CURRICULUM FOR 2-YEAR ASSOCIATE DEGREE / BS (4-YEAR) IN BIOTECHNOLOGY

Under graduate Education Policy 2023 and onward

DEPARTMENT OF BIOTECHNOLOGY
UNIVERSITY OF MALAKAND

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

SCHEME OF STUDIES FOR 2-YEAR ASSOCIATE DEGREE / BS (4-YEAR) IN BIOTECHNOLOGY

1. Associate degree (2-Year) Science (Biotechnology) and

Associate Degree (2-Year) Science (Biotechnology) shall comprise whole of four (4) semesters, 66 credit hours. Including General education courses of 30 credit hours, and Major (M) courses of 36 credit hours (single major as per UGE policy 2023). Semester 01 to 04.

2. BS (4-Year) in Biotechnology

BS (4-Year) in Biotechnology shall comprise whole of eight (8) semesters, 132 credit hours. Including General education courses of 30 credit hours, Major (M) courses of 90 credit hours (single major as per UGE policy 2023), and Interdisciplinary (I) course of 12 credit hours.

Semester -1			
Code	**Title**	**Cred. Hrs.**	**Course status**
ENG 101	Functional English	3	Gen-Edu
CHEM 110 / GS 117	Chemistry in Everyday Life / General Science	3	Gen-Edu
SOC 116 PSC 112	Introduction to sociology / Fundamental of Political Science	2	Gen-Edu
CS 110	Introduction to Information and Communication Technologies	3 (2+1)	Gen-Edu
ISL 112/ETH 118	Islamic Studies/Ethics (for non-Muslims)	2	Gen-Edu
BT 111	Cell Biology	3 (2+1)	Major
	Teaching of the Holy Quraan with Translation	Non-Credit	
	Total Credit Hours:	**16**	

Semester 2			
Code	**Title**	**Cred. Hrs.**	**Course status**
ENG 102	Introduction to Expository Writing	3	Gen-Edu
QR 101	Quantitative Reasoning-I (Mathematics)	3	Gen-Edu
PSC 111	Ideology and Constitution of Pakistan	2	Gen-Edu
SOC 319	Population Dynamics of Pakistan	2	Gen-Edu

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

ISL 113	Seerah and its Contemporary Application سیرت رسول ﷺ اور اس کی عصری معنویت/Any course from Arts and Humanities (General Education) for non- Muslims	2	Gen-Edu
BT 121	Microbiology	3 (2+1)	Major
	Teaching of the Holy Quraan with Translation	Non-Credit	
	Total Credit Hours:	**15**	

Semester 3			
Code	**Title**	**Cred. Hrs.**	**Course status**
MGT 215	Entrepreneurship	2	Gen-Edu
QR 102	Quantitative Reasoning-II (Statistics)	3	Gen-Edu
BT 231	Introduction to Biotechnology	3	Major
BT 232	Classical Genetics	3	Major
BT 233	Biochemistry-1	3 (2+1)	Major
BT 234	Molecular Biology	3	Major
	Teaching of the Holy Quraan with Translation	Non-Credit	
	Total Credit Hours:	**17**	

Semester 4			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 241	Analytical Chemistry & Instrumentation	3 (2+1)	Major
BT 242	Genetic Resources & Conservation	3	Major
BT 243	Biochemistry-II	3 (2+1)	Major
BT 244	Methods in Molecular Biology	3 (1+2)	Major
BT 245	Bioinformatics	3 (1+2)	Major
BT 246	Biosafety and Bioethics	3	Major
	Teaching of the Holy Quraan with Translation	Non-Credit	
	Total Credit Hours:	**18**	

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Semester 5			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 351	Immunology	3 (2+1)	Int-Disp
BT 352	Industrial Biotechnology	3 (2+1)	Major
BT 353	Genomics & Proteomics	3 (2+1)	Major
BT 354	Cell and Tissue Culture	3 (2+1)	Major
BT 355	Food Biotechnology	3(2+1)	Major
BT 356	Research Methodology & Skill Enhancement	3+0	Major
	Teaching of the Holy Quraan with Translation	Non-Credit	
Total Credit Hours:		**18**	

Semester 6			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 361	Molecular Diagnostics	3 (2+1)	Major
BT 362	Environmental Biotechnology	3 (2+1)	Major
BT 363	Animal Biotechnology	3 (2+1)	Major
BT 364	Hospital waste Management	3+0	Major
BT 365	Biological Physics	3+0	Int-Disp
BT 366	Virology	3+0	Int-Disp
	Teaching of the Holy Quraan with Translation	Non-Credit	
Total Credit Hours:		**18**	

Semester 7			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 471	Plant Biotechnology	3 (2+1)	Major
BT 472	Microbial Biotechnology	3 (2+1)	Major
BT 473	Health Biotechnology	3 (2+1)	Major

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

BT 474	Principals of Biochemical Engineering	3 (2+1)	Int-Disp
BT 475	**Field Experience/Internship/Research**	3	Major
	Teaching of the Holy Quraan with Translation	Non-Credit	
Total Credit Hours:		**15**	

Semester 8			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 481	Fermentation Biotechnology	3 (2+1)	Major
BT 482	Agriculture Biotechnology	3 (2+1)	Major
BT 483	Nanobiotechnology	3 (2+1)	Major
BT 484	Pharmaceutical Biotechnology	3+0	Major
BT 500	**Capstone Project/thesis**	3	Major
	Teaching of the Holy Quraan with Translation	Non-Credit	
Total Credit Hours:		**15**	

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website. For any query the office of the Registrar Academics may be approached for clarification/guidance.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Semester wise courses distribution

