ANNEXURE-I:

REVISED SCHEME OF STUDIES/COURSES FOR BS, M.PHIL AND PHD MICROBIOLOGY

BS MICROBIOLOGY

PROGRAM DESCRIPTION:

The Bachelor of Science in Microbiology program is designed in accordance with the provisions of the HEC Undergraduate Education Policy to provide students with a comprehensive understanding of microbial sciences, addressing both local and global perspectives. The program integrates cellular, molecular, genetic, and ecological dimensions to equip students with the skills necessary for research, industry, and further academic pursuits in microbiology and related fields. Spanning eight semesters, the curriculum offers a balanced and progressive learning experience. Throughout the program, students will gain hands-on experience with modern laboratory techniques, including but not limited to bacteriology, virology, immunology, and genetic engineering. Emphasis is placed on practical and technical proficiency, with a focus on molecular biology and biotechnological applications relevant to Pakistan's healthcare and industrial sectors. This approach ensures that graduates are well-prepared for the real-world challenges and opportunities in microbial sciences. Through this program, students will learn to effectively convey scientific knowledge and research findings, preparing them for careers in academia, research institutions, healthcare organizations, and the biotechnology industry, both within Pakistan and internationally.

STANDARD NOMENCLATURE:

For standardization, the recommended nomenclature for the four-year undergraduate degree program in Microbiology is "Bachelor of Science in Microbiology".

PROGRAM LEARNING OUTCOMES:

By the completion of Bachelor of Science in Microbiology, the graduates will be able to:

- Demonstrate a comprehensive understanding of fundamental concepts in the field of

Microbiology.

- Effectively apply microbiological methods and techniques as used in research and

diagnostics at different industrial and environmental levels.

- Communicate scientific knowledge and research findings effectively, while demonstrating a commitment to continuous learning and professional development in the field of Microbiology.
- Apply ethical principles and biosafety / biosecurity regulations in microbiological research and practices.

PROGRAM STRUCTURE:

The Bachelor of Science in Microbiology is structured in accordance with the provisions of the HEC Undergraduate Education Policy and comprises of 134 credit hours spread over 8 regular semesters, at minimum. Courses up-to a maximum of 144 credit hours may be offered, provided that the total number of credit hours are reasonably set to effectively achieve the Program Learning Objectives (PLOs) without putting an undue burden on students. Summary of the program including the model scheme of study is given below.

Minimum Credit Hours	134
General Education	32 credit hours (13 courses)
Discipline Related Courses / Major	60 credit hours (20 courses)
Interdisciplinary / Allied Courses	24 credit hours (8 courses)
Elective	12 credit hours (4 Courses)
Internship	3 credit hours
Capstone	3 credit hours

Semester Scheme/Plan of Studies (BS Microbiology)

SEMESTER 1		
S. No	**Category**	**Credit Hours**
1	Major I	3
2	Major II	3
3	Quantitative Reasoning – I *	3
4	Natural Science **	3
5	Functional English *	3
6	Applications of Information & Communication Technologies (ICT)*	3
TOTAL CREDIT HOURS: 18		

SEMESTER 2		
S. No	**Category**	**Credit Hours**
1	Major III	3
2	Major IV	3
3	Interdisciplinary I	3
4	Quantitative Reasoning – II*	3
5	Social Sciences***	2
6	Expository Writing*	3
TOTAL CREDIT HOURS: 17		

SEMESTER 3		
S. No	**Category**	**Credit Hours**
1	Major V	3
2	Major VI	3
3	Major VII	3
4	Arts & Humanities****	2
5	Islamic Studies* (Ethics for non-Muslim students)	2
6	Pakistan Studies*	2
7	Entrepreneurship*	2
TOTAL CREDIT HOURS: 17		

SEMESTER 4		
S. No	**Category**	**Credit Hours**
1	Major VIII	3
2	Major IX	3
3	Major X	3
4	Major XI	3
5	Civics & Community Engagement*	2
6	Ideology & Constitution of Pakistan*	2
TOTAL CREDIT HOURS: 16		

SEMESTER 5		
S. No	**Category**	**Credit Hours**
1	Major XII	3

2	Major XIII	3
3	Major XIV	3
4	Major XV	3
5	Interdisciplinary II	3
6	Interdisciplinary III	3
TOTAL CREDIT HOURS: 18		

SEMESTER 6		
S. No	**Category**	**Credit Hours**
1	Major XVI	3
2	Major XVII	3
3	Major XVIII	3
4	Interdisciplinary IV	3
5	Interdisciplinary V	3
TOTAL CREDIT HOURS: 15		

SEMESTER 7		
S. No	**Category**	**Credit Hours**
1	Major XIX	3
2	Major XX	3
3	Elective I	3
4	Interdisciplinary VI	3
5	Interdisciplinary VII	3
6	Internship	3
TOTAL CREDIT HOURS: 18		

SEMESTER 8		
S. No	**Category**	**Credit Hours**
1	Elective II	3
2	Elective III	3
3	Elective IV	3
4	Interdisciplinary VIII	3
5	Capstone	3
TOTAL CREDIT HOURS: 15		

*HEC designed model courses may be adopted.

**Any course in the broader category of “Natural Science” may be offered having relevance to the nature of the degree program.

*** Any course in the broader category of “Social Science” including but not limited to a course of Psychology, Sociology, Anthropology etc., may be offered.

**** Any course in the broader category of “Arts & Humanities” including but not limited to a course of regional or international language such as Chinese, Arabic, French, Spanish etc. or any other course such as Philosophy, History etc., may be offered.

*****Any advanced course in the field of Microbiology may be offered as an elective, where required in the above scheme as per available academic and faculty resources. Credit combination (reflecting balance of theory and lab/field work) would be arranged in accordance with the nature of the course.

Area/Field Specialization and Course Codes Assigned to Microbiology Courses

Area of Specialization	Specialization Code	Subjects Falling in the area	Course Code
Fundamental	0	Introduction of Microbiology	MIC100
		Mycology	MIC201
		Veterinary Microbiology	MIC402
		Microbial Plant Diseases	MIC403
		Pathology and Microbiology-I	MIC304
		Pathology and Microbiology-II	MIC305
Medical/Clinical	1	Bioethics, Biosafety & Biosecurity	MIC210
		Clinical & Diagnostic Microbiology	MIC311
		Antimicrobial Agents & Resistance	MIC412
		Medical Microbiology	MIC213
		Clinical Parasitology	MIC314
		Diagnostic Chemistry for Microbial Diseases	MIC415
		Infection Biology of Emerging and re-emerging Microbial Diseases	MIC716/816
		Advanced Medical Microbiology	MIC717/817
		Epidemiology and Public Health	MIC418
		Management of Infectious Waste	MIC419
Molecular/ Bioinformatics	2	Microbial Genetics	MIC220
		Introduction to Microbial Genomics	MIC321
		Structural and Computational Biology	MIC422
		Epigenetics	MIC423
		Molecular Mechanism of Diseases	MIC724/824
Immunology	3	Immunology	MIC230
		Molecular Immunology	MIC431
		Vaccinology	MIC432
		Host-Pathogen Interactions	MIC733/833
		Advanced Immunology	MIC734/834
Virology	4	Virology	MIC240
		Animal Virology	MIC441
		Diagnostic Virology	MIC342
		Viral Immunology	MIC743/843
		Viral Based Gene Therapy	MIC744/844
		Advanced Virology	MIC745/845
Environmental	5	Soil & Agricultural Microbiology	MIC350
		Environmental Microbiology	MIC351
		Aquatic Microbiology	MIC352
		Microbes and Climate Change	MC353
		Geomicrobiology	MIC454
		Bioremediation	MIC755/855
		Water and Wastewater Treatment Processes	MIC756/856

Anatomy/Taxonomy/ Physiology	6	Microbial Physiology & Metabolism	MIC160
		Microbial Diversity & Systematics	MIC161
		Microbial Biofilms	MIC462
		Nutrition and Gut Microbiome	MIC763/863
		Advanced Microbial Biofilms	MIC764/864
Applied/Industrial	7	Food Microbiology	MIC370
		Microbial Biotechnology	MIC471
		Microbial Enzyme Technology	MIC472
		Artificial Intelligence in Microbiology	MIC473
		Industrial Microbiology	MIC374
		Advances in Microscopy and Image Analysis	MIC475
		Advanced Food Microbiology	MIC776/876
		Advanced Forensic Microbiology	MIC777/877
		Advanced Techniques in Microbiology	MIC778/878

Codes For Internship and Capstone

S. No.	Title of Course	Course Code
1	Internship	MIC491
2	Capstone	MIC499

List of Interdisciplinary Courses

S. No.	Title of Course	Course Code
1.	Principles of Biochemistry	Relevant Department
2.	Bioinformatics	Relevant Department
3.	Scientific Inquiry & Research Methods	Relevant Department
4.	Sustainable Development Goals	Relevant Department
5.	Recombinant DNA Technology	Relevant Department
6.	Epidemiology & Public Health	MIC418
7.	Artificial Intelligence in Microbiology	MIC473
8.	Biostatistics	Relevant Department

List of Major Courses

S. No.	Title of Course	Course Code
1.	Introduction to Microbiology	MIC100
2.	Microbial Physiology & Metabolism	MIC160

3.	Microbial Diversity & Systematics	MIC161
4.	Mycology	MIC201
5.	Bioethics, Biosafety & Biosecurity	MIC210
6.	Medical Microbiology	MIC213
7.	Microbial Genetics	MIC220
8.	Immunology	MIC230
9.	Virology	MIC240
10.	Clinical & Diagnostic Microbiology	MIC311
11.	Soil & Agricultural Microbiology	MIC350
12.	Environmental Microbiology	MIC351
13.	Aquatic Microbiology	MIC352
14.	Food Microbiology	MIC370
15.	Industrial Microbiology	MIC374
16.	Antimicrobial Agents & Resistance	MIC412
17.	Vaccinology	MIC432
18.	Microbial Biotechnology	MIC471
19.	Cell Biology	Relevant Department
20.	Molecular Biology	Relevant Department

List of Elective Courses

S. No.	Title of Course	Course Code
1.	Pathology and Microbiology-I	MIC304
2.	Pathology and Microbiology-II	MIC305
3.	Clinical Parasitology	MIC314
4.	Introduction to Microbial Genomics	MIC321
5.	Diagnostic Virology	MIC342
6.	Microbes and Climate Change	MIC353
7.	Veterinary Microbiology	MIC402
8.	Microbial Plant Diseases	MIC403
9.	Diagnostic Chemistry for Microbial Diseases	MIC415
10.	Structural and Computational Biology	MIC422
11.	Epigenetics	MIC423
12.	Molecular Immunology	MIC431
13.	Animal Virology	MIC441
14.	Geomicrobiology	MIC454
15.	Microbial Biofilms	MIC462
16.	Microbial Enzyme Technology	MIC472
17.	Management of Infectious Waste	MIC419
18.	Histotechniques	MLT451

M.PHIL./ PhD MICROBIOLOGY

PROGRAM DESCRIPTION

The Master of Philosophy and Doctor of Philosophy Programs in Microbiology are designed in alignment with the HEC Graduate Education Policy 2023, aiming to provide students with a robust foundation in advanced microbiological sciences. Programs are designed to deepen students' understanding of microbial life, focusing on the latest research, technologies, and trends in the field. Through an interdisciplinary approach, students will critically analyze and synthesize complex microbiological concepts, preparing them for careers in research, academia, healthcare, and industry. The curriculum combines rigorous academic training with mandatory research, emphasizing the application of advanced experimental techniques and methodologies. Students will be equipped to conduct independent research, addressing complex problems in microbiology, such as antimicrobial resistance, environmental sustainability, and infectious diseases. Upon completion, graduates will be well-prepared to contribute to the advancement of microbiological sciences and develop innovative solutions to critical challenges facing Pakistan and the world.

PROGRAM LEARNING OUTCOMES

By the completion of MPhil/PhD in Microbiology, the graduates will be able to: Critically analyze and synthesize advanced concepts and current research in various fields of Microbiology. Apply advanced experimental techniques and methodologies to conduct independent research and solve complex problems in microbial science, with a focus on innovation and practical applications. Demonstrate the ability to effectively communicate scientific findings and theoretical concepts in Microbiology to both specialized and general audiences, ensuring clarity and scientific rigor.

M. Phil PROGRAM STRUCTURE

The standard program structure for Master of Philosophy in Microbiology is given below.

Minimum credit hours	30
Minimum course work requirement	24 credit hours (8 courses)
Thesis requirement (mandatory)	6 credit hours

SEMESTER I			
S.N.	**Course**	**Credit hours**	**Category**
1	Advanced Techniques in Microbiology (MIC778)*	3	Core
2	Research Methodology for Health and Biological Sciences (HBS600)*	3	Core
3	Advance Data Analysis for Health and Biological Sciences (HBS500)*	3	Core
4	Elective-I**	3	Elective
Total credit hours: 12			

SEMESTER II			
S.N.	**Course**	**Credit hours**	**Category**
1	Elective-II**	3	Elective
2	Elective-III**	3	Elective

3	Elective-IV**	3	Elective
4	Elective-V**	3	Elective
Total credit hours: 12			

SEMESTER III			
S.N.	**Course**	**Credit hours**	**Category**
1	Thesis ***	6	Research
Total credit hours: 6			

*These are the mandatory courses for the program, irrespective of the area of specialization.
**The university / concerned department may offer any advanced course in the field of Microbiology as an elective, where required in the above scheme as per available academic and faculty resources. Credit combination (reflecting balance of theory and lab / field work) must be arranged in accordance with the nature of the course.
***Research work for thesis must be conducted by students individually in accordance with the university's policy as approved through its statutory bodies provided that the same is in accordance with the HEC Graduate Education Policy (2023).

List of Elective Courses for M. Phil Program

Course Code	Title of Course	Credit hours
MIC716	Infection Biology of Emerging and Re-emerging Microbial Diseases	3
MIC717	Advanced Medical Microbiology	3
MIC724	Molecular Mechanism of Diseases	3
MIC734	Advanced Immunology	3
MIC743	Viral Immunology	3
MIC745	Advanced Virology	3
MIC776	Advanced Food Microbiology	3
MIC782	Research, Innovation and Entrepreneurship	3
MIC733	Host-Pathogen Interactions	3
MIC744	Viral Based Gene Therapy	3
MIC755	Bioremediation	3
MIC756	Water and Wastewater Treatment Processes	3
MIC763	Nutrition and Gut Microbiome	3
MIC764	Advanced Microbial Biofilms	3
MIC777	Advanced Forensic Microbiology	3
In addition to the above courses, the graduate students can also be enrolled in approved graduate courses of other departments such as Biotechnology & Genetic Engineering, Zoology and Biochemistry.		

PhD PROGRAM STRUCTURE

The standard program structure for Master of Philosophy in Microbiology is given below.

Minimum credit hours	18
Minimum course work requirement	18 credit hours (6 courses)
Thesis requirement	PhD Thesis (Mandatory)

S.N.	Course	Credit hours
1	Advanced Techniques in Microbiology*	3
2	Research Methodology for Health and Biological Sciences*	3
3	Advance Data Analysis for Health and Biological Sciences*	3

S.N.	Course	Credit hours
1	Elective-I**	3
2	Elective-II**	3
3	Elective-III**	3

SEMESTER III onwards	
1	Research/Thesis ***

*These are the mandatory courses for the program, irrespective of the area of specialization.

**The university / concerned department may offer any advanced course in the field of Microbiology as an elective, where required in the above scheme as per available academic and faculty resources. Credit combination (reflecting balance of theory and lab / field work) must be arranged in accordance with the nature of the course.

***Research work for thesis must be conducted by students individually in accordance with the university's policy as approved through its statutory bodies provided that the same is in accordance with the HEC Graduate Education Policy (2023).

Note: Students who have completed MIC 778 (Advanced Techniques in Microbiology), HBS 600 (Research Methodology for Health and Biological Sciences), and HBS 500 (Advanced Data Analysis for Health and Biological Sciences) during their M.Phil. in Microbiology are exempt from taking these courses in their Ph.D. program. Instead, they can choose additional elective courses from the listed PhD Courses.

