HEC CURRICULUM DIVISION

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Director General (Academics)
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Composed by Mr. Zulfiqar Ali, HEC Islamabad
CONTENTS

1. Introduction 7
2. Scheme of Studies for MS (2-year) in Biochemistry 22
3. Details of Courses MS (2-Year) in Biochemistry 23

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).
(Muhammad Raza Chohan)
Director General (Academics)
CURRICULUM DEVELOPMENT PROCESS

STAGE-I

STAGE-II

STAGE-III

STAGE-IV

CURRI. UNDER

CURRI. IN DRAFT STAGE

FINAL STAGE

FOLLOW UP STUDY

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APPRaisal Of 1st DRAFT BY EXP. OF COL./UNIV

PREP. OF FINAL CURRI.

QUESTIONNAIRE

CONS. OF CRC.

FINALIZATION OF DRAFT BY CRC

INCORPORATION OF REC. OF V.C.C.

COMMENTS

PREP. OF DRAFT BY

APPROVAL OF CURRI. BY

PRINTING OF CURRI.

REVIEW

FOREST. OF CURRI.

IMPLE. OF CURRI.

BACK TO STAGE-I

ORIENTATION COURSES

Abbreviations Used:
CRC. Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
CURRICULUM DEVELOPMENT CYCLE

1. Nominations from all Stakeholders
2. Selection of Relevant Members
3. Formulation of NCRC
4. Preliminary Meeting/ Preparation of Draft
5. Circulation of Draft for feedback (Local/Foreign)
6. Convening of Final NCRC
7. Composing/ Printing
8. Dissemination (Website/ Hard copies)
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>
</table>
| 1.    | Dr. Muhammad Hassan Khaskeli  
Professor,  
Department of Biochemistry,  
Shah Abdul Latif University,  
Khairpur. | Convener |
| 2.    | Dr. Seyyedha Abbas  
Associate Professor,  
Department of Biochemistry & Co-opted faculty in  
Medical Education Department.  
Foundation University Medical College  
DHA 1 Jinnah Avenue,  
Islamabad. | Secretary |
| 3.    | Prof. Dr. M. Kamran Azim  
Dean / Professor,  
Faculty of Life Science,  
Mohammad Ali Jinnah University,  
22-E, Block-6, PECHS,  
Karachi. | Member |
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<tr>
<th></th>
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<tr>
<td>4</td>
<td><strong>Prof. Dr. Saeeda Baig</strong></td>
<td>HoD / Professor, Department of Biochemistry, Ziauddin University, 4/B, Shahrah-e-Ghalib, Block-06, Clifton, Karachi.</td>
<td>Member</td>
</tr>
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<td>5</td>
<td><strong>Prof. Dr. Muhammad Asgher</strong></td>
<td>Professor of Biochemistry, Dean Faculty of Sciences, University of Agriculture, Faisalabad.</td>
<td>Member</td>
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<td>6</td>
<td><strong>Prof. Dr. Nakhshab Choudhry</strong></td>
<td>Professor, Department of Biochemistry, King Edward Medical University, Nila Gumbad, Lahore.</td>
<td>Member</td>
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<td>7</td>
<td><strong>Dr. Muhammad Ansar</strong></td>
<td>Professor, Faculty of Biological Sciences, Department of Biochemistry, Quaid-i-Azam University, Islamabad.</td>
<td>Member</td>
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<td>8</td>
<td><strong>Prof. Dr. Muhammad Zahid Qureshi</strong></td>
<td>Professor, Department of Chemistry, GC University, Lahore.</td>
<td>Member</td>
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<td>9</td>
<td><strong>Prof. Dr. Naheed Qadir</strong></td>
<td>Professor, Department of Biochemistry, People University of Medical &amp; Health Sciences, Shaheed Benazirabad, Nawabshah.</td>
<td>Member</td>
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<td>10</td>
<td>Prof. Dr. Wasim Shehzad</td>
<td>Member, Director, Institute of Biochemistry &amp; Biotechnology, University of Veterinary &amp; Animal Sciences, Out fall Road, Lahore.</td>
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<tr>
<td>11</td>
<td>Dr. Sumbul Khalid</td>
<td>Member, Associate Professor, Department of Bioinformatics &amp; Biotechnology, Room # 13, Hazrat Maryam Block, Female Campus, International Islamic University, Islamabad.</td>
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<tr>
<td>12</td>
<td>Dr. Ghazala Kaukab Raja</td>
<td>Member, Associate Professor / Director, University Institute of Biochemistry &amp; Biotechnology, PMAS Arid Agriculture University, Murree Road, Rawalpindi.</td>
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<td>13</td>
<td>Dr. Muhammad Ayub</td>
<td>Member, Associate Professor / Director, Institute of Biochemistry, University of Baluchistan, Quetta.</td>
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<td>14</td>
<td>Dr. Darakhshan Mehboob Saleem</td>
<td>Member, Associate Professor, Department of Biomedical Engineering, Sir Syed University of Engineering &amp; Technology, University Road, Karachi.</td>
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<td>15</td>
<td>Dr. Tahir Mehmood</td>
<td>Member, Head of Biochemistry Section, Department of Chemistry, University of Sargodha, Sargodha.</td>
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<td>16</td>
<td>Dr. Sajjad Ali</td>
<td>Assistant Professor /HoD, Department of Chemistry, Room # 323, Food Technology Building, Karakoram International University, Gilgit.</td>
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<td>17</td>
<td>Dr. Faheem Tahir</td>
<td>Chief Scientific Officer, Public Health Laboratories Division, National Institute of Health, Park Road, Chak Shahzad, Islamabad.</td>
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<td>18</td>
<td>Dr. Nouman Rasool</td>
<td>Assistant Professor, Department of Life Sciences, University of Management &amp; Technology, C-II, Johar Town, Lahore.</td>
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<td>Member</td>
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<tr>
<td>19</td>
<td>Dr. Dilawar Khan</td>
<td>Assistant Professor, Atta-ur-Rahman School of Applied Biosciences (ASAB), Department of Healthcare Biotechnology, NUST, H-12, Islamabad.</td>
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<tr>
<td>20</td>
<td>Dr. Salma Shahid</td>
<td>Assistant Professor, Faculty of Science &amp; Technology, Department of Biochemistry, Government College Women University, Faisalabad.</td>
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<td>Member</td>
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<tr>
<td>21</td>
<td>Dr. Hooria Younas</td>
<td>Assistant Professor, Department of Biochemistry, Kinnaird College for Women, 93-Jail Road, Lahore.</td>
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<td>22.</td>
<td>Dr. Muhammad Ateeq</td>
<td>Assistant Professor, Department of Chemistry, Sarhad University of Science &amp; Information Tech, Peshawar.</td>
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<tr>
<td>23.</td>
<td>Dr. Abdul Aziz</td>
<td>Assistant Professor, Department of Computer Science &amp; Bioinformatics, Khushal Khan Khattak University, Karak, KPK.</td>
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<td>24.</td>
<td>Dr. Naeem Khan</td>
<td>Assistant Professor, Department of Chemistry, Kohat University of Science &amp; Technology, Kohat.</td>
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<tr>
<td>25.</td>
<td>Dr. Aisha Siddiqua</td>
<td>Assistant Professor, Center of Biochemistry &amp; Biotechnology, Gomal University, Dera Ismail Khan, KPK.</td>
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<tr>
<td>26.</td>
<td>Dr. Asma Saeed</td>
<td>Assistant Professor, Department of Biological Sciences, Gomal University, Dera Ismail Khan, KPK.</td>
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<tr>
<td>27.</td>
<td>Dr. Muhammad Shahzad</td>
<td>Assistant Professor, Department of Biochemistry, IBMS, Khyber Medical University, Block-IV, PDA Building, Phase-V, Peshawar.</td>
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<td>28.</td>
<td>Dr. Umer Rashid</td>
<td>Assistant Professor, University of Gujrat, Gujrat.</td>
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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.
SCHEME OF STUDIES (2-Year)
MS/MPhil-BIOCHEMISTRY

