities of whole organisms and biological systems.

**Course Outline:**

- Introduction to omics and genomics
- DNA Databases
- Genome Sequencing and Annotation, Next generation sequencing
- Human genome project, Genome Mapping and organization
- Gene Discovery - Expressed Sequencing Tags (ESTs)
- Chromosome walking
- Structural Variation in the Genomes
- Sequence polymorphisms in genomes and SNPs
- Techniques: microarrays, Serial analysis of gene expression (SAGE)
- Proteomics: Introduction to Proteomics
- Protein database
- Proteomics technologies: 2D-gel electrophoresis, mass spectrometry, yeast 2-hybrid system, Tandem affinity purification, protein microarray
- Protein sequencing
- Protein linkage mapping

- Strategies for protein identification
- Protein modifications and proteomics
- Applications of proteome analysis to drug and biomarker discovery
- Interaction Proteomics
- Metabolomics: Introduction to Metabolomics
- Metabolic pathways resources: KEGG, Biocarta
- Nuclear Magnetic Resonance Spectroscopy and Mass Spectrometry in metabolomics.

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### **Recommended Books:**

1. Fundamentals of Advanced Omics Technologies: From Genes to Metabolites volume 63 (Eds. Carolina Simo, Alejandro Cifuentes, Virginia Garcia-Canas ), Elsevier, 2014
2. Lesk A. Introduction to Genomics. 2<sup>nd</sup> edition. NewYork: Oxford University Press, 2012.
3. Metabolomics: From Fundamentals to Clinical Applications (Ed. Alessandra Sussulini) Springer, 2017
4. Campbell MA, Heyer LJ. Discovering Genomics, Proteomics and Bioinformatics. Pearson education, 2009
5. Gibson G, Muse S. A Primer of Genome Science IRL. 3<sup>rd</sup> edition. Sinauer Associates Inc; 2009.
6. Batiza AF. Bioinformatics, Genomics, and Proteomics: Getting the Big Picture (Biotechnology in the 21st Century). Chelsea House Publishers; 2006.

7. Saccone C, Pesole G. Handbook of comparative genomics: principles and methodology. Wiley-Liss. 2003
8. Benjamin Lewin. Genes IX. Jones and Bartlett Publishers, 2007
9. Systems Biology (eds. Mohamed Al-Rubeai, Martin Fussenegger) Springer, 2007

### **Gene Expression and Regulation**

**Contact Hours:**

Theory =48

Practical = 0

Total = 48

**Credit Hours:**

Theory =**3.0**

Practical = **0.0**

Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

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

- Understand the basics of gene expression pathways
- Understand and analyze features involved in expression regulation.
- Analyze expression data and deduce regulatory patterns.

**Course Outline:**

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

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**  
**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. Molecular Cell Biology (2016 edition).
2. Cooper, Geoffrey M. The Cell - A Molecular Approach (2015 edition).
3. Benjamin Lewin. Gene X (2009 edition) and Gene XI (2013 edition)
4. TA Brown. Genomes 3 (2006 edition) & 4 (2017 edition).

**Food Biochemistry**

**Contact Hours:**

Theory = 48

Practical = 0

Total = 48

**Credit Hours:**

Theory = **3.0**

Practical = **0**

Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

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

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

### **Course Outline:**

- Food selection and meal planning for healthy individuals
- Absorption, storage and metabolic function of macro and micronutrients
- Balanced diet: recommended dietary allowances for different categories of the human beings
- Water's importance in Food Chemistry: Phases of water, the role of water as a solvent in food systems, the concept of water activity Measurement of energy of foods and expenditures
- Direct and indirect caloric measurement
- Basal metabolism, Obesity, BMR and Factors affecting BMR
- Respiratory quotient, Food borne diseases, Nutritional aspects and dietetic treatment of a few important primary nutritional and general diseases (anorexia, Endemic goiter, Idiosyncrasies)
- Fasting, Starvation, Food intolerance and food allergies, Clinical surveys, Physical examinations, Laboratory examinations, Dietary surveys, 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 method

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

- E. N. Whitney and S. R. Rolfes .2002. Understanding Nutrition. 9th edition. Wads worth Thomson learning: New York.
- J. I. Jain. 2008. Fundamentals of Biochemistry. S. Chand & Co. India
- L. Kathleen and M. S. Escott-Stump. 2009. Krause's Food, Nutrition and Diet Therapy. 11th Edition. Saunders.
- S. A. Joshi. 2002. Nutrition & Dietetics. 2nd Edition. Tata McGraw Hill Publishers
- U. Satayanarayna and U. Chakarapani. 2014. Biochemistry. 4th edition.