List of Elective Courses for PhD Program

Course Code	Title of Course	Credit hours
MIC816	Infection Biology of Emerging and Re-emerging Microbial Diseases	3
MIC817	Advanced Medical Microbiology	3
MIC824	Molecular Mechanism of Diseases	3
MIC834	Advanced Immunology	3
MIC843	Viral Immunology	3
MIC845	Advanced Virology	3
MIC876	Advanced Food Microbiology	3
MIC882	Research, Innovation and Entrepreneurship	3
MIC833	Host-Pathogen Interactions	3
MIC844	Viral Based Gene Therapy	3
MIC855	Bioremediation	3
MIC856	Water and Wastewater Treatment Processes	3
MIC863	Nutrition and Gut Microbiome	3
MIC864	Advanced Microbial Biofilms	3
MIC877	Advanced Forensic Microbiology	3
In addition to the above courses, the graduate students can also be enrolled in approved graduate courses of other departments such as Biotechnology & Genetic Engineering, Zoology and Biochemistry.		

MIC100 Introduction to Microbiology

Course Title : Introduction to Microbiology
Course Code : MIC100
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : None

Course Objectives:

- To become familiar with the foundation concepts of Microbiology
- To gain the knowledge of microscopy, culturing and staining concepts
- To understand the structure and functions of microorganisms
- To understand the concept of microbial control

Course Learning Outcome (CLOs)

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

- Understand the fundamental characteristics and classifications of microorganisms.
- Explain the basic principles of microbial growth, reproduction, and control.
- Apply microbiological knowledge to understand the roles of microorganisms in health, industry, and the environment.

Course Contents:

- Introduction to Microbiology
- Microorganisms and their Respective place in the World
- Differentiation Between Pro and Eukaryotic Cells
- Historical Development of Microbiology and its Scope
- Microscopy; Types, Principles and Staining Techniques
- Bacterial Cell Morphology and Arrangements
- Detailed Anatomy of Bacterial Cell (Glycocalyx, Flagella, Fimbrae, Pili, Cell Wall, Plasma Membrane, Cytoplasm, Nucleoid, Ribosomes, Inclusion Bodies, Endospore)
- Growth, Nutrition (physical and nutritional requirement and nutritional types; sources of energy, C, N, H, O, S, P, H2O, trace elements, growth factors) and Reproduction
- Bacterial Taxonomy and nomenclature, basis of classification of bacteria
- Measurement of Bacterial Growth by Direct & Indirect Methods
- Culture Media and its Types
- Basic properties of fungi, protozoa and algae
- An introduction to structure, size range, and propagation of viruses
- Control of microorganisms by physical and chemical methods

Practical

- Laboratory Safety Procedures: Containment and decontamination.

- An introduction to microscopy
- Principles of Staining Procedures: Simple staining, Gram's staining, Acid-fast staining, Cell Wall Staining, Capsule staining and Endospore staining.
- Study of cell motility by hanging drop preparation.
- Preparation and sterilization of bacteriological media and glassware.
- Inoculation techniques and culture media

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Microbiology
Week 2	Microorganisms and their Respective place in the World
Week 3	Differentiation Between Pro and Eukaryotic Cells
Week 4	Historical Development of Microbiology and its Scope
Week 5	Microscopy; Types, Principles and Staining Techniques
Week 6	Bacterial Cell Morphology and Arrangements
Week 7	Detailed Anatomy of Bacterial Cell
Week 8	Growth, Nutrition and Reproduction of bacteria (Continued)
Week 9	**Midterm Examination**

Week 10	Growth, Nutrition and Reproduction of bacteria
Week 11	Bacterial Taxonomy and nomenclature, basis of classification of bacteria
Week 12	Culture Media and its Types
Week 13	Measurement of Bacterial Growth by Direct & Indirect Methods Culture Media and its Types
Week 14	Basic properties of fungi, protozoa and algae
Week 15	Control of microorganisms by physical and chemical methods
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Talaro, K. P. Foundations in Microbiology: Basic Principles, McGraw-Hill Companies, N.Y.
2. Tortora, G. J., Funke, B. R. and Case, C. L. Microbiology: An Introduction, Benjamin-Cummings Publishing Company, U.S.A.
3. Black, J. G. Microbiology: Principles & Explorations, John Wiley and Sons, N.Y.
4. Parker, N., Scheegurt, M., Tu, A. T., Forster. B. M. and Lister, P. Microbiology. Openstax.
5. Prescott et al., Microbiology. McGraw- Hill Medical Publishing.
6. Cappuccino JG and Sherman N, Microbiology: a laboratory manual, Pearson Education.

MIC161 Microbial Diversity and Systematics

Course Title: Microbial Diversity and Systematics
Course Code: MIC161
Offered to: Undergraduate Students at Hazara University
Cr Hr.: 3(2+1)
Pre-requisite: Fundamentals of Microbiology

Course Objectives:

- To provide foundational and advanced knowledge of microbial classification systems, nomenclature rules, and systematics approaches.
- To develop an understanding of microbial diversity and evolutionary relationships through classical and molecular methods.
- To equip students with practical skills in microbial identification and taxonomy for application in research and diagnostic laboratories.

Course Learning Outcome (CLOs)

After learning this course, students will be expected to:

- Classify microorganisms based on their taxonomy and evolutionary relationships.
- Analyze the diversity of microorganisms in various ecological niches.
- Apply systematic methods to identify and characterize microorganisms.

Course Contents:

- Introduction to Microbial Taxonomy and Systematics; History and Importance
- Concepts: Taxonomy, Systematics, Species, Strains, and Nomenclature Rules
- Theory of Endosymbiosis and Microbial Evolution
- Microbial Diversity: Overview of Major Microbial Domains
- Conventional, Molecular and Genotypic Approaches for Microbial Classification and Identification
- Phylogenetic Tools and Polyphasic Taxonomy
    - Detailed classification and systematics of bacteria and archaea
    - Detailed classification of viruses, fungi, protozoa and Algae
    - Rickettsia, Chlamydia, Mycoplasma: Taxonomic Challenges
    - Study of Prions and Viroids and their placement in microbial world
    - Introduction to Microbiome Taxonomy and Metagenomics
    - Application in Diagnostics and Research: Clinical, Environmental, and Industrial Case Studies

Practical

- Microscopy and Gram staining
- Biochemical tests for microbial identification
- Use of API kits or automated diagnostic tools
- 16S rRNA sequence analysis (manual and software-based)

- Construction of phylogenetic trees using MEGA or similar software

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	**Topic to be covered**
Week 1	Introduction to Microbial Taxonomy and Systematics; History and Importance
Week 2	Concepts: Taxonomy, Systematics, Species, Strains, and Nomenclature Rules
Week 3	Theory of Endosymbiosis and Microbial Evolution. Microbial Diversity: Overview of Major Microbial Domains
Week 4	Classical and molecular basis of classification of prokaryotes and eukaryotes
Week 5	• Phylogenetic Tools and Polyphasic Taxonomy
Week 6	Detailed classification and systematics of bacteria and archaea
Week 7	Detailed classification and systematics of bacteria and archaea (continued)
Week 8	Detailed classification of viruses, fungi, protozoa and algae
Week 9	**Midterm Examination**
Week 10	Detailed classification of viruses, fungi, protozoa and algae (Continued)
Week 11	• Detailed classification of viruses, fungi, protozoa and Algae (Continued)
Week 12	• Rickettsia, Chlamydia, Mycoplasma: Taxonomic Challenges

Week 13	• Study of Prions and Viroids and their placement in microbial world
Week 14	Introduction to Microbiome Taxonomy and Metagenomics •
Week 15	Application in Diagnostics and Research: Clinical, Environmental, and Industrial Case Studies
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Garrity, G. M., Krieg, N. R., Brenner, D. J. Bergey's Manual of Systematic Bacteriology: The Proteobacteria. Williams and Wilkins Co, Baltimore.
2. Scott F. and Jon c. H. Evolutionary Analysis. Benjamin Cumming.
3. Roberto K. and Stanley M. Microbes and Evolution: The World T\that Darwin Never Saw. ASM. Press.
4. David L. K. Process in Microbial Ecology. Oxford University Press.
5. Ralf G. Dietzgen, R.F., and Ivan V. Kuzmin, I.V. Rhabdoviruses: Molecular Taxonomy, Evolution, Genomics, Ecology, Host-Vector Interactions, Cytopathology and Control Caister Academic Press. USA.

MIC418 Epidemiology & Public Health

Course Title : Epidemiology & Public Health
Course Code : MIC418
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Fundamentals of Microbiology; Fundamental of Statistics

Course Objectives:

- To learn the experimental, analytical, and statistical tools of epidemiology
- To learn about communicable diseases, their mode of transmission, reservoir, control, and prevention
- To prepare students for research career in public health professions

Course Learning Outcome (CLOs)

After completion of this course students will be able to:

- Explain the principles of epidemiology in relation to diseases.
- Analyze patterns of disease transmission and strategies for prevention and control.
- Apply epidemiological methods to public health challenges involving microorganisms.

Course Contents:

- Introduction to epidemiology: Definition, scope, and uses of epidemiology; Epidemiology and public health
- The historical context: Origins and Recent developments in epidemiology
- Health and Disease determinants: Difference between health and diseased conditions, Health status of population, Health determinants, indicators, and risk factors, Factors associated with causation of disease
- Measurement of disease frequency: Rate, Ratio and proportion, their types and uses in epidemiology, Incidence and prevalence, factor affecting disease prevalence and incidence, Morbidity, mortality rates, Interrelationships of the different measures
- Study design/ Types of studies in epidemiology: Observational and experimental studies, Descriptive studies, Ecological studies, Cross-sectional studies, Case-control studies, Cohort studies, randomized controlled trials, Field trials, Community trials
- Potential errors in epidemiological studies: systematic, random, and confounding errors
- Errors due to Biological variations and how to control these errors
- Chain of infection: Agents, reservoir, route of transmission, host
- Communicable and non-communicable diseases
- Ethical issues in epidemiology and principle of research ethics
- Community / public health: method of prevention of diseases, primary, secondary, and tertiary preventions
- Health education: scope and objectives, methods of communications in health education, targeting high risk population
- Quality of life and better life index

- Basic methods/tools/software of biostatistics and bioinformatics for data analysis, assessment, and solution of epidemiological/public health problems
- Summarizing data: Types of graphical and tabulated representations

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to epidemiology The historical context
Week 2	Health and Disease determinants
Week 3	Measurement of disease frequency
Week 4	Study design/ Types of studies in epidemiology (Continued)
Week 5	Study design/ Types of studies in epidemiology
Week 6	Potential errors in epidemiological studies
Week 7	Errors due to Biological variations and how to control these errors
Week 8	Chain of infection: Agents, reservoir, route of transmission, host Communicable and non-communicable diseases
Week 9	**Midterm Examination**
Week 10	Ethical issues in epidemiology and principle of research ethics
Week 11	Community / public health

Week 12	Health education Quality of life and better life index
Week 13	Basic methods/tools/software of biostatistics and bioinformatics (Continued)
Week 14	Basic methods/tools/software of biostatistics and bioinformatics
Week 15	Summarizing data: Types of graphical and tabulated representations
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Bhopal, R. S. Concepts of Epidemiology: Integrating the ideas, theories, principles, and methods of epidemiology. Oxford Press Inc. New York.
2. Fos, P. J. Epidemiology Foundations: The Science of Public Health. Wiley, John & Sons, Incorporate
3. Fris, R.H. Epidemiology for Public Health Practice. Jones & Bartlett Learning

Baily, S. Introduction to Epidemiologic Research Methods in Public Health Practice. Jones & Bartlett Learning.

MIC350 Soil & Agricultural Microbiology

Course Title: Soil & Agricultural Microbiology
Course Code: MIC350
Offered to: Undergraduate Students at Hazara University
Cr Hr.: 3(2+1)
Pre-requisite: Fundamentals of Microbiology

Course Objectives:

- To learn about composition, structure and properties of soil
- To study the role of microbes in soil health and fertility as well as on plant growth.
- To introduce the sustainable agriculture practices which replaces chemical dependency to eco-friendly approaches.

Course Learning Outcome (CLOs)

On successful completion of the course, the student should be able to:

- Explain the roles of microorganisms in soil health, nutrient cycling, and plant growth.
- Analyze the interactions between microorganisms, plants and the environment in agricultural systems.
- Apply soil and agricultural microbiology knowledge to enhance sustainable agricultural practices.

Course Contents:

- Introduction: Soil composition, physical and chemical properties
- Role of microbes in soil health: soil aggregate formation, C cycling, decomposition, composting, and disease suppression.
- Role of microbes in nutrient cycling, N cycle, Phosphorous solubilization and Sulfur cycle.
- Role of microbes in Plant growth: Plant Growth-Promoting Rhizobacteria (PGPR), biocontrol agents.
- Sustainable agricultural practices: Bio-fertilizers, bio-pesticides
- Agroforestry, crop rotation, soil conservation,
- Permaculture to maintain natural ecosystem.
- Integrated fish farming: Aquaponics and aquaculture

Practical

- Determination of soil structure, pH and texture
- Isolation of bacteria associated with “C” cycle
- Isolation of “N” fixing bacteria
- Isolation of microbe from rhizosphere

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies

- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	**Topic to be covered**
Week 1	Introduction: Soil composition, physical properties
Week 2	Soil aggregate formation, Soil chemical properties
Week 3	Role of microbes in soil health: C cycling, decomposition, biochar
Week 4	Role of microbes in nutrient cycling, N cycle, Phosphorous solubilization and Sulfur cycle
Week 5	Role of microbes in Plant growth: Plant Growth-Promoting Rhizobacteria (PGPR)
Week 6	Nutrient Acquisition by PGPR and its mechanism
Week 7	Biocontrol agents for plants diseases and their mode of action
Week 8	Types of biological control of plant diseases
Week 9	**Midterm Examination**
Week 10	Composting and its role in enhancing soil fertility, bio-fertilizers
Week 11	Sustainable agricultural practices: Bio-fertilizers
Week 12	Bio-pesticides types and functions
Week 13	Agroforestry, crop rotation, soil conservation, organic farming
Week 14	Permaculture to maintain natural ecosystem
Week 15	Integrated fish farming: Aquaponics and aquaculture
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Sylvia, D. M., Fuhrmann, J. J., Hartel, P. G., & Zuberer, D. A. (2005). *Principles and applications of soil microbiology* (pp. 373-404). Pearson.
2. Paul, E.A. Soil Microbiology, Ecology and Biochemistry. Elsevier Science.
3. Varma, A. Advanced Techniques in Soil Microbiology. Springer-Verlag New York, LLC.
4. Montet, D., & Ray, R. C. (Eds.). (2011). *Aquaculture Microbiology and Biotechnology, Volume Two*. CRC Press.
5. Vallabhaneni, S. Soil Microbiology- A Laboratory Manual. LAP Lambert Academic Publishing AG & Co. KG.

MIC311 Clinical & Diagnostic Microbiology

Course Title : Clinical & Diagnostic Microbiology
Course Code : MIC311
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamental Microbiology

Course Objectives:

- Understand the role of microorganisms in human health and disease.
- Learn methods for clinical specimen collection, processing, and microbial identification.
- Apply diagnostic microbiological techniques including culture, microscopy, biochemical testing, immunoassays, and molecular methods.
- Recognize the importance of antimicrobial resistance and perform sensitivity testing.

Course Learning Outcome (CLOs)

By the end of this course, students will be able to:

- Identify microbial pathogens and their role in human diseases.
- Apply diagnostic techniques to detect and characterize microbial infections.
- Evaluate treatment strategies and their effectiveness in controlling infectious diseases.