Semester -1			
Code	**Title**	**Cred. Hrs.**	**Course status**
ENG 101	Functional English	3	Gen-Edu
CHEM 110 / GS 117	Chemistry in Everyday Life / General Science	3	Gen-Edu
SOC 116 PSC 112	Introduction to sociology / Fundamental of Political Science	2	Gen-Edu
CS 110	Introduction to Information and Communication Technologies	3 (2+1)	Gen-Edu
ISL 112	Islamic Studies (Muslims)/Ethics (Non-Muslims	2	Gen-Edu
BT 111	Cell Biology	3 (2+1)	Major
	Total Credit Hours:	**16**	

CELL BIOLOGY **Course Code: BT 111**
Credit Hours: 3(2+1)

- **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.
- **Learning outcomes**: The students will be able to know about the cells types, organelles functions and structure/ultrastructure, thy will be able to know the structure and functions of nucleus and genetic materials.
- **Course Contents:**
- Introduction to cell theory including historical perspective; overview of membrane structure; composition and structure of membranes; membrane receptors and transport mechanisms; 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; cell movement - structure and function of cytoskeleton, centriole, cilia and flagella; nucleus; structure and function of chromosomes; cell cycle, mitosis and meiosis.
- **Practical:**
- Microscopy and staining techniques; study of prokaryotic, eukaryotic, plant and animal cells; cell

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

structure in the staminal hair of *Tradescantia*; study of different types of plastids; cellular reproduction; Mitosis: smear/squash preparation of onion roots.

- **Recommended Books:**

- 1. Alberts B and Johnson A, 2006. Molecular Biology of the Cell. 4th Edition; Garland Publishers, New York. (available at www.ncbi.nlm.nih.gov)
- 2. Karp, 2002. Cell and Molecular Biology. 3rd Edition; John Wiley and Sons, New York.
- 3. Alberts et al., 2009. Essential Cell Biology. 3rd Edition; Garland Publishers, New York.
- 4. Lodish et al,. 2007. Molecular Cell Biology. 6th Edition; Freeman and company, New York. (available at www.ncbi.nlm.nih.gov)
- 5. Cooper GM and Hausman RE, 2009. The Cell, a molecular approach. 5th Edition; Sinauer Associates, Inc.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Semester 2			
Code	**Title**	**Cred. Hrs.**	**Course status**
ENG 102	Introduction to Expository Writing	3	Gen-Edu
QR 101	Quantitative Reasoning-I (Mathematics)	3	Gen-Edu
PSC 111	Ideology and Constitution of Pakistan	2	Gen-Edu
SOC 319	Population Dynamics of Pakistan	2	Gen-Edu
ISL 113	Seerah and its Contemporary Application سیرت رسول ﷺ اور اس کی عصری معنویت /Any course from Arts and Humanities (General Education) for non- Muslims	2	Gen-Edu
BT 121	Microbiology	3 (2+1)	Major
	Total Credit Hours: 15		

MICROBIOLOGY (M)

Course Code: BT121
Credit Hours: 3(2+1)

Course Objectives:

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

Learning outcomes; At the end of this course, students will be able to know basics of various cells types and viruses structure.

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.

Practical:

Sterilization techniques; culturing of bacteria in liquid and on solid medium; Gram-staining of bacteria; colony and cell morphology; bacterial cell count and growth curves; biochemical tests.

Recommended Books:

1. Alcamo IE, 2010. Fundamentals of Microbiology. 9th Edition, Jones and Bartlett Publishers.
2. Madigan MT and Martinko J, 2010. Brock Biology of Microorganisms. 13th Edition; Pearson College Div.
3. Talaro KP, 2009. Foundations in Microbiology: Basic Principles. 7th Edition; McGraw-Hill

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

Publisher.

4. Black JG, 2007. Microbiology: principles and explorations. 7th Edition; John Wiley and Sons.
5. Baker et al., 2006. Instant Notes in Microbiology. 3rd Edition; Taylor and Francis.
6. Prescott et al., 2005. Microbiology. 6th Edition; McGraw-Hill Medical Publishing.
7. Cappuccino JG and Sherman N, 2013. Microbiology: a laboratory manual. 10th Edition; Pearson Education.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Semester 3			
Code	**Title**	**Cred. Hrs.**	**Course status**
MGT 215	Entrepreneurship	2	Gen-Edu
QR 102	Quantitative Reasoning-II (Statistics)	3	Gen-Edu
BT 231	Introduction to Biotechnology	3	Major
BT 232	Classical Genetics	3	Major
BT 233	Biochemistry-1	3 (2+1)	Major
BT 234	Molecular Biology	3	Major
	Total Credit Hours:	**17**	

INTRODUCTION TO BIOTECHNOLOGY (M) **Course Code: BT231**
Credit Hours: 3+0

- **Course Objectives:**
- To acquaint students with the basic concepts and significance of biotechnology as it stands today.
- Learning outcomes: the students will be able to know about the introduction of biotechnology and its applications.
- **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. Daugherty E, 2012. Biotechnology: Science for the New Millennium. 1st Edition, Revised; Paradigm Publication.
2. Smith JE, 2009. Biotechnology. 5th Edition; Cambridge University Press.
3. Nicholl TSD, 2004. An Introduction to Genetic Engineering. 2nd Edition; Cambridge University Press, UK.
4. Purohit SS, 2005. Biotechnology Fundamentals & Application. 4th Edition; Agro Bios, India.
5. Ratlegde C and Kristiansen B, 2006. Basic Biotechnology. 2nd Edition; Cambridge University Press, UK.
6. Thomas JA and Fuchs RL, 2002. Biotechnology and Safety Assessment. 3rd Edition; Academic Press, UK.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

CLASSICAL GENETICS (M) **Course Code: BT 232**
Credit Hours: 3+0

- **Course Objectives:**
- To acquaint students with classical aspects of genetics.
- **Learning outcomes**: students will be able to understand the basics of classical genetics, genetic materials, function and structure of gentic materials,
- **Course Contents:**
- Classical Mendelian genetics; monohybrid crosses, dominance, re-cessiveness, co-dominance, and semi-dominance; 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. 5th Edition; John Willy & Sons, New York.
2. Klug WS and Cumming MR, 2008. Concepts of Genetics. 9th Edition; Prentice Hall, USA.
3. Pierce B, 2004. Genetics: A Conceptual Approach. 2nd Edition; WH Freeman, New York.
4. Brooker R, 2011. Genetics: Analysis and Principles. 4th Edition; McGraw-Hill.
5. Pierce BA, 2011. Genetics: A conceptual approach. 4th Edition. WH Freeman Publisher.

