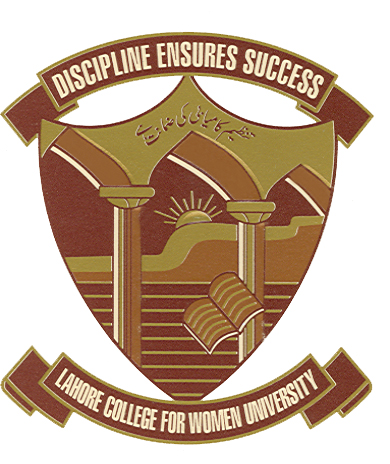
**BS BIOTECHNOLOGY**

**FOUR YEAR DEGREE PROGRAMME**

**(2023-2027)**



**DEPARTMENT OF BIOTECHNOLOGY**

**LAHORE COLLEGE FOR WOMEN UNIVERSITY, LAHORE**

**STANDARDIZED FORMAT (UGP 2023)**

**FOR BS (4 YEAR) IN BIOTECHNOLOGY**

**GENERAL STRUCTURE**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No.** | **Categories** | **Credit Hours (standard)** | **Credit Hours (Current)** |
| 1. | General education | 30 | 30 cr.hrs. |
| 2. | Disciplinary or major | Min 72 | 78 cr.hrs. |
| 3. | Interdisciplinary | Min 12 cr hrs | 12 cr. Hrs. |
| 4. | Field experience (internship) | 3 cr. hrs. | 3 cr. hrs. |
| 5. | Capstone project | 3 cr. hrs. | 3 cr. hrs. |
|  | **Total** | **120-144 cr. hrs** | **126 cr.hrs** |

* Total numbers of credit hours 120-144
* Duration 4 years
* Semester duration 16-18 weeks
* Semesters 8
* Course load per semester 15-18 Credit hours
* Number of courses per semester 5-6

**SCHEME OF STUDY**

**BS (4-Year) Biotechnology**

**2023-2027**

**YEAR ONE**

**SEMESTER-I**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| GEDU-101 | Functional English | 3 |
| GEDU-102 | Islamic Studies | 2 |
| GEDU-103 | Ethics (for Non-Muslim students in lieu of Islamic studies) | 2 |
| GEDU-104 | Application of Information and Communication Technologies | 2 |
| GEDU-104P | Application of Information and Communication Technologies (Practical) | 1 |
| BIOT-101 | Cell Biology | 2 |
| BIOT-101P | Cell Biology (Practical) | 1 |
| BIOT-102 | Microbiology | 2 |
| BIOT-102P | Microbiology (Practical) | 1 |
| BIOT-103 | Introduction to Biotechnology | 3 |
|  | **Total Credits** | **17** |

**SEMESTER-II**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| GEDU-151 | Expository English | 3 |
| GEDU-152 | Ideology and Constitution of Pakistan | 2 |
| GEDU-153 | Quantitative Reasoning-1 | 3 |
| BIOT-151 | Classical Genetics | 2 |
| BIOT-151P | Classical Genetics (Practical) | 1 |
| BIOT-152 | Environmental Biotechnology | 2 |
| BIOT-152P | Environmental Biotechnology (Practical) | 1 |
| BIOT-153 | Analytical Chemistry & Instrumentation | 2 |
| BIOT-153P | Analytical Chemistry & Instrumentation (Practical) | 1 |
|  | **Total Credits** | **17** |

**YEAR TWO**

**SEMESTER-III**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| GEDU-\*\*\* | Social Sciences | 2 |
| GEDU-\*\*\* | Natural Sciences | 2 |
| GEDU-\*\*\* P | Natural Sciences (P) | 1 |
| GEDU-201 | Quantitative Reasoning-II | 3 |
| BIOT-201 | Biochemistry I | 2 |
| BIOT-201P | Biochemistry I (Practical) | 1 |
| BIOT-202 | Agriculture Biotechnology | 2 |
| BIOT-202P | Agriculture Biotechnology | 1 |
| BIOT-203 | Genetic resources and conservation | 2 |
| BIOT-203P | Genetic resources and conservation (Practical) | 1 |
|  | **Total Credits** | **17** |

**SEMESTER-IV**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit hours** |
| GEDU-\*\*\* | Arts and Humanities | 2 |
| GEDU-251 | Entrepreneurship | 2 |
| GEDU-252 | Civics and Community Engagement | 2 |
| BIOT-251 | Molecular Biology | 2 |
| BIOT-251P | Molecular Biology (practical) | 1 |
| BIOT-252 | Biochemistry II | 2 |
| BIOT-252P | Biochemistry II | 1 |
| BIOT-253 | Biosafety &Bioethics | 3 |
|  | **Total** | **15** |

**YEAR THREE**

**SEMESTER-V**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** | |
| BIOT-301 | Elementary Biostatistics | 3 | |
| BIOT-302 | Principle of Biochemical Engineering | 2 | |
| BIOT-302P | Principle of Biochemical Engineering (Practical) | 1 | |
| BIOT-303 | Bioinformatics | 1 | |
| BIOT-303P | Bioinformatics (Practical) | 2 | |
| BIOT-304 | Methods in Molecular Biology | 1 | |
| BIOT-304P | Methods in Molecular Biology (Practical) | 2 | |
| BIOT-489 | Field experience/Internship | | 3 |
|  | **Total** | **15** | |

**SEMESTER-VI**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
|  | \*Introduction to computer (Allied) | 2 |
|  | Introduction to computer (Practical) | 1 |
|  | \*Artificial intelligence (Allied) | 3 |
| BIOT-351 | Genomics and Proteomics | 3 |
| BIOT-352 | Microbial Biotechnology | 2 |
| BIOT-352P | Microbial Biotechnology (Practical) | 1 |
| BIOT-353 | Food Biotechnology | 2 |
| BIOT-353P | Food Biotechnology (Practical) | 1 |
| BIOT-354 | Immunology | 2 |
| BIOT-354P | Immunology (Practical) | 1 |
|  | **Total** | **15** |

\*One course (from the two) will be selected before the start of the semester.

**YEAR FOUR**

**SEMESTER-VII**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
|  | Physics for Biologists (Allied) | 3 |
|  | Research Methodology & Skill Enhancement (Allied) | 3 |
| BIOT-401 | Virology | 3 |
| BIOT-402 | Industrial Biotechnology | 2 |
| BIOT-402P | Industrial Biotechnology (Practical) | 1 |
| BIOT-354 | Clinical Microbiology | 2 |
| BIOT-354P | Clinical Microbiology (Practical) | 1 |
|  | **Total** | **15** |

**YEAR FOUR - SEMESTER VIII**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
|  | Biomathematics (Allied) | 3 |
| BIOT-451 | Pharmaceutical Biotechnology | 3 |
| BIOT-452 | Forensic Biotechnology | 3 |
| BIOT-453 | Health Biotechnology | 3 |
| BIOT-499 | Capstone Project | 3 |
|  | **Total** | **15** |

**Sem 1 to 4 credit hrs.** 17+17+17+15 = 66

**Sem 5 to 8 credit hrs.** 15+15+15+15 = 60

**Major**= 9+9+9+9 +9+6+15+12= 78

**Total Credit hrs. 126**

**Minor in Biotechnology 12 credit hrs.**

**Students may opt any of the following courses (minimum 12 credit hours) as per availability of resources**.

|  |  |  |
| --- | --- | --- |
| Serial No. | course | Credit hr. |
|  | Introduction to Biotechnology | 3+0 |
|  | Principles of Biochemical Engineering | 3+0 |
|  | Genomics and Proteomics | 3+0 |
|  | Health Biotechnology | 3+0 |

**List of Minors for student of BS Biotechnology Program**

Student of Biotechnology may opt any one or two of the following minors as per availability of resources and offering of concerned department

1- Minor in Chemistry

2- Minor in Botany

3- Minor in Zoology

4- Minor in Environmental Sciences

5- Minor in Computer Sciences

6- Minor in Mathematics

7- Minor in Statistics

8- Minor in Geography

*-Weightage of theory and practical credits may be changed by an institution depending on the laboratory facilities available*

*-Biotechnology courses that are offered to other departments as their allied courses will be on the availability of faculty member expertise and number of students.*

**DETAIL OF COURSES**

**YEAR ONE**

**Semester-I**

**BIOT-101: CELL BIOLOGY Credit hrs. 2**

COURSE OBJECTIVES

To acquaint students with features of eukaryotic cells, functions of different compartments and the overall structure/ultrastructure of cells as visualized by electron microscopy.

COURSE CONTENTS

Introduction to cell theory including historical perspective; overview of membrane structure and chemical constituents of the cell; function, isolation and molecular organization of cellular organelles specifically the endoplasmic reticulum, lysosome, micro-bodies, mitochondrial ultra-structure and function, chloroplast ultra-structure and the mechanism of photosynthesis; composition and structure of membranes; membrane receptors and transport mechanisms; cell movement - structure and function of cytoskeleton, centriole, cilia and flagella; nucleus; structure and function of chromosomes; cell cycle, mitosis and meiosis.