**Renewable Bioenergy Resources (31)****Contact Hours:**

Theory =48

Practical = 00

Total = 48

**Credit Hours:**Theory = **3.0**

Practical = 0.0

Total = **3.0**

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**Course Objective:**

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

**Learning Outcome:**

Students completing this course will be able to:

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

**Course Outline:**

- Energy perspective, Current methods, Biomass possibilities
- Fundamental concepts in understanding biofuel and bioenergy production of Mass Balances
- Energy Balances, Thermodynamics, Organic compounds



- Chemistry of plant materials, Production of bio-renewable resources including Herbaceous crops, Woody crops, Algae
- Conversion of biomass into heat and power: Direct combustion, Thermal gasification, Anaerobic digestion
- Processing of biomass into chemicals and fuels; Sugars, Alcohols, Biodiesel Thermochemical conversion, Fischer Tropsch Fuels etc,
- Ethanol - issues & future prospects
- Biodiesel - uses, production, processes,
- Biomass & Bioenergy wrap-up
- Fuel cells, Transportation - hybrids, flexfuels, fuel cells etc.
- Environmental impact of the bio-economy: Land use, Pollution, Climate change etc, *Natural burial*
- Economics of bio-renewable resources with reference to Feedstock costs, Capital costs, Operating costs

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%

### **Recommended Books:**

1. Robert C. Brown. Biorenewable Resources – Engineering New Products from Agriculture  
Publisher: Blackwell Publishing Professional, 2003 ISBN: 978-0-8138-2263-1
2. Wim Soetaert and Erik Vandamme (Editors), Biofuels. Publisher: Wiley ISBN: 978-0-470-02674-8 Year: 2009
3. Donald Klass, Biomass for Renewable Energy, Fuels, and Chemicals. Publisher: Academic Press ISBN: 978-0-12-410950-6 Year: 1998

4. Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy, Technologies and Sustainable Living (30th anniversary edition). Gaiam.
5. Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19-926178-4).

### **Molecular Mechanisms of Diseases**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

After completing this course, student should be able to;

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

**Course Outline:**

- A general introduction to Basic Mechanisms of Disease and Risk Factors.
- Origin and development of the disease
- Genetic diseases. (Muscular dystrophy, bone deformities, skin diseases)
- Microbial Infections.
- Viral infections and its factors
- Immunopathogenesis (Inflammation, Fibrosis, Hypersensitivity, Autoimmunity, Immunodeficiency).
- Degeneration
- Pathogenesis of Cancer.

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Brownstein M. J and Khodursky A, Functional Genomics (Methods in Molecular Biology). Humana Press (2010).
2. Strachan T, Read A. P, Human Molecular Genetics, 4<sup>th</sup> ed, Garland Science, New York (2010).
3. Glazer A. N, MICROBIAL BIOTECHNOLOGY, Fundamentals of Applied Microbiology, Hiroshi Nikaido University of California, Berkeley (2008).
4. Updated research Published in Nature Review Cell & Molecular Biology.
5. Articles Published in Nature Review Genetics.

**Molecular Evolution**

**Contact Hours:**

Theory = 48  
 Practical = ---  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

After completing this course the students should be able to:

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

**Course Outline:**

- Molecular Basis of Evolution
- Allele Dynamics in Populations
- DNA and Amino Acid Sequence Evolution
- Rates and Patterns of Molecular Evolution

- Molecular Phylogenetics and Phylogenetic Trees
- Reticulate Evolution and Phylogenetic Networks
- Evolution by DNA Duplication
- Evolution by Molecular Tinkering
- Mobile Elements in Evolution
- Prokaryotic Genome Evolution
- Eukaryotic Genome Evolution
- The Evolution of Gene Regulation
- Experimental Molecular Evolution

### Teaching Methodology

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### Assessment

#### Theory 100%

##### Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

##### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### Recommended Books:

1. Molecular and Genome Evolution. (2016). Latest Edition. Dan Graur. Oxford University Press.
2. An Introduction to Molecular Evolution and Phylogenetics. (2015). Lindell Bromham. Oxford University Press.
3. Molecular Evolution. (1997). Latest Edition. Wen Hsiung Li. Oxford University Press.