Course Contents:

- Scope and importance of clinical microbiology, Human microbiota and opportunistic infections.
- Biosafety and biosecurity in clinical laboratories, Good clinical laboratory practices (GCLP).
- Types of clinical specimens: blood, urine, sputum, stool, swabs, body fluids.
- Aseptic techniques and guidelines for specimen collection, Transport media and preservation.
- Direct microscopy: staining methods (Gram stain, acid-fast staining), Culture methods: selective and differential media.
- Biochemical identification of bacteria, Serological tests (agglutination, ELISA, immunofluorescence).
- Molecular diagnostics (PCR, RT-PCR, LAMP, nucleic acid hybridization)
- Brief introduction to common bacterial pathogens e.g. Staphylococcus, streptococcus enterococcus, Enterobacteriaceae, Pseudomonas, Clostridium and Mycobacteria.
- Sample collection and diagnosis of viral infections, virus isolation, serological diagnosis, and molecular detection.
- Diagnostic virology of key infections (Hepatitis viruses, HIV, Influenza, Herpesviruses)
- Diagnosis of fungal infections: culture, microscopy, antigen tests, Common pathogenic fungi (Candida, Aspergillus, Cryptococcus)
- Diagnostic parasitology: stool examination for helminths and protozoa, serological and molecular detection of parasites
- Principles of antimicrobial action and resistance, Disk diffusion (Kirby-Bauer method)
- MIC determination (broth dilution, E-test), Detection of resistance mechanisms (ESBLs, MRSA, Carbapenemases)

- Quality control and accreditation of diagnostic microbiology lab, Internal and external quality assurance.
- Standardization of laboratory procedures, Accreditation standards (ISO 15189, CAP, CLSI guidelines)

Practical

- Sample collection from different environmental and bodily fluids and sites.
- Transportation, processing, and preservation of of clinical samples and biochemical tests
- Internship in hospitals/pathological labs

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Scope and importance of clinical microbiology, Human microbiota and opportunistic infections.
Week 2	Biosafety and biosecurity in clinical laboratories, Good clinical laboratory practices (GCLP).
Week 3	Types of clinical specimens: blood, urine, sputum, stool, swabs, body fluids. Aseptic techniques and guidelines for specimen collection, Transport media and preservation.
Week 4	Direct microscopy: staining methods (Gram stain, acid-fast staining), Culture methods: selective and differential media.
Week 5	Biochemical identification of bacteria, Serological tests (agglutination, ELISA, immunofluorescence).
Week 6	Molecular diagnostics (PCR, RT-PCR, LAMP, nucleic acid hybridization).

Week 7	Brief introduction to common bacterial pathogens e.g. Staphylococcus, streptococcus enterococcus, Enterobacteriaceae, Pseudomonas, Clostridium and Mycobacteria.
Week 8	Sample collection and diagnosis of viral infections, virus isolation, serological diagnosis, and molecular detection.
Week 9	**Midterm Examination**
Week 10	Diagnostic virology of key infections (Hepatitis viruses, HIV, Influenza, Herpesviruses).
Week 11	Diagnosis of fungal infections: culture, microscopy, antigen tests, Common pathogenic fungi (Candida, Aspergillus, Cryptococcus).
Week 12	Diagnostic parasitology: stool examination for helminths and protozoa, serological and molecular detection of parasites.
Week 13	Principles of antimicrobial action and resistance, Disk diffusion (Kirby-Bauer method), MIC determination (broth dilution, E-test), Detection of resistance mechanisms (ESBLs, MRSA, Carbapenemases).
Week 14	Quality control and accreditation of diagnostic microbiology lab, Internal and external quality assurance.
Week 15	Standardization of laboratory procedures, Accreditation standards (ISO 15189, CAP, CLSI guidelines).
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Bailey and Scotts Diagnostic Microbiology 15th Edition, Elsevier 2021.
2. Patrick R. Murray, Ken S. Rosenthal and Michael A. Pfaller, Medical Microbiology 9th Elsevier.
3. Mark Gladwin and Bill Trattler Clinical Microbiology made a ridiculously simple 5th edition, MedMaster 2011.
4. Jawetz, Melnick, & Adelberges Medical Microbiology 27th edition, McGraw-Hill, 2016.

MIC412 Antimicrobial agents & resistance

Course Title : Antimicrobial agents & Resistance
Course Code : MIC412
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

By the end of this course, students will be able to:

1. Describe the classification, mechanism of action, and therapeutic use of antibacterial, antifungal, antiviral, antiprotozoal, and anti-nematodal agents.
2. Explain the molecular and biochemical mechanisms of resistance among bacteria, viruses, fungi, protozoa, and helminths.
3. Understand the epidemiology and public health impact of antimicrobial resistance (AMR) on a global and local scale.
4. Demonstrate knowledge of laboratory methods used for identification and susceptibility testing of antimicrobial-resistant organisms.
5. Evaluate and apply principles of antimicrobial stewardship to promote rational drug use.
6. Explore emerging antimicrobial therapies and novel approaches to combat resistance.

Course learning outcomes (CLOs):

By the end of this course, the students will be able to:

- Understand the mechanisms of action of various antimicrobial agents and their roles in treating microbial infections.
- Analyze the factors contributing to antimicrobial resistance and its impact on public health.
- Apply knowledge of antimicrobial resistance to develop strategies for the effective use of antimicrobial agents and to mitigate the spread of resistance.

Course Contents:

1: Introduction to Antimicrobial Agents

- History and discovery of antimicrobial agents
- Classification and sources of antimicrobial agents
- General principles of antimicrobial therapy, including criteria used for the selection of antimicrobial agents used for the therapy of diseases

2: Mechanisms of Action of Antimicrobial Agents

- Cell wall synthesis Inhibitors (e.g., β-lactams, glycopeptides)
- Agents affecting cell membrane function (e.g., polymyxins)
- Protein synthesis Inhibitors (e.g., aminoglycosides, tetracyclines)
- Nucleic acid synthesis Inhibitors (e.g., fluoroquinolones, rifampin)
- Antimetabolites (e.g., sulfonamides, trimethoprim)

3: Antifungal Agents

- Classes of antifungal drugs:
- Polyenes (e.g., amphotericin B)
- Azoles (e.g., fluconazole, itraconazole)
- Echinocandins (e.g., caspofungin)
- Others (e.g., flucytosine, terbinafine)

- Mechanisms of action and resistance
- Clinical uses and toxicity

4: Antiviral Agents

- Classification of antiviral drugs by viral type:
- Anti-herpesvirus agents (e.g., acyclovir)
- Anti-influenza agents (e.g., oseltamivir)
- Antiretrovirals (e.g., reverse transcriptase inhibitors, protease inhibitors)
- Anti-hepatitis agents
- Mechanisms of action and resistance
- Challenges in antiviral therapy

5: Antiparasitic Agents

- Antiprotozoal agents:
  Metronidazole, chloroquine, artemisinin, nitazoxanide
  Uses in malaria, amoebiasis, giardiasis, leishmaniasis
- Anti-nematodal agents:
  Albendazole, mebendazole, ivermectin, pyrantel pamoate
  Mechanisms and clinical applications
  Resistance development in protozoa and helminths

6: Antimicrobial Resistance Mechanisms

- Enzymatic degradation or modification of drugs
- Target site alteration
- Efflux pumps and reduced permeability
- Resistance mechanisms in viruses, fungi, protozoa, and helminthes
- Genetic elements involved in resistance: plasmids, transposons, integrons

7: Detection and Laboratory Diagnosis of Resistance

- Phenotypic methods:
  Disk diffusion, MIC, E-test
- Genotypic methods:
  PCR, sequencing, resistance gene detection
- Quality assurance in susceptibility testing

8: Epidemiology and Public Health Impact

- Global and regional surveillance of AMR
- Multidrug-resistant organisms (e.g., MRSA, VRE, CRE)
- AMR in viral, fungal, and parasitic infections
- Zoonotic and environmental reservoirs of AMR
- AMR surveillance programs (e.g., GLASS, WHONET)
- One Health approach to AMR

9: Antimicrobial Stewardship and Infection Control

- Principles and core components of antimicrobial stewardship programs
- Rational prescribing and drug selection in human and veterinary medicine
- Hospital infection control practices

- Role of healthcare professionals in AMR control: Policy and regulation for AMR containment

10: Emerging Therapies and Future Perspectives

- Novel antimicrobial agents and alternative therapies
- Phage therapy and CRISPR-based interventions
- Immunotherapy and vaccines as alternatives
- Strategies to overcome resistance: drug combinations, adjuvants.

Practical:

- Disk diffusion assay
- Minimum Inhibitory concentration (MIC)

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Antimicrobial Agents
Week 2	Mechanisms of Action of Antimicrobial Agents
Week 3	Antifungal Agents
Week 4	Antiviral Agents
Week 5	Antiparastic agents
Week 6	Antimicrobial Resistance Mechanisms
Week 7	Antimicrobial Resistance Mechanisms (continued)
Week 8	Detection and Laboratory Diagnosis of Resistance

Week 9	Midterm Examination
Week 10	Detection and Laboratory Diagnosis of Resistance (continued)
Week 11	Epidemiology and Public Health Impact
Week 12	Epidemiology and Public Health Impact (continued)
Week 13	Antimicrobial Stewardship and Infection Control
Week 14	Emerging Therapies and Future Perspectives
Week 15	Emerging Therapies and Future Perspectives (continued)
Week 16	Final Examination

Recommended Books

1. Lippincott's Illustrated Reviews: Pharmacology, Karen Whalen et al. Publisher: Wolters Kluwer
2. Pharmacology for Medical Graduates (5th Edition) Authors: Tara V. Shanbhag & Smita Shenoy. Publisher: Elsevier Health Sciences
3. Jawetz, Melnick & Adelberg's Medical Microbiology Author: Geo. Brooks, Karen Carroll, et al. Publisher: McGraw-Hill Education
4. Antimicrobial Chemotherapy Authors: Roger Finch, David Greenwood, et al. Publisher: Oxford University Press
5. Basic and Clinical Pharmacology Author: Bertram Katzung Publisher: McGraw-Hill Education.

MIC473 Artificial Intelligence in Microbiology

Course Title : Artificial Intelligence in Microbiology
Course Code : MIC473
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamental Microbiology

Course Objectives:

- Apply AI techniques to analyze microbiological data, including genomic and clinical datasets.
- Integrate AI in microbial diagnostics and infectious disease management.
- Evaluate the ethical and practical implications of AI in microbiology.
- Utilize AI in drug discovery, genome sequencing, and proteomics research.

Course Learning Outcome (CLOs)

By the end of this course, students will be able to:

- Understand the basic concepts of artificial intelligence and its potential applications in
- microbiology.
- Recognize the ways in which artificial intelligence (AI) can be used to analyze
- microbiological data and improve research outcomes.
- Explore simple AI tools or platforms that can assist in microbiological studies, without
- needing to understand the underlying technical details.

Course Contents:

- Introduction to Artificial Intelligence (AI) in Microbiology: Definition and scope of AI. History and evolution of AI in Science. Role of AI in microbiology. Key AI techniques; Machine Learning, Neural Networks, and Deep Learning. AI tools and plateforms
- AI in microbial identification: Understanding microbes using AI, Phenotypic identification of microbes using AI and molecular identification using AI.
- AI in Predictive Diagnostics and Disease Management: AI in Predictive Diagnostics, Computer-Aided Diagnosis (CADx) and AI in Infectious Disease Management.
- AI in Drug Design and Development: AI-assisted Drug Design, High-throughput Screening and Structure-Based Drug Design using AI.
- AI in Microbial genomics and Molecular Biology: AI in DNA Sequence Analysis, AI in Genome Sequencing, AI in gene prediction, AI in proteomics and Genome-Wide Association Studies (GWAS) using AI.
- Applications of AI in Disease Prediction and Epidemiology: Disease Prediction from Sequence Analysis and AI in Epidemic Outbreak Prediction.
- Current Advancements and Breakthroughs in AI in Microbiology: AI in Microbial Ecology, AI in Antibiotic Resistance Studies and Cutting-edge AI Research in Microbiology.
- Limitations and Ethical Considerations of AI in Microbiology: Limitations of AI in Microbiology, Ethical Issues and Privacy Concerns and Regulatory Challenges and Future prospects

Practical

- Students will explore various online platforms and freely available tools
- Students will analyze given Microbiological/DNA/RNA/Protein data using the online platforms/tools

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Artificial Intelligence (AI) in Microbiology: Definition and scope of AI. History and evolution of AI in Science.
Week 2	Role of AI in microbiology. Key AI techniques; Machine Learning, Neural Networks, and Deep Learning. AI tools and platforms
Week 3	AI in microbial identification
Week 4	AI in Predictive Diagnostics and Disease Management: AI in Predictive Diagnostics, Computer-Aided Diagnosis (CADx)
Week 5	AI in Predictive Diagnostics and Disease Management: AI in Infectious Disease Management.
Week 6	AI in Drug Design and Development: AI-assisted Drug Design,
Week 7	High-throughput Screening and Structure-Based Drug Design using AI.
Week 8	AI in Microbial genomics and Molecular Biology: AI in DNA Sequence Analysis
Week 9	**Midterm Examination**
Week 10	AI in Genome Sequencing, AI in gene prediction
Week 11	AI in proteomics and Genome-Wide Association Studies (GWAS) using AI.
Week 12	Applications of AI in Disease Prediction and Epidemiology: Disease Prediction from Sequence Analysis
Week 13	AI in Epidemic Outbreak Prediction.

Week 14	Current Advancements and Breakthroughs in AI in Microbiology: AI in Microbial Ecology, AI in Antibiotic Resistance Studies and Cutting-edge AI Research in Microbiology.
Week 15	Limitations and Ethical Considerations of AI in Microbiology: Limitations of AI in Microbiology, Ethical Issues and Privacy Concerns and Regulatory Challenges and Future prospects
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Heifetz, A. (2022). Artificial Intelligence in Drug Design. Humana Press.
2. Juhas, M. (2023). Brief Lessons in Microbiology: From the Origin of Life to Artificial Intelligence. Springer.
3. Krittanawong, C. (2024). Artificial Intelligence in Clinical Practice: How AI Technologies Impact Medical Research and Clinics (First edition). Elsevier Inc.
4. Pathak, Y., Saikia, S., Pathak, S., Patel, J. K., and Prajapati, B. (2023). Artificial Intelligence in Bioinformatics and Chemoinformatics (First edition). CRC Press.
5. Razmi, R. M. (2024). AI Doctor: The Rise of Artificial Intelligence in Healthcare: A Guide for Users, Buyers, Builders, and Investors. John Wiley & Sons, Inc.
6. Srivastava, A., and Mishra, V. (2024). Artificial Intelligence in Microbiology. Elsevier Science & Technology.

MIC240 Virology

Course Title : Virology
Course Code : MIC240
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : None

Course Objectives:

- To identify major components of viruses
- To understand the systems and traits used for classification of viruses
- To describe how viruses interact with host cells
- To examine the ways that viruses persist in host cells

Course Learning Outcome (CLOs)

After completing this course, the students should know the:

- Describe the structure, classification, and life cycles of viruses.
- Analyze the mechanisms of viral infection, replication, and host interactions.
- Apply knowledge to understand the prevalence, and control of viral infections.

Course Contents:

- Introduction to virology (Historical milestones, nature and general characters)
- Origin and evolution of viruses: regressive, cellular, and co-evolution
- Principles of electron microscopy
- Viral taxonomy and classification: principles of viral classification, overview of ICTV and Baltimore classification systems.
- Structure and composition of viruses: viral components (nucleic acid, capsid, envelope enzymes) and morphological types (helical, icosahedral, complex), with special focus on animal viruses and bacteriophages.
- Viral replication cycles: Lytic and lysogenic
- Viral entry and uncoating mechanisms (fusion, endocytosis, direct penetration)
- Viral genome expression: Strategies for viral mRNA synthesis, post transcriptional modifications and viral translation mechanisms
- Viral replication strategies: DNA viruses, RNA viruses, retro and para-retroviruses
- Viral assembly and release: Genome packaging mechanisms, lytic and non-lytic release
- Lysogeny and latent infection: generalized and specialized transduction
- Principles of viral diagnostic procedures
- Subviral agents: Prion and Viroids

Practical

- Isolation of bacteriophages from environmental samples.
- Assessment of antibiotic sensitivity of isolated bacteriophage-infected bacteria.

- Calculation and application of multiplicity of infection (MOI)

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to virology (Historical milestones, nature and general characters)
Week 2	Introduction to virology (continued)
Week 3	Origin and evolution of viruses
Week 4	Principles of electron microscopy
Week 5	Viral taxonomy and classification: ICTV and Baltimore (continued)
Week 6	Viral taxonomy and classification: ICTV and Baltimore
Week 7	Structure and composition of viruses (continued)
Week 8	Structure and composition of viruses
Week 9	**Midterm Examination**
Week 10	Lytic cycle of viral replication (attachment and entry)
Week 11	Lytic cycle of viral replication (gene expression and replication strategies)
Week 12	Lytic cycle of viral replication (assembly and exit)
Week 13	Lysogeny (generalized and specialized transduction)

Week 14	Principles of viral diagnostic procedures
Week 15	Subviral agents: Prion and Viroids
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Mahy, B.W.J., & Van Regenmortel, M.H.V.Encyclopedia of Virology. Elservier
2. Cann, A. J. Principles of Molecular Virology. Academic Press.
3. Robert, W. Molecular Biology. McGraw-Hill Sciences
4. Ralf G. Dietzgen, R.F., and Ivan V. Kuzmin, I.V. Rhabdoviruses: Molecular Taxonomy, Evolution, Genomics.
5. Caister. Ecology, Host-Vector Interactions, Cytopathology and Control Academic Press. USA.