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Department may offer core/elective courses from the given list (but not limited to) according to the availability of resources.
LIST OF MS/MPhil Biochemistry Courses

1. Advances in Molecular Genetics
2. Advances in Biochemistry
3. Advances in Clinical Biochemistry
4. Advances in Molecular Biology
5. Advances in Endocrinology
6. Advances in Biotechnology
7. Advanced Biostatistics
8. Advanced Bioinformatics
9. Recent Trends in Immunology
10. Advanced Fermentation Biotechnology
11. Community Nutrition
12. Protein Structure, Function and Engineering
13. Enzymes - Mechanism & Kinetics
14. Advances in Cell Biology
15. DNA Techniques and Clinical Applications
16. Good Laboratory Practices and Quality Control
17. Signal Transduction
18. Biochemistry of Metabolic Disorders
19. Biochemistry of Natural Products
20. Recombinant DNA Technology
21. Research Methodology
22. Advanced Biochemical Techniques
23. Genomics, Proteomics and Metabolomics
24. Gene Expression and Regulation
25. Food Biochemistry
26. Renewable bioenergy Resources
27. Molecular Mechanism of Diseases
28. Molecular Evolution
29. Seminar
30. Special Problem/ Specific assignment
31. Drug Designing and Metabolism
32. Forensic Serology and DNA Analysis
33. Application of Nanomaterials in Biosciences
34. Stem Cell and Therapeutics
35. Neuroscience
36. Structural Bioinformatics
37. Plant Genomics
38. Biochemistry of Drugs and their Resistance

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

Contact Hours: Credit Hours:
Theory = 48 Theory = 3.0
Practical = 00 Practical = 0.0
Total = 48 Total = 3.0

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

Learning Outcome:
After completing this course students should be able to;
- Understand the role of genetics to address various problems
- Liaison between classical and modern genetics

Course Outline:
- Genes in Pedigrees.
- Organization of the human genome:
- The limited autonomy of the mitochondrial genome,
- Human gene Expression,
  - Pseudogenes and genes fragments,
  - Transposition through an RNA intermediate.
  - Human Genome Expression.
  - Instability of the human genome: mutations.
  - Physical and transcript mapping: the importance of sequence tagged sites.
  - Identifying human and animal disease genes.
- Molecular pathology.
- Genetic testing in individuals and population.
- Cancer Genetics.
- Complex Disease theories and results.
- Genetic manipulation of animals.
- General gene therapy strategies.
- Treatment using conventional animals or human products.

Teaching Methodology
- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities
Assessment  
Theory  
100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:

Advances in Biochemistry

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

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

--------------------------------------------------------------------------------------

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

Learning Outcome:
After completing this course students should be able to:
- Liaison between classical and advances biochemistry.

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

Teaching Methodology
- Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

Advances in Clinical Biochemistry

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<td>Total = 64</td>
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</table>

Course Objective:
• This course will provide advanced concepts in clinical biochemistry
• The practical component will cover advanced techniques for clinical diagnosis.

**Learning Outcome:**
After completing this course, students should be able to;
• Discuss and explain the pathophysiology and biochemistry associated with diagnostic tests performed in clinical biochemistry laboratories
• Understand the significance of quality assurance and quality control in diagnostic procedures
• Have the necessary skills to promote the significance of clinical diagnosis in treatment strategies

**Course Outline:**
• Biochemical investigation and quality control
• Use, acquisition and interpretation of biochemical data in clinical medicine
• Use of chemistry analyzer in clinical diagnostics
• Fluid and electrolyte disorders
• Acid-base disorders
• Disorders of calcium, magnesium and phosphorus
• Renal disorders: Proteinuria, Renal tubular disorders and renal calculi
• Hepatic disorders: Acute and chronic liver disease
• Clinical enzymology and biomarkers
• Abnormalities of lipid metabolism
• Thyroid diseases
• Diabetes mellitus
• Reproduction endocrinology
• Biochemical nutrition
• Specific protein markers
• Cancer biochemistry and tumour markers
• Use of isotopes in medical diagnosis
• Autoimmune and immunodeficiency disorders
• Literature / leaflet review of concerned practical and instruments

**PRACTICAL:**

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

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

Assessment
Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%
Recommended Books:


Advances in Molecular Biology

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Course Objective:
- To impart advance knowledge of life processes at molecular level
- To motivate students for using advanced molecular biology techniques
- To understand the theory behind the new technologies

Learning Outcome:
Upon successful completion of the course, the student will be able to:
1. **Describe** cell to cell adhesion and cell to cell communications
2. **Describe and Discuss** transcription and post transcriptional modifications leading to synthesis of proteins.
3. **Perform** the following wet laboratory techniques

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

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:
1. Review articles

Advances in Endocrinology

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

Course Objective:
• To understand the pathways for the release and control of different hormones
• To update the students with current developments in the field of endocrinology

Learning Outcome:
After completing this course, students should be able to:
• Explain the latest achievements related to endocrinology
• Comprehend the possibilities to target endocrinology against metabolic diseases like obesity, diabetes, etc.