### Seminar

#### Contact Hours:

Theory =48  
 Practical = 0  
 Total = 48

#### Credit Hours:

Theory = **3.0**  
 Practical = 0  
 Total = **3.0**

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**Course Objective:**

- To explore ideas from recent research
- To develop presentation skills.

**Learning Outcome:**

Students completing this course will be able to:

- Present an idea in a scientific way
- Explore topics by discussion
- Identify and sort out research questions

**Course Outline:**

Student will prepare and present seminars on a topic assigned by teacher.

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment****Theory 100%****Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Special Problem/Specific Assignment****Contact Hours:**

Theory =48

Practical = 0

Total = 48

**Credit Hours:**

Theory = **3.0**

Practical = 0

Total = **3.0**

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**Course Objective:**

- To explore ideas from recent research
- To develop presentation skills

**Learning Outcome:**

Students completing this course will be able to:

- Present an idea in a scientific way
- Explore topics by discussion
- Identify and sort out research questions

**Course Outline:**

Student will prepare and present seminars on a topic assigned by teacher.

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Drug Designing and Metabolism****Contact Hours:**

Theory = 48

Practical = 0.0

Total = 48

**Credit Hours:**

Theory = **3.0**

Practical = **0**

Total = **3.0**

**COURSE OBJECTIVES:**

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

**Learning Outcome:**

After completing this course students should be able to;

- a. Understand the drug designing strategies ,drug distribution, acid-base properties
- b. Acquire basic knowledge of general pathways of drug metabolism, computer aided drug design,
- c. Understand and explain phases, structure, and analytical development of drug, Drug Development Activities and Timeline

**COURSE OUTLINE:****Drug Metabolism**

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

**Drug Designing Strategies**

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

## Teaching Methodology

- Lecturing
- Written Assignments

## Assessment

### Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

### Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

## RECOMMENDED BOOKS:

1. Foyes principle of Medicinal Chemistry, seventh eds.,(2012)
2. Wilson and Gisvold's Text book of organic Medicinal and Pharmaceutical Chemistry,12<sup>th</sup> eds.,2011
3. Burger's Medicinal Chemistry and Drug discovery edited by Donald J. Abraham, John Wiley & Sons incorporated Philadelphia (2003)
4. Comprehensive Medicinal Chemistry, Taylor J.B and David J. Triggle. Pergmon Press Amsterdam (2007).
5. Pharmaceuticals in the Environments: Sources, Fate, Effect and Risk. Klaus Kummerer, 2<sup>nd</sup> edition, Springer (2004)
6. Physical Chemistry for the Bioscience. Raymond Chang, University Science Books (2005).
7. Smith and Williams Introduction to the principles of drug design and drug action by H. John Smith 4<sup>th</sup> eds., CRC Taylor and Francis New York (2006).
8. The organic Chemistry of drug design and drug action by Richard B. Silverman 2<sup>nd</sup> Edition Elsevier Academics Press, California (2004).

## Forensic Serology and DNA Analysis

### Contact Hours:

Theory = 32  
Practical = 00  
Total = 32

### Credit Hours:

Theory =2.0  
Practical = 0.0  
Total = 2.0

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### Course Objective:

- To acquaint students with the understanding the forensic science with special reference to DNA and Serology.
- To help them understand the detection of human biological fluids and their importance.



- To understand the role and utility of biological fluids as evidence in criminal investigation system.

### **Learning Outcome:**

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

- The importance of serological fluids like blood semen and saliva found on the crime scene.
- Importance of Forensic DNA and Serology in legal investigations, and the importance of quality control and quality assurance systems in Forensic Sciences.
- How obtaining DNA profile helps in parentage testing and relationship/sibship testing and the importance of lineage markers and familial searching using DNA database.
- The significance of DNA profiling, different interpretations and its outcomes.

### **Course Outline:**

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

### **Teaching Methodology**

- Lecturing
- Written Assignments

- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Goodwin, William, Adrian Linacre, and SibteHadi. An introduction to forensic genetics. Vol. 2. John Wiley & Sons, 2011.USA.
2. Butler, J. M. (2009). Fundamentals of forensic DNA typing. Academic Press. 2<sup>nd</sup> Edition, New York, USA
3. Butler, J. M. (2011). Advanced topics in forensic DNA typing: methodology. Academic Press. 1<sup>st</sup> Edition, New York, USA.
4. XanthéMallett, Teri Blythe, Rachel Berry Advances in Forensic Human Identification2014 – CRC Press. USA.
5. Richard Li, Forensic Biology, Second Edition March 11, 2015, CRC Press. USA.