MIC441 Animal Virology

Course Title : Animal Virology
Course Code : MIC441
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : General Virology

Course Objectives:

- To identify traits for viral identification
- To understand the virus penetration and replication inside the host cell
- To study the anti-viral agents and control mechanisms

Course Learning Outcome (CLOs)

Upon successful completion of the course, the students should have following abilities:

- Demonstrate knowledge of important viral disease that apply to a wide variety of animal species
- Apply knowledge of pathogenesis of viruses to determine appropriate and effective method of controlling the spread and transmission

Course Contents:

- Classification and structure of animal viruses
- Host cells for viral multiplication, productive infections
- One-step multiplication curve
- Impact of viral infection on host cell
- Replication of viral genome
- Maturation and release of animal viruses
- Molecular biology, biochemistry and genetics of the following viruses: Picornaviruses, Poxviruses, Myxoviruses, Paramyxoviruses, Rubella viruses, Rhabdoviruses, Reoviruses, Herpes viruses, Hepatitis viruses, Retroviruses and Tumor viruses (DNA & RNA)
- Interference with viral multiplication
- Interferon and chemotherapeutic agents

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Classification and structure of animal viruses (Continued)
Week 2	Classification and structure of animal viruses
Week 3	Host cells for viral multiplication, productive infections (Continued)
Week 4	Host cells for viral multiplication, productive infections
Week 5	One-step multiplication curve
Week 6	Impact of viral infection on host cell (Continued)
Week 7	Impact of viral infection on host cell
Week 8	Replication of viral genome (Continued)
Week 9	**Midterm Examination**
Week 10	Replication of viral genome
Week 11	Maturation and release of animal viruses
Week 12	Molecular biology, biochemistry and genetics of the viruses as exemplified in contents (Continued)
Week 13	Molecular biology, biochemistry and genetics of the viruses as exemplified in contents (Continued)
Week 14	Molecular biology, biochemistry and genetics of the viruses as exemplified in contents
Week 15	Interference with viral multiplication Interferon and chemotherapeutic agents
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Alan, J. C. Principles of Molecular Virology. Academic Press.
2. Roizman, Griffin, Malcolm A. Martin, et al. Fundamental Virology. Lippincott Williams and Wilkins.

3. Robe, L., Malcolm, A. M., Diane, E. et al. Fields Virology Lippincott Williams and Wilkins.
4. Brian, W. M. and Mahy, B. W. A Dictionary of Virology Academic Press.
5. Nigel J. J. D., K., Leppard, A. E., A., Easton, K. L. Introduction to Modern Virology. Blackwell Science, Inc.
6. Alan J. C. Virus Culture: A Practical Approach Oxford University Press.

MIC419 Management of Infectious Waste

Course Title : Management of Infectious Waste
Course Code : MIC419
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : None

Course Objectives:

- To enable students to identify different types of hazardous materials used/generated in clinical labs.
- To enable students to identify risk of infections associated with different type of wastes.
- To equip students with the necessary skills required for handling and management of hazardous wastes.

Course Learning Outcome (CLOs)

At the end of the course, students should have:

- Knowledge for identification of different types of hazards and strategies to cope with hazardous waste, if encountered
- Necessary skills and competence in performing different laboratory tasks while minimizing risk posed by microorganisms for themselves and their fellows

Course Contents:

- An introduction to the management of infectious waste materials
- Types of infectious materials: handling and methods of their disposal
- Segregation of waste materials in labs
- Infectious diseases and methods of spread of causative agents
- Laboratory and Hospital acquired infections: possible sources and causes
- Hazardous groups of microorganisms including genetically modified organisms
- Basic containment rules and laboratory containment levels
- Control measures and maintenance of control. Guidelines for workers in pathological Laboratories and postmortem rooms
- Rules for safe conduct of field work/expeditions in outdoor settings
- Risk assessment: recognition of hazards, competence, elimination of hazards, collection of data etc.
- Risk group personnel: their education, training and monitoring
- Radiation hazards and disposal of radioactive wastes

Practical

- Demonstration of laboratory design and facilities
- Demonstration of various methods to control microbial population
- Visit to laboratory/hospitals for the evaluation of efficiency of the waste management plan
- Identification of pathogens in infectious waste
- Identification of infectious waste in water reservoirs

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Practical classes in laboratory

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	An introduction to the management of infectious waste materials
Week 2	Types of infectious materials: handling and methods of their disposal
Week 3	Segregation of waste materials
Week 4	Infectious diseases and methods of spread of agents involved
Week 5	Laboratory and Hospital acquired infections: possible sources and causes
Week 6	Laboratory and Hospital acquired infections: possible sources and causes
Week 7	Hazardous groups of microorganisms including genetically modified organisms

Week 8	Basic containment rules and laboratory containment levels
Week 9	**Midterm Examination**
Week 10	Basic containment rules and laboratory containment levels
Week 11	Control measures and maintenance of control
Week 12	Rules for safe conduct of field work/expeditions in outdoor settings
Week 13	Risk assessment: recognition of hazards, competence, elimination of hazards, collection of data etc.
Week 14	Risk group personnel: their education, training and monitoring
Week 15	Radiation hazards and disposal of radioactive waste
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Frosch, M., Martin C. and Maiden, J. Handbook of Meningococcal Disease: Infection Biology, Vaccination, Clinical Management. John Wiley & Sons, Inc U.S.A.
2. Gillespie, S., and Hawkey, P. Principles and Practice of Clinical Bacteriology. John Wiley& Sons, Inc U.S.A.
3. Callahan, R.J. Emerging Biological Threats: A Reference Guide. Greenwood Publishing Group, Incorporated.
4. Miller, C.H., and Palenik, J.C. Infection Control and Management of Hazardous Materials for the Dental Team. Elsevier Health Sciences.
5. Peter A. Infectious and Medical Waste Management

MIC201 Mycology

Course Title : Mycology
Course Code : MIC201
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : None

Course Objectives:

- To discuss the importance of fungi in various ecological roles and impact on human affairs
- To learn the characteristics and taxonomy of the micro and macrofungi and fungal relationship with other organisms
- To demonstrate a working knowledge of how fungi grow, reproduce, and where and how they can be isolated

Course Learning Outcome (CLOs)

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

- Identify the major groups of fungi and their ecological roles.
- Explain the physiological and biochemical processes unique to fungi.
- Apply mycological knowledge to understand fungal interactions with other organisms and environments.

Course Contents:

- Introduction to mycology
- General characteristics, structure and physiology of fungi
- Physical and nutritional factors affecting the growth of fungi
- Detailed structure and types of hyphae and mycelium
- Spores in fungi
- Fundamentals of fungal classification
- Structural development and reproduction in fungi including cell cycle
- Fungal metabolism (with reference to food and beverages)
- Fermentation processes using Fungi
- Animal and human fungal diseases
- Mycotoxins
- Edible Fungi
- Beneficial and harmful impacts of fungi

Practical

- Introduction to laboratory equipment
- Culture media for growth of fungi
- Isolation and identification of pure culture of fungi

- Field trip for mushroom collection and putting together a lab notebook that incorporates the sketches of collected fungi
- 10 minutes presentation by each student to the class on a fungal species of his choice

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to mycology
Week 2	General characteristics, structure and physiology of fungi
Week 3	Physical and nutritional factors affecting the growth of fungi
Week 4	Detailed structure and types of hyphae and mycelium
Week 5	Spores in fungi
Week 6	Fundamentals of fungal classification
Week 7	Structural development and reproduction in fungi including cell cycle (Continued)
Week 8	Structural development and reproduction in fungi including cell cycle
Week 9	**Midterm Examination**
Week 10	Fungal metabolism (with reference to food and beverages
Week 11	Fermentation processes using Fungi
Week 12	Animal and human fungal diseases

Week 13	Mycotoxins
Week 14	Edible fungi
Week 15	Beneficial and harmful impacts of fungi
Week 16	**Final Examination**

Reference Books (Latest Editions):

a. Hocking, A.D., Pitt, J.I., Samson, R.A., Thrane, U. Advances in Food Mycology, Springer.

b. Webster, J. and Weber, R. Introduction to Mycology, Cambridge University Press.

c. Ainsworth, G.C. Overview: Introduction to the History of Mycology. Cambridge University Press.

d. Inderjeet K. S. and Surinder K. W. Textbook of Fungi and Their Allies.

e. Katherine B., Daniel J. E. Cellular and Molecular Biology of Filamentous Fungi. ASM Press

f. Caister Gioconda, S-B. and Richard, C. A. Pathogenic Fungi: Insights in Molecular Biology. Academic Press.

MIC402 Veterinary Microbiology

Course Title : Veterinary Microbiology
Course Code : MIC402
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To learn about viral and bacterial infections of animals and birds
- To learn about common pathogens of human and animals
- To get know how of symptoms, diagnosis, epidemiology and control of veterinary infections

Course Learning Outcome (CLOs)

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

- Explain the major types of microbes responsible for veterinary infections
- Use the knowledge to prevent the spread of pathogens from animals to humans

Course Contents:

- Study of major animal diseases in Pakistan. Etiology, Symptomatology, Immunology, Epidemiology, diagnosis, and prevention of following diseases:
    - Tuberculosis, Anthrax, Brucellosis, Johne's Disease, Bovine Mastitis, tick fever, Salmonellosis (including Pullorum)
    - Rabies, Foot and Mouth Disease, New castle Disease, Infectious laryngotracheitis, Fowl pox, Sore Mouth of sheep and goats, avian influenza, infectious bursal disease (Gumboro), hydropericardium syndrome (Angara)
    - Emerging viral disease
- Importance of Zoonoses in Pakistan
- Quarantine and international control of animal livestock farming

Practical

- Isolation of etiological agents of infections from infected animals
- Isolation of etiological agents of infections from poultry
- Mode of immunization of birds and animals
- Field trips

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 2	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 3	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 4	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 5	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 6	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 7	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 8	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 9	**Midterm Examination**
Week 10	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 11	Study of major animal diseases in Pakistan and their causative agents (Continued)
Week 12	Study of major animal diseases in Pakistan and their causative agents
Week 13	Importance of Zoonoses in Pakistan (continued)
Week 14	Quarantine and international control of animal livestock farming (continued)
Week 15	Quarantine and international control of animal livestock farming
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Martin E., Jones, H., William T. and Hubbert, V. H. Zoonoses: Recognition, Control and Prevention, Blackwell Publishing.

2. Mettenleiter, T. C and F. Sobrino, F. Animal Viruses: Molecular Biology Caister Academic Press.
3. Songer, J, G., and Post, K. Veterinary Microbiology: Bacterial and Fungal Agents of Animal Disease. 1st Edition. Wiley, John & Sons, Incorporated.
4. Quinn, P.J., Markey, B.K., Leonard, F.C., Hartigan, P., Fanning, S. Veterinary Microbiology and Microbial Disease. Wiley, John & Sons, Incorporated.

MIC403 Microbial Plant Diseases

Course Title : Microbial Plant Diseases
Course Code : MIC403
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology; Mycology

Course Objectives:

- To recognize the economic importance of microbial plant diseases
- To learn about bacterial, fungal, and viral diseases of the plants
- To enable students to develop the strategies for the control of plant diseases

Course Learning Outcome (CLOs)

On completion of the course, the student should have skills to:

- Identify plant diseases by observing symptoms, and using available diagnostic techniques
- Use the acquired knowledge for educating the community to control the spread, and for management of diseases in the field

Course Contents:

- Importance of plant diseases in Pakistan
- Nature and classification of plant diseases
- Etiology and symptoms of plant diseases of field crops, fruits, and vegetables
- Fungal diseases: Rusts, Smuts, Wilts and Root rots
- Bacterial diseases: Blights, Cankers, Leaf spots and Rots
- Viral diseases: Mosaics, Dwarfs, Stunts, Yellows, Leaf curl, Witches Broom, Ring spots and Wilts
- Quarantine, eradication, and International Plant Protection
- Cultural practices in disease control, chemical control
- Resistant varieties
- Future problems and prospects of Plant Microbiology

Practical

- Sample collection, isolation, and identification of plant pathogen (farms, orchards, nurseries etc.)
- Field trips

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Practical classes in laboratory

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Importance of plant diseases in Pakistan
Week 2	Nature and classification of plant diseases
Week 3	Etiology and symptoms of plant diseases of field crops, fruits, and vegetables
Week 4	Fungal diseases: Rusts and Smuts
Week 5	Fungal diseases: Wilts and Root rots
Week 6	Bacterial diseases: Blights and Cankers
Week 7	Bacterial diseases: Leaf spots and Rots
Week 8	Viral diseases: Mosaics, Dwarfs and Stunts
Week 9	**Midterm Examination**
Week 10	Viral diseases: Yellows, Leaf curl, Witches Broom
Week 11	Viral diseases: Ring spots and Wilts
Week 12	Quarantine, eradication, and International Plant Protection
Week 13	Cultural practices in disease control, chemical control
Week 14	Resistant varieties
Week 15	Future problems and prospects of Plant Microbiology
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Tronsmo, A.M., Djurle, A., Munk, L., Yuen, J. & Collinge, D.B. Plant Pathology and Plant Diseases

2. Narayanasamy, P. Soilborne Microbial Plant Pathogens and Disease Management. Nature and Biology
3. Kumar, P., Tiwari, A.K., Kamle, M., Abbas, Z. & Singh, P. Plant Pathogens: Detection and Management for Sustainable Agriculture

MIC304 Pathology and Microbiology-I

Course Title : Pathology and Microbiology-I
Course Code : MIC304
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 2(2+0)
Pre-requisite : None

Course Objectives

- To discuss concepts of general pathology
- To recognize signs and symptoms that are considered red flag for serious disease
- To disseminate pertinent information and findings, and ascertain the appropriate steps to follow during physical therapy management

Course Learning Outcome (CLOs)

- The course will develop an understanding among students about the pathology of underlying clinical disease states and involving the major organ systems
- Students will have necessary problem-solving skills and information about pathology and Microbiology to decide about referral of a case to another health care provider for alternative intervention

Course Contents:

- Introduction: General pathology, cell injury and death, Causes of cell injury, Pathogenesis of necrosis and apoptosis, Sub cellular responses
- Cell adaptations: Relevant examples: Hyperplasia, Hypertrophy, Atrophy, Metaplasia and intracellular accumulation
- Inflammation: Acute inflammation, Vascular events and cellular events, Chemical mediators
- Chronic inflammation: General and granulomatous inflammation, Morphologic patterns of acute and chronic inflammation
- Healing & Repair: Normal controls of healing and repair, Repair by connective tissue, Wound healing
- Hemodynamic disorders: Edema and its types, Hyperemia /congestion, Hemorrhage, Thrombosis, Embolism, Infarction, Shock
- Diseases Of Immunity: General features of immunity. Hypersensitivity reactions, Immune deficiencies, Autoimmunity, Amyloidosis
- Neoplasia: Nomenclature of neoplasia, Molecular basis of neoplasia, Carcinogenic agents of neoplasia, Clinical aspects of neoplasia
- Microbiology; The Bacteria: Bacterial cell structure, its forms and function, Identification and classification of bacteria, Gram stain
- Methods of studying micro-organism: Culturing, inoculation and identification, Types of medicine, Physical states of media
- Microbial growth: Stages in the normal growth curve
- Microbial genetics: Prokaryotic transcriptions and translations, Conjugations, Mutation and its causes
- Mechanism of drug resistances and its pathogenesis: Gateway to infection, Resident flora and its mechanism of invasions, Classic stages of clinical infection, Sterilization and disinfection.