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

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

Assessment
Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:

Advances in Biotechnology

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

Learning Outcome:
Upon successful completion of the course, students will be able to:
- Understand principles and applications of various aspects of biotechnology
- Critically appraise recent research areas in the field of biotechnology
- Recognize and evaluate the methods and applications of biotechnology in animal, plants and biomedical sciences

Course Outline:
Scope and Current applications of Biotechnology
Gene Technology, Genomics and the Human Genome Project
Gene editing, animal cloning, transgenesis, and gene therapy
- Microbial Metabolism
- Fermentation, Biosynthesis of Metabolites, Primary and Secondary metabolites
- Biotechnological Process
- Upstream and Downstream processing
- Industrial Applications of Fermentation Products
  - Pharmaceutical Industry
  - Antibiotics
  - Vitamins
  - Food/Textiles/Pulp/Detergent Industry
  - Amino Acids
  - Enzymes
- Intellectual Property Rights in Biotechnology
  - Patents
  - Patentable subject matter
  - The novelty requirement

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

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

Advanced Biostatistics

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Course Objective:
• To design Biological trials
• To address major issues in the design of a study
• To use latest statistical tools

**Learning Outcome:**
After completing this course students should be able to;
• Handle their data sets independently
• Evaluate and optimize experiments based on statistical analysis performed
• Develop an awareness of Total Quality Management

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

**Teaching Methodology**
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

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

**Mid Term (40%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:
• Geoffery, R. Norman, David L. Streiner BIOSTATISTICS: THE BARE ESSENTIALS. 2000. B.C. DeckelInc
• Gerry, P. Quinn, Micheal J. Kenough, EXPERIMENTAL DESIGN AND DATA ANYSIS FOR BIOLOGISTS. 2002. Cambridge University Press.

Advanced Bioinformatics

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

Learning Outcome:
At the end of the course, the students would be able to:
• Search databases accessible on the internet for literature relating to molecular biology and biotechnology
• Manipulate DNA and protein sequences using stand-alone PC programs and Webservers
• Find homologues, analyse sequences, construct and interpret evolutionary trees
• Analyse protein sequences, identify proteins, and retrieve protein structures from databases.
• Understand structure determination, homology modelling and computational drug design.
• Process biological data, interpret and model biological information and apply this to the solution of biological problems in any arena involving molecular data.

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

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

**Recent trends in immunology**

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<th>Credit Hours:</th>
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**Course Objective:**
- To acquaint students with the principle and working of immune system
- To equip students with recent developments and research in immunology
- To enable students to identify challenges related to autoimmune diseases

**Learning Outcome:**
After completing this course students should be able to;
- Understand recent challenges in the field of immunology
- Describe the principles involved in the immune response

**Course Outline:**
- Overview and elements of the immune system
- Cells and Organs of the Immune System
- Immunogens & Antigens
- Antibody Structure and Function
- Complement System
- Genetic Basis of Ab Structure
- Role of Major Histocompatibility Complex (MHC) in the Immune Response
- The T Cell Receptor: Structure and Genetic Basis
- Adaptive Immune Response
• Antigen-Antibody Interactions - ImmunoAssays
• Antibody and Cell-Mediated Reactions
• Immunology of HIV Infection
• Infection and Immunity
• Immunopathology, Immune Regulation & Tolerance
• Autoimmunity
• Clinical Scenarios
• Transplantation
• Immunoprophylaxis (Vaccines)
• Disorders of the Immune Response
• Immunology of Cancer
• Modern Antibody Therapy

Practicals:

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

Teaching Methodology

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

Assessment

Theory 100%

Mid Term (40%)

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

Final Term (60%)

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


Advanced Fermentation Biotechnology

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Course Objective:
The course has been designed to provide:
- Provide comprehensive knowledge about advanced techniques involved in industrial fermentation processes and their control
- All aspects of physiology and biochemistry of microorganisms during fermentation process
- Technical skills to development economic production processes for different industrial products

Learning Outcome:
After studying this course, the students are expected to:
- Isolate, characterize Select microbial strains for different fermentation processes
- Develop efficient and optimum fermentation processes for different products
- Scale up the fermentation processes from lab scale to industrial fermentors

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

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

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment

Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:
Community Nutrition

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Course Objective:
Students completing this course will have a broader understanding of
- Fundamental concepts in community nutrition.
- Nutrition problems on population level and identification of groups at risk for malnutrition.
- Local, national and international community nutrition assistance programs and their analysis
- The practical component will impart basic laboratory skills.

Learning Outcome:
Upon successful completion of this course, the students should be able to;
- Demonstrate understanding of community nutrition practices
- Carry out community nutritional assessment.
- Demonstrate understanding of culture, religion, beliefs, values and behaviors on community nutrition status.
- Collect, analyze and critically evaluate data on nutrition problems in communities.
- Manage time and demonstrate skills in written and oral communication.

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

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

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

Assessment
Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:

Protein Structure, Functions and Engineering

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

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

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

Learning Outcome:

After studying this course, the students will be able to:
• Utilize the knowledge of proteins physical properties to develop strategies for purification and/or analysis
  • Design strategies for identifying protein-protein or protein-small molecule interactions
  • Analyze the purity and stability of proteins for efficient storage
  • Design proteomic approaches to the study of proteins
  • Design experimental approaches to protein engineering and expression

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

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%


- Tests/Quiz 10%

**Recommended Books:**

1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.