RECOMMENDED BOOKS

1. Essential Cell Biology Sixth Edition 2023. Bruce Alberts , Karen Hopkin , Alexander Johnson , David Morgan , [Keith Roberts](https://www.amazon.com/s/ref=dp_byline_sr_book_5?ie=UTF8&field-author=Keith+Roberts&text=Keith+Roberts&sort=relevancerank&search-alias=books), [Peter Walter](https://www.amazon.com/s/ref=dp_byline_sr_book_6?ie=UTF8&field-author=Peter+Walter&text=Peter+Walter&sort=relevancerank&search-alias=books) , Rebecca Heald . Publisher. W. W. Norton & Company.
2. Cell Biology. 4th Edition – 2022 . Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, Graham Johnson. Elsevier.
3. Alberts B and Johnson A, 2006. Molecular Biology of the Cell. 4th Edition; Garland Publishers, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
4. Karp, 2002. Cell and Molecular Biology. Third Edition; John Wiley and Sons, New York.
5. Alberts *et al*., 2009. Essential Cell Biology.Third Edition; Garland Publishers, New Yor
6. Lodish *et al,.* 2007. Molecular Cell Biology. Sixth Edition; Freeman and Company, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))

**BIOT-101 P: CELL BIOLOGY (Practical) Credit hr. 1**

PRACTICALS

Microscopy and staining techniques; study of prokaryotic, eukaryotic, plant and animal cells; cell structure in the staminal hair of *Tradescantia*; study of different types of plastids; cellular reproduction; Mitosis: smear/squash preparation of onion roots.

**BIOT-102: MICROBIOLOGY Credit hrs. 2**

COURSE OBJECTIVES

This course aims to familiarize students with fundamentals of prokaryotic and eukaryotic microbial life including viruses.

COURSE CONTENTS

Overview and history of microbiology including microbial diversity (Archaea, bacteria, fungi, algae, protozoa), nutrition, growth, metabolism; cultivation; viruses; control of microorganisms: sterilization and disinfection, antimicrobial agents, antibiotics, antibiotic resistance and susceptibility, antifungal and antiviral agents; cell death; symbiosis, carbon, nitrogen, sulfur and phosphorus cycles; microbiology of soil, freshwater and seawater.

RECOMMENDED BOOKS

1. Brock Biology of Microorganisms. 2020. Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl. 16th Edition, Pearson Publishers. US.
2. Microbiology: An Introduction. 2018. by Gerard Tortora, Berdell Funke, Christine Case. 13th Edition, Pearson Publishers. US.
3. Microbiology: A Laboratory Manual, Global Edition. 2017. James G. Cappuccino, Chad T. Welsh. Pearson Education. US
4. Prescott's Microbiology. 2016. Joanne Willey, Linda Sherwood, Christopher J. Woolverton. 10th Edition. McGraw Hill publishers US.
5. Benson's Microbiological Applications Laboratory Manual By Heidi Smith, Alfred Brown · 2021
6. Laboratory Exercises in Microbiology. By Robert A. Pollack, Lorraine Findlay, Walter Mondschein, R. Ronald Modesto, 2018. Wiley publishers US.
7. Alcamo IE, 2010. Fundamentals of Microbiology. Ninth Edition, Jones and Bartlett Publishers.
8. Madigan MT and Martinko J, 2010. Brock Biology of Microorganisms. 13th Edition; Pearson College Div.
9. Talaro KP, 2009. Foundations in Microbiology: Basic Principles. Seventh Edition; McGraw Hill Publisher.
10. Black JG, 2007. Microbiology: principles and explorations. SeventhEdition; John Wiley and Sons.
11. Baker et al., 2006. Instant Notes in Microbiology. ThirdEdition; Taylor and Francis.
12. Prescott et al., 2005. Microbiology. SixthEdition; McGraw-Hill Medical Publishing.
13. Cappuccino JG and Sherman N, 2013. Microbiology: a laboratory manual. Tenth Edition; Pearson Education.

**BIOT-102: MICROBIOLOGY (Practical) Credit hr. 1**

PRACTICALS

Sterilization techniques; culturing of bacteria in liquid and on solid medium; Gram-staining of bacteria; microscopic observation of yeast, lactophenol blue staining of fungi, colony and cell morphology; bacterial cell count and growth curves; biochemical tests. Lethal effects of UV light on microbial growth, evaluation of antiseptics by disc diffusion method.

**BIOT-103: INTRODUCTION TO BIOTECHNOLOGY Credit hrs. 3**

COURSE OBJECTIVES

To acquaint students with the basic concepts and significance of biotechnology as it stands today.

COURSE CONTENTS

Biotechnology- definition and history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture (food, livestock, fisheries, algae, fungi, etc.); protection of biotechnological products; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world

RECOMMENDED BOOKS

1. William J. Thieman. and Michael A Palladino. 2021. Introduction to Biotechnology 4th edition Published by Pearson.
2. [Firdos Alam Khan](https://www.routledge.com/search?author=Firdos%20Alam%20Khan) . 2020 Biotechnology Fundamentals 3rd edition CRP press
3. Daugherty E, 2012. Biotechnology: Science for the New Millennium. First Edition, Revised; Paradigm Publication.
4. Smith JE, 2009. Biotechnology. Fifth Edition; Cambridge University Press.
5. Nicholl TSD, 2004. An Introduction to Genetic Engineering. Second Edition; Cambridge University Press, UK.
6. Purohit SS, 2005. Biotechnology Fundamentals & Application. Fourth Edition; Agro Bios, India.
7. Ratlegde C and Kristiansen B, 2006. Basic Biotechnology. Second Edition; Cambridge University Press, UK.
8. Thomas JA and Fuchs RL, 2002. Biotechnology and Safety Assessment. Third Edition; Academic Press, UK.

**SEMESTER-II**

#### BIOT-151: classical Genetics Credit hrs. 2

COURSE OBJECTIVES

To acquaint students with classical aspects of genetics.

COURSE CONTENTS

Classical Mendelian genetics; monohybrid crosses, dominance, recessiveness, codominance, and semidominance; principle of independent assortment; dihybrid and trihybrid ratios; gene interactions; epistasis and multiple alleles; ABO blood type alleles and Rh factor alleles in humans; probability in Mendelian inheritance; structure of chromosomes; organization of genes and genomes; nucleic acid function; DNA as warehouse of genetic information; experimental evidence that DNA is genetic material; sex determination; linkage and crossing over.

RECOMMENDED BOOKS

1. Snustad DP and Simmons MJ, 2008. Principals of Genetics. Fifth Edition; John Willy & Son, New York.
2. Klug WS and Cumming MR, 2008. Concepts of Genetics. Ninth Edition; Prentice Hall, USA.
3. Pierce B, 2004. Genetics: A Conceptual Approach. Second Edition; WH Freeman, New York.
4. Brooker R, 2011. Genetics: Analysis and Principles. Fourth Edition; McGraw-Hill.
5. Pierce BA, 2011. Genetics: A conceptual approach. Fourth Edition. WH Freeman Publisher.

**BIOT-151P: classical Genetics (Practical) Credit hrs. 1**

PRACTICALS:

Introduction to Fast plants and Drosophila. Set up a Drosophila opened-ended cross, Pollinate Fast Plants, ABO blood group, Isolation of DNA from Drosophila

**BIOT-152: ENVIRONMENTAL BIOTECHNOLOGY Credit hrs. 2**

COURSE OBJECTIVES

To acquaint students with conservation and reclamation of environment through biotechnology

COURSE CONTENTS

Introduction to environmental biotechnology; fundamentals of biological interventions; genetic manipulation strategies in environmental biotechnology; pollution indicators and pollution control strategies; bioreactors; domestic waste water treatment; industrial effluent treatment; sludge treatment; contaminated land and bioremediation; phytoremediation; landfills and composts; concept of integrated environmental biotechnology; biodegradation and biotransformation of hazardous chemicals; products of environmental biotechnology.

RECOMMENDED BOOKS

1. Fluker MH, 2010. Environmental Biotechnology. CRC Press.
2. Faster CF and Wase J, 2004. Environmental Biotechnolog. John Willey & Sons.
3. Evans GM and Furlong JC, 2010. Environmental Biotechnology Theory and Application. Second Edition; Wiley-Blackwell Publishers.
4. Srinivas T, 2008. Environmental Biotechnology. First Edition; New Age International Publishers.
5. Spencer JFT and Spencer ALR, 2004. [Environmental Microbiology: Methods and Protocols (Methods in Biotechnology)](http://www.amazon.com/Environmental-Microbiology-Methods-Protocols-Biotechnology/dp/1588291162/ref=sr_1_4/103-2543373-2080619?ie=UTF8&s=books&qid=1178312454&sr=1-4). 1st Edition; Humana Press.
6. Hurst et al., 2007. Manual of Environmental Microbiology. Third Edition; ASM Publishers.

**BIOT-152 (P): ENVIRONMENTAL BIOTECHNOLOGY (Practical) Credit hrs. 1**

PRACTICALS

Biodegradation of environmental pollutants by microorganisms; bacteriology of drinking water; microscopic studies of water specimens collected from various locations; field survey of polluted areas and field study for pollution indicators (e.g., plants, microorganisms and air).