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction: General pathology, cell injury and death
Week 2	Cell adaptations
Week 3	Inflammation
Week 4	Chronic Inflammation
Week 5	Healing & Repair
Week 6	hemodynamic Disorders
Week 7	Diseases Of Immunity
Week 8	Neoplasia
Week 9	**Midterm Examination**
Week 10	Microbiology; The Bacteria
Week 11	Methods of Studying Micro-Organism
Week 12	Microbial Growth

Week 13	Microbial genetics
Week 14	Mechanism of drug resistances and its pathogenesis (Continued)
Week 15	Mechanism of drug resistances and its pathogenesis
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Goodman, C.C. and Fuller, K.S. Pathology: implication for the Physical Therapist. Elsevier: USA
2. Kumar, V., Abbas, A.K and Aster J.C. Robbins basic pathology. Elsevier: Philadelphia.
3. Levinson, W. Review of medical microbiology and immunology. McGraw-Hill: Canada.
4. Thomson, A.D. and Cotton, R.E. Lecture notes on pathology. FA Davis

MIC305 Pathology and Microbiology-II

Course Title	:	Pathology and Microbiology-II
Course Code	:	MIC305
Offered to	:	Undergraduate Students at Hazara University
Cr Hr.	:	3(2+1)
Pre-requisite	:	None

Course Objectives:

- To describe consequences of pathologic processes on the structure and function of the human body
- To discuss selected disorders/diseases common to acute care.
- To explain normal structure and function, in relation to disease processes

Course Learning Outcome (CLOs)

At the end of course, the student will be able to:

- Explain basic concepts, terminologies, etiology, and characteristics of pathological processes
- Provide working knowledge of clinical pathology lab importance in allied medical/health fields

Course Contents:

- The Integumentary System: Skin Lesions, Signs and Symptoms of Skin Disease, Aging and the Integumentary System, Common Skin Disorders, Skin Infections, Skin Cancer, Skin Disorders Associated With Immune, Dysfunction, Thermal Injuries, Miscellaneous Integumentary Disorders
- The Cardiovascular System: Signs and Symptoms of Cardiovascular Disease, Aging and the Cardiovascular System, Gender Differences and the Cardiovascular System, Diseases Affecting the Heart Muscle, Disease Affecting the Cardiac Nervous System, Diseases Affecting the Heart Valves, Diseases Affecting the Pericardium, Diseases Affecting the Blood Vessels, Other Cardiac Considerations
- The Lymphatic System: Anatomy and Physiology, Inflammation and Infection in the Lymphatic System
- The Respiratory System: Aging and the Pulmonary System, Infectious and Inflammatory Diseases, Obstructive Diseases, Environmental and Occupational Diseases, Near Drowning, Congenital Disorders, Parenchymal Disorders, Disorders of the Pulmonary Vasculature, Disorders of the Pleural Space
- Introduction To Pathology Of The Musculoskeletal System: Advances in Musculoskeletal Biotechnology, Biologic Response to Trauma, Aging and the Musculoskeletal System, The Musculoskeletal System and Exercise, Musculoskeletal System Disease
- Metabolic Disorders: Osteoporosis, Osteomalacia, Paget's disease
- Infectious Diseases Of The Musculoskeletal System: Osteomyelitis, Infections of Prostheses and Implants, Diskitis, Infectious (Septic) Arthritis, Infectious (Inflammatory) Muscle Disease, Extra pulmonary tuberculosis, Summary of Special Implications for the Therapist

- Musculoskeletal Neoplasms: Primary Tumors, Primary Benign Bone Tumors, Primary Malignant Bone Tumors, Multiple Myeloma, Primary Soft Tissue Tumors, Metastatic Tumors
- Soft Tissue, Joint And Bone Disorders: Soft Tissue, Joint, Bone
- Pathology Of The Nervous System: Introduction and overview of Central Nervous System Disorders, Pathogenesis, Clinical Manifestations, Diagnosis, Treatment, Prognosis
- Infectious Disorders Of The Central Nervous System: Overview, Meningitis, Encephalitis, Brain Abscess, Prion Disease
- Central Nervous System Neoplasms: Primary Brain Tumors, Specific Primary Brain Tumors, Primary Intraspinal Tumors, Metastatic Tumors, Paraneoplastic Syndromes, Leptomeningeal Carcinomatosis, Pediatric Tumors
- Degenerative Diseases Of The Central Nervous System: Amyotrophic Lateral Sclerosis, Alzheimer's Disease, Alzheimer's Dementia, and Variants, Dystonia, Huntington's Disease, Multiple Sclerosis, Parkinsonism and Parkinson's disease
- Stroke: Stroke, Vascular Disorders of the Spinal Cord
- Medical Microbiology: G +Ve Cocci (Staphylococci, Streptococci); G –Ve Cocci (Neisseria); G +Ve Spore Forming Rods (Bacilli, Clostridia); G –Ve rods (introduction to Enterics); Acid Fast Bacilli (Mycobacteria); Spirochetes Introduction, Treponemes; Basic Virology, General characteristics of virus, viral structure, nomenclature and classification; Mycology, Introduction to mycology; Parasitology, Introduction to protozoan

Practical

- Microscope
- Calcification
- Osteogenic sarcoma
- Granulation tissue
- Chronic inflammation (cholecystitis)
- Acute inflammation (appendicitis)
- Fibroadenoma
- Carcinoma of breast
- Actinomycosis
- Culture media
- Gram staining
- Z-N staining
- Giant cell tumor
- Examination of urine

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	The Integumentary System (Continued)
Week 2	The Integumentary System
Week 3	The Cardiovascular System (Continued)
Week 4	The Cardiovascular System
Week 5	The Lymphatic System The Respiratory System (Continued)
Week 6	The Lymphatic System The Respiratory System
Week 7	Introduction To Pathology Of The Musculoskeletal System
Week 8	Metabolic Disorders Infectious Diseases Of The Musculoskeletal System (Continued)
Week 9	**Midterm Examination**
Week 10	Metabolic Disorders Infectious Diseases Of The Musculoskeletal System (Continued)
Week 11	Metabolic Disorders Infectious Diseases Of The Musculoskeletal System
Week 12	Musculoskeletal Neoplasms Soft Tissue, Joint And Bone Disorders Pathology Of The Nervous System (Continued)
Week 13	Musculoskeletal Neoplasms Soft Tissue, Joint And Bone Disorders Pathology Of The Nervous System
Week 14	Stroke Medical Microbiology (Continued)

Week 15	Stroke Medical Microbiology
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Goodman, C.C. Pathology: implications for the Physical therapist.
2. Robbins. Basics and advanced Human Pathology.
3. Thomas and Cotton. Lecture notes on Pathology. Blackwell Scientific Publications, Oxford

MIC210 BIOETHICS, BIOSAFETY & BIOSECURITY

Course Title : Biosafety and Biosecurity

Course Code : MIC210

Offered to : Undergraduate Students at Hazara University

Cr Hr. : 3(3+0)

Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To provide an overview of the critical aspects of biosecurity, biosafety and biocontainment
- To deliver the guiding principles of laboratory safety such as identification, assessment, and control of the broad variety of risks encountered in the labs
- To understand and address bioethical issues in microbiological research

Course Learning Outcomes (CLOs)

By the end of this course, the students will be able to:

- Explain the ethical, biosafety and biosecurity principles governing microbiological research and practices.
- Analyze the importance of biosafety and biosecurity in handling microorganisms.
- Apply ethical, biosafety and biosecurity guidelines to ensure responsible conduct in microbiology-related activities.

Course Contents:

- Introduction to Biosafety and Biosecurity: Detailed concept of Risk and Hazardous Environment including Chemical, Radiological and Biological Hazards; Lab acquired infections and Bioterrorism. Importance of biosafety and biosecurity in minimizing the risk of lab acquired infections and bioterrorism.
- Biosafety Concepts and Strategies: Microorganism's risk groups, relationship between risk groups and biosafety levels, Concepts of primary and secondary barriers, biosafety cabinets and their types, designing of labs based on Biosafety and Biological Containment parameters.
- Biosecurity Concepts and Strategies: Key components of a biosecurity program (physical security, pathogen accountability, personnel reliability, transport security, information security) Emergency response plan for breaches of biosecurity
- Operational Biosafety Practices and Procedures: General biosafety practices and procedures applicable to all laboratories handling infectious agents, biosafety practices and procedures applicable to BSL2, BSL3, BSL4 laboratories
- Risk Assessment & Management: Risk assessment for microorganisms, factors affecting risk assessment (agent, host, environment, behavioral), ideal risk assessment for laboratories handling dangerous pathogens, risk management strategies, Preventions, Surveillance and Monitoring
- Biosafety Program Management: Structure of a biosecurity and biosafety program
- Risk Communication: Explain what is meant by risk communication, communicating crisis information to the public, communication of laboratory accidents and breaches
- Infectious Waste Management: Outline the types of infectious waste generated in the laboratory, treatment methods

- Transportation of Infectious Substances: Biological Select Agents or Toxins, Outline the regulatory framework governing the transportation of infectious substances, classification, packaging, labeling, documentation and shipping requirements
- Emergency Planning and Response: Responding to spill of infectious materials and other accidents in the laboratory
- Introduction to Bioethics
- Bioethical Principles: Human dignity and human rights, Benefit and harm, Autonomy and individual responsibility, Consent, Persons without the capacity to consent, Respect for human vulnerability and personal integrity, Privacy and confidentiality etc.
- Bioethical issues: Stem cells, Assisted reproduction, Human cloning, Gene editing, Genetically Modified Organisms, Recombinant DNA
- Ethical Review Committee

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Biosafety and Biosecurity
Week 2	Biosafety Concepts and Strategies
Week 3	Biosecurity Concepts and Strategies
Week 4	Operational Biosafety Practices and Procedures
Week 5	Risk Assessment & Management
Week 6	Risk Assessment & Management
Week 7	Biosafety Program Management

Week 8	Infectious Waste Management
Week 9	Midterm Examination
Week 10	Transportation of Infectious Substances
Week 11	Emergency Planning and Response
Week 12	Introduction to Bioethics
Week 13	Bioethical Principles
Week 14	Bioethical issues
Week 15	Ethical Review Committee
Week 16	Final Examination

Reference Books (Latest Editions):

1. US Health Department, Biosafety in Microbiological and Biomedical Laboratories
2. Fleming, D.O. and Hunt, D.L. Biological Safety: Principles and Practices
3. Laboratory Biosafety Manual. World Health Organization.
4. Laboratory Biosafety Guidelines. Public Health Agency of Canada.
5. Guidance on Regulations for the Transport of Infectious Substances. World Health Organization.
6. Wooley, D.P. and Byers, K.B. Biological Safety: Principles and Practices
7. Bioethics core curriculum, section 1: Syllabus Ethics Education Programme (UNESCO) https://unesdoc.unesco.org/ark:/48223/pf0000246885.locale=en

MIC213 Medical Microbiology

Course Title : Medical Microbiology
Course Code : MIC213
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To understand pathogenesis of microorganisms
- To learn basic mechanism of infection and molecular mechanism of pathogenesis

Course Learning Outcome (CLOs)

At the end of the course students will acquire the following abilities:

- Describe the major microbial pathogens that cause human diseases.
- Understand the mechanisms of microbial pathogenesis, diagnosis, and treatment.
- Apply medical microbiology knowledge to develop strategies for disease prevention and control.

Course Contents:

- Introduction: Host-parasite interactions
- Determination of pathogenicity and molecular mechanisms of pathogenesis
- Study of viral diseases including, AIDS, Hepatitis viruses, Rabies, and Influenza viruses
- Study of bacterial infections with emphasis on mechanisms of pathogenesis of the following groups: Streptococcus, Staphylococcus, Pseudomonas, Corynebacterium, Vibrio, Salmonella, Clostridium, Bacillus, Campylobacter, Helicobacter, Mycobacterium, and Mycoplasma.
- Rickettsial and protozoan diseases
- Classical and newly emerging pathogens

Practical

- Collection, transportation & microscopic examination of clinical samples
- Infections of ear, nose, throat, eye, GIT, urogenital tract (swabs)
- Isolation and identification of selected microorganisms
- Antibiotic assays by disc diffusion and dilution methods
- Determination of MIC and MBC
- Agglutination test (Widal test)
- Urine analysis (physical, chemical and microbiological)
- ESR

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures

- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction: Host-parasite interactions
Week 2	Determination of pathogenicity and molecular mechanisms of pathogenesis
Week 3	Study of viral diseases exemplified in contents (Continued)
Week 4	Study of viral diseases exemplified in contents (Continued)
Week 5	Study of viral diseases exemplified in contents
Week 6	Study of bacterial infections exemplified in contents (Continued)
Week 7	Study of bacterial infections exemplified in contents (Continued)
Week 8	Study of bacterial infections exemplified in contents (Continued)
Week 9	**Midterm Examination**
Week 10	Study of bacterial infections exemplified in contents (Continued)
Week 11	Study of bacterial infections exemplified in contents (Continued)
Week 12	Study of bacterial infections exemplified in contents (Continued)
Week 13	Study of bacterial infections exemplified in contents
Week 14	Rickettsial and protozoan diseases
Week 15	Classical and newly emerging pathogens

Week 16	Final Examination

Reference Books (Latest Editions):

1. Cowan, S. T., Steel, K. J., Barrow, G. I and Feltham, R. K. A. Cowan and Steel's Manual for the Identification of Medical Bacteria, Cambridge University Press, U.S.A.
2. Hawkey, P and Lewis, D. Medical Bacteriology: A Practical Approach. Oxford University Press, U.K.
3. Mims, C., Dockrell, H., Goering, R., Roitt, I Wakelin, D. and Zuckerman, M. Medical Microbiology. Mosby Co., M.O.
4. Murray, P. R., Rosenthal, K. S., Pfaller, M. A. and Rosenthal, K. S. Medical Microbiology, Elsevier Health Science, N.Y.
5. Murray, Baron, Pfaller, Tenover, Yolken. Manual of Clinical Microbiology. ASM Press USA.
6. Brooks, G., Carroll, K.C., Butel, J., Morse, S. Jawetz Melnick & Adelbergs Medical Microbiology. McGraw-Hill Companies. North America.

MIC314 Clinical Parasitology

Course Title : Clinical Parasitology
Course Code : MIC314
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To impart knowledge concerning biological, epidemiological, and ecological aspects of parasites
- To enable students to understand the pathogenesis, clinical presentations, and complications of parasitic diseases
- To equip student with knowledge related to diagnosis, prevention, control, and treatment of parasitic infections
- To discuss about endemic parasites, national parasitic problems and re-emerging parasitic infection

Course Learning Outcome (CLOs)

The students should be able to:

- Describe the worldwide distribution of important parasitic infections, epidemiological principles, effect of social and demographic patterns and vulnerability to parasitic disease
- Culture and recover parasites and diagnose parasitic infections through immunological and molecular methods
- Analyze the data obtained from history and clinical investigations and convert it into a meaningful diagnostic formulation

Course Contents:

- Introduction to parasitology: classification, morphology, life cycle, Etiology, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of:
    - *Protozoa*
    - *Entamoeba histolytica*
    - *Giardia lamblia*
    - *Plasmodium spp*
    - *Balantidium coli*
    - *Trypanosoma spp,*
    - *Leishmania spp,*
    - *Toxoplasma gondii*
    - *Trichomonas vaginalis*.
- Helminthes: Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of:
    - *Ascaris lumbricoides*
    - *Enterobius vermicularis*
    - *Trichuris trichiura*
    - *Ancylostoma duodeum and Necator americanus*
    - *Wucherria bancrofti*
    - *Taenia solium & Taenia saginata*

    - *Echinococcus granulosus, Hymenolepsis nana*
    - *Schistosoma haematobium*
    - *Fasciola hepatica.*
- Mediators/vectors of parasitic infection
- Recent advances in the diagnosis and control of parasitic infections
- Newly emerging parasitic infections

Practical

- Collection and processing of clinical samples
- Urine examination for parasitological investigations: microscopic and macroscopic
- Stool Examination for Parasitological investigations: microscopic and staining methods
- Trichrome stain Modified acid stain
- Intestinal parasites of Entamoeba histolytica trophozoite: Trichrome staining technique for staining *E. histolytica* Acridine orange technique for *E. Histolytica*
- Identification of *Trichomonas vaginalis*
- Blood examination: thick and thin blood films methods
- Staining blood films leishmania stain, Giemsa stain, Field stain
- Blood concentration methods
- Examination of trypanosomes
- Detection of different stages of malarial parasites in blood
- Field's Thick and Thin film Technique
- Identification of male & female worms of *Enterobius vermicularis*