**Enzymes- Kinetics and Mechanisms**

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**Course Objective:**

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

**Learning Outcome:**

After completing this course students should be able to:

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

**Course Outline:**

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

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

Teaching Methodology

Assessment

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<td>Mid Term (40%)</td>
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  - Project/case study/Presentation 20%
  - Assignments 20%
  - Tests/Quiz 10%
| Final Term (60%) | 50% |
  - Written (Long Questions, Short Questions, MCQs) 50% |
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:
2. Lab Manual in Biochemistry, Immunology and Biotechnology,
   Company Limited, New Delhi.
   NY, USA.
   Publishers, New York, NY, USA.
   Worth Publishers, New York, NY, USA.

Advances in Cell Biology

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

Credit Hours: 
Theory = 3.0
Practical = 0.0
Total = 3.0

Course Objective:
• To provide knowledge about the recent developments in cell biology.

Learning Outcome:

Upon successful completion of the course, the student will be able to:
• Acquire latest knowledge of recent developments in cell biology.
• Ability to understand and analyze research data published in journals on cell biology.

Course Outline:
• Introduction of recent developments in cell biology
• Articles published in peer reviewed journals will be discussed

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities
Assessment

Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:
1. Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. Molecular Cell Biology (2016 edition).

DNA Techniques and Clinical Applications

<table>
<thead>
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<tbody>
<tr>
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<tr>
<td>Total = 64</td>
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Course Objective:
- To learn major advanced clinical research techniques employed in the diagnosis of various diseases
- To develop and enhance practical skills in the postgraduate students for the revolutionary progress in human genomics

Learning Outcome:

Upon successful completion of the course, the student will be able to:
- Understand the theory behind the new technologies related to different areas of biology and how to apply of these technologies to a specific research question.
- Have a clear concept of the primary characteristics of application of quantitative and qualitative research in basic sciences to clinical practice.
• Understand the application of antenatal techniques for the diagnosis and prediction of diseases in the unborn.

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

**Teaching Methodology**
- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**

**Theory** 100%

**Mid Term (40%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommendation Books:**
1. Molecular Biology Techniques: An Intensive Laboratory Course by Walt Ream (Author), Katharine G. Field (Author)

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

Contact Hours: 
Theory = 48 
Practical = 00 
Total = 48

Credit Hours: 
Theory = 3.0 
Practical = 0.0 
Total = 3.0

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

Learning Outcome:
After completing this course, students should be able to:
- Understand the difference between quality control and quality assurance
- Acquire basic knowledge of laboratory design and management
- Understand pre and post analytical errors
- Technically defend scientific data by its quality and reliability using GLP
- Apply the regulations and standards associated with GLP
- Understand consequences of non-compliance regulated laboratories.

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

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment

Theory  100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

1. Good Laboratory Practice: Nonclinical Laboratory Studies Concise Reference (2010) by Mindy J. Allport-Settle, Pharma Logica Inc, NC, USA

Biochemistry of Metabolic Disorders

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

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

Learning Outcome:
After completing this course students should be able to:
  b. Learn the underlying molecular basis of the metabolic disorders.
c. Relate the cause to the clinical characteristic of the disorder.
d. Understand how obesity is related to non-insulin dependent Diabetes Mellitus.
e. Correlate hypercholesterolemia to development of atherosclerosis.
f. Distinguish Insulin dependent and non-insulin dependent diabetes mellitus.

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

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

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

Assessment

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Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:


Contact Hours: 

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<td>Theory = 3.0</td>
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Biochemistry of Natural Products

Course Objective:
• To give deep insights of natural products biochemistry
• To extend basic knowledge about the metabolism of natural products

Learning Outcome:
Scholars completing this course will be able to;
• Understand the deeper concepts of natural products biochemistry
• Explain the mechanistic pathways for metabolism of natural products
• Discuss the implication of natural products in biological pathways
• Discover the application of course in related fields

Course Outline:
• Introduction to natural products in biological system
• Common mechanisms in biological chemistry for metabolism of natural products
• Biosynthesis of lipids and their catabolic reactions
• Fatty acids, steroids and terpenoids biosynthesis
• Pathways involved in the biosynthesis fatty acids, steroids and terpenoids
• Biosynthesis of thromboxanes, leukotrienes, prostaglandins’ biosynthesis and their catabolic mechanism
• Carbohydrates transformation to different natural products
• Biosynthesis of secondary metabolites (alkaloids) using amino acids as starting material
• Synthesis of polyketides in biological systems
• Biosynthesis of some representative natural products; Penicillin, cephalosporins, erythromycin, morphine, coenzyme B₁₂ and tetrapyrrols

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

Recombinant DNA Technology

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<td>Practical = 00</td>
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</table>
Course Objective:
- To clarify creative use of modern tools and techniques for manipulation of genomic sequences
- To expose students to application of recombinant DNA technology in biotechnological research

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

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

Course Outline:

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

Teaching Methodology

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

Assessment

Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
• Tests/Quiz 10%

Recommended Books:
1. Principles of Gene Manipulation by Sandy Primose and Richard Twyman
2. A text book of Biotechnology by S. Chand
3. Gene Biotechnology by Shailendra Singh
5. An Introduction to Genetic Engineering by Dr. Desmond S. T. Nicholl

RESEARCH METHODOLOGY

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

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

Learning Outcome:
After completing this course students should be able to;
• Understand the concepts and identify the overall process of research design
• Select appropriate qualitative or quantitative method for data collection
• Write a research proposal suitable for submission to a research funding body
• Understand academic malpractice, including plagiarism, and how to avoid it

Course Outline:
• Introduction to Research
• Role of Research and Types of Research
• Epidemiological Studies, Basic Studies; Descriptive & Analytical Studies
• Research Methods, Samples and Population, Probability and Nonprobability Sampling Problems and Hypotheses
• Formulation of Research Hypotheses, Importance of Problems and Hypotheses
• Study Design
• Selection of Research Topic and Research Supervisor
• Variable; Independent & Dependent Variables
• Methods of Data Collection
• Review of Literature and Literature Citations
• Bibliography/ References, Research Ethics, Plagiarism and its Consequences
• Writing of Research Grant Application
Writing of Synopsis, Research Thesis, Writing of Manuscript and Research Report