**BIOT-153: ANALYTICAL CHEMISTRY AND INSTRUMENTATION Credit hrs. 2**

COURSE OBJECTIVES

To acquaint students with key analytical chemistry concepts involving identification and analysis at the molecular level by introducing a variety of analytical chemistry techniques and their applications at the molecular level**;** designing analytical chemistry methods to obtain analysis data with the high precision and accuracy from experiments**;** demonstrating biochemical laboratory techniques and explaining the theory and background behind these techniques.

COURSE CONTENTS

Introduction to various analytical techniques; principles and applications of various types of chromatography including paper, thin layer, gel filtration, ion-exchange, affinity, high performance liquid chromatography (HPLC), gas chromatography, GC-MS and LC–MS; spectroscopy types including nuclear magnetic resonance (NMR), visible, ultraviolet, luminescence, flame, atomic absorption, fluorescence, emission and inductively coupled plasma emission spectroscopy (ICPMS); principles and applications of flow cytometry; introduction to X-ray diffraction; general analytical instrumentations and methods of fractionation and characterization of proteins and nucleic acids including dialysis, ultra-filtration, lyophilisation, ultracentrifuge and amino acid analyzer.

RECOMMENDED TEXTBOOKS

1. Boyer RF, 2011. Biochemistry Laboratory: Modern Theory and Techniques. Second Edition; Prentice Hall
2. Wilson K, 2010. Principles and Techniques of Biochemistry and Molecular Biology. Seventh Edition; Cambridge University Press.
3. Christian GD, 2003. Analytical Chemistry. Sixth Edition, John Wiley and Sons, New York.
4. Chung et al., 2005. Analytical Methods validation and Instrument Performance verification. First Edition; John Wiley and Sons, New York.
5. Sharma BK, 2005. Instrumental Method of Chemical analysis. First Edition; Meerut Goel Publishing House, India.
6. Harris DC, 2010. Quantitative Chemical analysis. Eighth Edition; WH Freeman, New York.

**BIOT-153 (P): ANALYTICAL CHEMISTRY AND INSTRUMENTATION (Practical) Credit hrs. 1**

Practicals

Separation of biomolecules by paper, column and thin layer chromatography; determination of molecular weight of proteins by gel filtration; identification of sugars, proteins, electrolytes etc. by UV/Visible spectrophotometer; determination of sodium and potassium content in blood serum by flame photometer and mineral analysis of plant tissues using atomic absorption spectrophotometer.

**YEAR TWO**

**Semester-III**

**BIOT-201: BIOCHEMISTRY- I Credit hrs :2**

### COURSE OBJECTIVES

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

COURSE CONTENTS

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

#### RECOMMENDED BOOKS

1. Nelson DL and Cox MM, 2012. Lehninger Principles of Biochemistry. Sixth Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)

2. Stryer et al., 2006. Biochemistry. Sixth Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)

3. Voet D and Voet TG, 2008. Biochemistry. Fourth Edition; John Wiley and Sons, New York.

4. Murray et al., 2012. Harper’s Illustrated Biochemistry. 29th Edition; McGraw-Hill Medical Publishing.

5. Ferrier DR, 2013. Lippincott’s Biochemistry. Sixth Edition; Lippincott Williams &Wilkin Publishing Company.

6. GP Gajera, SV Patel, BA Golakiya Fundamentals of Biochemistry A text Book . International Book Distributating. 2008. India.

6. Schantz JT, 2007. A Manual for Biochemistry Protocols. World Scientific Publishing. (*available online*)

**BIOT-201P: BIOCHEMISTRY- I (Practical) Credit hrs :1**

PRACTICALS

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

**BIOT-202: AGRICULTURE BIOTECHNOLOGY Credit hrs :2**

COURSE OBJECTIVES

To acquaint students with techniques and skills employed for producing transgenic crops.

COURSE CONTENTS

Agriculture biotechnology and its applications in crop improvements; cell and plant tissue culture methodology; improvement of plants via plant cell culture; plant molecular biomarkers; direct and indirect methods of plant and animal transformation: gene gun method of transformation, *Agrobacterium* mediated transformation, chloroplast transformation and polyethylene glycol (PEG) mediated transformation; transgenic crops with herbicide, biotic and abiotic stress resistance; problems related to transgenic plants; genetically modified organisms (GMOs); field evaluation and commercialization of GMOs; possible effects of releasing GMOs into the environment; biofertilizers, biopesticides and their types; non-symbiotic nitrogen fixers; present and future prospects of biofertilizers.

RECOMMENDED BOOKS

1. Qaim M, 2010. Agricultural Biotechnology in Developing Countries: Towards Optimizing Benefits for Poor. Springer
2. Kempken F, 2010. Genetic Modification of Plants: Agriculture, Horticulture and Forestry (Biotechnology in Agriculture and Forestry). Springer.
3. Herren RV, 2012. Introduction to Agricultural Biotechnology. Second Edition; Delmar Cengage Learning.
4. Slater A, 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Second Edition; Oxford University Press, USA
5. Altman A, 2011. Plant Biotechnology and Agriculture: Prospects for the 21st Century. First Edition; Academic Press.

**BIOT-202(P): AGRICULTURE BIOTECHNOLOGY (Practical) Credit hrs :1**

PRACTICALS

Preparation of Murashige and Skoog medium and stocks of macronutrients, micronutrients, and hormones; selection of ex-plant, medium preparation and callus induction; culturing *Agrobacterium* and using it to infect plant callus; selection of transformants; regeneration of plantlets and acclimatization; plant DNA extraction and PCR for detecting introduction of foreign DNA into plants.

#### BIOT 203: Genetic resources and Conservation Credit hrs :2

COURSE OBJECTIVES

To acquaint students with importance of bio-resources and their conservation especially in relation to Pakistan.

COURSE CONTENTS

Introduction to genetic resources and their significance; plant genetic resources - utilization, opportunities and constraints; strategic role of plant genetic resources in achieving global food security and sustainable agriculture; overview of wild and domesticated genetic resources of Pakistan; genetic diversity in endangered species; genotype-environment interactions; gene pools and genetic boundaries; genetic drift, inbreeding, migration and gene flow; introduction to extinction and its causes; threatened animal and plant species; conservation of genetic resources through mapping of existing biological diversity; assessing conservation status; management strategies; laws and treaties of conservation; quarantine regulations; future prospects of genetic conservation.

RECOMMENDED BOOKS

1. Primack RB, 2012. A Primer of Conservational Biology. Fifth Edition; Sinauer Associates Inc.
2. Virchow D, 1999. Conservation of Genetic Resources: Costs and Implications for a Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. Springer.
3. Mills LS, 2012. Conservation of Wildlife Populations: Demography, Genetics, and Management. Second Edition; Wiley-Blackwell.
4. Kamau EC and Winter G, 2009. Genetic Resources, Traditional Knowledge and the Law: Solutions for Access and Benefit Sharing. First Edition; Earthscan.
5. Primack RB, 2010. Essentials of Conservational Biology. Fifth Edition; Sinauer Associates Inc.
6. Frankham R, 2010. Introduction to Conservation Genetics. Second Edition; Cambridge University Press.

#### BIOT 203(P): Genetic resources and Conservation (Practical) Credit hrs:1

PRACTICALS:

Experiments on Diversity Studies,

* Standard methods of sample collection and preservation.
* Analysis Techniques of wild organisms and fossil Samples.
* Visits to National Parks
* Visits to Plant and Animal Genetic Resources Conservation Centers.

**BIOT 251: Molecular Biology Credit hrs:2**

COURSE OBJECTIVES

To acquaint students with the chemistry and biology of macromolecules.

COURSE CONTENTS

Introduction to molecular biology and history; structure and function of DNA; chromatin and structure of chromosomes; protein structure and function; DNA replication in prokaryotes and eukaryotes; transcription in prokaryotes and eukaryotes; post transcriptional processing (e.g., RNA splicing, alternative splicing, editing); genetic code; translation, post-translational processing in prokaryotes and eukaryotes; protein folding, targeting and turnover; DNA damage and repair, recombination and transposable elements. Signaling and control of gene regulation in prokaryotes and eukaryotes.

RECOMMENDED BOOKS

1. Nelson D and Cox MM, 2009. Lehninger Principles of Biochemistry. Fifth Edition; WH Freeman, New York.
2. Lodish et al., 2012. Molecular Cell Biology. Seventh Edition; WH Freeman, New York
3. Berg et al., 2006. Biochemistry. Sixth Edition; WH Freeman, New York.
4. Alberts et al., 2007. Molecular Biology of The Cell. Fifth Edition; Garland Science
5. Weaver R, 2011. Molecular Biology. Fifth Edition; McGraw-Hill

**BIOT 251: Molecular Biology (Practical) Credit hrs:1**

PRACTICALS

Isolation & Purification of DNA, Determination of Concentration of DNA using spectrophotometer. Hypochormocity determination of DNA,

**BIOT 252: BIOCHEMISTRY- II Credit hrs:2**

COURSE OBJECTIVES

This course is a continuation of Principles of Biochemistry I, and aims to familiarize students with the key concepts of intermediary metabolism of proteins, nucleic acids, carbohydrates and lipids.