BIOCHEMISTRY-1 (M) **Course Code: BT 233**
Credit Hours: 3(2+1)

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.

Learning outcomes; At the end of the course, students will be able to know basics of the molecular form of life and the functions of biomolecules.

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

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

and potentiators, basic kinetics, derivation of Km and Vmax; coenzymes and vitamins; nucleic acids - structure and function.

Practical:

Preparation of laboratory solutions and pH determination; qualitative and quantitative tests for carbohydrates, proteins and lipids; enzyme activity assays. Extraction of lipids, carbohydrates, and protiens.

Recommended Books:

1. Nelson DL and Cox MM, 2012. Lehninger Principles of Biochemistry. 6th Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)
2. Stryer et al., 2006. Biochemistry. 6th Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)
3. Voet D and Voet TG, 2008. Biochemistry. 4th Edition; John Wiley and Sons, New York.Murray et al., 2012. Harper's Illustrated
4. Biochemistry. 29th Edition; McGraw-Hill Medical Publishing.
5. Ferrier DR, 2013. Lippincott's Biochemistry. 6th Edition; Lippincott Williams &Wilkin Publishing Company.
6. Schantz JT, 2007. A Manual for Biochemistry Protocols.World Scientific Publishing. (*available online*)

MOLECULAR BIOLOGY (M)

Course Code: BT234
Credit: 3+0

- **Course Objectives:**
- To acquaint students with the chemistry and biology of macromolecules.
- **Learning outcomes**: The student will be able to understand about the structure and function of DNA, the basic mechanism of DNA replication, transcription, translation and their regulation both in eukaryotes and prokaryotes.
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- **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.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

- **Recommended Books:**

1. Nelson D and Cox MM, 2009. Lehninger Principles of Biochemistry. 5th Edition; WH Freeman, New York.
2. Lodish et al., 2012. Molecular Cell Biology. 7th Edition; WH Freeman, New York
3. Berg et al., 2006. Biochemistry. 6th Edition; WH Freeman, New York.
4. Alberts et al., 2007. Molecular Biology of the Cell. 5th Edition; Garland Science
5. Weaver R, 2011. Molecular Biology. 5th Edition; McGraw-Hill

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Semester 4			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 241	Analytical Chemistry & Instrumentation	3 (2+1)	Major
BT 242	Genetic Resources & Conservation	3	Major
BT 243	Biochemistry-II	3 (2+1)	Major
BT 244	Methods in Molecular Biology	3 (1+2)	Major
BT 245	Bioinformatics	3 (1+2)	Major
BT 246	Biosafety and Bioethics	3	Major
Total Credit Hours:		**18**	

ANALYTICAL CHEMISTRY & INSTRUMENTATION (M) **Course Code:BT241**

Credit Hours:3(2+1)

Course Objectives:

Students will acquire knowledge about sampling, sample handling and preparation and rss and data reporting. In addition, they will learn and develop about the classical techniques of analytical chemistry and quality control and quality assurance

Course Contents:

Chemometrics:

Sampling, significant figures, stoichi01netric calculations, measurement errors, analysis of variance (ANOVA), arithmetic mean, median, mode, standard deviation/relative standard deviation, confidence limits, Gaussian distribution, least square method, tests for significance, outliers

Quality Control and Quality Assurance:

Definitions, seven tools for quality control, the concept of quality assurances quality assurance techniques, validations based on design qualification (DQ), installation qualification (IQ), operational qualification (OQ) and performance qualification (PQ), calibrations, monitoring and quality reviews, periodical trainings, six sigma concepts, ISO standards.

Classical Analytical Methods:

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

BT241 Lab.

Calibration of volumetric glassware, electronic and analytical equipment

Statistical evaluation Of analytical data including linear regression analysis,

Constructing a calibration curve from a given analytical data using spread sheet software

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Determination of hardness of water using EDTA

Determination Of chloride in tap water sample

Estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry Gravimetric analysis. Determination of barium in barium nitrate

Determination of nickel in a given steel sample. Determination of bicarbonates in a clinical sample using back-titration Determination of cation in a mixture by complexometric titration

Studying the effect of common ions on solubility of sparingly soluble salts (e. g. AgCl /PbSO4

Recommended Books;

1. Skoog, D. A., West, P. M. , Holler, F. J., Crouch, S. Re, Fundamentals of Analytical Chemistry, 9th ed., Brooks Cole Publishing Company, (20 13).
2. Christian, G. D., Analytical Chemistry. 6th ed., John-Wiley & Sons, New York, (2006).
3. Harris, D. C. Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, 'New York, USA, (201 1).
4, Kealey, D. and Haines, P, J, Instant Notes., Analytical Chemistry, Bios Scientific Publishers Limited, Oxford, UK, (2002).
5. Matthios, Otto, CHEMOMETRICS-Statistics and Computed applications in Analytical Chemistry, 2nd ed., Wiley-VCH, Germany, (2()07).
6. Mitra A., Fundamentals of Quality Control and Improvement, 3rd ed., John- Wiley & sons, (2008).
7. Miller, J. and Miller, J., Statistics and Chemometrics for Analytical Chemistry, 5th ed., Prentice Hall (2005).