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

Assessment

Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:

Advanced Biochemical Techniques

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<td>Total = 64</td>
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Course Objective:
- To provide information of principles & mechanism of different equipments and analysis of advance Biochemical techniques and Biological sampling
- To Provide students with a “snapshot” of a career in research
- To Improve problem solving and deductive reasoning skills
- Transition student’s knowledge to practical applications

Learning Outcome:
On successful completion of this course the students will be able to:
• Describe the principles behind a number of common biochemical techniques.
• Explain the strengths and weaknesses of a technique for particular applications.
• Combine different biochemical methods to address a complex biological question.
• Troubleshoot biochemical methods based on their scientific principles.
• Read, communicate and critically evaluate course-related scientific literature

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

Practicals:
• One dimensional electrophoresis
• Two-dimensional electrophoresis basic protocols
• DNA isolation
• Basic protocol PCR
• Protein blotting basic and alternate protocols
• Desalting
• Protein fractionation
• Determination of molecular size
• Spectrophotometric and colorimetric estimation of protein concentration.
• Immunization of mice
• Preparation of nuclear and cytoplasmic extracts from mammalian cells
• Staining techniques
• Chromosomes staining
• Preparation of standard curve and estimation of various Solutions
• Using A280 for protein estimation
• Fiber analysis
• Estimation of carbohydrate/ soluble and insoluble, cellulose, hemicellulose and lignin.
• Properties of peptides and protein and their implications for HPLC method development
• Detection and quantitation of radio-labelled proteins and DNA in gels and blots
Teaching Methodology

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

Assessment

Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
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- Tests/Quiz 10%

Recommended Books:

Genomics, Proteomics and Metabolomics

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

**Learning Outcome:**

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

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

**Course Outline:**

- Introduction to omics and genomics
- DNA Databases
- Genome Sequencing and Annotation, Next generation sequencing
- Human genome project, Genome Mapping and organization
- Gene Discovery - Expressed Sequencing Tags (ESTs)
- Chromosome walking
- Structural Variation in the Genomes
- Sequence polymorphisms in genomes and SNPs
- Techniques: microarrays, Serial analysis of gene expression (SAGE)
  - Proteomics: Introduction to Proteomics
  - Protein database
  - Proteomics technologies: 2D-gel electrophoresis, mass spectrometry, yeast 2-hybrid system, Tandem affinity purification, protein microarray
  - Protein sequencing
  - Protein linkage mapping
  - Strategies for protein identification
  - Protein modifications and proteomics
  - Applications of proteome analysis to drug and biomarker discovery
  - Interaction Proteomics
  - Metabolomics: Introduction to Metabolomics
  - Metabolic pathways resources: KEGG, Biocarta

**Teaching Methodology**

- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities
Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
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• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

Gene Expression and Regulation

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Course Objective:
• To provide an overview of gene expression pathways
• To provide knowledge about regulatory mechanisms
• To elaborate the techniques used for analysis of gene expression

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

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

**Course Outline:**

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

**Teaching Methodology**

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

**Assessment**

- **Theory**
  
  **Mid Term (40%)**
  - Written (Long Questions, Short Questions, MCQs) 50%
  - Project/case study/Presentation 20%
  - Assignments 20%
  - Tests/Quiz 10%

- **Final Term (60%)**
  - Written (Long Questions, Short Questions, MCQs) 50%
  - Project/case study/Presentation 20%
  - Assignments 20%
  - Tests/Quiz 10%

**Recommended Books:**

1. Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. Molecular Cell Biology (2016 edition).

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**Food Biochemistry**

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

**Learning Outcome:**
On successful completion of this course the students will be able to:
- Explain the absorption, storage and metabolic function of macro and micronutrients.
- Describe the role of nutrients in the optimal functioning of key biochemical pathways in the body.
- Integrate biochemical mechanisms with disease pathology and clinical treatment options.
- Provide a coherent argument for the use of nutrient supplementation and food therapy
- Promoting health and wellbeing through optimal biochemical pathway functions.

**Course Outline:**
- Food selection and meal planning for healthy individuals
- Absorption, storage and metabolic function of macro and micronutrients
- Balanced diet: recommended dietary allowances for different categories of the human beings
- Water's importance in Food Chemistry: Phases of water, the role of water as a solvent in food systems, the concept of water activity Measurement of energy of foods and expenditures
- Direct and indirect caloric measurement
- Basal metabolism, Obesity, BMR and Factors affecting BMR
- Respiratory quotient, Food borne diseases, Nutritional aspects and dietetic treatment of a few important primary nutritional and general diseases (anorexia, Endemic goiter, Idiosyncrasies)
- Fasting, Starvation, Food intolerance and food allergies, Clinical surveys, Physical examinations, Laboratory examinations, Dietary surveys, FAO global information and early warning system for food and agriculture.
• Micronutrients: Sources, Daily allowance, Deficiency diseases; Biological importance of vitamins and minerals.
• Nutrigenomics (influence of genetic variation on nutrition, effects of nutrition, nourishment or lack of nutrition on the genetic expression and correlating gene expression or SNPs with a nutrient's absorption.)
• Preservation of food by UV-radiation / chemical method

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

Renewable Bioenergy Resources (31)

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63
Course Objective:

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

Learning Outcome:

Students completing this course will be able to:

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

Course Outline:

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

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment

Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%

Recommended Books:
2. Wim Soetaert and Erik Vandamme (Editors), Biofuels. Publisher: Wiley
Molecular Mechanisms of Diseases

Contact Hours: 

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<tr>
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<td>Practical = 0</td>
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<tr>
<td>Total = 48</td>
<td>Total = 3.0</td>
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Course Objective:
- To provide basic concepts of mechanisms of diseases
- To provide understanding of mechanisms of genomic instability, signal transduction and the networks of cellular responses.