COURSE CONTENTS

Introduction to metabolism and basic aspects of bioenergetics and biochemical thermodynamics (endergonic and exergonic reactions); phosphoryl group transfer and ATP production; metabolism, oxidation-reduction; carbohydrate metabolism and regulation (glycolysis, glycogenolysis; gluconeogenesis; pentose phosphate pathway); citric acid cycle (reactions, energetics and control), electron transport chain, oxidative phosphorylation, shuttle mechanisms (glycerol-phosphate shunt), lipid metabolism (energy yield from fatty acid oxidation, ketone bodies, acyl glycerol, compound lipids, cholesterol); photosynthesis; Calvin Cycle; metabolism of nitrogenous compounds (amino acid synthesis, catabolism, purine and pyrimidine synthesis); nucleic acid metabolism and control; urea cycle; integration of metabolism.

RECOMMENDED BOOKS:

1. Nelson DL and Cox MM, 2012. Lehninger Principles of Biochemistry. Sixth Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)

2. Stryer et al., 2006. Biochemistry. Sixth Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)

3. Voet D and Voet TG, 2008. Biochemistry. Fourth Edition; John Wiley and Sons, New York.

4. Murray et al., 2012. Harper’s Illustrated Biochemistry. 29th Edition; McGraw-Hill Medical Publishing.

5. Ferrier DR, 2013. Lippincott’s Biochemistry. Sixth Edition; Lippincott Williams &Wilkin Publishing Company.

6. GP Gajera, SV Patel, BA Golakiya Fundamentals of Biochemistry A text Book . International Book Distributating. 2008. India.

7. Instant Notes Biochemistry, Third edition David Hames and Nigel Hooper, 3rd Edition Tayler and Francis.

8. György Hegyi, József Kardos, Mihály Kovács, András Málnási-Csizmadia, László Nyitray, Gábor Pál, László, Introduction to Practical Biochemistry 2013, Eötvös Loránd University

9. Schantz JT, 2007. A Manual for Biochemistry Protocols. World Scientific Publishing. (available online)

**BIOT 252P: BIOCHEMISTRY- II (Practical) Credit hr:1**

PRACTICALS

Basic biochemical methods such as iodine test for polysaccharides, fermentation of sugars by Baker’s yeast; isolation of amylose and amylopectin from starch; extraction of glycogen from liver; acid and enzymatic hydrolysis of glycogen; extraction and estimation of lipids from plant tissue/seed and lipid separation from different tissues; fractionation by thin layer chromatography (TLC).

**BIOT 253: BIOSAFETY AND BIOETHICS Credit hrs: 3**

COURSE OBJECTIVES

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

COURSE CONTENTS

Introduction to Biosafety - definition, concept, uses and abuses of genetic information, and biohazards; good laboratory practices; risks related to genetically modified organisms (GMO); international rules and regulations for biosafety and GMOs; introduction to bioethics; ethical issues related to GMOs; euthanasia, reproductive and cloning technologies, transplants and eugenics; patenting, commercialization and benefit sharing; role of national bioethics committees; biosafety guidelines from a national perspective.

RECOMMENDED BOOKS

1. [Altman](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1/191-1100051-4484068?_encoding=UTF8&field-author=Arie%20Altman&ie=UTF8&search-alias=books&sort=relevancerank) A and  [Hasegawa](http://www.amazon.com/s/ref=ntt_athr_dp_sr_2/191-1100051-4484068?_encoding=UTF8&field-author=Paul%20Michael%20Hasegawa&ie=UTF8&search-alias=books&sort=relevancerank) PM, 2012. Plant Biotechnology and Agriculture: Prospects for the 21st Century. First Edition; Academic Press.
2. Laboratory Biosafety Manual , WHO, 2006. Third Edition; AITBS Publishers and Distributors, India. (Available online free of cost).
3. Furr AK, 2000. CRC Handbook of Laboratory Safety. Fifth Edition; CRC Press.
4. Jose Maria A, 2003. Genes Technology and Policy. Available online at; <http://www.apdip.net/publications/iespprimers/eprimer-genes.pdf>
5. Krishna VS, 2007. Bioethics and Biosafety in Biotechnology. New Age International Publishers.
6. National Biosafety Guidelines, 2005. Pakistan Environmental protection Agency (*Available online*)

**YEAR THREE**

**Semester-V**

**BIOT 302:PRINCIPLES OF BIOCHEMICAL ENGINEERING Credit hrs. 2**

COURSE OBJECTIVES

To acquaint students with fundamentals of biochemical engineering.

COURSE CONTENTS

Introduction to microorganisms and biological molecules; principles of enzyme catalysis; methods of enzyme and cell immobilization; enzyme kinetics; internal mass transfer effect on immobilized growth; stoichiometry models of microbial growth; structured model, of microbial growth; bioreactors - continuous stirred tank bioreactors, plug-flow and packed bed bioreactors, imperfect mixing, fed batch bioreactors, gas liquid mass transfer in bioreactors, power requirement for bioreactor, sterilization and heat transfer in bioreactors; introduction to bioproduct recovery; biological product manufacturing; economic analysis of bioprocesses; case study: penicillin.

RECOMMENDED BOOKS

1. Douglas SC and Blanch HW, 1997. Biochemical Engineering. Second Edition; CRC Publishers.

2. Bailey et al., 1986. Biochemical Engineering Fundamentals. Second Edition; McGraw-Hill

3. Aiba et al., 1973. Biochemical Engineering. Second Edition; Academic Press.

4. [Katoh](http://www.amazon.com/Shigeo-Katoh/e/B0034Q9GYI/ref=ntt_athr_dp_pel_1) S and [Yoshida](http://www.amazon.com/s/ref=ntt_athr_dp_sr_2?_encoding=UTF8&field-author=Fumitake%20Yoshida&search-alias=books&sort=relevancerank) F, 2009. Biochemical Engineering, a textbook for engineers, chemists and biologist**s**. Wiley VCH

5. [Clark](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=Douglas%20S.%20Clark&search-alias=books&sort=relevancerank) DS and[Blanch](http://www.amazon.com/Harvey-W.-Blanch/e/B001KI8Y8Q/ref=ntt_athr_dp_pel_2) HW, 1997. Biochemical Engineering, Second Edition (Chemical Industries). Second Edition; CRC Press

**BIOT 302P:PRINCIPLES OF BIOCHEMICAL ENGINEERING (Practical) Credit hr. 1**

PRACTICALS

Unstructured microbial growth with application of Monod model; inhibition kinetics and nutrient uptake rate; methods of immobilization via binding and physical retention; yield coefficient and stoichiometry; production of enzymes by structured and segregated models; bioreactor design and analysis (batch, fed-batch and continuous); enzyme catalysis in the CSTR; packed bed and plug flow bioreactor; rheology of fermentation broth; mixing and gas-liquid mass transfer, heat transfer, media and bioreactor sterilization techniques; techno-economic analysis of a typical bioprocess.

**BIOT 303: Bioinformatics Credit hr. 1**

OBJECTIVES

To familiarize students with biological data mining from online databases and the use of various bioinformatics tools for extracting and processing biological data.

COURSE CONTENTS

Introduction; bio-computing; biological databases - types and retrieval of nucleic acid (or genomic) or protein sequence information; sequence alignment - pairwise, multiple; phylogenetics; *in silico* identification of protein motifs and domains; structural bioinformatics of proteins and RNAs including protein modeling and prediction of their interactions with other proteins and small molecules; identification of genes and promoter regions within genomes; networks; strategies for whole genome sequencing and assembly.

RECOMMENDED BOOKS

1. Claverie JM and Notredame C, 2006. Bioinformatics for Dummies. Second Edition; Wiley Publishing.

2. Xiong J, 2006. Essential Bioinformatics. First Edition; Cambridge University Press.

3. Xia X, 2007. Bioinformatics and the Cell:Modern Computational Approaches in Genomics, Proteomics and Transcriptomics. First Edition. Springer

4. Mathura V and Kangueane P, 2009. Bioinformatics: A Concept-Based Introduction. Springer

5. Mount DW, 2004. Bioinformatics Sequence and Genome Analysis. Second Edition; Cold Spring Harbor Laboratory Press.

6. Sperschneider V, 2008. Bioinformatics: Problem Solving Paradigms. Springer.

**BIOT 303P: Bioinformatics (Practical) Credit hrs. 2**

RECOMMENDED DATABASES AND TOOLS

1. NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc.
2. Bioedit, Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip, MEGA4.0 etc.

**BIOT 304: METHODS IN MOLECULAR BIOLOGY Credit hrs. 1**

COURSE OBJECTIVES

To acquaint students with the experimental aspects of molecular biology

COURSE CONTENTS

Introduction to recombinant DNA technology; restriction and modifying enzymes; cloning and expression vectors and their types; expression of recombinant proteins and their purification by affinity chromatography; polymerase chain reaction (PCR) - types; (inverse, touch-down, nested, hemi-nested, pit stop, multiplex, reverse transcriptase, RACE, real-time) and its applications; detection of mutations and/or SNPs; DNA fingerprinting; analysis of nucleic acids by gel electrophoresis – horizontal, vertical, pulse field, denaturing gradient gel electrophoresis; analysis of proteins by native and SDS-PAGE; 2-D gels; generation of antibodies and their uses; enzyme-linked immunosorbant assay; Southern, Western, Northern blotting.