GENETIC RESOURCES & CONSERVATION. (M) **Course: BT242**

Credit Hours: 3+0

Course Objectives:

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

Learning outcomes; the students will be able to know about the genetic resources and strategies for conservation of genetic resources.

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:

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

1. Primack RB, 2012. A Primer of Conservational Biology. 5th 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.2nd Edition; Wiley-Blackwell.
4. Kamau EC and Winter G, 2009. Genetic Resources, Traditional Knowledge and the Law: Solutions for Access and Benefit Sharing. 1st Edition; Earthscan.
5. Primack RB, 2010. Essentials of Conservational Biology. 5th Edition; Sinauer Associates Inc.
6. Frankham R, 2010. Introduction to Conservation Genetics. 2nd Edition; Cambridge University Press.

BIOCHEMISTRY-II (M)

Course Code: BT243
Credit Hours: 3(2+1)

- **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.
- **Learning outcomes**: Biochemistry-II is an extension of the course "Principles of Biochemistry I". Taking this course will acquaint students about the basic ideas of metabolism of proteins, nucleic acids, carbohydrates and lipids. The students will also gain knowledge about the analysis of serum lipids (total cholesterol, triglyceride), serum glucose, liver functions test and renal functions.
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- **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.
- **Practical:**
- Enzymatic analysis of serum lipids (total cholesterol, triglyceride), serum glucose, liver functions test and renal functions.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

- **Recommended Books:**
- 1. Nelson DL and Cox MM, 2012. Lehninger Principles of Biochemistry. 6th Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)
- 2. Stryer et al., 2006. Biochemistry. 6th 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. 6th Edition; Lippincott Williams &Wilkin Publishing Company.
- 6. Schantz JT, 2007. A Manual for Biochemistry Protocols. World Scientific Publishing. (*available online*)

METHODS IN MOLECULAR BIOLOGY (M) **Course Code: BT244**
Credit Hours: 3(1+2)

Course Objectives:

To acquaint students with the experimental aspects of molecular biology

Learning outcomes: The student will be able to understand basic concept of gene cloning, using different molecular biological techniques (PCR, Electrophoreses, SDS PAGE etc.). this is more of a practical course based on laboratory experiments.

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.

Practical:

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

Recommended Books:

1. Ausubel FM, 2005. Short Protocols in Molecular Biology (2 volume set). 5th Edition; John Wiley and Son.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

2. Green MR and Sambrook J, 2001. Molecular Cloning: A Laboratory Manual. 3rd Edition; Cold Spring Harbor Laboratory Press.
3. Primrose SB and Twyman R, 2006. Principles of Gene Manipulation and Genomics. 7th Edition; Wiley-Blackwell.
4. Wilson K and Walker J, 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition; Cambridge University Press.
5. Walker JM and Rapley, 2008. Molecular Biomethods Handbook (Methods in Molecular Biology). 2nd Edition; Humana Press.

BIOINFORMATICS (M) **Course Code: BT245**

Credit Hours: 3(1+2)

Objectives:

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

Learning outcomes; At the end of this course the student will be familiarized with basic online databases, tools and softwares used in the field molecular biology

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 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.

Recommended Books:

1. Claverie JM and Notredame C, 2006. Bioinformatics for Dummies. 2nd Edition; Wiley Publishing.
2. Xiong J, 2006. Essential Bioinformatics. 1st Edition; Cambridge University Press.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

3. Xia X, 2007. Bioinformatics and the Cell: Modern Computational Approaches in Genomics, Proteomics and Transcriptomics. 1st Edition. Springer
4. Mathura V and Kangueane P, 2009. Bioinformatics: A Concept-Based Introduction. Springer
5. Mount DW, 2004. Bioinformatics Sequence and Genome Analysis. 2nd Edition; Cold Spring Harbor Laboratory Press.

BIOSAFETY AND BIOETHICS (M) **Course Code: BT246**

Credit Hours: 3+0

Course Objectives:

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

Learning outcomes: the students will be able to know about biosafety protocols, bioethics and its applications.

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 A and Hasegawa PM, 2012. Plant Biotechnology and Agriculture: Prospects for the 21st Century. 1st Edition; Academic Press.
2. Laboratory Biosafety Manual, WHO, 2006. 3rd Edition; AITBS Publishers and Distributors, India. (Available online free of cost).
3. Furr AK, 2000. CRC Handbook of Laboratory Safety. 5th Edition; CRC Press. 4. Jose Maria A, 2003. Genes Technology and Policy. Available online at;

http://www.apdip.net/publications/iespprimers/eprimer-genes.pdf

5. Krishna VS, 2007. Bioethics and Biosafety in Biotechnology. New Age International Publishers.
6. National Biosafety Guidelines, 2005. Pakistan Environmental protection Agency (*Available online*)

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Semester 5			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 351	Immunology	3 (2+1)	Int-Disp
BT 352	Industrial Biotechnology	3 (2+1)	Major
BT 353	Genomics & Proteomics	3 (2+1)	Major
BT 354	Cell and Tissue Culture	3 (2+1)	Major
BT 355	Food Biotechnology	3(2+1)	Major
BT 356	Research Methodology & Skill Enhancement	3+0	Major
Total Credit Hours:		**18**	

IMMUNOLOGY (M) **Course Code: BT351**
Credit Hours: 3(2+1)

- **Course Objectives:**
- To acquaint students with the basic principles of innate and adaptive immune systems.
- Learning outcomes; the students will be able to understand the basics of immune system, body defense mechanisms, infectious diseases and vaccinations.
- **Course Contents:**
- Overview of the immune system as the body's main defence 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.
- **Practical:**
- Agglutination tests; enzyme-linked immunosorbent assay (ELISA); blood group determination (ABO and Rh); Western blot; Ouchterlony analysis
- **Recommended Books:**

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

- 1. Kuby J, 2007. Immunology. 6th Edition; WH Freeman, New York.
- 2. Janeway et al., 2001. Immunobiology - The immune system in health and disease. 5th Edition; Garland Science Publisher, New York.
- 3. Anderson WL, 1999. Immunology. 1st Edition; Wiley-Blackwell.
- 4. Delves PJ et al., 2012. Roitt's Essential Immunology. 12th Edition. Wiley-Blackwell
- 5. Abbas AK and Lichtman AH, 2010. Basic Immunology: Functions and Disorders of the Immune System. Third illustrated Edition; Saunders Publisher.
- 6. Harlow E and David L, 1988. Antibodies, A laboratory Manual. 1st Edition; Cold Spring Harbor laboratory Press.

