CURRICULUM

OF

BIOCHEMISTRY

BS

2018

HIGHER EDUCATION COMMISSION
ISLAMABAD
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. Mukhtar Ahmed</td>
<td>Chairman, HEC</td>
</tr>
<tr>
<td>Prof. Dr. Arshad Ali</td>
<td>Executive Director, HEC</td>
</tr>
<tr>
<td>Mr. Muhammad Raza Chohan</td>
<td>Director General (Academics)</td>
</tr>
<tr>
<td>Dr. Muhammad Idrees</td>
<td>Director (Curriculum)</td>
</tr>
<tr>
<td>Syeda Sanober Rizvi</td>
<td>Deputy Director (Curriculum)</td>
</tr>
<tr>
<td>Mr. Riaz-ul-Haque</td>
<td>Assistant Director (Curriculum)</td>
</tr>
<tr>
<td>Mr. Muhammad Faisal Khan</td>
<td>Assistant Director (Curriculum)</td>
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</tbody>
</table>

Composed by Mr. Zulfiqar Ali, HEC Islamabad
CONTENTS

1. Introduction 7
2. Standardized Format for BS (4-Year) in Biochemistry
3. Scheme of Studies for BE/BS (4-year) in Biochemistry 21
4. Details of Courses for BE/BS Biochemistry. 24

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. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. 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 after every three years 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 international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

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 (www.hec.gov.pk).

(Fida Hussain)
Director General (Academics)
Abbreviations Used:
CRC.   Curriculum Revision Committee
VCC.   Vice Chancellor’s Committee
EXP.   Experts
COL.   Colleges
UNI.   Universities
PREP.  Preparation
REC.   Recommendations
MINUTES OF THE FINAL MEETING OF HEC NATIONAL CURRICULUM
REVISION COMMITTEE ON BIOCHEMISTRY HELD AT HEC REGIONAL
CENTRE, PESHAWAR FROM FEBRUARY 26th to 27th, 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:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name &amp; Institution</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dr. Muhammad Hassan Khaskeli&lt;br&gt;Professor,&lt;br&gt;Department of Biochemistry,&lt;br&gt;Shah Adbul Latif University,&lt;br&gt;Khairpur.</td>
<td>Convener</td>
</tr>
<tr>
<td>2.</td>
<td>Dr. Seyyedha Abbas&lt;br&gt;Associate Professor,&lt;br&gt;Department of Biochemistry &amp; Co-opted faculty in&lt;br&gt;Medical Education Department.&lt;br&gt;Foundation University Medical College&lt;br&gt;DHA 1 Jinnah Avenue,&lt;br&gt;Islamabad.</td>
<td>Secretary</td>
</tr>
<tr>
<td>3.</td>
<td>Prof. Dr. M. Kamran Azim&lt;br&gt;Dean / Professor,&lt;br&gt;Faculty of Life Science,&lt;br&gt;Mohammad Ali Jinnah University,&lt;br&gt;22-E, Block-6, PECHS,&lt;br&gt;Karachi.</td>
<td>Member</td>
</tr>
<tr>
<td>4.</td>
<td>Prof. Dr. Saeeda Baig&lt;br&gt;HoD / Professor,&lt;br&gt;Department of Biochemistry,&lt;br&gt;Ziauddin University, 4/B, Shahrah-e-Ghalib,&lt;br&gt;Block-06, Clifton,&lt;br&gt;Karachi.</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td>Name and Title</td>
<td>Institution</td>
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<tr>
<td>5</td>
<td>Prof. Dr. Muhammad Asgher</td>
<td>Professor of Biochemistry, Dean Faculty of Sciences, University of Agriculture, Faisalabad.</td>
</tr>
<tr>
<td>6</td>
<td>Prof. Dr. Nakhshab Choudhry</td>
<td>Professor, Department of Biochemistry, King Edward Medical University, Nila Gumbad, Lahore.</td>
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<tr>
<td>7</td>
<td>Dr. Muhammad Ansar</td>
<td>Professor, Faculty of Biological Sciences, Department of Biochemistry, Quaid-i-Azam University, Islamabad.</td>
</tr>
<tr>
<td>8</td>
<td>Prof. Dr. Muhammad Zahid Qureshi</td>
<td>Professor, Department of Chemistry, GC University, Lahore.</td>
</tr>
<tr>
<td>9</td>
<td>Prof. Dr. Naheed Qadir</td>
<td>Professor, Department of Biochemistry, People University of Medical &amp; Health Sciences, Shaheed Benazirabad, Nawabshah.</td>
</tr>
<tr>
<td>10</td>
<td>Prof. Dr. Wasim Shehzad</td>
<td>Director, Institute of Biochemistry &amp; Biotechnology, University of Veterinary &amp; Animal Sciences, Out fall Road, Lahore.</td>
</tr>
<tr>
<td>11</td>
<td>Dr. Sumbul Khalid</td>
<td>Associate Professor, Department of Bioinformatics &amp; Biotechnology, Room # 13, Hazrat Maryam Block, Female Campus, International Islamic University, Islamabad.</td>
</tr>
<tr>
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<td>12.</td>
<td>Dr. Ghazala Kaukab Raja</td>
<td>Associate Professor / Director</td>
</tr>
<tr>
<td>13.</td>
<td>Dr. Muhammad Ayub</td>
<td>Associate Professor / Director</td>
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<tr>
<td>14.</td>
<td>Dr. Darakhshan Mehboob Saleem</td>
<td>Associate Professor</td>
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<tr>
<td>15.</td>
<td>Dr. Tahir Mehmood</td>
<td>Head of Biochemistry Section</td>
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<tr>
<td>16.</td>
<td>Dr. Sajjad Ali</td>
<td>Assistant Professor / HoD</td>
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<td>17.</td>
<td>Dr. Faheem Tahir</td>
<td>Chief Scientific Officer</td>
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<td>18.</td>
<td>Dr. Nouman Rasool</td>
<td>Assistant Professor</td>
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<td>19.</td>
<td>Dr. Dilawar Khan</td>
<td>Assistant Professor</td>
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<tr>
<td>20.</td>
<td>Dr. Salma Shahid</td>
<td>Assistant Professor</td>
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<tr>
<td>21.</td>
<td>Dr. Hooria Younas</td>
<td>Assistant Professor</td>
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<td>22.</td>
<td>Dr. Muhammad Ateeq</td>
<td>Assistant Professor</td>
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<td>23.</td>
<td>Dr. Abdul Aziz</td>
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<td>Dr. Naeem Khan</td>
<td>Assistant Professor</td>
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<tr>
<td>25.</td>
<td>Dr. Aisha Siddiqua</td>
<td>Assistant Professor</td>
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</table>
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