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered

Week 1	Introduction to parasitology, classification, morphology and life cycle of parasites
Week 2	Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 3	Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 4	Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 5	Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 6	Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 7	Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 8	Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents
Week 9	**Midterm Examination**
Week 10	Helminthes: Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 11	Helminthes: Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 12	Helminthes: Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents (Continued)
Week 13	Helminthes: Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab diagnosis, treatment, prevention, and control of parasites exemplified in contents
Week 14	Mediators/vectors of parasitic infection
Week 15	Recent advances in the diagnosis and control of parasitic infections Newly emerging parasitic infections
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Anne, Z, and Gary C. Veterinary Clinical Parasitology. Blackwell publishing.
2. Principles and Practice of Clinical Parasitology. Wiley, John & Sons Sun, T.
3. Progress in Clinical Parasitology. Springer-Verlag New York, LLC
4. Clinical Parasitology: A Practical Approach. Elsevier Health Sciences

MIC342 Diagnostic Virology

Course Title : Diagnostic Virology
Course Code : MIC342
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : General Virology

Course Objectives:

- To learn about the diagnostic tools for viral infections
- Collection, transportation and processing of clinical samples from infected patients

Course Learning Outcome (CLOs)

At the end of the course students will acquire the following abilities:

- Skill to carefully collect, process and analyze the sample from infected Persons
- Ability to perform different detection tests in laboratory settings

Course Contents:

- History and Introduction
- Development of diagnostic virology and laboratory diagnosis of the viral diseases
- Laboratory management and biosafety
- Collection, transportation and processing of specimen
- Methods for the diagnosis of herpesviruses, adenoviruses, rotaviruses, coronaviruses, viruses associated with rash diseases, hepatitis viruses, enteroviruses, retroviruses, poxviruses, orthomyxoviruses, paramyxoviruses and arboviruses.
- Conventional rapid molecular detection of viruses
- Interpretation of lab investigations

Practical

- Collection and safe handling of viral samples
- Practicing biological containment
- Identification of infectious viral agents through ELISA & PCR

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%

- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	History and Introduction
Week 2	Development of diagnostic virology and laboratory diagnosis of the viral diseases
Week 3	Laboratory management and biosafety (Continued)
Week 4	Laboratory management and biosafety
Week 5	Collection, transportation and processing of specimen
Week 6	Methods for the diagnosis of viruses exemplified in contents (Continued)
Week 7	Methods for the diagnosis of viruses exemplified in contents (Continued)
Week 8	Methods for the diagnosis of viruses exemplified in contents (Continued)
Week 9	**Midterm Examination**
Week 10	Methods for the diagnosis of viruses exemplified in contents (Continued)
Week 11	Methods for the diagnosis of viruses exemplified in contents (Continued)
Week 12	Methods for the diagnosis of viruses exemplified in contents (Continued)
Week 13	Methods for the diagnosis of viruses exemplified in contents
Week 14	Conventional rapid molecular detection of viruses
Week 15	Interpretation of lab investigations
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Leonard C. N. Virology: Molecular Biology and Pathogenesis. ASM Press.
2. Kudesia, G. Clinical and Diagnostic Virology. Cambridge University Press.
3. John R. S. and Warnes A. Diagnostic Virology Protocol: Method in Molecular Biology. Humana Press.

4. Stephenson, J.R., and Warnes, A. Diagnostic Virology Protocols Springer-Verlag New York, LLC
5. Bachmann, P.A. New Developments in Diagnostic Virology. Springer-Verlag New York, LLC
6. Stephen N. J. K., & Gert Van Zyl. Virology. Churchill Livingstone.

MIC415 Diagnostic Chemistry for Microbial Diseases

Course Title	:	Diagnostic Chemistry for microbial Diseases
Course Code	:	MIC415
Offered to	:	Undergraduate Students at Hazara University
Cr Hr.	:	3(2+1)
Pre-requisite	:	Fundamentals of Microbiology; Human Physiology

Course Objectives:

- To develop the skills for microbial diagnosis based on visual observations and biochemical tests
- To learn about different human body organ and their functional evaluation in diseased condition
- To learn sample collection from different parts of the body

Course Learning Outcome (CLOs)

On completion of the course, the student should be able to:

- Describe the fundamentals concepts critical to analytical procedures in diagnostic chemistry
- Demonstrate mastery for use of basic relevant techniques and perform correct analysis to yield accurate and precise results

Course Contents:

- The concept of visually detectable and undetectable changes, direct and indirect evidence for the diagnosis of microbial diseases.
- Gastrointestinal function tests based on salivary digestion: a brief description of salivary digestion, the role of saliva in prevention of dental diseases and digestion and test based on salivary enzyme and its interpretation.
- Gastric digestion and tests:
    - Brief description of gastric digestion
    - Collection, analysis, and interpretation of Fasting content
    - Fractional Test Meal (FTM) secretion
    - Basal acid secretion
    - Alcohol test meal secretion
    - Augmented histamine test secretion
    - Insulin hypoglycaemic test secretion
- Intestinal digestion:
    - Brief description of intestinal secretions, pancreatic enzymes, pancreatic hormones and liver secretions involved in digestion, tests and their interpretation
    - Amylase activity in serum and urine
    - Faeces Examination, Physical, chemical and microscopic examination
    - Test for endocrine function of pancreas
- Glucose estimation in blood and urine
    - Glucose Tolerance Test (GTT)
    - Renal Threshold
    - Ketone bodies in urine and intestinal absorption
    - Brief description of intestinal absorption, test and its interpretation
    - Xylose excretion test.

- Role of gastrointestinal tract disturbances in development of anemia
- Kidney Function Tests:
    - Brief description of kidney functions
    - Tests and their interpretations
- Urinalysis:
    - Collection of urine
    - Physical, chemical and microscopic examination
    - Estimation of waste products
    - Blood urea and serum creatinine, tests for specific functions of kidney
    - Test for Glomeruli Filtration Rate
    - Urea clearance test
    - Creatinine clearance test
- Phenolsulphonephthalein Excretion test and test for maximal tubular capacity:
    - Concentration test
    - Dilution test
- Liver Function Tests:
    - Brief description of liver Functions (Circulatory, Excretory, Metabolic, Protective and Haematologic functions)
    - Tests based on Abnormality of pigment metabolism, Qualitative Test
    - Van den Bergh Test, Quantitative Test
    - Estimation of Serum Bilirubin, Detection of Bile Pigments and Urobilinogen in urine
    - Plasma Proteins, Plasma Total Proteins, Albumin, Globulins, A/G Ratio
    - Flocculation Test
    - Lipid metabolism, A brief description of lipid profile
    - Blood Cholesterol estimation
    - Liver's part in carbohydrate metabolism
    - Galactose tolerance test
    - Excretion of Injectable, Bromosulphthalein Retention Test
    - Detoxification Function
    - Hippuric acid synthesis, a brief description of tests based on Blood Ammonia, Prothrombin Time, Serum enzyme activity (Transaminases, Alkaline phosphatases, lactic dehydrgenase)
- A brief description of cerebrospinal fluid (CSF)

Practical

- Sample collection from different organs
- Transportation of clinical samples and biochemical tests
- Internship in hospitals/pathological labs

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning

- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	The concept of visually detectable and undetectable changes, direct and indirect evidence for the diagnosis of microbial diseases
Week 2	Gastrointestinal function tests based on salivary digestion
Week 3	Gastric digestion and tests as exemplified in contents (Continued)
Week 4	Gastric digestion and tests as exemplified in contents
Week 5	Intestinal digestion: Description of tests exemplified in contents
Week 6	Glucose estimation in blood and urine
Week 7	Role of gastrointestinal tract disturbances in development of anemia
Week 8	Kidney Function Tests
Week 9	**Midterm Examination**
Week 10	Urinalysis: Description of tests as exemplified in contents
Week 11	Phenolsulphonephthalein Excretion test and test for maximal tubular capacity
Week 12	Liver Function Tests: Introduction and description of tests exemplified in contents (Continued)
Week 13	Liver Function Tests: Introduction and description of tests exemplified in contents (Continued)
Week 14	Liver Function Tests: Introduction and description of tests exemplified in contents
Week 15	A brief description of cerebrospinal fluid (CSF)

Week 16	Final Examination

Reference Books (Latest Editions):

1. Ellen, J.B., James, J., Ellen, J.B., Marie, L.L., Michael, A.P. Manual of Clinical Microbiology. ASM Press.
2. Paul, G. E., Janet, D. E. Laboratory Diagnosis of Infectious Diseases: Essentials of Diagnostic. Lippincot Williams and Wilkins.
3. Connie R. M., Donald C. L. and George M. Textbook of Diagnostic Microbiology.
4. K.B., and Abaynesh, T. Quality of Liver & Kidney Functional Tests among Medical Laboratories. LAP Lambert Academic Publishing AG & Co. KG.
5. Mousmi D. and Prasad G. B. Microbes: Concept and Application. Wiley Blackwell

MIC220 Microbial Genetics

Course Title : Microbial Genetics
Course Code : MIC220
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To understand the foundation concepts of organization and structure of microbial genomes
- To become familiar with the concept of genome stability and plasticity
- To explain methods of genetic recombination and gene transfer

Course Learning Outcomes (CLOs)

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

- Demonstrate basic knowledge microbial genomes, their structures and organization
- Demonstrate detailed knowledge about horizontal gene transfer in microorganisms
- Demonstrate the concept of genetic mapping

Course Contents:

- Introduction to Microbial Genetics, Differentiation Between Pro and Eukaryotic Genomes
- Microbial Replication, Transcription and Translation
- Core Genome vs Pan Genome, Chromosomal Islands
- An Introduction to Mobile Genetic Elements (MGEs), Plasmids, Integrons, Transposons, Insertion Sequences
- Plasmids and Episomes: Genetic Structure and Types, Plasmids Replication (Circular vs Linear), Plasmids Copy Number and Partitioning System, Plasmids Incompatibility
- Genome Stability and Horizontal Gene Transfer
- Davis's U-tube experiment and bacterial conjugation. F+, F- and Hfr strains and conjugation, Mapping bacterial genes with interrupted conjugation
- Mathematical problems for bacteria gene mapping based on interrupted conjugation
- Role of transfer (tra) operon in transfer of genetic material
- Molecular mechanism of conjugation in Gram negative and Gram-positive bacteria
- Transposons: structure and function, Composite and complex transposons (Tn10 and Tn3 transposable elements), Replicative and non-replicative transposition, Conjugative transposons, Regulation of transposition
- Integrons and insertion sequences
- Genetic recombination: Molecular mechanism of genetic recombination (Holliday junction formation)
- Transformation and competence: Transformation in gram positive bacteria (Streptococcus, Bacillus), Transformation in gram negative bacteria (Neisseria, Haemophilus)
- Transduction and phages, Generalized and specialized transduction, Gene mapping in phages, Transduction: using phages to map bacterial genes
- An introduction to Archaeal Genome, Gene transfer mechanisms in archaea, Gene expression in archaea

- Eukaryotic microbial genomes (yeast, micro-algae and protozoa)

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Microbial Genetics, Differentiation Between Pro and Eukaryotic Genomes
Week 2	Microbial Replication, Transcription and Translation
Week 3	Core Genome vs Pan Genome, Chromosomal Islands. An Introduction to Mobile Genetic Elements (MGEs), Plasmids, Integrons, Transposons, Insertion Sequences
Week 4	Plasmids and Episomes: Genetic Structure and Types, Plasmids Replication (Circular vs Linear), Plasmids Copy Number and Partitioning System, Plasmids Incompatibility
Week 5	Genome Stability and Horizontal Gene Transfer
Week 6	Davis's U-tube experiment and bacterial conjugation. F+, F- and Hfr strains and conjugation, Mapping bacterial genes with interrupted conjugation
Week 7	Mathematical problems for bacteria gene mapping based on interrupted conjugation, Role of transfer (tra) operon in transfer of genetic material
Week 8	Molecular mechanism of conjugation in Gram negative and Gram-positive bacteria
Week 9	**Midterm Examination**
Week 10	Transposons: structure and function, Composite and complex transposons (Tn10 and Tn3 transposable elements), Replicative and non-replicative

	transposition, Conjugative transposons, Regulation of transposition. Integrons and insertion sequences
Week 11	Genetic recombination: Molecular mechanism of genetic recombination (Holliday junction formation)
Week 12	Transformation and competence: Transformation in gram positive bacteria (Streptococcus, Bacillus), Transformation in gram negative bacteria (Neisseria, Haemophilus)
Week 13	Transduction and phages, Generalized and specialized transduction, Gene mapping in phages, Transduction: using phages to map bacterial genes
Week 14	An introduction to Archaeal Genome, Gene transfer mechanisms in archaea, Gene expression in archaea
Week 15	Eukaryotic microbial genomes (yeast, micro-algae and protozoa)
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Snyder, L. and Champness W. Molecular genetics of bacteria. American Society for Microbiology.
2. Dale, J.W. and Park, S.F. Molecular genetics of bacteria. John Wiley & Sons.
3. Bainbridge, B.W. Genetics of microbes. Springer Science & Business Media.
4. Griffiths, A.J. An introduction to genetic analysis. Macmillan.
5. Streips, U.N. and Yasbin, R.E. Modern microbial genetics. New York: Wiley-Liss.

MIC422 Structural and Computational Biology

Course Title	:	Structural and Computational Biology
Course Code	:	MIC422
Offered to	:	Undergraduate Students at Hazara University
Cr Hr.	:	3(3+0)
Pre-requisite	:	Molecular Biology; Introduction to computing

Course Objectives:

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

Course Learning Outcome (CLOs)

On completion of the course, the student should be able to:

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

Course Contents:

- Macromolecular Crystallography and X-ray diffraction, Nuclear magnetic resonance spectroscopy of proteins, Mass spectrometry, Electron paramagnetic resonance
- Cryo-electron microscopy, Multiangle light scattering, Small angle scattering, Ultrafast laser spectroscopy, Dual-polarization interferometry and circular dichroism
- The structural mechanism of enzymes and catalysis
- Protein-nucleic acid interactions
- Structural Genomics
- Structural Proteomics
- Gene Regulation of development
- Macromolecular assemblies and higher order structures including oligomers, viruses, molecular machines, metalloproteins, membrane proteins and biological complexity
- Homology modeling and molecular docking
- Bioinformatics in Structural Biology
- Interpretation and assessment of published research in structural biology

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Macromolecular Crystallography and X-ray diffraction, Nuclear magnetic resonance spectroscopy of proteins, Mass spectrometry, Electron paramagnetic resonance (Continued)
Week 2	Macromolecular Crystallography and X-ray diffraction, Nuclear magnetic resonance spectroscopy of proteins, Mass spectrometry, Electron paramagnetic resonance
Week 3	Cryo-electron microscopy, Multiangle light scattering, Small angle scattering, Ultrafast laser spectroscopy, Dual-polarization interferometry and circular dichroism (Continued)
Week 4	Cryo-electron microscopy, Multiangle light scattering, Small angle scattering, Ultrafast laser spectroscopy, Dual-polarization interferometry and circular dichroism
Week 5	The structural mechanism of enzymes and catalysis
Week 6	Protein-nucleic acid interactions
Week 7	Structural Genomics
Week 8	Structural Proteomics
Week 9	**Midterm Examination**
Week 10	Gene Regulation of development
Week 11	Macromolecular assemblies and higher order structures including oligomers, viruses, molecular machines, metalloproteins, membrane proteins and biological complexity (Continued)
Week 12	Macromolecular assemblies and higher order structures including oligomers, viruses, molecular machines, metaloproteins, membrane proteins and biological complexity
Week 13	Homology modeling and molecular docking

Week 14	Bioinformatics in Structural Biology
Week 15	Interpretation and assessment of published research in structural biology
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Leonard J. Banaszak. Foundations of Structural Biology. Academic Press.
2. Quincy Teng. Structural Biology: Practical NMR Applications. Springer.
3. Anders Liljas, Lars Liljas, Jure Piskur and GÃran Lindblom. Textbook of Structural Biology. World Scientific Publishing Company.
4. Mary Luckey. Membrane Structural Biology: With Biochemical and Biophysical Foundations. Cambridge University Press.
5. Gabriel Waksman, Michael Caparon and Scott Hultgren. Structural Biology of Bacterial Pathogenesis. American Society for Microbiology.
6. Bernhard Rupp. Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology. Garland Science.