INDUSTRIAL BIOTECHNOLOGY (M) **Course Code: BT352**

Credit Hours: 3(2+1)

Course Objectives:

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

Learning outcomes

- Describe and explain the potentials and applications of biotechnology fields.
- Relate biosafety and bioethics consideration for biotechnology-related products commercialization.
- Compare and contrast the policy, scope and research area of industrial biotechnology in Malaysia and other countries.
- Be aware on biosafety, bioethics and the important of IP for biotechnology products.
- Discuss on the potential of biotechnology products and their commercialization opportunity.
- Demonstrate mapping and grouping of Industrial Biotechnology Companies wih their related fields.

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.

Practical:

Chairman
Department of Biotechnology
University of Malaya

Assistant Registrar
(Academics)
University of Malaya
05-Dec-2023

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, an exposure to laboratories of advanced research institutes.

Recommended Books:

1. Okafor N, 2007. Modern Industrial Microbiology and Biotechnology. 1st Edition; Science Publishers, USA.
2. Waites et al., 2001. Industrial Microbiology: An Introduction. Blackwell Science Ltd.
3. Shara et al., 2009. Industrial Biotechnology. 1st Edition; Nova Science Publishers
4. Abhilasha MS, 2009. Industrial Biotechnology. ANE Books
5. Singh R and Ghosh S, 2004. Industrial Biotechnology. Global Vision Publishing House

GENOMICS AND PROTEOMICS (M)

Course Code: BT353
Credit Hours: 3 (2+1)

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.

Learning outcomes: the students will be able to know about various techniques of genomics and 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, pyro-sequencing, Solexa, Helicos, Roche 454, real-time and nano-pore sequencing; sequence assembly, obstacles and solutions; estimating gene number – over-prediction and under-prediction, homology searches, exon prediction programs, integrated gene-finding software packages; structural variation in the genome and its applications; microarray and RNA interference; 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. 4th Edition; Garland Science.
2. Saccone C and Pesole G, 2003. Handbook of Comparative Genomics: Principles and Methodology. 1st Edition; Wiley-Liss.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

3. Town C, 2002. Functional Genomics. First Edition; Springer.
4. Krebs et al., 2010. Lewin Genes X. 10th Edition; Jones and Bartlett Publishers.
5. Al-Rubeai M and Fussenegger M, 2010. Systems Biology (Cell Engineering). 1st Edition; Springer.

CELL AND TISSUE CULTURE (M) **Course Code: BT354**
Credit Hours: 3(2+1)

Course Objectives:

The aim of this course is to provide students with a thorough understanding of the importance of cell, tissue and organ culture and its application in life sciences.

Learning outcomes: The outcome of this course will be to familiarize the students with basic concept of in vitro culturing of both mammalian and plant cells and tissues on artificial growth media.

Course Outline:

Plant cell and tissue culture: requirements for *in vitro* cultures; culture facilities; sterile techniques; media preparation and handling; callus cultures; cell suspension cultures; protoplast culture; haploid cultures, organ culture; meristem culture for virus elimination; embryo culture and embryo rescue; regeneration of plants and micro-propagation; somaclonal variation; industrial uses of plant cell culture; tissue culture in genetic engineering and biotechnology. **Mammalian cell culture**: origin and principles of cell culture; qualitative characteristics of cell cultures; cell counting and analysis; cryopreservation; cell banking and subculture (variety of different systems); primary cell culture techniques; development of immortalized cell line; detection of microbial contaminants; animal cells for bioassays and bioproducts; design and operation of animal cell culture bioreactors for therapeutic protein production; growth environment; Stem cell culture

Recommended Books:

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

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

FOOD BIOTECHNOLOGY. (M) **Course Code: BT355**
Credit Hours: 3(2+1)

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

Learning outcomes: This course will give students the knowledge about the food microorganisms and their role in food manufacturing and spoilage. The students will be informed about the role of different enzymes that are playing their role in the food preparation and damage. They will be able to learn about the role of different biotechnological techniques that are being used in the detection of food damaging microbes. This course will enable students to learn about increasing the nutritional quality of food, preservation of food for a long time and to bring genetic modification in food ingredients for beneficial purposes. The students will be taught about the various methods that are being used for the isolation of different microorganisms involved in the foods fermentation.

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.

Practical:

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.

Recommended Books:

1. Joshi VK, 2012. Food Biotechnology. 1st Edition; I K International Publishing House.
2. Campbell-Platt G, 2009. Food Science and Technology. 1st Edition; Wiley-Blackwell.
3. Singh RP, 2008. Introduction to Food Engineering. 4th Edition; Academic Press
4. Belitz HD, 2009. Food Chemistry. 4th Edition; Springer. 5. Nielsen SS, 2010. Food Analysis. 4th Edition; Springer

RESEARCH METHODOLOGY & SKILL ENHANCEMENT (M) **Course Code: BT356**

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Credit Hours: 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.

Learning outcome

At the end of this course, the students will be able to develop critical thinking skills, choose research methods and understand their limitations, data analysis and develop enhanced scientific writing skills.