**Applications of Nanomaterials in Biosciences**

**Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

**Credit Hours:**

Theory =**3.0**  
 Practical = 0  
 Total = **3.0**

**Course Objective:**

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

### **Learning Outcome:**

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

- Understand the basic knowledge of Nanomaterials.
- Illustrate the links between medical problem, biological scenarios, chemical issues and mechanical performance.
- Understand the applications of nanomaterials in early medical diagnostics, drug targeting, drug delivery, Nano surgery and other biological fields.
- Select and manipulate materials for a particular application in the human body.
- Evaluate the performance of materials based on scientific knowledge of its composition, structure and properties.
- Know the limitations of the biomaterials and the characteristics that might influence changes over time.

### **Course Outline:**

Introduction to nanomaterials:

- Introduction to nanotechnologies for medicine and healthcare – challenges and opportunities
- Nanoparticles in medicine
- Recent developments in the safety of nanomaterials

Nanotechnologies for regenerative medicine and tissue engineering

- Nanotechnologies for regenerative medicine and tissue engineering – overview
- Nanomaterials for regeneration of bone and cartilage
- Scaffolds and nanocomposites for tissue engineering
- Using stem cells in tissue engineering
- Electrospinning in tissue engineering

Nano-Diagnostics

- Introduction to nano-diagnostics
- Extracellular vesicles in health and disease
- Engineered nanoparticles for cancer diagnostics and therapy
- Nanoparticles for medical imaging

Nano-Biosensors

- Requirements of biosensing systems
- Electrochemical sensing methodologies
- Optical sensing methodologies

Nano-Pharmaceuticals

- Nanotechnologies and nanoparticles for drug delivery and therapy
- Approaches to nanoparticle targeting
- Nano–Radiopharmaceuticals
- Polymer-based nanoparticles for drug delivery and therapeutics
- Nano-biosensors (devices) – examples from research and industry

### **Teaching Methodology**

- Lecturing
- Written Assignments

- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. C. M. Niemeyer, C. A. Mirkin, —Nanobiotechnology: Concepts, Applications and PerspectivesII, Wiley – VCH, (2004).
2. T. Pradeep, —Nano: The EssentialsII, McGraw – Hill education, (2007).
3. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, II Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and ImpactII, Wiley – VCH, (2005).
4. Nicholas A. Kotov, —Nanoparticle Assemblies and SuperstructuresII, CRC, (2006).
5. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.

**Stem Cells and Therapeutics**

**Contact Hours:**

Theory =48  
 Practical = ---  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

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

- Understand the basic types of stem cells and comprehend their possible therapeutic uses

- Explain the differences between the stem cell based and regular drug-based therapies.

### **Course Outline:**

- Introduction to stem cells; Principles and applications
- Concept of the stem cells
- Self-renewal and differentiation potential of stem cells
- Maintaining Stemness: Interaction between HSCs and the cellular micro environment
- Stem cells and their specific molecular markers
- Cell signaling in stem cells
- Stem cells; Embryogenesis; Differentiation;
- Stem cells models, past, present and future;
- Immunobiology of stem cell transplantations;
- Types of stem cells and their clinical potential: Embryonic and non-embryonic stem cells; Adult stem cells; Induced pluripotent stem cells;
- Stem cells in regenerative medicine, Regenerative medicine and reprogramming;
- Hematopoietic stem cells and their therapeutic potential
- Use of stem cells in burns and wounds, ocular diseases, diabetes, etc
- Generation of specific cells from pluripotent stem cells
- Commercial opportunities for iPSCs
- Limitations in reprogramming and differentiation fields
- Cancer stem cells and tumorigenesis
- Stem cells and aging
- Bioreactors of pluripotent stem cells and future challenges
- Ethical issues in stem cell research

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%

- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Ulrich, Henning, Davidson Negraes, Priscilla, Working with Stem Cells (Principles and Applications) edition illustrated, Springer, 2016
2. Tarik Regad, Thomas J. Sayers, Robert C. Rees, Principles of Stem Cell Biology and Cancer: Future Applications and Therapeutics 1<sup>st</sup> edition, John Wiley and Sons 6 March 2015
3. Kaushik D. Deb and Satish M. Totey, Stem Cells Technologies Basics and Applications New edition, Tata McGraw-Hill 2009
4. Paul Knoepfler., Stem Cells, An Insider's Guide, 1<sup>st</sup> edition, World Scientific Publishing Co.Pte. Ltd, 2013
5. Edited by D. Ho, Ronal Hoffman and Esmail D. Zanjani., Stem cell transplantation (Biology, Processing, Therapy) Wiley-Blackwell, 2006
6. Vertes, Alain A; Qureshi, Nasib; Caplan, Arnold I; More...Stem Cells in Regenerative Medicine: Science, Regulation and Business Strategy, 1<sup>st</sup> edition, Wiley Blackwell, 2015
7. Patrick J. Sullivan , and Elena K. Mortensen., Induced Stem Cells, Nova Science publishers Inc; UK ed. Edition 2012