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

### Compulsory Courses (student has no choice)

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<td>English I</td>
<td>3+0</td>
<td>Social Science</td>
<td>3+0</td>
</tr>
<tr>
<td>English II</td>
<td>3+0</td>
<td>Marketing &amp; Management</td>
<td>3+0</td>
</tr>
<tr>
<td>English III (Writing &amp; Comm)</td>
<td>3+0</td>
<td>Organic Chemistry</td>
<td>2+1</td>
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<tr>
<td>English IV/University optional</td>
<td>3+0</td>
<td>Inorganic Chemistry</td>
<td>2+1</td>
</tr>
<tr>
<td>Pakistan studies</td>
<td>2+0</td>
<td>Physical Chemistry</td>
<td>2+1</td>
</tr>
<tr>
<td>Islamic studies/Ethics</td>
<td>2+0</td>
<td>Analytical Chemistry</td>
<td>2+1</td>
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<tr>
<td>Mathematics I</td>
<td>3+0</td>
<td>Genetics</td>
<td>2+1</td>
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<tr>
<td>Mathematics II/Biostatistics*</td>
<td>3+0</td>
<td>Microbiology</td>
<td>3+0</td>
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<tr>
<td>Intro. to Computer Science</td>
<td>3+0</td>
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### General Courses (to be chosen from other Departments)