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. Bryman A, 2001. Social research methods. 2nd Edition; Oxford University Press.
2. Awan JA, 2003. Scientific Presentation. Unitech Communication, Faisalabad, Pakistan.
3. Kumar R, Kindersley D, 2010. Research Methodology: A step by step guide for beginners. Third Edition; SAGE Publications.
4. Kothari CR, 2004. Research Methodology: Methods and Techniques. Second Revised Edition; New Age International Publishers, New Delhi.
5. Durrani SA, 2004. Technical Writing. Higher Education Commission, Islamabad.

Semester 6			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 361	Molecular Diagnostics	3 (2+1)	Major
BT 362	Environmental Biotechnology	3 (2+1)	Major
BT 363	Animal Biotechnology	3 (2+1)	Major
BT 364	Hospital waste Management	3+0	Major
BT 365	Biological Physics	3+0	Int-Disp
BT 366	Virology	3+0	Int-Disp
Total Credit Hours:		**18**	

MOLECULAR DIAGNOSTICS (M) **Course Code: BT361**
Credit Hours: 3**(2+1)**

Course Objectives:

To acquaint students with modern techniques used in molecular diagnostics.

Learning outcome

At the end of this course, the students will learn the basic principles and the application of modern techniques used in the field of Biotechnology

Courses Contents:

Introduction and applications of molecular diagnostics techniques in agriculture and forensic sciences; polymerase chain reaction (PCR); detection of mutations and single nucleotide polymorphisms (SNPs) by restriction fragment length polymorphisms (RFLPs); DNA sequencing; blotting techniques (e.g., Southern, Northern and Western); enzyme-linked immunosorbant assays (ELISA); immunofluorescence staining and immunohistochemistry; micro-arrays; *in situ* hybridization; molecular cytogenetics.

Practical:

ELISA; PCR. Visits to various diagnostic, pathology laboratories and/or research institutes.

Recommended Books:

1. Debnath et al., 2010. Molecular Diagnostics: Promises and Possibilities. Springer

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

2. Deniese D Wilson, 2008. Manual of Laboratory and diagnostic tests. McGraw-Hills publisher.
3. Brown TA, 2010. Gene Cloning and DNA analysis. 6th Edition. Wiley-Blackwell Publishing.
4. Buckingham et al., 2007. Molecular Diagnostics Fundamentals, Methods, and Clinical Applications. First Edition. FA Davis Publisher.
5. Walker JM and Rapley R, 2005. Medical Biomethods Handbook. Humana Press.

ENVIRONMENTAL BIOTECHNOLOGY. (M) **Course Code: BT362**
Credit Hours: 3(2+1)

Course Objectives:

To acquaint students with conservation and reclamation of environment through biotechnology

Learning outcomes: At the end of the course the students will have learnt about various types of pollutions and biologically process using for the remediation of pollutions.

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.

Practical:

Field survey of polluted areas and field study for pollution indicators organisms.

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. 2nd Edition; Wiley-Blackwell Publishers.
4. Srinivas T, 2008. Environmental Biotechnology. 1st Edition; New Age International Publishers.
5. Spencer JFT and Spencer ALR, 2004. Environmental Microbiology: Methods and Protocols (Methods in Biotechnology). 1st Edition; Humana Press.
6. Hurst et al., 2007. Manual of Environmental Microbiology. 3rd Edition; ASM Publishers.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

ANIMAL BIOTECHNOLOGY (M) **Course Code: BT363**
Credit Hours: 3(2+1)

Course Objectives:
To acquaint students with techniques for engineering transgenic animals and embryonic micromanipulations

Learning outcomes; The students will learn about the different techniques being used for the breeding of animals. Commercial preparation of various ingredients that are essential for improving the health of animals. They will be provided the knowledge about the use of monoclonal antibodies for the diagnosis and therapy of different diseases in animals. The students will be informed about the social and ethical implications of animal biotechnology.

Course Contents:
Introduction and history of transgenic animals; role of synthetic peptides/proteins in animal health; use of monoclonal antibodies as a diagnostic/therapeutic agents; cytokines and their potential therapeutic value as applicable to the diagnosis of microbial infections; micromanipulations of farm animal embryos; use of biotechnological techniques in animal breeding strategies; gene transfer through embryo microinjection; ethical and social issues in animal biotechnology.

Practical:
Aquaculture methods and various DNA recombinant techniques for animal biotechnology

Recommended Books:

1. Freshney IR, 2010. Culture of animal cells: A manual of basic techniques and specialized application. 6th Edition; Wiley-Blackwell
2. Masters JR, 2000. Animal cell culture. 3rd Edition; Oxford University Press.
3. Lanza et al., 2001. Methods of tissue engineering Academic Press Inc.
4. Doyle et al., 1998. Cells and tissue culture: Laboratory procedures in biotechnology. Wiley, John and Sons.
5. Barnum S, 2004. Biotechnology: An Introduction (with Infotrac) Brooks /Cole.
6. Tourte Y and Catherine TC, 2005. Genetic Engineering and Biotechnology: Concepts, Methods, and Agronomic Applications. Science Publishers.
7. Houdebine LM, 2003. Animal Transgenesis and Cloning. 1st Edition; John Wiley and Sons.

HOSPITAL WASTE MANAGEMENT (M) **Course Code BT364**

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Credit hours 3(2+1)

Course Objectives:

To acquaint students with the principles and applications of clinical waste management.

Course Contents:

An introduction to the management of infectious materials/waste; various types of infectious material and methods of their handling and disposal; laboratory and hospital acquired infections - possible sources and causes; hazardous microorganisms; basic containment rules and laboratory contamination levels, control measures; guidelines for workers in microbiology and pathology labs, and post-mortem rooms; rules for safe conduct during field work and outdoor activities; risk assessment including recognition of hazards; competence and elimination of hazards; collection of data, etc.; risk group personnel and their education, training and monitoring; radiation hazards and disposal of radioactive waste.

Practical:

Techniques for waste minimization; waste sorting; anaerobic and aerobic compositing; industrial and hospital waste treatment processes.