Learning Outcome:
After completing this course, student should be able to;
- Understand the molecular and cellular mechanisms of disease
- Acquire basic knowledge of microbial infections and genetic diseases.
- Understand Immunopathogenesis

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

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

Assessment
Theory 100%
Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:
4. Updated research Published in Nature Review Cell & Molecular Biology.
5. Articles Published in Nature Review Genetics.

Molecular Evolution

Contact Hours:  
Theory = 48  
Practical = ---  
Total = 48

Credit Hours:  
Theory = 3.0  
Practical = 0.0  
Total = 3.0

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

Learning Outcome:
After completing this course the students should be able to:
• Describe evolutionary process at the molecular level
• Apply molecular methods to study genetic variation within and between species
• Explain and justify different models of sequence evolution and their application in phylogenetic analysis

Course Outline:
• Molecular Basis of Evolution
• Allele Dynamics in Populations
• DNA and Amino Acid Sequence Evolution
• Rates and Patterns of Molecular Evolution
• Molecular Phylogenetics and Phylogenetic Trees
• Reticulate Evolution and Phylogenetic Networks
• Evolution by DNA Duplication
• Evolution by Molecular Tinkering
• Mobile Elements in Evolution
• Prokaryotic Genome Evolution
• Eukaryotic Genome Evolution
• The Evolution of Gene Regulation
• Experimental Molecular Evolution

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

Seminar

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Course Objective:
• To explore ideas from recent research
• To develop presentation skills.

**Learning Outcome:**
Students completing this course will be able to:
• Present an idea in a scientific way
• Explore topics by discussion
• Identify and sort out research questions

**Course Outline:**
Student will prepare and present seminars on a topic assigned by teacher.

**Teaching Methodology**
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

**Assessment**

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**Mid Term (40%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

**Final Term (60%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

**Special Problem/Specific Assignment**

**Contact Hours:**

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**Credit Hours:**

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</table>

**Course Objective:**
• To explore ideas from recent research
• To develop presentation skills

**Learning Outcome:**
Students completing this course will be able to:

• Present an idea in a scientific way
• Explore topics by discussion
• Identify and sort out research questions

**Course Outline:**

Student will prepare and present seminars on a topic assigned by teacher.

**Teaching Methodology**

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

**Assessment**

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**Mid Term (40%)**

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

**Final Term (60%)**

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

**Drug Designing and Metabolism**

**Contact Hours:**

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**Credit Hours:**

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**COURSE OBJECTIVES:**

• This course will provide basic and fundamental concepts of drug designing strategies and development.
• The contents will provide understanding of drug designing and metabolic changes of drugs and other related organic compounds.
Learning Outcome:
After completing this course students should be able to;

g. Understand the drug designing strategies, drug distribution, acid-base properties
h. Acquire basic knowledge of general pathways of drug metabolism, computer aided drug design,
i. Understand and explain phases, structure, and analytical development of drug, Drug Development Activities and Timeline

COURSE OUTLINE:
Drug Metabolism

- General Pathways of Drug Metabolism
- Sites of Drug Biotransformation
- Role of Cytochrome P450, Monooxygenases in Oxidative Biotransformations
- Oxidative Reactions, Reductive Reactions, Hydrolytic Reactions phase II, Conjugation Reactions
- Factors Affecting Drug Metabolism

Drug Designing Strategies

- Objectives of drug designing
- Drug Distribution, Acid–Base Properties
- Phases of drug development,
- Cost and time factor in drug development,
- Market potential of the drug, Screening of natural products,
- Identification of lead molecules,
- Structure based drug design
- Analytical development,
- Stability studies, Sponsor Role and Responsibilities,
- FDA Role and Responsibilities,
- Regulations governing Drug Development,
- Drug Development Activities and Timeline
- Research and Early Development Activities
- Pre-clinical Evaluation/Testing, First in Human Evaluation
- Clinical Development: Phases and Activities, NDA Application/Submission
- Post-Approval Sponsor Responsibilities
- Pre-formulation and formulation studies
- Bioavailability testing
- Establishment of drug standards
- Chemical and toxicological evaluation
- Determination of safety and efficacy in animals and humans
- Establishment of dosing limits, Understanding of drug interaction
- Drug modification

**Teaching Methodology**
- Lecturing
- Written Assignments

**Assessment**

**Mid Term (40%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

**Final Term (60%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

**RECOMMENDED BOOKS:**

1. Foyes principle of Medicinal Chemistry, seventh eds.,(2012)

Forensic Serology and DNA Analysis

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<tr>
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<tr>
<td>Total = 32</td>
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Course Objective:
- To acquaint students with the understanding the forensic science with special reference to DNA and Serology.
- To help them understand the detection of human biological fluids and their importance.
- To understand the role and utility of biological fluids as evidence in criminal investigation system.

Learning Outcome:
At the end of the course, the students would be able to understand:
- The importance of serological fluids like blood semen and saliva found on the crime scene.
- Importance of Forensic DNA and Serology in legal investigations, and the importance of quality control and quality assurance systems in Forensic Sciences.
- How obtaining DNA profile helps in parentage testing and relationship/sibship testing and the importance of lineage markers and familial searching using DNA database.
- The significance of DNA profiling, different interpretations and its outcomes.
Course Outline:
- Essentials to Forensic Serology
- Blood Serology
- Semen Serology and saliva detection
- Other biological fluids
- Forensic genetics
- Polymorphism DNA structure
- STR’s and SNP’s
- Screening of biological evidence
- DNA extraction from evidence samples
- Robotics in DNA extraction
- Different DNA quantification methods
- Amplification and Analysis of STR
- Genotyping and Capillary Electrophoresis
- Interpretation of genetic profiles
- Artefacts in genotyping
- Population genetics
- Statistical interpretation
- Lineage markers and familial searching
- The basis of paternity and sibship testing
- Non-human DNA typing
- Role of Quality control and Quality Assurance in Forensic DNA and Serology
- Criminal Justice System of Pakistan
- Evidentiary value of DNA evidence

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

Assessment
Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%
Recommended Books:

4. Xanthé Mallett, Teri Blythe, Rachel Berry Advances in Forensic Human Identification 2014 – CRC Press. USA

Applications of Nanomaterials in Biosciences

Contact Hours: 

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Credit Hours:

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Course Objective:

- To give historical and updated overview of the biomaterial-based devices
- To provide the knowledge in basics of nanotechnology in biotechnology.
- To introduce regulatory and ethical concerns dealing with the implementation and commercialization of biomaterials and medical devices.