<table>
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<th>Subject</th>
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<tbody>
<tr>
<td>Social Science</td>
<td>3+0</td>
<td>Marketing &amp; Management</td>
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<tr>
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<td>3+0</td>
<td>Organic Chemistry</td>
<td>2+1</td>
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<td>Organic Chemistry</td>
<td>2+1</td>
<td>Analytical Chemistry</td>
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<td>Genetics</td>
<td>2+1</td>
<td>Microbiology</td>
<td>3+0</td>
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### Discipline-Specific Foundation Courses

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<th>Subject</th>
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<th>Subject</th>
<th>Cr hr</th>
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<tr>
<td>Introductory Biochemistry</td>
<td>2+1</td>
<td>Biosafety &amp; Ethics</td>
<td>2+1</td>
<td>Elective-I</td>
<td>3+0</td>
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<tr>
<td>Carbohydrates &amp; Lipids</td>
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<td>Plant Biochemistry</td>
<td>2+1</td>
<td>Elective-II</td>
<td>3+0</td>
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<tr>
<td>Amino Acids &amp; Proteins</td>
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<td>Clinical Biochemistry</td>
<td>2+1</td>
<td>Elective-III</td>
<td>3+0</td>
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<tr>
<td>Human Physiology</td>
<td>3+0</td>
<td>Research Planning &amp; Scientific Writing</td>
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### Elective Courses within the Major

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**Note**: Elective courses are to be chosen from the given list. OR Any other course depending upon the expertise available.

**TOTAL CREDIT HOURS = 136**

*NCRC RECOMMENDATIONS*
# Semester-Wise Scheme of Studies for BS (4 Year) in Biochemistry

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DETAIL OF GENERAL COURSES

Organic Chemistry

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<tr>
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<td>Practical = 1.0</td>
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<tr>
<td>Total = 64</td>
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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:**

<table>
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<th>Theory</th>
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<tr>
<td>• Written (Long Questions, Short Questions, MCQs)</td>
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<td>• Project/case study/Presentation</td>
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<td>• Assignments</td>
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<td>• Tests/Quiz</td>
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<tr>
<td>Final Term (60%)</td>
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<td>• Written (Long Questions, Short Questions, MCQs)</td>
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<tbody>
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<td>• Written</td>
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<tr>
<td>• Practical performance</td>
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<td>• Note book and Viva</td>
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**Recommended Books:**

**Inorganic Chemistry**

<table>
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<th>Credit Hours:</th>
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<tbody>
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<tr>
<td>Practical     = 32</td>
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<tr>
<td>Total         = 64</td>
<td>Total        = 3.0</td>
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</table>

**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-halogen, pseudo-halogen 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:**

<table>
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<tr>
<th>Theory</th>
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</thead>
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**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)

<table>
<thead>
<tr>
<th>Practical</th>
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</table>

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**


**Physical Chemistry**

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<td>Practical = 1.0</td>
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<td>Total = 64</td>
<td>Total = 3.0</td>
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</table>
**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:
Analytical Chemistry

Contact Hours: Credit Hours:
Theory = 32 Theory = 2.0
Practical = 32 Practical = 1.0
Total = 64 Total = 3.0

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 KMnO$_4$ and K$_2$Cr$_2$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
Recommended Books:

Microbiology

Contact Hours: Credit Hours:
Theory = 32 Theory = 2.0
Practical = 32 Practical = 1.0
Total = 64 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
Recommended Books:


Genetics

<table>
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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:**

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<td>Final Term (60%)</td>
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**Recommended Books:**

2. Modern Genetics by Ayala & Kiger. The Benjamin Cummings, Co. Inc. California, USA
5. Genomes 3 by T. S. Brown: Garland Science; New York
6. Human Molecular Genetics 3 by Tom Strachan and Addrew P. Read: Garland Science; New York
DETAIL OF DISCIPLINE-SPECIFIC FOUNDATION COURSES

Introductory Biochemistry

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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:

CARBOHYDERATES AND LIPIDS

Contact Hours:                   Credit Hours:
Theory  = 32                    Theory  = 2.0
Practical = 32                   Practical = 1.0
Total   = 64                     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 Oligosaccharides 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 tests
• 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