Recommended Books:

1. LaGrega et al., 2001. Hazardous Waste Management. 2nd Edition; McGraw-Hills.
2. McDougall et al., 2001. Integrated Solid Waste Management: A Life Cycle Inventory. 2nd Edition; Blackwell Publishers.
3. WHO Biosafety Manual, World Health Organization, 2001. WHO, Geneva.
4. Garvin ML, 1995. Infectious Waste Management: A Practical Guide. LewisPublishers, Inc.
5. Wayne LT, 1995. Biohazardous Waste: Risk Assessment, Policy, and Management. Lewis Publishers, Inc.
6. Hickman HL and Anderson WC , Principles of Integrated Solid Waste Management. MSW Management

BIOLOGICAL PHYSICS (I) **Course Code BT365**

Credit Hours (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

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

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. Fourth Edition; Academic Press.
4. Newman, 2008. Physics of the Life Sciences. Springer. 5. Duncan, 1975. Physics for Biologist Blackwell Science.

VIROLOGY (I) Course code BT366

Credit Hour (3+0)

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

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 J Saunders V. Virology: Principles and Applications. First Edition; Wiley.
4. Wagner et al., 2007. Basic Virology. Third Edition; Wiley-Blackwell
5. Flint SJ, 2009. Principles of Virology, Vol. 2: Pathogenesis and Control. 3rd Edition; AMS Press

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Semester 7			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 471	Plant Biotechnology	3 (2+1)	Major
BT 472	Microbial Biotechnology	3 (2+1)	Major
BT 473	Health Biotechnology	3 (2+1)	Major
BT 474	Principals of Biochemical Engineering	3 (2+1)	Int-Disp
BT 475	**Field Experience/Internship/Research**	3	Major
Total Credit Hours:		**15**	

PLANT BIOTECHNOLOGY (M)

Course Code: BT471
Credit Hours: 3(2+1)

Course objectives:
To familiarize students with plant improvement through various biotechnological approaches

Learning outcomes: The students will be able to know about potency of cell and in-vitro propagation of plant species

Course contents: History of plant biotechnology; protoplast isolation and culture; *in vitro* fertilization; totipotancy; meristems culture for virus elimination, callus culture; haploid production; embryogenesis; somaclonal variation, somatic embryo, *in-vitro* multiplication; cryopreservation; germ plasma preservation. Plant genetic engineering; delivery system (electroparation, agrobactgerim and particle gun); transgenic plant production and molecular analysis; biosafety guidelines; DNA finger printing; Immunity in plants, role of hormones, auxin, gibberellins, cytokinins, abscisic acid, ethylene in growth and development from embryo to adult, organogenesis, the root tip and shoot apex, seed development, germination and dormancy, senescence and programmed cell death, cell walls, primary and secondary growth, phototropism, photoperiodism, vernalization.

Practical:

Preparation of different basic media and their components; Seed culture; embryo culture; anther culture, microspore culture, micro propagation by auxiliary buds; adventitious shoot proliferation; plant regeneration by organogenesis; somatic embryogenesis from callus culture.

Recommended Readings

Knox R. Bruce 2001. Biology, 2nd Edition, MeGraw-Hill Book Company, NSW 2069, Australia
Recent Research Papers

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

MICROBIAL BIOTECHNOLOGY (M) **Course Code: BT472**
Credit Hours: 3(2+1)

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. Learning outcomes; At the end of this course the students will be able to know about microorganisms and their applications in biotechnology.

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.

Practical:

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.

Recommended Books:

1. Glick BR et al., 2009. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition; ASM Press.
2. Mukhopadhyay SN, 2004. Process Biotechnology Fundamentals. 2nd Edition. Anshan Publisher.
3. Goodsell DS, 2004. Bionanotechnology: Lessons from Nature. John Wiley and Sons.
4. Ray RC, 2005. Microbial Biotechnology in Agriculture and Aquaculture. NBN International.
5. Kreuzer H and Massey A, 2005. Biology and Biotechnology Science, Applications, and Issues. 1st Edition; ASM Press.
6. Harding SE, 2010. Biotechnology and Genetic Engineering Reviews. 1st Edition. Nottingham University Press.

HEALTH BIOTECHNOLOGY. (M) **Course Code: BT473**
Credit Hours3(2+1)

Course Objectives:

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

Learning outcomes; the students will be equipped with basics techniques, molecular diagnosis,

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

recombinant DNA technology and gene therapy.

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. 1st Edition; Elsevier Health Sciences.
2. Schacter B. Z. 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. 1st Edition; CRC Press

PRINCIPLES OF BIOCHEMICAL ENGINEERING (I) **Course Code: BT474**
Credit Hours: 3(2+1)

Course Objectives:

To acquaint students with fundamentals of biochemical engineering.

Learning outcome:

After finishing this course, the students are expected to:

- Present unit operations together with the fundamental principles for basic methods in production technique for biologically based products.
- Calculate yield and production rates in a biological production process, and also interpret data.
- Calculate the need for oxygen and oxygen transfer in a biological production process.
- Give an account of important microbial industrial processes.
- Give an account of traditional and up-to-date methods for optimizing of biologically based production processes.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

- Give an account of and discuss contemporary and future fields within industrial biotechnology (e.g. bio-fuel, bio-refinery, sustainable chemistry).

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.

Practical:

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.