Learning Outcome:

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

- Understand the basic knowledge of Nanomaterials.
- Illustrate the links between medical problem, biological scenarios, chemical issues and mechanical performance.
- Understand the applications of nanomaterials in early medical diagnostics, drug targeting, drug delivery, Nano surgery and other biological fields.
- Select and manipulate materials for a particular application in the human body.
- Evaluate the performance of materials based on scientific knowledge of its composition, structure and properties.
- Know the limitations of the biomaterials and the characteristics that might influence changes over time.

Course Outline:

Introduction to nanomaterials:
• Introduction to nanotechnologies for medicine and healthcare – challenges and opportunities
• Nanoparticles in medicine
• Recent developments in the safety of nanomaterials
Nanotechnologies for regenerative medicine and tissue engineering
• Nanotechnologies for regenerative medicine and tissue engineering – overview
• Nanomaterials for regeneration of bone and cartilage
• Scaffolds and nanocomposites for tissue engineering
• Using stem cells in tissue engineering
• Electrospinning in tissue engineering
Nano-Diagnostics
• Introduction to nano-diagnostics
• Extracellular vesicles in health and disease
• Engineered nanoparticles for cancer diagnostics and therapy
• Nanoparticles for medical imaging
Nano-Biosensors
• Requirements of biosensing systems
• Electrochemical sensing methodologies
• Optical sensing methodologies
Nano-Pharmaceuticals
• Nanotechnologies and nanoparticles for drug delivery and therapy
• Approaches to nanoparticle targeting
• Nano–Radiopharmaceuticals
• Polymer-based nanoparticles for drug delivery and therapeutics
• Nano-biosensors (devices) – examples from research and industry

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment

Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:

**Stem Cells and Therapeutics**

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**Course Objective:**
- TO introduce concepts and importance of stem cells
- To elaborate and update different types of stem cells with their therapeutic potential

**Learning Outcome:**
After completing this course, the students should be able to:
- Understand the basic types of stem cells and comprehend their possible therapeutic uses
- Explain the differences between the stem cell based and regular drug-based therapies.

**Course Outline:**
- Introduction to stem cells; Principles and applications
- Concept of the stem cells
- Self-renewal and differentiation potential of stem cells
- Maintaining Stemness: Interaction between HSCs and the cellular micro environment
- Stem cells and their specific molecular markers
- Cell signaling in stem cells
- Stem cells; Embryogenesis; Differentiation;
- Stem cells models, past, present and future;
- Immunobiology of stem cell transplantations;
- Types of stem cells and their clinical potential: Embryonic and non-embryonic stem cells; Adult stem cells; Induced pluripotent stem cells;
- Stem cells in regenerative medicine, Regenerative medicine and reprogramming;
- Hematopoietic stem cells and their therapeutic potential
- Use of stem cells in burns and wounds, ocular diseases, diabetes, etc
- Generation of specific cells from pluripotent stem cells
- Commercial opportunities for iPSCs
- Limitations in reprogramming and differentiation fields
- Cancer stem cells and tumorigenesis
- Stem cells and aging
- Bioreactors of pluripotent stem cells and future challenges
- Ethical issues in stem cell research

**Teaching Methodology**
- Lecturing
- Written Assignments
- Audio visual aid
- Class discussion
- Class activities

**Assessment**

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**Mid Term (40%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Final Term (60%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

**Recommended Books:**

Neuroscience

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

Course Objective:
• To provide basic and fundamental concepts of nervous system
• To comprehend the role of neurotransmitters in the modulation of brain function
• To understand mechanism and signaling pathways in the brain in health and diseases

Learning Outcome:
After completing this course students should be able to;
• Acquire the understanding of mechanism involved in the transmission of information in the brain
• Describe the modulation of brain function
• Analyze the role of neurotransmitters in various diseases
• Understand the role of neuron specific signaling pathways

Course Outline:
• Introduction to neuroscience: Nervous system, Sympathetic, Parasympathetic and motor nervous system and their functions, Brain and its functions, Neuron and glia, structure of a neuronal cell, types of glia, Blood brain barriers
• Neuronal Circuits: Neuronal circuit in emotional control, Neuronal circuit in reward and addiction, Neuronal regulation of stress
• Receptors: Ionotropic and metabotropic receptors, signal transduction pathways, G-proteins, protein phosphorylation, Signaling to the nucleus, regulation of gene expression
• Neurotransmitters: Excitatory and inhibitory amino acid neurotransmitters, Functions in the brain, Pain pathways in brain, Role of excitatory neurotransmitter in learning and memory, Diseases associated with the malfunctioning of these neurotransmitters, Neuronal degeneration
• Catecholamines: Functions in the brain, Diseases associated with the malfunctioning
• Neuroendocrine and motivational systems: Endocrine systems, Feeding behavior, Stress
• Diseases of the nervous system: Addiction, Depression, Schizophrenia, Epilepsy, Alzheimer, Parkinson, Prion, Motor Neuron Disease

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities
Assessment

Theory 

Mid Term (40%) 
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%) 
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:

2. Darakhshan Haleem, Neurochemistry, Neuropharmacology and Behavior: Outlines on the mechanism of brain function, 2010
5. Progress in Neuroscience, Readings from Scientific American, John Wiley.

Structural Bioinformatics

Contact Hours: 

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Course Objective:

- To provide concepts in structural bioinformatics
- To familiarize students with macromolecular structural data mining from online databases
- To enhance understanding of structural bioinformatics tools for protein structural analysis and structure-function relationships of major macromolecules.