**Neuroscience**

**Contact Hours:**

Theory = 48  
 Practical =0.0  
 Total = 48

**Credit Hours:**

Theory = **3.0**  
 Practical = **0.0**  
 Total = **3.0**

**Course Objective:**

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

**Learning Outcome:**

After completing this course students should be able to;

- Acquire the understanding of mechanism involved in the transmission of information in the brain
- Describe the modulation of brain function
- Analyze the role of neurotransmitters in various diseases
- Understand the role of neuron specific signaling pathways

### **Course Outline:**

- Introduction to neuroscience: Nervous system, Sympathetic, Parasympathetic and motor nervous system and their functions, Brain and its functions, Neuron and glia, structure of a neuronal cell, types of glia, Blood brain barriers
- Neuronal Circuits: Neuronal circuit in emotional control, Neuronal circuit in reward and addiction, Neuronal regulation of stress
- Receptors: Ionotropic and metabotropic receptors, signal transduction pathways, G-proteins, protein phosphorylation, 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

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Christophe Habas, The Neuroimaging of Brain Diseases: Structural and Functional Advances (Contemporary Clinical Neuroscience) 1st ed. 2018 Edition
2. Darakhshan Haleem, Neurochemistry, Neuropharmacology and Behavior: Outlines on the mechanism of brain function, 2010
3. Mark F. Bear, Barry W. Connors & Michael A. Paradiso, Neuroscience: Exploring the brain, 2006
4. Jack R. Cooper, Floyd E. Bloom and Robert H. Roth. The Biochemical Basis of Neuropharmacology Oct 17, 2002
5. Progress in Neuroscience, Readings from Scientific American, John Wiley.
6. Philip, G. Strange, Brain Biochemistry and Brain Disorders, 1993 Oxford Press.
7. George, J. Siegal, B. W. Agranoff, S. K. fisher , M. D. Uhler, Basic Neurochemistry: Molecular, Cellular and Medical Aspects, Lippincott D. Uhler.

**Structural Bioinformatics****Contact Hours:**

Theory = 32

Practical = 32

Total = 64

**Credit Hours:**Theory = **2.0**Practical = **1.0**Total = **3.0****Course Objective:**

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

**Learning Outcome:**

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

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

**Course Outline:**

- Concepts in structural bioinformatics
- Overview of protein structure
- Computational aspects of macromolecular structure determination by X-ray crystallography and NMR spectroscopy
- Computer aided molecular modeling and visualization
- The Protein Data Bank, SCOP and CATH databases
- Protein Structure Quality Assurance; protein structure validation.



- Protein structure comparison and alignment
- Protein secondary structure assignment and prediction
- Protein tertiary structure prediction: homology modeling, ab initio prediction and fold recognition methods
- Principles and methods of molecular docking and ligand design
- Structural bioinformatics in drug discovery
- Inferring protein function from structure
- Using Programming Language (e.g. Python) to facilitate protein structural analysis

### **Practicals:**

- Survey of Protein Structure Databases.
- Protein structure visualization and analysis.
- Secondary structure prediction
- Protein tertiary structure prediction by homology modeling method.
- Ligand docking

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### **Recommended Books:**

1. Structural Bioinformatics by Philip E Bourne.
2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3<sup>rd</sup> Edition, Andreas D. Baxevanis (Editor), B.F. Francis Oullette (Editor), ISBN: 978-0-471-47878-2.
3. Arthur M. Lesk, Introduction to Bioinformatics Oxford University Press.

4. Introduction to Bioinformatics: A Theoretical and Practical Approach, Humana Press.
5. DW Mount, Bioinformatics: Sequence and Genome Analysis, Second Edition, CSHL Press, USA.