Recommended Books:

1. Douglas SC and Blanch HW, 1997. Biochemical Engineering. 2nd Edition; CRC Publishers.
2. Bailey et al., 1986. Biochemical Engineering Fundamentals. 2nd Edition; McGraw-Hill
3. Aiba et al., 1973. Biochemical Engineering. 2nd Edition; Academic Press.
4. Katoh S and Yoshida F, 2009. Biochemical Engineering, a textbook for engineers, chemists and biologists. Wiley VCH
5. Clark DS and Blanch HW, 1997. Biochemical Engineering, 2nd Edition (Chemical Industries). 2nd Edition; CRC Press.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Semester 8			
Code	**Title**	**Cred. Hrs.**	**Course status**
BT 481	Fermentation Biotechnology	3 (2+1)	Major
BT 482	Agriculture Biotechnology	3 (2+1)	Major
BT 483	Nanobiotechnology	3 (2+1)	Major
BT 484	Pharmaceutical Biotechnology	3+0	Major
BT 500	**Capstone Project/thesis**	3	Major
Total Credit Hours:		**15**	

FERMENTATION BIOTECHNOLOGY (M) **Course Code: BT481**
Credit Hours: 3(2+1)

Course Objectives:

To acquaint students with theoretical and experimental techniques used for fermentation.

Learning outcomes: After finishing this course, the students are expected to:

- Students will be able to recognize the fundamentals of microbial fermentation
- Can isolate industrially important organisms from soil
- Acquire the shills to produce microbial biomass, metabolites and enzymes
- Understand the different types of downstream processing
- Based on the skills acquired in this course, students will be able to optimize different bacterial fermentation processes

Course Contents:

Overview of fermentation technology: definition, economics, applications; strain development and improvement: isolation of microorganisms - plating, criteria for selection and improvement through genetic engineering; growth requirement of various organisms and media preparation; stoichiometry of microbial growth; preparation of inoculum; microbial growth kinetics in batch culture; continuous culture; sterilization: modes & kinetics of sterilization, design of batch and continuous sterilization process, air sterilization & theory of fibrous filters; fluid rheology: classification, Newtonian & non-Newtonian factors effecting KLa in fermentation vessel; design of bioreactors and configuration for free and immobilized cells; waste treatment; tissue engineering for plant and animal cell cultures; aeration and agitation; product recovery; scaling-up of fermentation process

Practical:

Initiation of a bacterial/plant or animal cell/tissue culture in a simple conical flask or in a fermenter depending on availability and its handling according to the techniques introduced in theory as

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

sterilization, media formulation, growth kinetics, product recovery, an introduction to pilot / industrial scale fermenters etc.

Recommended Books:

1. Doran PM, 2012. Bioprocess Engineering Principles.2nd Edition; Academic Press.
2. McNeil B, 2008. Practical Fermentation Technology. John Willey & Sons 3. El-Mansi et al., 2007. Fermentation Microbiology and Biotechnology. CRC Press.
4. Shuler ML and Kargi F, 2002. Bioprocess Engineering: Basic concept. Prentice Hall.

AGRICULTURE BIOTECHNOLOGY. (M) **Course Code: BT482**
Credit Hours: 3(2+1)

Course Objectives:

To acquaint students with techniques and skills employed for producing transgenic crops.
Learning outcomes: At the end of this course the student will be able to understand the basics principles of plant genetic engineering and their potential use in the field of agriculture

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; bio-fertilizers, bio-pesticides and their types; non-symbiotic nitrogen fixers; present and future prospects of bio-fertilizers.

Practical:

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 trans formant's; regeneration of plantlets and acclimatization; plant DNA extraction and PCR for detecting introduction of foreign DNA into plants.

Recommended Books:

1. Qaim M, 2010. Agricultural Biotechnology in Developing Countries: Towards Optimizing Benefits for Poor. Springer
2. Kemp Ken F, 2010. Genetic Modification of Plants: Agriculture, Horticulture and Forestry (Biotechnology in Agriculture and Forestry). Springer.
3. Herren RV, 2012. Introduction to Agricultural Biotechnology. 2nd Edition; Delmar Cengage Learning.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

4. Slater A, 2008. Plant Biotechnology: The Genetic Manipulation of Plants. 2nd Edition; Oxford University Press, USA
5. Altman A, 2011. Plant Biotechnology and Agriculture: Prospects for the 21st Century. 1st Edition; Academic Press.

NANOBIOTECHNOLOGY (M) **Course Code: BT483**
Credit Hours: 3(2+1)

Course Objectives:

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

Course Contents:

Introduction; interface between nanotechnology and bio-nanotechnology; manipulating molecules; carbon fullerenes and nanotubes; non-carbon nanotubes and fullerene-like materials; quantum dots; nanowires, nanorods and other nanomaterial's; magnetic nanoparticles; natural biological assembly at the nanoscale and nanometric biological assemblies (complexes); nanobionics and bio-inspired nanotechnology; applications of biologica assemblie in nanotechnology; medical, cosmetics, agriculture, water and other applications of nano-biotechnology; future prospects of nano-biotechnology; 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. 1st Edition; Imperial College Press.
2. Renugopalakrishnan V and Lewis RV, 2006. Bio-nanotechnology: Proteins to Nano devias. Springer.
3. Greco et al., 2004. Nano Scale Technology in Biological Systems. CRC Press.
4. Mirkin CA and Niemeyer CM, 2007. Nano-biotechnology II: More Concepts and Applications. John Wiley & Sons.
5. Niemeyer CM and Mirkin CA, 2004. Nano-biotechnology. 1st Edition; Wiley VCH.

PHARMACEUTICAL BIOTECHNOLOGY (M) **Course Code BT484**
Credit Hours (3+0)

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:

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

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. 2nd Edition; Wiley-Blackwell.
2. Kokate C, 2012. Textbook of Pharmaceutical Biotechnology. ELSEVIER
3. Crommelin et al.,2007. Pharmaceutical Biotechnology: Fundamentals andApplications. 3rd Edition. Informa Healthcare.
4. am Ende DJ, 2010. Chemical Engineering in the Pharmaceutical Industry: R&D to Manufacturing. 1st Edition; Wiley
5. Subramanian G, 2012. Biopharmaceutical Production Technology. 1st Edition. Wiley-VCH.

Chairman
Department of Biotechnology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023