RECOMMENDED BOOKS

# [Ausubel](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=Frederick%20M.%20Ausubel&search-alias=books&sort=relevancerank) FM, 2005.  Short Protocols in Molecular Biology (2 volume set). Fifth Edition; John Wiley and Son.

# Green MR and Sambrook J, 2001. Molecular Cloning: A Laboratory Manual. Third Edition; Cold Spring Harbor Laboratory Press.

# [Primrose](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=Sandy%20B.%20Primrose&search-alias=books&sort=relevancerank) SB and [Twyman](http://www.amazon.com/s/ref=ntt_athr_dp_sr_2?_encoding=UTF8&field-author=Richard%20Twyman&search-alias=books&sort=relevancerank) R, 2006. Principles of Gene Manipulation and Genomics. Seventh Edition; Wiley- Blackwell.

# Wilson K and Walker J, 2010. Principles and Techniques of Biochemistry and Molecular Biology. Seventh Edition; Cambridge University Press.

# Walker JM and Rapley, 2008. Molecular Biomethods Handbook (Methods in Molecular Biology). Second Edition; Humana Press.

**BIOT 304P: METHODS IN MOLECULAR BIOLOGY (Practical) Credit hrs. 1**

PRACTICALS

Preparation of stock and working solutions; isolation of nucleic acids and their quantification; restriction digestion of DNA and preparation of restriction maps; gel electrophoresis; polymerase chain reaction (PCR); detection of mutations by restriction fragment length polymorphism; preparation of chemically competent cells; transformation of bacteria with plasmid DNA; analysis of proteins by SDS-PAGE

**BIOT 351: GENOMICS and PROTEOMICS Credit hrs. 3**

COURSE OBJECTIVES

The overarching goal of this course is to provide students with a thorough overview of both the theoretical and experimental aspects of structural and functional genomics as well as proteomics.

COURSE CONTENTS

Organization and structure of genomes; genetic mapping (RFLP, microsatellite, SNP); high-resolution physical mapping (STS, EST); flow cytometry; somatic cell and radiation hybrids; artificial chromosomes in bacteria and yeast; hierarchical and whole genome shotgun sequencing; DNA sequencing strategies - manual and automated sequencing, pyrosequencing, Solexa, Helicos, Roche 454, real-time and nanopore sequencing; sequence assembly, obstacles and solutions; estimating gene number – over-prediction and under-prediction, homology searches, exon prediction programs*,* integrated gene-finding software packages*; s*tructural variation in the genome and its applications; microarray and RNA interference; proteomics; cellular communication/signaling pathways; protein-protein interactions and validation - yeast two hybrid system, affinity purification-mass spectrometry (AP-MS), tandem affinity purification (TAP) tagging, fluorescence resonance energy transfer (FRET) and co-immunoprecipitation.

RECOMMENDED BOOKS

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

**BIOT 352: MICROBIAL BIOTECHNOLOGY Credit hrs. 2**

COURSE OBJECTIVES

To acquaint students with how modern methods may be employed to enhance the characteristics of microbes that are commonly used in various industries including food, agriculture and pharmaceutical.

COURSE CONTENTS

Issues and scope of microbial biotechnology; genetically modified microorganisms; microbes as tools for microbiological research; biotechnological potential of microbes; significance of microorganisms in food production, fermentation, pharmaceutical and other industries; vaccine development and production; microbiological mining, biofuels and use of microbes in petroleum industry; plant-microbe interactions; bio-fertilizers, biopesticides, composting; antimicrobials; significance of microbial biotechnology in the economic development of Pakistan.

RECOMMENDED BOOKS

1. Microbial Biotechnology in the Laboratory and Practice Theory, Exercises, and Specialist Laboratories. 2023
2. Microbial Biotechnology, 2019 Elsa Cooper, Syrawood Publishing House.
3. Basic Laboratory Methods for Biotechnology Textbook and Laboratory Reference By Lisa A. Seidman, Cynthia J. Moore, Jeanette Mowery · 2022
4. Microbial Biotechnology, 2019 Elsa Cooper, Syrawood Publishing House.
5. Molecular biotechnology, Principles and applications of recombinant DNA. Bernard R. Glick and Cheryl L. Patten. 2017. American society of Microbiology, USA. 5th edition.
6. Glick BR et al., 2009. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Fourth Edition; ASM Press.
7. Mukhopadhyay SN, 2004. Process Biotechnology Fundamentals. Second Edition. Anshan Publisher.
8. Goodsell DS, 2004. Bionanotechnology: Lessons from Nature. John Wiley and Sons.
9. Ray RC, 2005. Microbial Biotechnology in Agriculture and Aquaculture. NBN International.
10. Kreuzer H and Massey A, 2005. Biology and Biotechnology Science, Applications, and Issues. First Edition; ASM Press.
11. Harding SE, 2010. Biotechnology and Genetic Engineering Reviews. First Edition. Nottingham University Press.

**BIOT 352P: MICROBIAL BIOTECHNOLOGY (Practical) Credit hrs. 1**

PRACTICALS

Isolation and screening of potential microbes from different environmental sources; lab scale production of bacterial enzymes; lab-scale production of alcohol by yeast; the use of microbes in bioleaching; use of microbes in microbial enhanced oil recovery.

**BIOT 353: FOOD BIOTECHNOLOGY** **Credit hrs. 2**

COURSE OBJECTIVES

To acquaint students with the role of microorganisms in food and the food industry in addition to principles of enzymology, and food engineering

COURSE CONTENTS

Food composition, probiotics, fermented foods, food enzymes, colors and additives; overview of metabolic engineering of bacteria for food ingredients; techniques used for production of food ingredients by microbes; genetic modification of plant starches for food applications; biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables; microbial food spoilage and food borne diseases; detection and control of food borne bacterial pathogens; food safety and quality control; international aspects of quality and safety assessment of food derived by modern biotechnology.

RECOMMENDED BOOKS

1. V.A. Vaclavik, Elizabeth Christian and Tad Campbell .2021. Essential of Food Science 5th edition Springer
2. Mousumi Sen .2021. Food Chemistry Willy
3. M. Khuddus . 2019. Enzyme in Food Biotechnology production applications and future prospects Academic press Elsevier
4. Nielsen SS, 2017. Food Analysis. 5th Edition; Springe
5. Joshi VK, 2012. Food Biotechnology. First Edition; I K International Publishing House.
6. Campbell-Platt G, 2009. Food Science and Technology. First Edition; Wiley-Blackwell.
7. Singh RP, 2008. Introduction to Food Engineering. Fourth Edition; Academic Press
8. Belitz HD, 2009. Food Chemistry. Fourth Edition; Springer.
9. Nielsen SS, 2010. Food Analysis. 4th Edition; Springer

**BIOT 353P: FOOD BIOTECHNOLOGY (Practical)** **Credit hr. 1**

PRACTICALS

Pure culture study of fermented products such as yogurt, bread, pickles, acetic acid etc.; isolation and handling of microbial flora of fermented products as *Lactobacilli, Saccharomyces, Aspergillus, Acetobacter* etc.; preparation of fermented products using pure cultures; effect of pH on the microbial flora of different fermented products.

**BIOT 354: IMMUNOLOGY Credit hrs. 2**

COURSE OBJECTIVES

To acquaint students with the basic principles of innate and adaptive immune systems.

COURSE CONTENTS

Overview of the immune system as the body’s main defense mechanism; elements of innate and acquired immunity; cells and organs of the immune system; properties of antibodies and antigens together with their structure, function and interactions; genetics of antibody structure and diversity; expression of immunoglobulin genes; VDJ recombination; antigen processing and presentation; major histocompatibility complex; monoclonal and polyclonal antibodies; T-cell receptors, maturation, activation, and differentiation; B-cell generation, activation, and differentiation; complement system, hypersensitivity, cytokines, resistance and immune response to infectious diseases, cell-mediated effector response, leukocyte migration and inflammation, vaccines, diseases of the immune system - autoimmunity, transplantation immunology.

#### RECOMMENDED BOOKS

Kuby J, 2007. Immunology. Sixth Edition; WH Freeman, New York.

Janeway et al., 2001. Immunobiology - The immune system in health and disease. Fifth Edition; Garland Science Publisher, New York.

Anderson WL, 1999. Immunology. First Edition; Wiley-Blackwell.

Delves PJ et al., 2012. Roitt’s Essential Immunology. 12th Edition. Wiley-Blackwell

Abbas AK and Lichtman AH, 2010. Basic Immunology: Functions and Disorders of the Immune System. Third illustrated Edition; Saunders Publisher.

Harlow E and David L, 1988. Antibodies, A laboratory Manual. First Edition; Cold Spring Harbor laboratory Press.

**BIOT 354P: IMMUNOLOGY (Practical) Credit hr. 1**

PRACTICALS

Agglutination tests; enzyme-linked immunosorbent assay (ELISA); blood group determination (ABO and Rh); Western blot; Ouchterlony analysis

**YEAR FOUR**

**Semester-VII**

**BIOT 401: VIROLOGY Credit hrs. 3**

Course Objectives

Aim of this course is to provide a generalized overview of virology as its stands today.