## PLANT GENOMICS

### **Contact Hours:**

Theory = 48  
 Practical = 0  
 Total = 48

### **Credit Hours:**

Theory = **3.0**  
 Practical = **0**  
 Total = **3.0**

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### **Course Objective:**

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

### **Learning Outcome:**

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

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

### **Course Outline:**

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

- Analysis of Plant Biodiversity and Molecular Evolution
- Candidate Gene analysis

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

### **Assessment**

#### **Theory 100%**

#### **Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

#### **Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

### **Recommended Books:**

1. Plant Omics: Trends and Applications 1st ed. 2016 Edition by Khalid Rehman Hakeem (Editor), Hüseyin Tombuloğlu (Editor), Güzin Tombuloğlu (Editor) Springer; 1st ed. 2016 edition (August 24, 2016)
2. Plant Genes, Genomes and Genetics 1st Edition by Erich Grotewold (Author), Joseph Chappell (Author), Elizabeth A. Kellogg (Author) Wiley-Blackwell; 1 edition (May 26, 2015)
3. From Plant Genomics to Plant Biotechnology Hardcover – 2017 by Palmiro Poltronieri Et Al (Author) Woodhead Publishing (2017)
4. Caetano-Anolles G (2010) Evolutionary Genomics and Systems Biology. Wiley-Blackwell, Hoboken, NJ, USA.
5. Somers DJ, Langridge P, Gustafson JP (2011) Plant Genomics: Methods and Protocols, Methods in Molecular Biology. Humana Press Inc., NY, USA.
6. Pevsner J (2009) Bioinformatics and Functional Genomics. Wiley-Blackwell, Hoboken, NJ, USA.
7. Galperin MY and Koonin EV (2003) Frontiers in Computational Genomics. Caister Academic Press, Norfolk, UK.
8. Principles and Practices of Plant Genomics, Volume 3: Advanced Genomics 1st Edition by Chittaranjan Kole (Editor), Albert G. Abbott (Editor) CRC Press; 1 edition (June 16, 2017)

## Biochemistry of Drugs and their Resistance

### **Contact Hours:**

Theory = 48  
Practical = 00  
Total = 48

### **Credit Hours:**

Theory =3.0  
Practical =0.0  
Total = 3.0

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### **Course Objective:**

Course Objectives:

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

### **Learning Outcome:**

After completing this course, students should be able to;

- Familiarize with major classes of antimicrobials, molecular basis of their mode of action and resistance
- Understand the use of antimicrobials in clinical practice along with detection of antimicrobial sensitivity for antimicrobial stewardship
- Analyze emerging drug resistance issues in real life

### **Course Outline:**

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

### **Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**  
**Theory 100%**

**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

1. Antimicrobial Resistance Global Report on Surveillance. (2014) World Health Organization Geneva, Switzerland.
2. Anti Antimicrobial Resistance Policy Government of Pakistan
3. Latest Research Articles from Journals

**Biochemistry of Control system**

**Contact Hours:**

Theory = 48  
Practical = 00  
Total = 48

**Credit Hours:**

Theory =3.0  
Practical = 0.0  
Total = 3.0

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**Course Objective:**

The course aims to provide:

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

**Learning Outcome:**

After completing this course the students will be able to:

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

**Course Outline:**

Homeostatic control system:

- General characteristics and the balance concept

- Chemical homeostasis and components of homeostatic systems
- Receptors, signal transduction mechanisms for plasma-membrane receptors

#### Neural control system:

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

#### Sensory control System:

- Pathways and basic characteristics of sensory coding; Somatic sensation; Vision, hearing, vestibular system
- Chemical senses, association cortex and perceptual processing

#### Muscles:

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

#### Hormones:

- Definition and characteristics of hormones
- Major endocrine systems and their target tissues
- Synthesis and chemistry of various hormones, and their mechanism of release
- Plasma membrane and intracellular receptors and transportation of hormones
- Molecular mechanisms of signal transduction and role of G-proteins
- Second messengers cAMP, cGMP, Ca<sup>2+</sup>, DAG and IP3 and their role in regulation
- Termination of signal transduction and cross talk among signalling systems
- Physiological functions and interrelations of various hormones and enzymes in metabolism.