Assessment:
Theory 70%
Mid Term (40%)
PROTEINS AND NUCLEIC ACIDS

Contact Hours: Credit Hours:
Theory = 32 Theory = 2.0
Practical = 32 Practical = 1.0
Total = 64 Total = 3.0

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.
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:**

HUMAN PHYSIOLOGY

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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.
- 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

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
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:
   Pearson
   C.W., John Wiley and Sons, New York.
Enzymology

Contact Hours:  
Theory = 32  
Practical = 16  
Total = 48

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

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**

- 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**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**


**Molecular Biology**

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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:


Metabolism I

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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 biosynthetic 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
• β-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, Thrombaxanes 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:
Contact Hours:  Credit Hours:
Theory = 48  Theory = 3.0
Practical = 0  Practical = 0
Total = 48  Total = 3.0

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, transmethylation, transpeptidation and decarboxylation
- Amino acid degradation and urea cycle
- Inborn errors of metabolism
- Nitrogen balance
- Biosynthesis of non-essential amino acids
- Major pathways and strategies of energy metabolism: Organ specialization: Brain, Muscle, Adipose tissue 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 acidura
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:

DETAIL OF MAJOR COURSES

CELL BIOLOGY

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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:


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**Biosafety and Bioethics**

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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:

Bioinformatics

Contact Hours:  Credit Hours:
Theory = 32  Theory = 2.0
Practical = 32  Practical = 1.0
Total = 64  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.
o Phylogenetic Analysis.
o Computational Approaches in Comparative Genomics.
o Proteomics and Protein Identification.
o Molecular modeling and visualization.
o Protein Structure Prediction and Analysis.
o 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:

**Immunology**

<table>
<thead>
<tr>
<th>Contact Hours:</th>
<th>Credit Hours:</th>
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<tr>
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<tr>
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</tbody>
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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:

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:**

**METHODS IN MOLECULAR BIOLOGY**

<table>
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<tbody>
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<td>Total = 80</td>
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</table>

**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:**


**BIOCHEMICAL TECHNIQUES**

<table>
<thead>
<tr>
<th><strong>Contact Hours:</strong></th>
<th><strong>Credit Hours:</strong></th>
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<tbody>
<tr>
<td>Theory = 16</td>
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<td>Total = 80</td>
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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:**

<table>
<thead>
<tr>
<th>Theory</th>
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<tr>
<td>Mid Term (40%)</td>
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</table>
• 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

**Clinical Biochemistry**

<table>
<thead>
<tr>
<th>Contact Hours:</th>
<th>Credit Hours:</th>
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<tr>
<td>Theory = 16</td>
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<tr>
<td>Total = 80</td>
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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)

Immunoglobin 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:**


**Environmental Biochemistry**

<table>
<thead>
<tr>
<th>Contact Hours:</th>
<th>Credit Hours:</th>
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<tbody>
<tr>
<td>Theory = 32</td>
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<tr>
<td>Practical = 32</td>
<td>Practical = 1.0</td>
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</table>
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:**

7. An Air That Kills Andrew Schneider and David McCumber Berkley Publishing (Penguin Group) January 2005

**PLANT BIOCHEMISTRY**

<table>
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<tr>
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<tr>
<td>Total</td>
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**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
- CO2 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:**

<table>
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<tr>
<th>Theory</th>
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**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:**


3. Plant Biochemistry by T. Wood & Mercer

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**BIOENERGETICS**

**Contact Hours:**

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<thead>
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<th>Theory</th>
<th>Total</th>
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<tbody>
<tr>
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**Credit Hours:**

<table>
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<tr>
<td>3.0</td>
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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**

**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**

- Written
- Practical performance
- Note book and Viva

**Recommended Books:**

Biomembranes and Cell Signaling

Contact Hours:

<table>
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<tbody>
<tr>
<td>Practical</td>
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Credit Hours:

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<tr>
<td>Total</td>
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</table>

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-κB;
- 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:**

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**Nutritional Biochemistry**

<table>
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<th>Contact Hours:</th>
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<tr>
<td>Theory = 32</td>
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<tr>
<td>Practical = 32</td>
<td>Practical = 1.0</td>
</tr>
<tr>
<td>Total = 64</td>
<td>Total = 3.0</td>
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</table>