Course Contents

Historical perspective; general properties of viruses; classification and nomenclature; virus structure and assembly; replication cycle and genetics of viruses; animal and plant viruses; propagation, detection and quantification of viruses; pathogenesis and immune response of viral infections; laboratory diagnosis of viral diseases; vaccines and antiviral drugs; epidemiology; tumor viruses; viral vectors and gene therapy; emerging viruses; specific aspects of selected viral diseases

PRACTICALS

Agglutination test, ELISA, CPE, Plaque Assay,Serology, Genotyping, PCR, real time PCR, Western Blotting, Cell culture.

Recommended Books

1. Flint et al., 2009. Principles of Virology. ASM Press, USA.
2. Lal S, 2007. The Biology of Emerging Viruses. Wiley-Blackwell, USA.
3. [Carter](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=John%20Carter&search-alias=books&sort=relevancerank) J [Saunders](http://www.amazon.com/s/ref=ntt_athr_dp_sr_2?_encoding=UTF8&field-author=Venetia%20Saunders&search-alias=books&sort=relevancerank) V. Virology: Principles and Applications. First Edition; Wiley.
4. [Wagner](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=Edward%20K.%20Wagner&search-alias=books&sort=relevancerank) et al., 2007. Basic Virology. Third Edition; Wiley-Blackwell
5. [Flint](http://www.amazon.com/S.-Jane-Flint/e/B0034Q40AS/ref=ntt_athr_dp_pel_1) SJ, 2009. Principles of Virology, Vol. 2: Pathogenesis and Control. Third Edition; AMS Press

**RESEARCH METHODOLOGY & SKILL ENHANCEMENT (3+0)**

COURSE OBJECTIVES

To familiarize students with various methods used for conducting research and latest trends in the field of biotechnology through reading and understanding scientific literature, preparing scientific manuscripts, designing research projects and presenting them.

COURSE CONTENTS

Introduction; unethical academic practices (plagiarism); need of research and research types; extraction and review of literature; identifying a research problem and formulating a hypothesis; designing a study; data collection, interpretation and analysis; writing a research report, project, thesis and/or research article or review; preparing posters; making scientific presentations; intellectual property.

RECOMMENDED BOOKS

1. Fundamentals of Research Methodology. 2020. Vicence Fernandez. Bryman A, . Social research methods. Second Edition; Oxford University Press.
2. Research Design: Qualitative, Quantitative and Mixed Methods Approaches 2014. 4th Editionby [John W. Creswell](https://www.amazon.com/John-W-Creswell/e/B001H6M9V4/ref=dp_byline_cont_book_1) . SAGE Publications, Inc Edition
3. Awan JA, 2003. Scientific Presentation. Unitech Communication, Faisalabad, Pakistan.
4. Kumar R, Kindersley D, 2010. Research Mehthodology: a step by step guide for beginners. Third Edition; SAGE Publications.
5. Kothari CR, 2004. Research Methodology: Methods and Techniques. Second Revised Edition; New Age International Publishers, New Delhi.

Durrani SA, 2004. Technical Writing. Higher Education Commission, Islamabad

**BIOT 402: INDUSTRIAL BIOTECHNOLOGY Credit hrs. 2**

COURSE OBJECTIVES

To provide students with a broad-based introduction to the field of industrial biotechnology.

COURSE CONTENTS

Industrial biotechnology – introduction and scope; microorganisms commonly used in industry; media and nutritional requirements of industrial organisms; screening for productive strains and strain improvement; culture collections; fermentation and fermenters; extraction of fermented products; production of beer, wines, spirits and vinegar; use of single cell proteins as food products; biocatalysts; microbial insecticides; production of metabolites: organic acids and amino acids; vaccines and antibiotic production

RECOMMENDED BOOKS

1. Verma P, 2022. Industrial Microbiology and Biotechnology. Edition 1st; Springer Nature; pg: 1-747
2. Thatoi. H., et al., 2021. Bioprocessing of Enzymes in Industry, Healthcare and Sustainable environment, 1st Edition, Springer Nature
3. Das D., et al.2021. Industrial biotechnology. CRC Press Publisher,
4. Peter F Stanbury, Allan Whitaker, Stephen J Hall. 2016. Copyright © 2016 Elsevier Ltd. All rights reserved.
5. Shijie Liu. 2020. Bioprocess Engineering: Kinetics, Sustainability and reactor design 3rd ed.. Elsevier
6. Okafor N, 2017. Modern Industrial Microbiology and Biotechnology. 2nd Edition; CRC Press
7. Waites et al., 2009. Industrial Microbiology: An Introduction. Blackwell Science Ltd.
8. Shara et al., 2009. Industrial Biotechnology. First Edition; Nova Science Publishers
9. Abhilasha MS, 2009. Industrial Biotechnology. ANE Books

**BIOT 402P: INDUSTRIAL BIOTECHNOLOGY (Practical) Credit hrs. 1**

PRACTICALS

Isolation of *lactobacillus* from dairy products, fruit juices, etc.; fermentation of different sugars by bacteria (or other microorganisms); identification of proteases/ amylases producing bacteria; extraction of hydrolytic crude enzymes from microbes; effect of environmental factors (e.g., pH, temperature, salt, etc.) on activity of crude enzymes.

**BIOT 354: CLINICAL MICROBIOLOGY Credit hrs. 2**

**COURSE OBJECTIVES**

This course will provide the conceptual basis for understanding pathogenic microorganisms and particularly address the fundamental mechanisms of their pathogenicity. It will also provide opportunities for a student to develop both informative and diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases

**COURSE CONTENTS**

An introduction to clinical bacteriology. Hazzards in clinical microbiology laboratory. Role and importance of normal flora in different parts of body. Respiratory tract infections. Infections of eye, ear and skin. Fluids from infected joints, CSF, pleural and peritoneal fluids. Differential diagnosis of selective systemic bacterial infections of GIT, genitourinary, cardiovascular and central nervous system. Nosocomial infections: prevention and control, Principles of latest diagnostic procedures. Post operative infections. Antimicrobial Chemotherapies and their targets. Drug resistance, drug-bacteria relationship, clinical implications, and prevention. Medically important viruses and fungus, their diagnosis and prevention.

**RECOMMENDED BOOKS**

1. [Michael A. P Faller](http://www.bookdepository.com/author/Michael+A.+Pfaller)., (2015) Manual of clinical microbiology. 11th edition [American Society for Microbiology](http://www.bookdepository.com/publishers/American+Society+for+Microbiology) Washington DC
2. [Geo. F. Brooks](http://www.bookdepository.com/author/Geo.+F.+Brooks)  ,[Janet S. Butel](http://www.bookdepository.com/author/Janet+S.+Butel) , By [Stephen A. Morse](http://www.bookdepository.com/author/Stephen+A.+Morse)., (2013). Jawetz Melnick & Adelbergs Medical Microbiogy,26th edition, [McGraw-Hill Education Europe](http://www.bookdepository.com/publishers/McGraw-Hill+Education+-+Europe), New York.
3. Patricia Tille., (2013) Bailey & Scott's Diagnostic Microbiology.13th edition. [Elsevier Health Sciences Division](http://www.bookdepository.com/publishers/Elsevier+-+Health+Sciences+Division), St Louis.
4. Gladwin, M., Trattler,B., Trattler. B., 2004 Clinical Microbiology Made Ridiculously Simple, 3rd Edition, MedMaster, Incorporated
5. Jones, S.L., and Ed. Jones,R.,2001, Clinical Laboratory Pearls . Lippincott Williams & Wilkins
6. Murray, P.R., Rosenthal, K.S., Pfaller, M.A., Rosenthal, K.S., (2005), Medical Microbiology: Elsevier Health Science
7. Hawkey, P and Lewis, D., 2004. Medical Bacteriology: A Practical Approach. 2nd Edition .Oxford University Press;
8. Stephen, J., Mims, C.A., Nash, A.2000. Mims' Pathogenesis of Infectious Disease. 5th Edition. Academic Press Inc.,U.S.
9. Greenwood, D., Slack, C.B.R., and Peutherer,J.F., 2002. Medical Microbiology: A Guide to Microbial Infections: Pathogensis, Immunity, Laboratory Diagnosis and Control

**BIOT 354P: CLINICAL MICROBIOLOGY (Practical) Credit hrs. 1**

**PRACTICALS**

1. Good laboratory practices

2. Collection and processing of different clinical specimen.

3. Isolation and identification of pathogens from different clinical specimen.

4. Antibiotic sensitivity test by various techniques.

**SEMESTER-VIII**

**BIOT 451: PHARMACEUTICAL BIOTECHNOLOGY Credit hrs. 3**

COURSE OBJECTIVES

To familiarize students with the general process of drug development, basic concepts of biopharmaceuticals and how they are better than conventional drugs.

COURSE CONTENTS

Introduction and basic concepts of pharmaceutical biotechnology; properties of an effective drug; drug development process; selection of a lead molecule from available pool, lab scale studies, pilot scale studies and clinical trials (Phase I, II and III); drug toxicity; impact of genomics and other related technologies on drug discovery; use of DNA and protein microarrays in identification of disease targets and for monitoring effectiveness of drugs; pharmacogenomics; plants and microorganisms as sources of drugs; polymers: classification, polymerization and characterization; controlled drug release system and its advantages and disadvantages over conventional release methods; legal and regulatory issues.