MIC432 Vaccinology

Course Title : Vaccinology
Course Code : MIC432
Offered to : Graduate Students of Hazara University
CrHr : 3(2+1)
Pre-requisite : General Immunology

Course Objectives:

The objectives of this course are to:

- Provide a comprehensive overview on history, types and immunology of vaccines and the latest developments in vaccine science
- Explain with examples that how the vaccines developed for corresponding diseases provide individual as well as community protection
- Impart up-to-date knowledge about the recent advancements in procedures used in the field of vaccinology
- Provide a foundation for other advanced courses in immunology and infectious diseases

Course Learning Outcome (CLOs)

By the end of this course, the students will be able to:

- Understand the basic principles of vaccine development, including the biological mechanisms of immune response stimulation.
- Analyze the different types of vaccines, their components, and the methods used for their production and evaluation.
- Apply knowledge of vaccinology to assess the impact of vaccines on public health and to understand strategies for vaccine deployment and immunization programs.

Course Contents:

- Introduction to Vaccine
- History of Vaccination; How it started?
- Basic Principles of Vaccine Immunology and Memory of Adaptive Immune System
- The Creation of Vaccines; Classical Strategies and Targets for Development
- Estimation of Vaccine Induced Serological Responses
- Types and Mechanism of action of DNA Vaccines, RNA Vaccines, Hybrid Vaccines, Conjugate Vaccines
- Examples of Vaccines provided under EPI, Pakistan: Salmonella, Pneumonia, MMR, Diarrhea, Malaria, Influenza, Cholera, Polio and Dengue Vaccines, Tuberculosis, Rota virus
- Recent advancements in vaccine platforms (SARS-COV-2)
- Pre-clinical evaluation and Human clinical trials
- Challenges to vaccine development and reasons of failure against various infectious diseases
- Communicating Vaccine Safety to Population

- Hesitancy and Public Perception (With special reference to polio vaccination program in Pakistan)

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience
- The relevant lecture material i.e., notes, slides etc. will be added week-wise before/after the delivery of scheduled lecture (as and when found appropriate by the instructor).
- The students are advised to regularly visit the University LMS/CMS for the access of uploaded material.

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Vaccine
Week 2	History of Vaccination; How it started?
Week 3	Basic Principles of Vaccine Immunology and Memory of Adaptive Immune System
Week 4	The Creation of Vaccines; Classical Strategies and Targets for Development
Week 5	Estimation of Vaccine Induced Serological Responses
Week 6	Types and Mechanism of action of DNA Vaccines, RNA Vaccines, Hybrid Vaccines, Conjugate Vaccines (Continued)
Week 7	Types and mechanism of action of DNA Vaccines, RNA Vaccines, Hybrid Vaccines, Conjugate Vaccines

Week 8	Examples of Vaccines provided under EPI, Pakistan (Continued)
Week 9	**Midterm Examination**
Week 10	Examples of Vaccines provided under EPI, Pakistan
Week 11	Recent advancements in vaccine platforms (SARS-COV-2)
Week 12	Pre-clinical evaluation and Human clinical trials
Week 13	Challenges to vaccine development and reasons of failure against various infectious diseases
Week 14	Communicating Vaccine Safety to Population
Week 15	Hesitancy and Public Perception (With special reference to polio vaccination program in Pakistan)
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Milligan, G.N and Barrett A. Vaccinology: An Essential Guide: Willey Blackwell
2. Emily P. Wen, Narahari S. Pujar, Ronald Ellis. Vaccine Development and Manufacturing; Wiley Series in Biotechnology and Bioengineering; Willey Blackwell
3. Myers MD, and Pineda, D. Do Vaccines Cause That? A Guide for Evaluating Vaccine Safety Concerns; Immunizations for Public Health

MIC423 Epigenetics

Course Title : Epigenetics
Course Code : MIC423
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Molecular Biology

Course Objectives:

- To give insight into the genetic regulation
- To learn heritable changes in gene expression and cellular phenotypes
- To learn about changes in phenotypes other than changes in underlying DNA sequences

Course Learning Outcome (CLOs)

On successful completion of the course, the students should have:

- A thorough understanding of epigenetics and its importance in gene regulation and disease
- Theoretical and practical concepts for analysis of DNA-methylation and histone modification

Course Contents:

- Genome organization of eukaryotes
- Structure of chromosomes
- Structure of gene
- Types of DNA
- Types of RNA
- Regulatory sites on DNA
- Heterochromatin and euchromatin
- Genetic modulation by CpG Island, DNA methylation and its implication on gene expression
- Types of methylases, DNA/RNA methylation, and its implication on gene expression
- Types of acetylases, acetylation of histones
- Book marking, Imprinting, Maternal effects, Paramutation, X chromosome inactivation, Position effect, Gene silencing
- Implication of epigenetic on gene expression, cellular differentiation and signal transduction

Practical

- Karyotyping of eukaryotes
- Detection of CpG motifs by restriction enzymes
- Detection of CpG motif by PCR
- Detection of methylated sites on DNA

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures

- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Genome organization of eukaryotes
Week 2	Structure of chromosomes
Week 3	Structure of gene Types of DNA
Week 4	Types of RNA
Week 5	Regulatory sites on DNA
Week 6	Heterochromatin and euchromatin (continued)
Week 7	Heterochromatin and euchromatin
Week 8	Genetic modulation by CpG Island, DNA methylation and its implication on gene expression
Week 9	**Midterm Examination**
Week 10	Types of methylases, DNA/RNA methylation, and its implication on gene expression
Week 11	Types of acetylases, acetylation of histones
Week 12	Book marking, Imprinting, Maternal effects, Paramutation, X chromosome inactivation, Position effect, Gene silencing, Transvection and Reprogramming (continued)
Week 13	Book marking, Imprinting, Maternal effects, Paramutation, X chromosome inactivation, Position effect, Gene silencing, Transvection and Reprogramming
Week 14	Transvection and Reprogramming

Week 15	Implication of epigenetic on gene expression, cellular differentiation and signal transduction
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Trygye Tollefbol. Handbook of Epigenetics. Academic Press.
2. Jhon Hancock. Cell signaling. Oxford University Press.
3. Benedikt H. and Brian K. H. Epigenetics: Linking Genotype and Phenotype in Development and Evolution University of California Press.
4. Richard C. F. Epigenetics. W. W. Norton & Company.
5. Nessa Carey. The Epigenetic Revolution. Columbia University Press.

MIC230 Immunology

Course Title : Immunology
Course Code : MIC230
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : None

Course Objectives:

- To understand the role of the immune system in both maintaining health and contribution to disease
- To conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens
- To highlight the experimental nature of Immunology and to promote acquisition of laboratory experimentation

Course Learning Outcome (CLOs)

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

- Explain the components and functions of the immune system in microbial defense.
- Analyze the immune responses to various pathogens and their implications for health.
- Apply immunological principles to develop and evaluate vaccines and therapies.

Course Contents:

- Introduction: chronological development and scope of immunology
- General introduction to the innate and adoptive immune system (types)
- Innate immunity and its types: First and second line of defenses
- Cells and tissues of immune system
- The antigens: structure (simple and complex molecules, proteins, and polysaccharides) and immunogenicity, immunogens, Haptens
- Immunoglobulin: structure and function; classes, subclasses, types, and subtypes
- The genetic basis of antibody structure
- Antigen-antibody interactions
- Humoral immune response to an antigen: clonal selection to an antibody production
- Antigen presenting cells and Major Histocompatibility Complex
- Cellular immune response to an antigen: classes of T cells and their role in immune response
- Chemical messengers of immune system: Cytokines, Chemokines etc.

Practical

- Differential leukocyte Count
- Blood grouping (ABO & Rh)
- Immunodiagnostic methods
- Agglutination tests
- Precipitation tests
- Gel diffusion Test

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction: chronological development and scope of immunology.
Week 2	General introduction to the innate and adoptive immune system (types)
Week 3	Innate immunity: First and second line of defences (continued)
Week 4	Innate immunity: First and second line of defences (continued)
Week 5	Innate immunity: First and second line of defences (continued)
Week 6	Innate immunity: First and second line of defences
Week 7	Cells and tissues of immune system
Week 8	The antigens: structure (simple and complex molecules, proteins, and polysaccharides) and immunogenicity
Week 9	**Midterm Examination**
Week 10	Immunoglobulin: structure and function; classes, subclasses, types, and subtypes; immunoglobulin genetics and antibody diversity
Week 11	The genetic basis of antibody structure
Week 12	Antigen-antibody reactions

Week 13	Humoral immune response to an antigen: clonal selection to an antibody production
Week 14	Antigen presenting cells and MHC Cellular immune response to an antigen: classes of T cells and their role in immune response (Continued)
Week 15	Cellular immune response to an antigen: classes of T cells and their role in immune response Chemical messengers of immune system: Cytokines, Chemokines etc.
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. Basic immunology: Functions and disorders of the immune system Philadelphia, US: Elsevier Health Sciences.
2. Coico, R., & Sunshine, G. Immunology, A Short Course. Sussex, UK: Wliley-Blackwell.
3. Sompayrac, L. How the Immune System Works. Sussex, UK: Willey Blackwell.

MIC431 Molecular Immunology

Course Title : Molecular Immunology
Course Code : MIC431
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Immunology

Course Objectives:

- To understand the role of immune cells surface receptors involved in immune response and histocompatibility
- To learn about immune response other than antibody production i.e., complements system
- To study the molecular mechanisms of various molecules involved in induction of immune response

Course Learning Outcome (CLOs)

At the end, the student will be able to:

- Describe the role of antibodies and cell receptors in biocompatibility
- Explain the role of innate and adoptive immune responses at molecular level

Course Contents:

- Introduction to molecular basis of immunogenicity and antigenic specificity: distinction and parameters
- Molecular basis of antigen antibody interactions: Chemical bonds involved, study and kinetics employing mono and polyvalent ligands
- Quantitative measurements of antibody precipitated in an immune complex
- Basis of immunodominance
- Immunochemical aspects of polysaccharide antigens of selective group of Microorganisms and their significance
- Structure and functions of human immunoglobulins: Sequence studies, genetic variants, three dimensional configurations and location of paratope in the molecule of IgG, IgM, and IgA, Antibody diversity, maturation of B lymphocytes and expression of Immunoglobulin genes
- Structure function of the T-cell Receptor: Molecular basis of T cell antigen recognition and activation, Immunoglobulin superfamily
- T-cell gene rearrangement and generation of diversity
- Toll like receptors, chemokines and cytokines
- Human Leukocyte Antigens: classes, distribution, chemistry and basis of polymorphism
- Complement System: Chemistry, components, activation via classical and alternate pathway, complement genes, their expression and regulation

Practical

- Immunization of animal with particulate and soluble antigens
- Characterization of immune cells
- T & B cell identification

- Hemolytic plaque assay
- Complement fixation

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to molecular basis of immunogenicity and antigenic specificity: distinction and parameters
Week 2	Molecular basis of antigen antibody interactions: Chemical bonds involved, study and kinetics employing mono and polyvalent ligands (Continued)
Week 3	Molecular basis of antigen antibody interactions: Chemical bonds involved, study and kinetics employing mono and polyvalent ligands
Week 4	Quantitative measurements of antibody precipitated in an immune complex
Week 5	Basis of immunodominance
Week 6	Immunochemical aspects of polysaccharide antigens of selective group of Microorganisms and their significance
Week 7	Structure and functions of human immunoglobulins (Continued)
Week 8	Structure and functions of human immunoglobulins
Week 9	**Midterm Examination**
Week 10	Structure function of the T-cell Receptor: Molecular basis of T cell antigen recognition and activation, Immunoglobulin superfamily

Week 11	T-cell gene rearrangement and generation of diversity
Week 12	Toll like receptors, chemokines and cytokines
Week 13	Human Leukocyte Antigens: classes, distribution, chemistry and basis of polymorphism
Week 14	Complement System: Chemistry, components, activation via classical and alternate pathway, complement genes, their expression and regulation (Continued)
Week 15	Complement System: Chemistry, components, activation via classical and alternate pathway, complement genes, their expression and regulation
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Bert Popping, B. Molecular Biological and Immunological Techniques and Applications for Food Chemists. Wiley, John & Sons, Incorporated
2. Abbas, A.K., Lichtman, A. H., Pillai, S. Cellular and Molecular Immunology. Elsevier Health Sciences.
3. Kenneth M. Janeway's Immunobiology. Garland Science.
4. Chames, P. Antibody Engineering: Methods and Protocols, Second Edition. Springer-Verlag New York, LLC
5. Clark, D.P. Molecular Biology. Elsevier S

MIC743 Viral Immunology

Course Title : Viral Immunology
Course Code : MIC743
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : General Virology; Immunology

Course Objectives:

The objectives of this course are:

- To understand the basic concept in virology important in context with interaction of viruses with immune system.
- To study the mechanisms by which our immune system deals with pathogens with major focus on viruses.
- To study the pathogenesis of selected viruses and understand the immune evasion strategies adopted by them hence posing major challenges in development of therapeutic approaches.
- To understand several vaccination strategies in practice against several viruses.

Course Learning Outcome (CLOs)

Besides revisiting the basic concepts of virology, students after completion of this course, should develop an understanding of

- Fundamental concepts of viral interaction with host
- Importance of innate and adaptive immune systems in preventing and clearing viral infections
- Role of different immune cells involved in humoral, and cell mediated immune response against viral infections
- Why the majority of viral infections are difficult to treat in the modern era as compared to bacterial, fungal and parasitic infections?

Course Contents:

- Introduction to Viruses, Animal Viruses, classification and structure
- Replication, transcription and translation of RNA viruses
- Replication, transcription and translation of DNA viruses
- Innate and Adaptive Immunity against Viruses
- Cell-Mediated Immunity in Viral Infections
- Destruction of Virus-Infected Cells by Antibody and Complement
- Immune evasion strategies by viruses
- Pathogenesis and immune evasion of selected viruses i.e., COVID-19 and Coronaviruses, Flu and Influenza Viruses, HIV, Zika and Dengue viruses, Ebola virus, Hepatitis Viruses
- Vaccination strategies against viruses
- Future in Viral Immunology and Immunopathology

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions

- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to course
Week 2	Introduction to Viruses, Animal Viruses, classification and structure
Week 3	Replication, transcription and translation of RNA viruses
Week 4	Replication, transcription and translation of DNA viruses
Week 5	Innate and Adaptive Immunity against Viruses
Week 6	Cell-Mediated Immunity in Viral Infections Destruction of Virus-Infected Cells by Antibody and Complement
Week 7	Immune evasion strategies by viruses
Week 8	Pathogenesis and immune evasion of selected viruses (Continued)
Week 9	**Midterm Examination**
Week 10	Pathogenesis and immune evasion of selected viruses (Continued)
Week 11	Pathogenesis and immune evasion of selected viruses (Continued)
Week 12	Pathogenesis and immune evasion of selected viruses (Continued)
Week 13	Pathogenesis and immune evasion of selected viruses
Week 14	Vaccination strategies against viruses

Week 15	Future in Viral Immunology and Immunopathology
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Acheson, N. H. Fundamentals of molecular virology. Wiley and Sons.
2. Carter, J., Saunders, V. & Saunders, V. A. Virology: principles and applications. Wiley & Sons.
3. Levinson, W. Review of medical microbiology and immunology. McGraw-Hill Education.
4. Notkins, A. L. Viral Immunology and Immunopathology. Academic Press, USA.
5. Abbas, A. K., Lichtman, A. H. & Pillai, S. Innate Immunity. Cellular and Molecular Immunology. Elsevier Health Sciences.
6. Owen, J. A., Punt, J. & Stranford, S. A. Kuby immunology. WH Freeman and Company.

MIC351 Environmental Microbiology

Course Title : Environmental Microbiology
Course Code : MIC351
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Introduction to Microbiology

Course Objectives:

- To enable students to identify diversified environmental implications on public health
- To enable students to identify wastewater health hazards and its management

Course Learning Outcome (CLOs)

After the completion of course, students will have skills and knowledge about:

- Analyze the roles of microorganisms in environmental processes and sustainability.
- Apply microbiological techniques to monitor and manage environmental health.
- Evaluate the impact of microbial activities on ecosystems and biogeochemical cycles.