#### **Recommended Books:**

1. Barret, K.E., S.M. Barman, S. Boitano and H. Brooks. 2012. Ganong's Review of Medical Physiology. 24<sup>th</sup> Ed. McGraw Hill, New York, USA.
2. Hall, J.E. 2015. Guyton and Hall Text Book of Medical Physiology. 13<sup>th</sup> Ed. W.B. Saunders Company, Philadelphia, USA.
3. Lim, W., B. Mayer and T. Pawson. 2014. Cell Signaling: Principles and Mechanisms. Taylor & Francis Group, New York, USA.
4. Nelson, D.L. and M.M. Cox. 2013. Lehninger Principles of Biochemistry. 6<sup>th</sup> Ed. WH Freeman & Company, New York, USA.
5. Voet, D., J.G. Voet and C.W. Pratt. 2013. Fundamentals of Biochemistry, Life at the Molecular Level. 4<sup>th</sup> Ed. John Wiley & Sons. Inc., New York, USA.

6. Nilius, B. 2015. Reviews of Physiology, Biochemistry and Pharmacology, Vol. 163. Springer-Verlag Publishers, New York, LLC, USA.
7. Rodwell, V and D. Bender. 2015. Harpers Illustrated Biochemistry. 30<sup>th</sup> Ed. McGraw Hill, New York, USA.

**COMPULSORY COURSES IN ENGLISH FOR BS  
(4 YEAR) IN BASIC & SOCIAL SCIENCES**

**English I (Functional English)**

**Objectives:** Enhance language skills and develop critical thinking.

**Course Contents:**

Basics of Grammar  
Parts of speech and use of articles  
Sentence structure, active and passive voice  
Practice in unified sentence  
Analysis of phrase, clause and sentence structure  
Transitive and intransitive verbs  
Punctuation and spelling

**Comprehension**

Answers to questions on a given text

**Discussion**

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers

**Translation skills**

**Urdu to English**

**Paragraph writing**

Topics to be chosen at the discretion of the teacher

**Presentation skills**

Introduction

*Note: Extensive reading is required for vocabulary building*

**Recommended Books:**

1. **Functional English**
  - a) Grammar



1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
  2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506
- b) Writing
1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
- c) Reading/Comprehension
1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
- d) Speaking

## **English II (Communication Skills)**

**Objectives:** Enable the students to meet their real life communication needs.

### **Course Contents:**

#### **Paragraph writing**

Practice in writing a good, unified and coherent paragraph

#### **Essay writing**

Introduction

#### **CV and job application**

Translation skills

Urdu to English

#### **Study skills**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

#### **Academic skills**

Letter/memo writing, minutes of meetings, use of library and internet

#### **Presentation skills**

Personality development (emphasis on content, style and pronunciation)

*Note: documentaries to be shown for discussion and review*

## Recommended Books:

### Communication Skills

- a) Grammar
  - 1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
  
- b) Writing
  - 3. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
  - 4. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
  
- c) Reading
  - 1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
  - 2. Reading and Study Skills by John Langan
  - 5. Study Skills by Richard York.

## **English III (Technical Writing and Presentation Skills)**

**Objectives:** Enhance language skills and develop critical thinking

### **Course Contents:**

#### **Presentation skills**

#### **Essay writing**

Descriptive, narrative, discursive, argumentative

#### **Academic writing**

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

#### **Technical Report writing**

#### **Progress report writing**

*Note: Extensive reading is required for vocabulary building*

### **Recommended Books:**

#### Technical Writing and Presentation Skills

- a) Essay Writing and Academic Writing
  1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
  2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
  3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirsznner and Stephen R. Mandell. St. Martin's Press.
- b) Presentation Skills
- c) Reading  
The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

**Annexure "B"**

## Pakistan Studies (Compulsory)

### Introduction/Objectives:

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

### Course Outline:

1. **Historical Perspective**
  - a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
  - b. Factors leading to Muslim separatism
  - c. People and Land
    - i. Indus Civilization
    - ii. Muslim advent
    - iii. Location and geo-physical features.
2. **Government and Politics in Pakistan**

Political and constitutional phases:

  - a. 1947-58
  - b. 1958-71
  - c. 1971-77
  - d. 1977-88
  - e. 1988-99
  - f. 1999 onward
3. **Contemporary Pakistan**
  - a. Economic institutions and issues
  - b. Society and social structure
  - c. Ethnicity
  - d. Foreign policy of Pakistan and challenges
  - e. Futuristic outlook of Pakistan

### Recommended Books:

1. Burki, Shahid Javed. *State & Society in Pakistan*, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign Policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.