RECOMMENDED BOOKS

1. Kayser O, 2012. Pharmaceutical Biotechnology: Drug Discovery and Clinical Application. Second Edition; Wiley-Blackwell.
2. Kokate C, 2012. Textbook of Pharmaceutical Biotechnology. ELSEVIER
3. Crommelin et al., 2007. Pharmaceutical Biotechnology: Fundamentals and Applications. Third Edition. Informa Healthcare.
4. am Ende DJ, 2010. Chemical Engineering in the Pharmaceutical Industry: R&D to Manufacturing. First Edition; Wiley
5. Subramanian G, 2012. Biopharmaceutical Production Technology. First Edition.Wiley-VCH

**BIOT 452:** **FORENSIC BIOTECHNOLOGY Credit hrs. 3**

**COURSE OBJECTIVES**

This course will provide the conceptual basis for understanding fundamental concept of forensic science and its application in society. It will also provide opportunities for a student to develop both informative and diagnostic skills in forensic Biotechnology, including the practical application and interpretation of laboratory tests for the diagnosis of criminals.

**COURSE OUTLINE**

An introduction to Forensic Science, Principles, Laws of Forensic Science, Historical Background, Need of Forensic Science in present scenario, Forensic Science Laboratories, Laboratories at central and state level. Crime : Definition, types and causes of crime. Investigation & examination of various types of cases (a) Murder (b) Rape (c) Burglary (d) Railway & Air Crashes (e) Road Accidents etc. Location, Collection & Evaluation of various types of Tool Marks & Trace Evidences (Paint, Soil, Glass, Detective Dyes, GSR etc.). 1. Crime Detection Devices: UV, IR, X-Rays, their nature and applications, Detective Dyes, Neutron Radiography, Microscopy, Chromatography, DNA analyzer. Fingerprints Examination: History & Development, Fundamental Principles, Types of Fingerprints, Classification of Fingerprints, Fingerprint characteristics. Recent Advanced Techniques used in Forensic Science : Lie Detection, Voice Identification, DNA Profiling, Narco Analysis, Brain Fingerprinting.

**RECOMMENDED BOOKS**

1. [Val McDermid](http://www.bookdepository.com/author/Val-McDermid) (2014)Forensics : The Anatomy of Crime [Profile Books Ltd](http://www.bookdepository.com/publishers/Profile-Books-Ltd)
2. [Jim Fraser](http://www.bookdepository.com/author/Jim-Fraser) (2015).Forensic Science: A Very Short Introduction [Oxford University Press](http://www.bookdepository.com/publishers/Oxford-University-Press)

# Mike Maguire, Rod Morgan, and Robert Reiner (2012) The Oxford Handbook of Criminology. 5th edition . Oxford press

1. DNA Technology in Forensic Science (1992) National Research Council (US) Committee on DNA Technology in Forensic Science. Washington (DC): [National Academies Press (US)](http://www.nap.edu/)

**BIOT 453: HEALTH BIOTECHNOLOGY Credit hrs. 3**

COURSE OBJECTIVES

To acquaint students with biotechnology in healthcare including diagnostic tools, immunization and therapeutics.

COURSE CONTENTS

Introduction to health biotechnology; social acceptance of medical biotechnology; molecular basis of disease; molecular and genetic markers; detection of mutations and infectious agents; active and passive immunization; vaccines (live, killed, recombinant DNA vaccines, subunit vaccines, DNA vaccines, edible vaccines); organ transplantation; applications of transgenic animals (animal models of diseases, farming and enhancement of farm animals); drug delivery systems; blood transfusion and grafting techniques; pharmacogenetics; gene therapy; biopharmaceuticals from plants; stem cell technology

RECOMMENDED BOOKS

1. Pongracz J and Keen M, 2009. Medical Biotechnology. First Edition; Elsevier Health Sciences.

2. Schacter BZ, 2005. Biotechnology and Your Health: Pharmaceutical Applications. Chelsea House Publishers,

3. Chetan DM and Dinesh KP, 2006. Health and Pharmaceutical Biotechnology. Firewall Media.

4. Bustillo LGT and Pena IG, 2012. Biotechnology: Health, Food, Energy and Environment Applications (Biotechnology in Agriculture, Industry and Medicine). Nova Science Publication.

5. Dogramatzis, 2010. Health care Biotechnology. First Edition; CRC Press

**Allied Courses**

**Course Title: Elementary Biostatistics**

**Course Code:** BIOT-301

**Credit Hours: 3 (3+0)**

**Course Synopsis:**

The discussion of the concept of basic tools of statistics will be made students to familiarize the data analysis by using SPSS and their application to real world problems.

**Course Objective:**

* To discuss the concept of basics of statistics.
* To acquaint the students with basics of probability, sampling techniques and testing procedures.

1. To familiarize students with the considerations of working with and interpreting biological data.
2. To familiarize students with basic univariate analyses, and when to apply them.

**Course Contents:** Introduction of Biostatistics, measurements and measurement scales, sampling and statistical inference, the scientific method and design of experiments. Descriptive statistics, frequency distribution, graphical representation of data (graphs for quantitative and qualitative data), measure of central tendency (mean, median and mode), measures of dispersion (variance, coefficient of variation). Some Basic probability concepts, Two views of probability: objective and subjective, elementary properties of probability, calculating probability of event, bayes theorem, sensitivity, specificity, predictive value positive and negative, screening. Some important sampling distributions (sampling distribution of sample means and difference between sample means). Hypothesis testing (testing hypothesis of single population mean, difference between two population means, paired comparisons). Analysis of variance, multiple post-hoc test: multiple comparison test (LSD and Duncan’s test), experimental design (completely randomized, randomized complete block design, repeated measure design and factorial experiment).

**Course Learning Outcome:**

The students should be able

* To learn the basic knowledge of Statistics and utilizing SPSS software to present and analyze the data of different fields.

**Recommended Books:**

1. Daniel, W. W., Cross, C. L. (1995). *Biostatistics: A Foundation for Analysis in the Health Sciences* (11th Edition). John Wiley & Sons, Inc.
2. & Mallery, P. (2019). *IBM SPSS statistics 26 step by step: A simple guide and reference (16th ed.).* Routledge. New York.
3. Witte, R. S., & Witte, J. S. (2017). *Statistics. John Wiley & Sons.* USA.
4. Chaudry, S. M., & Kamal, S. (2010). *Introduction to statistical theory Part I*. Ilmi Kitab Khana. Lahore.
5. Chaudhry, S. M., & Kamal, S. (2009). *Introduction to statistical theory: Part II.* Ilmi Kitab Khana. Lahore.
6. De Sá, J. P. M. (2007). *Applied statistics using SPSS, Statistica, Matlab and R (2nd ed.).* Springer Science & Business Media. New York.

**---- Physics for Biologists 3(3+0)**

COURSE OBJECTIVES

This course is intended for students studying life sciences and aims to impart fundamental concepts of physics in the context of biological systems.

COURSE CONTENTS

Essentials of thermodynamics; concept of entropy, enthalpy and Gibb’s free energy; order and disorder in biological systems; molecules, diffusion, random walks and friction; methods of studying macromolecules; interactions of molecules in 3-D space – determining binding and dissociation constants; molecular motors; sedimentation; Reynold’s number; chemical forces and self-assembly; physics of ion channels.

RECOMMENDED BOOKS

1. Nelson P, 2004. Biological Physics, Energy, Information and Life. First Edition; WH Freeman & Company.

2. Kirsten et al., 2010. Introduction to Biological Physics for the Health and Life Sciences. Second Edition; John Wiley & Sons.

3. Davidovits P, 2013. Physics for Biology & Medicine. 4th Edition; Academic Press.

4. Newman, 2008. Physics of the Life Sciences. Springer.

5. Duncan, 1975. Physics for Biologist. Blackwell Science.

**---- Biomathematics 3(3+0)**

Course Objectives

This course aims to provide students with the essential concepts of biomathematics and how these can be employed for analyzing real data.

COURSE CONTENTS

*Preliminaries:* Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities, binomial theorem and its use. *Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions. *Derivatives and their Applications:* Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

*Integration and Definite Integrals:* Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals. Application and importance of calculus for biotechnology; the exponential growth curve and growth equation.

Recommended Books

1. Helfgott M, and Moore D, 2011. Introductory Calculus for the Natural Sciences. CreateSpace Independent Publishing Platform, USA.
2. Neuhauser C, 2010. Calculus for Biology and Medicine. Prentice Hall
3. Anton H et al., 2005. Calculus: A New Horizon. John Wiley, New York.
4. Thomas GB and Finney AR, 2005. Calculus. Addison-Wesley, Reading, USA.
5. Kumar A, 2011. Mathematics for biologist. First Edition; Alpha science international.