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

- Acquire the knowledge of Structural Bioinformatics and Structural Biology
- Understand and apply the concepts of structural bioinformatics in various fields

**Course Outline:**

- Concepts in structural bioinformatics
- Overview of protein structure
- Computational aspects of macromolecular structure determination by X-ray crystallography and NMR spectroscopy
- Computer aided molecular modeling and visualization
- The Protein Data Bank, SCOP and CATH databases
- Protein Structure Quality Assurance; protein structure validation.
- Protein structure comparison and alignment
- Protein secondary structure assignment and prediction
- Protein tertiary structure prediction: homology modeling, abinitio prediction and fold recognition methods
- Principles and methods of molecular docking and ligand design
- Structural bioinformatics in drug discovery
- Inferring protein function from structure
- Using Programming Language (e.g. Python) to facilitate protein structural analysis

**Practicals:**

- Survey of Protein Structure Databases.
- Protein structure visualization and analysis.
- Secondary structure prediction
- Protein tertiary structure prediction by homology modeling method.
- Ligand docking

**Teaching Methodology**

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

**Assessment**

**Theory** 100%
Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:
1. Structural Bioinformatics by Philip E Bourne.
5. DW Mount, Bioinformatics: Sequence and Genome Analysis, Second Edition, CSHL Press, USA.

PLANT GENOMICS

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

Course Objective:
- To impart fundamental concepts of structural, functional, and comparative genomics of plants
- To develop understanding of the latest in-silico tools and their applications in plant sciences

Learning Outcome:

At the end of the course, students will be able to;
- Understand in depth knowledge of plant genomics
- Learn genomics-assisted advanced technologies and their applications in plant sciences
- Gain a deeper insight into the execution and analysis of plant genomics data and related research work
Course Outline:

- Introduction: Basic concepts about plants and plant genomes (nuclear and organelle)
- Structural Genomics of Plants
- Structure of the Plant Nuclear and Organelle Genomes
- Sequencing of Plant Genomes
- Exploration of Plants genomes databases and sequence comparisons
- Functional Genomic Studies in Plants
- Prediction of genes and detection of protein function using bioinformatics tools
- Genetic transformation in plants
- Construction of mutant libraries
- The DNA Microarrays in Plants
- Gene Expression studies and analysis strategies in plants
- Proteomic and metabolomic profiling
- Plant Models and role in understanding plants genomics
- Arabidopsis thaliana, Oryza sativa, Medicago truncatula, Tomato, Sugarcane, Physcomitrella patens
- Genomics and Genetic Variability in Plants
- Molecular Markers assisted High-throughput genotyping
- Analysis of Plant Biodiversity and Molecular Evolution
- Candidate Gene analysis

Teaching Methodology

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

Assessment

Theory 100%

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Project/case study/Presentation 20%
- Assignments 20%
- Tests/Quiz 10%

Recommended Books:

Biochemistry of Drugs and their Resistance

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Course Objective:
Course Objectives:

- This course will introduce the major classes of antimicrobials and other drugs
- To understand the mode of action of different drugs
- To understand mechanisms of drug resistance in different diseases

Learning Outcome:
After completing this course, students should be able to;

- Familiarize with major classes of antimicrobials, molecular basis of their mode of action and resistance
- Understand the use of antimicrobials in clinical practice along with detection of antimicrobial sensitivity for antimicrobial stewardship
- Analyze emerging drug resistance issues in real life

Course Outline:

- Indiscriminate use of medicines
- Introduction to antibiotics
- Classes of drugs and their mode of action
- Drug side effects and drug-drug interactions
• Mechanisms of drug resistance
• Drug resistance detection
• Antimicrobial prophylaxis and empiric therapy
• Antimicrobial stewardship
• Human consumption of antibiotics through food chain;
• Antibiotic Sensitivity Test
• MRSA;
• Roll Back Malaria
• Drug resistance issues: MDR, TDR and XDR Tuberculosis
• Emerging and re-emerging drug resistance issues

Teaching Methodology
• Lecturing
• Written Assignments
• Audio visual aid
• Class discussion
• Class activities

Assessment
Theory 100%

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Project/case study/Presentation 20%
• Assignments 20%
• Tests/Quiz 10%

Recommended Books:
2. Anti Antimicrobial Resistance Policy Government of Pakistan
3. Latest Research Articles from Journals

Biochemistry of Control system

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Course Objective:
The course aims to provide:
- Information on significance of different control systems for normal physiological functions
- Comprehensive knowledge about structures, classification, and properties of hormones
- Understanding of the mechanism of action and diseases associated with hormones

**Learning Outcome:**
After completing this course the students will be able to:
- Elaborate the role of different control systems
- Demonstrate advanced knowledge on mechanisms of hormone action
- Consolidate the knowledge regarding interaction of hormone, enzymes and other molecules

**Course Outline:**
**Homeostatic control system:**
- General characteristics and the balance concept
- Chemical homeostasis and components of homeostatic systems
- Receptors, signal transduction mechanisms for plasma-membrane receptors

**Neural control system:**
- Structure of the nervous system mechanism of neural transmission
- Membrane resting, graded and action potentials
- Synapses and their functional anatomy, synaptic effectiveness
- Neurotransmitters and neuromodulators
- Neural growth and regeneration
- Blood-brain barrier and cerebrospinal fluid;

**Sensory control System:**
- Pathways and basic characteristics of sensory coding; Somatic sensation; Vision, hearing, vestibular system
- Chemical senses, association cortex and perceptual processing

**Muscles:**
- Structure of skeletal muscles and muscle fibers
- Molecular mechanisms of muscle contraction and relaxation
- Skeletal-muscle energy metabolism
- Smooth muscles, voluntary and involuntary actions, local control of motor neurons

**Hormones:**
- Definition and characteristics of hormones
- Major endocrine systems and their target tissues
- Synthesis and chemistry of various hormones, and their mechanism of release
- Plasma membrane and intracellular receptors and transportation of hormones
- Molecular mechanisms of signal transduction and role of G-proteins
- Second messengers cAMP, cGMP, Ca²⁺, DAG and IP3 and their role in regulation
- Termination of signal transduction and cross talk among signalling systems
- Physiological functions and interrelations of various hormones and enzymes in metabolism.

**Recommended Books:**