7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

## ISLAMIC STUDIES (Compulsory)

### Objectives:

This course is aimed at:

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

### Detail of Courses:

#### Introduction to Quran Studies

- 1) Basic Concepts of Quran
- 2) History of Quran
- 3) Uloom-ul -Quran

#### Study of Selected Text of Holly Quran

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

#### Study of Selected Text of Holly Quran

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

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

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

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

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

### **Introduction To Sunnah**

- 1) Basic Concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom-ul-Hadith
- 5) Sunnah & Hadith
- 6) Legal Position of Sunnah

### **Selected Study from Text of Hadith**

#### **Introduction To Islamic Law & Jurisprudence**

- 1) Basic Concepts of Islamic Law & Jurisprudence
- 2) History & Importance of Islamic Law & Jurisprudence
- 3) Sources of Islamic Law & Jurisprudence
- 4) Nature of Differences in Islamic Law
- 5) Islam and Sectarianism

#### **Islamic Culture & Civilization**

- 1) Basic Concepts of Islamic Culture & Civilization
- 2) Historical Development of Islamic Culture & Civilization
- 3) Characteristics of Islamic Culture & Civilization
- 4) Islamic Culture & Civilization and Contemporary Issues

#### **Islam & Science**

- 1) Basic Concepts of Islam & Science
- 2) Contributions of Muslims in the Development of Science
- 3) Quran & Science

#### **Islamic Economic System**

- 1) Basic Concepts of Islamic Economic System
- 2) Means of Distribution of wealth in Islamic Economics
- 3) Islamic Concept of Riba
- 4) Islamic Ways of Trade & Commerce

#### **Political System of Islam**

- 1) Basic Concepts of Islamic Political System
- 2) Islamic Concept of Sovereignty
- 3) Basic Institutions of Govt. in Islam

#### **Islamic History**

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids

#### **Social System of Islam**

- 1) Basic Concepts Of Social System Of Islam

- 2) Elements Of Family
- 3) Ethical Values Of Islam

**Reference Books:**

- 1) Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)



**COMPULSORY MATHEMATICS**  
**COURSES FOR BS (4 YEAR)**

**(FOR STUDENTS NOT MAJORING IN**  
**MATHEMATICS)**

**1. MATHEMATICS I (ALGEBRA)**

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

**Specific Objectives of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

*Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer’s rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression.

*Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices.

*Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

**Recommended Books:**

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

**Statistics-I  
Credit 3 (2-1)**

Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantiles and Mode in grouped and un-grouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

**Practical:**

- a. Frequency Distribution
- b. Stem-and-Leaf diagram
- c. Various types of Graphs
- d. Mean, Geometric mean Harmonic Mean,
- e. Median, Quartiles Deviation, mean Deviation.
- f. Standard Deviation, Variance, Coefficient of variation,
- g. Skewness and kinesis

**Recommended Books:**

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crashaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2<sup>nd</sup> Ed. (1986) Fran II. Dietrich-II and Thomas J. Keans

Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Inference Theory: Estimation and testing of hypothesis, Type—I and type-II error, Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test, Test of association of attributes using  $\chi^2$  (chi-square) Testing hypothesis about variance.

**Practical:**

- a. Sampling random sampling
- b. Stratified random sampling.
- c. Sampling distribution of mean
- d. Testing of hypotheses regarding population mean
- e. Testing of hypotheses about the difference between population means
- f. Chi-square test
- g. Testing of Correlation Coefficient
- h. Fitting of simple linear regression
- i. One-way ANOVA
- j. Two-way ANOVA

**Recommended Books:**

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. Principles and Procedures of Statistics A Bio-material approach, 2<sup>nd</sup> Edition, 1980 by R. G. D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2<sup>nd</sup> Edition (1980) by K. A. Gomez and A. A. Gomez

**Introduction to Information and Communication Technologies**

**Course Structure:** Lectures: 2 Labs: 1 **Credit Hours:** 3

**Pre-requisite:** **None** **Semester:** 1

**Course Description:**

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

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

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

**Course Contents:**

Basic Definitions & Concepts

Hardware: Computer Systems & Components

Storage Devices, Number Systems

Software: Operating Systems, Programming and Application Software

Introduction to Programming, Databases and Information Systems

Networks

Data Communication

The Internet, Browsers and Search Engines

The Internet: Email, Collaborative Computing and Social Networking

The Internet: E-Commerce

IT Security and other issues

Project Week

Review Week

**Text Books/Reference Books:**

1. Introduction to Computers by Peter Norton, 6th International Edition, McGraw-Hill

2. Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6<sup>th</sup> Edition, McGraw-Hill
3. Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer
4. Fundamentals of Information Technology by Alexis Leon, Mathews Leon, Leon Press.