**NANOBIOTECHNOLOGY 3 (3+0)**

COURSE OBJECTIVES

To acquaint students with key integrative technologies and use of nanoparticles in biological systems

COURSE CONTENTS

Introduction; interface between nanotechnology and bionanotechnology; manipulating molecules; carbon fullerenes and nanotubes; non-carbon nanotubes and fullerene-like materials; quantum dots; nanowires, nanorods and other nanomaterials; magnetic nanoparticles; natural biological assembly at the nanoscale and nanometric biological assemblies (complexes); nanobionics and bio-inspired nanotechnology; applications of biological assemblies in nanotechnology; medical, cosmetics, agriculture, water and other applications of nanobiotechnology; future prospects of nanobiotechnology; use of nanotechnology for diagnosing and curing disease.

RECOMMENDED BOOKS

1. Gazit E, 2007. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. First Edition; Imperial College Press.

2. Renugopalakrishnan V and Lewis RV, 2006. Bionanotechnology: Proteins to Nanodevices. Springer.

3. Greco et al., 2004. NanoscaleTechnology In Biological Systems. CRC Press.

4. Mirkin CA and Niemeyer CM, 2007. Nanobiotechnology II: More Concepts and Applications. John Wiley & Sons.

# 5. [Niemeyer](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=Christof%20M.%20Niemeyer&search-alias=books&sort=relevancerank) CM and [Mirkin](http://www.amazon.com/s/ref=ntt_athr_dp_sr_2?_encoding=UTF8&field-author=Chad%20A.%20Mirkin&search-alias=books&sort=relevancerank) CA, 2004. Nanobiotechnology. First Edition; Wiley VCH.

**CS2-XXX Artificial Intelligence**

**Credit Hours 3(2-3)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Program:** BSCS | | **Semester:** | | |
| **Pre-Requisite:** Object Oriented Programming | | **Follow Up:** None | | |
| **Course Description**  Artificial Intelligence has emerged as one of the most significant and promising areas of computing. This course focuses on AI methodology and fundamentals; intelligent agents; search algorithms; game playing; machine learning; uncertainty and probability theory; probabilistic reasoning in AI; Bayesian networks; decision making, and reinforcement learning. This is an introductory course on Artificial Intelligence. Several assignments will be given to enable the student to gain practical experience in using these techniques. | | | | |
| **Course Learning Outcomes** | | | | **Bloom Taxonomy** |
| **CLO-01**  **CLO-02**  **CLO-03**  **CLO-04** | Learn "Artificial" Intelligence and how to identify systems with Artificial Intelligence.  Understand AI search algorithms and AI agents, to build simple knowledge-based systems.  Implement artificial intelligence techniques and case  Studies  Analyze and interpret different artificial intelligence techniques for problem solving. | | | C1, C2  C2  C3  C4 |
| **TextbooksC2**  1. Russell, S. and Norvig, P. “Artificial Intelligence. A Modern Approach”, 3rd ed, Prentice  Hall, Inc., 2015.  2. Artificial Intelligence by Luger, 4th edition Pearson Education. | | | | |
| **Reference Books / Material**  1. Norvig, P., “Paradigms of Artificial Intelligence Programming: Case studies in Common  Lisp”, Morgan Kaufman Publishers, Inc., 1992.  2. Severance, C.R., 2016. “Python for everybody: Exploring data using Python 3.”  CreateSpace Independent Publ Platform.  3. Joshi, P., 2017. “Artificial intelligence with python.” Packt Publishing Ltd. | | | | |
| **Course Distribution** | Theory: % 30  Problem Analysis: % 45  Solution Design: % 20  Social and Ethical Issues: % 5 | | | |
| **Marks Distribution** | **Theory:**  ***Mid Term***  Assignment: Marks: 10  Quiz: Marks: 10  Mid Term Exam: Marks: 30  ***End Term***  End Term Exam: Marks: 50 | | **Practical:**  Practical: Marks: 100 | |
| **Technology Involved** (Multimedia, Overhead Projector, Web, etc.) | | | | |
| **Practiced Techniques** (Class Room Lecture, Presentation, Workshop, Group Discussion, Survey, etc.) | | | | |

**Theory**

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| **Week** | **Topic** | **Recommendation of Learning Activities** (Assignments, Quizzes, Practical, Case study, Project, Lab work or reading assignment) | **Objectives/**  **Outcomes** (PLO, CLO) |
| 1 | Artificial Intelligence  Introduction: What is AI, Foundations, History, Branches of AI, scope of Weak AI and Strong AI | Reading Assignment | CLO-01  PLO-01 |
| 2 | Artificial Intelligence  Intelligent agents: Introduction, types, difference between cybernetic intelligence and artificial intelligence, Objectives of AI | Assignment 1 | CLO-01  PLO-02 |
| 3 | Reasoning  Logical agents: Propositional Logic  First Order Logic: Syntax and Semantics, Extensions and Notations, Inference Rules involving quantifiers, generalized modus ponens | Reading Assignment | CLO-02  PLO-03 |
| 4 | Knowledge Representation  Introduction, Examples (Animal-Bird, Snow-Ice etc.), Conceptual Graphs, | Reading Assignment | CLO-02  PLO-03 |
| 5 | Expert Systems  Introduction and Applications | Test 1 | CLO-02  PLO-04 |
| 6 | Problem Solving  Solving problems by searching: Formulating Problems  Depth-first Search, Breadth-First Search | Reading Assignment | CLO-03  PLO-06 |
| 7 | Problem Solving  Informed searching Methods: Best First Search, A\*  Constraint Satisfaction Problems | Quiz/Presentation | CLO-03  PLO-06 |
| 8 | Problem Solving  Adversarial Search-Game Playing: Introduction, Min-Max Algorithm, alpha beta Pruning, Example of chess | Reading Assignment | CLO-04  PLO-05 |
| **Mid Term Exam** | | | |

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| **Week** | **Topic** | **Recommendation of Learning Activities** (Assignments, Quizzes, Practical, Case study, Project, Lab work or reading assignment) | **Objectives/**  **Outcomes** (CLO, PLO) |
| 9 | Learning  Learning from Observations: General model of learning agents,  Inductive Learning, Learning Decision Trees, Supervised Learning | Reading Assignment | CLO-03  PLO-06 |
| 10 | Learning  Unsupervised Learning, Connectionist network, Belief Networks | Test 2 | CLO-03  PLO-05 |
| 11 | Learning  Reinforcement Learning, Active and Passive Learning | Reading Assignment | CLO-04  PLO-06 |
| 12 | Uncertainty  Acting under uncertainty, Basic probability Notation, Axioms of Probability, Bayes Rules | Quiz | CLO-03  PLO-07 |
| 13 | Probabilistic Reasoning  Representing vagueness: Fuzzy sets and fuzzy logic | Reading Assignment | CLO-03  PLO-05 |
| 14 | Probabilistic Reasoning  Introduction to Probabilistic Reasoning, Rule Based Method for Uncertain Reasoning,  Representing ignorance: Dempster -Shafer theory | Reading Assignment | CLO-04  PLO-07 |
| 15 | Genetic Algorithms and Evolutionary Paradigms, Recent Trends in AI | Presentation | CLO-03 |
| 16 | Case Studies: Eliza, Mycin, Siri, Alexa | Presentation | CLO-04  PLO-07 |
| **Final Term Exam** | | | |

**Lab**

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| **Week** | **Topic** | **Recommendation of Learning Activities** (Assignments, Quizzes, Practical, Case study, Project, Lab work or Reading assignment) | **Objectives/**  **Outcomes** (PLO, CLO) |
| 1 | Introduction to Python, Handling Python with some examples, Simple program, its various sections and their usage | Practical | CLO-03  PLO-05 |
| 2 | Implement Python programs with loops, Working with System Clock, Birth date program, Identification of alphabets (small and upper case) | Practical | CLO-03  PLO-05 |
| 3 | Implement Python programs with conditionals. | Practical | CLO-03  PLO-05 |
| 4 | Implementation of DFS, Implementation of Breadth First Search | Practical | CLO-03  PLO-05 |
| 5 | Implementation of Best First Search, A\* | Practical | CLO-03  PLO-05 |
| 6 | Working with simple Chabot, Implement Tower of Hanoi. | Practical | CLO-03  PLO-05 |
| 7 | Working with Predicates, rules and inferences, Simple Program | Practical | CLO-03  PLO-05 |
| 8 | Handling mathematical operations, Developing simple calculator | Practical | CLO-03  PLO-05 |
| 9 | Handling logic under various rules, to calculate the distance between source and destination | Practical | CLO-03  PLO-05 |
| 10 | Implementation of Python basic Libraries such as Math, Numpy and Scipy | Practical | CLO-03  PLO-05 |
| 11 | List Processing, creation, addition, deletion of list elements, List Processing, searching | Practical | CLO-03  PLO-05 |
| 12 | Comparison of list elements, Finding and removing negative values from list | Practical | CLO-03  PLO-05 |
| 13 | Implementation of Bayes Rules | Practical | CLO-03  PLO-05 |
| 14 | Bayes Rules using different datasets | Practical | CLO-03  PLO-05 |
| 15 | Implementation of Decision Trees | Practical | CLO-03  PLO-05 |
| 16 | Decision Trees using different datasets | Practical | CLO-03  PLO-05 |
| **Final Term Exam** | | | |