**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:


RESEARCH PLANNING & SCIENTIFIC WRITING

Contact Hours: 
- Theory = 48
- Total = 48

Credit Hours: 
- Theory = 3.0
- Total = 3.0

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

Learning Outcome:

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

CURRENT TRENDS IN BIOCHEMISTRY

Contact Hours:                                Credit Hours:
Theory    = 48                                Theory    = 3.0
Practical = 0                                 Practical = 0.0
Total      = 48                                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:                                Credit Hours:

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:
3. Introduction to Cane Sugar Technology. by G.H. Jenkins Elsevier
4. British pharmacopoeia.
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:  Credit Hours:
Theory    = 48       Theory    = 2.0
Practical = 0        Practical = 0.0
Total     = 48       Total     = 3.0

Course Objective:
The specific objects are as follows:

- 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:**

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**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:**

**GENOMICS**

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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:**

**PROTEOMICS**

**Contact Hours:**

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**Credit Hours:**

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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:

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Recommended Books:

GENERAL ViroLOGY

Contact Hours:                                      Credit Hours:
Theory   =48                                      Theory   = 3.0
Practical = 0                                    Practical = 0
Total     = 48                                    Total     = 3.0
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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-adoeno and poxviruses, Nanoviruses,
- Miscellaneous viruses.

**Teaching Methodology:**
- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

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**Recommended Books:**


**CELL AND TISSUE CULTURE**

| Contact Hours: | Credit Hours: |
Theory = 48
Practical = 0
Total = 48

Theory = 3.0
Practical = 0
Total = 3.0

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
Recommended Books:

PHARMACOLOGY

Contact Hours: 

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Credit Hours: 

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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.
• 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:**

9. Prof Dr A Qayum, Fundamentals of Experimental Pharmacology.

ANTIMICROBIALS AND CHEMOTHERAPEUTICS

Contact Hours: 

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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 (β-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:**


**FUNCTIONAL GENOMICS**

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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:**


**STRUCTURAL BIOLOGY**

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**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, metaloproteins, 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:


DRUG DEVELOPMENT

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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:**

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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

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**FERMENTATION BIOTECHNOLOGY**

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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:


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**NEUROCHEMISTRY**

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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, Schiziphrenia, Epilepsy, Other psychiatric disorders including Dyskinesia, Myelin diseases, Multiple Sclerosis, Parkinsons disease, Myasthenia Gravis.

**Teaching Methodology:**
- Lecturing
- Written Assignments
- Class activities and discussion

**Assessment:**

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<tr>
<th>Theory</th>
<th>100%</th>
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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:**


**TOXICOLOGY**

<table>
<thead>
<tr>
<th>Contact Hours:</th>
<th>Credit Hours:</th>
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<tr>
<td>Theory = 48</td>
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<td>Total = 48</td>
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</table>

**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, toxico kinetics and toxico dynamics 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, Propose 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:

**Biodiversity**

<table>
<thead>
<tr>
<th>Contact Hours:</th>
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<tr>
<td>Theory = 36</td>
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<td>Total = 36</td>
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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:


Water and Mineral Metabolism

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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:**

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**Recommended Books:**

COMPULSORY COURSES
BS (4 YEARS) IN BASIC & SOCIAL SCIENCES

English I (Functional English)

Contact Hours:  Credit Hours:
Theory = 48  Theory = 3.0
Practical = 0  Practical = 0
Total = 48  Total = 3.0

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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

103
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:

**ENGLISH II** (Communication Skills)

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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:

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Recommended Books:

5. Reading and Study Skills by John Langan

ENGLISH III (Technical Writing and Presentation Skills)

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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:
PAKISTAN STUDIES

Contact Hours: 

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Credit Hours: 

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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)
Recommended Books:


**ISLAMIC STUDIES**

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**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,”
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:


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:**


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

**Course Objective:**

**Learning Outcome:**

**Course Outline:**

**Unit 1. What is Statistics?**

**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, Historigram, 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

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

Unit 11. Regression and Correlation

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:


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.