Course Contents:

- An introduction to environmental pollutants and their impact
- Air microbiology
- Microbiology of water including water pollution, detection and elimination of polluting bacteria from water sources
- Water purification by various means
- Microbiology of wastewater including disposal and treatment
- An introduction to bioremediation
- Environmental pollution: an introduction to environmental diseases
- Microbiology of food and milk pertaining to public health
- Prevention and control of epidemic diseases
- Prophylactic measures and vaccines
- Nosocomial and community acquired infection
- Bio monitoring
- National and international standards for monitoring the environment
- Biosensors and bio indicators
- Surveillance of epidemics through GIS
- Environmental Laws and Regulations

Practical

- Detection of water, air, and soil pollutants
- Isolation of microbes from air samples
- Designing of schemes as flow diagram for waste-water treatment/management
- Demonstration of BOD and COD
- Demonstration of MPN technique
- Case study for different epidemics

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Practical classes in laboratory

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	An introduction to environmental pollutants and their impact
Week 2	Aero microbiology
Week 3	Microbiology of water including water pollution and detection and elimination of polluting bacteria from waters
Week 4	Water purification by various means
Week 5	Microbiology of wastewater including disposal and treatment
Week 6	Microbiology of food and milk pertaining to public health
Week 7	Prevention and control of epidemic diseases
Week 8	Prophylactic measures and vaccines
Week 9	Midterm Examination
Week 10	An introduction to bioremediation Environmental pollution: an introduction to environmental diseases
Week 11	Nosocomial and community acquired infection biomonitoring
Week 12	National and international standards for monitoring the environment
Week 13	Biosensors and bioindicators

Week 14	Surveillance of epidemics through GIS
Week 15	Environmental Laws and Regulations
Week 16	Final Examination

Reference Books (Latest Editions):

1. Robert S. Burlage, Principles of Public Health Microbiology
2. Ian Pepper, Charles Gerba, Terry Gentry, Environmental Microbiology
3. Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology: An Introduction

MIC352 Aquatic Microbiology

Course Title : Aquatic Microbiology
Course Code : MIC352
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To develop the understanding of aquatic reservoirs and their ecosystem
- To understand the portability of water and implication of freshwater microbes on geochemical environment

Course Learning Outcome (CLOs)

At the end of the course students will acquire the following abilities:

- Analyze the diversity and ecological roles of microorganisms in aquatic ecosystems.
- Apply microbiological methods to assess water quality and microbial processes in aquatic environments.
- Evaluate the impact of microbial activities on the health and sustainability of aquatic ecosystems.

Course Contents:

- Introduction to fresh and marine water environments and their microbiology
- Zonation and stratifications in lakes and ponds
- Zonation and microbial stratification in marine environment
- Effect of movement of water in fresh water and marine environment
- Laws of ecology with reference to fresh and marine water ecosystems
- Environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms
- Enumeration of bacteria: sampling and samplers, processing and actual enumeration procedures
- Fresh and marine water microorganisms: Important groups of fresh and marine water microorganisms
- Advantages and disadvantages of fresh and marine water microorganisms including their importance in biotechnology
- Aquaculture and some common microbiological problems
- Common diseases of fresh and marine water fauna: Important examples

Practical

- Study of microbial population from aqueous habitat (Cynobacteria, Photosynyhetic bacteria, halophytes, luminescence organisms)
- Study of microbial counts from aquatic samples
- Antimicrobial activity of aquatic microbes

- Biological oxygen demand of water sample
- Effect of physical factors on microbial flora of water

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to fresh and marine water environments and their microbiology (Continued)
Week 2	Introduction to fresh and marine water environments and their microbiology
Week 3	Zonation and stratifications in lakes and ponds
Week 4	Zonation and microbial stratification in marine environment
Week 5	Effect of movement of water in fresh water and marine environment
Week 6	Laws of ecology with reference to fresh and marine water ecosystems
Week 7	Environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms (Continued)
Week 8	Environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms
Week 9	**Midterm Examination**
Week 10	Enumeration of bacteria: sampling and samplers, processing and actual enumeration procedures

Week 11	Fresh and marine water microorganisms: Important groups of fresh and marine water microorganisms
Week 12	Advantages and disadvantages of fresh and marine water microorganisms including their importance in biotechnology (Continued)
Week 13	Advantages and disadvantages of fresh and marine water microorganisms including their importance in biotechnology
Week 14	Aquaculture and some common microbiological problems
Week 15	Common diseases of fresh and marine water fauna: Important examples
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Gjedrem, T. Selection and Breeding Programs in Aquaculture. Springer-Verlag, New York, LLC.
2. Laybourn, P. and Johanna. Freshwater Biology, Volume 51, Number 10. Blackwell Publishing.
3. Robson, G. D, van West P. and Gadd, G. M. Exploitation of Fungi. Cambridge University Press.
4. Berthelin, J. Effect of Mineral-Organic-Microorganism Interactions on Soil and Freshwater Environments. Springer-Verlag New York, LLC
5. David Sigee, D. Freshwater Microbiology: Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment. Wiley, John & Sons

MIC454 Geomicrobiology

Course Title : Geomicrobiology
Course Code : MIC454
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To understand the role of microorganisms in earth biosphere
- To understand the importance of microorganism in mineralization
- To learn about new role of microorganisms in space exploration

Course Learning Outcome (CLOs)

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

- Appreciate the significance of MOs in earth evolution and maintenance of ecosystem
- Demonstrate the role of MOs in bioremediation, mineralization and decontamination
- Comprehend the future role of MOs in space

Course Contents:

- Brief Overview Earth Structure, Geological Time Sale.
- Introduction to Geo Microbiology, Universal Tree of Life, Overview of the Bacteria, Archaea, and Eukarya
- Role of Microbes in evolution of the biosphere, Early evidence for life, Stromatolites and microbial mats
- Microfossils and microbial paleobiology
- Microbes and Thermodynamics
- Microbial Energy Generation, Chemosynthesis and autotroph, Photosynthesis and Phototrophy, Photoheterotrophy
- Contaminants, Bioremediation and microbe-mineral interactions
- Methanogenesis; carbon uptake and fixation; mineralization of organic matter; greenhouse gases; gas hydrates; aerobic and anaerobic methane oxidation
- Metal speciation; Mn and Fe oxidation; metal oxidizers and anoxygenic phototrophs; chemical and bacterial metal reduction; bacterial mechanisms for metal detoxification; uptake of essential elements
- Phosphorus chemistry; global phosphorus cycle, P as a limiting nutrient in marine systems, phosphodiester and phosphonate compounds; bacterial mechanisms for uptake and P-regulated gene expression
- Extremophiles
- Cave Microbiology
- Astrobiology

Practical

- Isolation and characterization of microorganisms from caves and hot water springs
- Field trip to local caves, hot water springs

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Brief Overview Earth Structure, Geological Time Sale.
Week 2	Introduction to Geo Microbiology, Universal Tree of Life, Overview of the Bacteria, Archaea, and Eukarya
Week 3	Role of Microbes in evolution of the biosphere, Early evidence for life, Stromatolites and microbial mats
Week 4	Microfossils and microbial paleobiology
Week 5	Microbes and Thermodynamics
Week 6	Microbial Energy Generation, Chemosynthesis and autotroph, Photosynthesis and Phototrophy, Photoheterotrophy
Week 7	Contaminants, Bioremediation and microbe-mineral interactions
Week 8	Methanogenesis; carbon uptake and fixation; mineralization of organic matter; greenhouse gases; gas hydrates; aerobic and anaerobic methane oxidation.
Week 9	**Midterm Examination**
Week 10	Metal speciation; Mn and Fe oxidation; metal oxidizers and anoxygenic phototrophs; chemical and bacterial metal reduction;
Week 11	Bacterial mechanisms for metal detoxification; uptake of essential elements
Week 12	Phosphorus chemistry; global phosphorus cycle, P as a limiting nutrient in marine systems, phosphodiester and phosphonate compounds

Week 13	Bacterial mechanisms for uptake and P-regulated gene expression Extremophiles
Week 14	Cave Microbiology
Week 15	Astrobiology
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Madigan, M.T., Martinko, M.J. & Parker, J. Brock Biology of Microorganisms. Prentice Hall.
2. Fenchel, T., King, G.M. & Blackburn, T.H. Bacterial Biogeochemistry: the ecophysiology of mineral cycling. Academic Press.
3. Paul, E. & Clark, E.F. Soil Microbiology and Biochemistry. Academic Press.
4. Stevenson, F.J & Cole, M.A. Cycles of Soils: Carbon, Nitrogen, Phosphorus, Sulfur, Micronutrients. Wiley.

Bioremediation

Course Title : Bioremediation
Course Code : MIC755 / MIC855
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Basic knowledge of microbial metabolism

Course Objectives:

- To learn about details of biodegradation, its mechanism and microbial species involved
- To study microbial existence and role in biodegradation process
- T have knowledge about cost effective and long-term solutions for environmental pollution and its eradications

Course Learning Outcome (CLOs)

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

- Integrate the basic principles of microbiology required for understanding the biodegradation of hazardous and toxic organic compounds
- Become familiar with current pollution problems and potential biological remediation technique
- Solve problems often encountered in application of bioremediation

Course Contents:

- Introduction to course: Bioremediation overview
- Bioremediation techniques for polluted environment: in-situ, ex-situ and engineered
- Bioremediation strategies: Composting, Natural attenuation, Bioaugmentation, Co-metabolism, Biostimulation, Phytoremediation
- Type, nature and source of pollutants
- Factor influencing bioremediation
- Types of organisms used in bioremediation: bacteria, fungi, algae and yeast
- Role of different enzymes in bioremediation of pollutants
- Bioremediation pathways of pollutants: dyes, plastics, polychlorinated biphenyls, aromatic and polyaromatic hydrocarbons and pesticides.
- Bioavailability processes for contaminants in soils and sediments
- Biosurfactants and its types
- Xenobiotics: introduction, types and sources
- Molecular strategies of microbial adaptation (acclimation) to xenobiotics

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to course: Bioremediation overview
Week 2	Bioremediation techniques for polluted environment: in-situ, ex-situ and engineered
Week 3	Bioremediation strategies (Continued)
Week 4	Bioremediation strategies
Week 5	Type, nature and source of pollutants
Week 6	Factor influencing bioremediation
Week 7	Types of organisms used in bioremediation
Week 8	Role of different enzymes in bioremediation of pollutants
Week 9	**Midterm Examination**
Week 10	Bioremediation pathways of pollutants (Continued)
Week 11	Bioremediation pathways of pollutants
Week 12	Bioavailability processes for contaminants in soils and sediments
Week 13	Biosurfactants and its types
Week 14	Xenobiotics: introduction, types and sources
Week 15	Molecular strategies of microbial adaptation (acclimation) to xenobiotics
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Poltronieri, P., Fernando D'urso, O. Biotransformation of Agricultural Waste and By-Products: The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier, USA.
2. Mitchell, R., G. J-Dong. Environmental Microbiology. John Wiley & Sons.
3. Jördening H.-J., J. Winter. Environmental Biotechnology. Concepts and Applications. Wiley-VCH Verlag GmbH & Co.
4. Sing, V. P., D. Raymond, Jr. Stapleton. Biotransformations: Bioremediation Technology for Health and Environmental Protection, Elsevier, Amsterdam.
5. Wackett, L. P., C. D Hershberger. Biodegradation and Biocatalysis. ASM Press.

Advanced Techniques in Microbiology

Course Title : Advanced Techniques in Microbiology
Course Code : MIC778 / MIC878
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Foundational courses in General Microbiology and Molecular Biology are required.

Course Objectives:

1. To understand the theoretical principles of advanced microbiological techniques across genomics, proteomics, metabolomics, cell biology, and molecular diagnostics.
2. To explore how these techniques are used in academic, clinical, environmental, and industrial microbiological research.
3. To develop the ability to critically assess and choose appropriate tools and techniques for solving complex microbiological problems.

Course Learning Outcome (CLOs)

By the end of this course, students will be able to:

- Demonstrate proficiency in using advanced analytical techniques and tools for the detection, quantification, and analysis of microorganisms and microbial processes.
- Evaluate the strengths, limitations, and applications of various analytical methods in microbiological research.
- Integrate advanced analytical tools to design and conduct complex experiments, interpret data, and draw conclusions in microbial research.

Course Contents:

- Overview of Advanced Microbiological Techniques
- Advanced Microscopy Techniques
- Microbial Cell Sorting & Imaging Cytometry – Principles and Applications: Cell sorting, microbial viability assays, microbial population structure, Single-cell analysis, FACS
- Transcriptomics and RNA-Seq Approaches
- Quantitative PCR and Digital PCR
- Next Generation Sequencing (NGS) in Microbiology
- Bioinformatics Tools for Microbial Data
- Mass Spectrometry in Microbial Analysis
- CRISPR-Cas and Gene Editing in Microbes
- Stable Isotope Probing and Microbial Tracking
- Microfluidics and Lab-on-a-Chip
- Biosensors and Nanotechnology in Microbiology
- Student Presentations-Integration of Techniques in Microbial Research

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions

- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning

Videos/Digital Resources:

- ThermoFisher, Illumina, and NEB technique explainer videos (freely available)
- YouTube channels like iBiology, Addgene, or JoVE (video journals)

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Overview of Advanced Microbiological Techniques: Need and scope of microbiological techniques, overview of classical vs. modern techniques, classification of techniques (analytical, genetic, functional), evolution from classical culture-based methods to molecular, imaging, and omics tools, Why are advanced-techniques essential in microbiology?
Week 2	Advanced Microscopy Techniques: Comparison of confocal, Fluorescence, scanning electron, transmission electron, and atomic force microscopy. Focus on their resolving power, sample preparation, and applications in microbial morphology, live-cell and biofilm imaging, and ultrastructural studies.
Week 3	Microbial Cell Sorting & Imaging Cytometry – Principles and Applications: Working of flow cytometers, fluorescence labeling, and its application in microbial viability, sorting, and antibiotic susceptibility testing. Highlight emerging single-cell omics technologies.
Week 4	Quantitative PCR (qPCR) and Digital PCR: Principles behind real-time PCR and how it differs from conventional PCR, primer design, Absolute and relative quantification, detection limits, probe vs. dye-based detection, SYBR Green, TaqMan assays, and applications in microbial quantification, gene expression and pathogen quantification, Digital PCR as a next-level tool for precise absolute quantification.
Week 5	Transcriptomics and RNA-Seq Approaches: Analyzing the total RNA output of microbial cells, RNA extraction, cDNA synthesis, sequencing, and differential gene expression analysis, How it helps in understanding microbial behavior under stress or during infection.
Week 6	Next Generation Sequencing (NGS) in Microbiology: Principles of massively parallel sequencing, including Illumina and Nanopore platforms, applications in 16S rRNA gene sequencing, metagenomics, whole genome sequencing, microbial diversity studies, and pathogen detection.
Week 7	Bioinformatics Tools for Microbial Data: BLAST, genome annotation, microbial diversity analysis (QIIME, MOTHUR).
Week 8	Mass Spectrometry in Microbial Analysis: Proteomic techniques like MALDI-TOF, LC-MS/MS, and their role in identifying and quantifying microbial proteins, Metabolomics and Lipidomics techniques like GC-MS, NMR-based metabolite profiling to understand cellular metabolic pathways and responses.
Week 9	**Midterm Examination**
Week 10	*Continued from previous week*
Week 11	CRISPR-Cas and Gene Editing in Microbes: Mechanism and natural CRISPR-Cas defense system, Adaptation for gene editing, microbial genome editing/Gene knockout/knock-in, Applications in functional genomics, antimicrobial resistance studies, and development of CRISPR-based diagnostics (e.g., SHERLOCK, DETECTR).
Week 12	Stable Isotope Probing and Microbial Tracking: SIP as a technique to trace microbial metabolic activity using 13C or 15N-labeled substrates, How non-cultivable microbes can be studied using metataxonomics, FISH, and other

	molecular techniques and relevance in environmental and gut microbiota studies.
Week 13	Microfluidics and Lab-on-a-Chip: Basics of microchannel systems, concept of lab-on-a-chip and microfluidic platforms for studying antibiotic susceptibility, microbial interactions and high-throughput screening.
Week 14	Biosensors and Nanotechnology in Microbiology: Types of biosensors (optical, electrochemical, piezoelectric) and their components (bioreceptor, transducer), FRET-based biosensors in rapid microbial detection, especially in food safety and clinical diagnostics.
Week 15	Student Presentations-Integration of Techniques in Microbial Research: Each student shall present a mini research proposal integrating a chosen advanced technique, its principle, workflow, data analysis, limitations and applications.
Week 16	**Final Examination**

Reference Books (Latest Edition):

1. Molecular Microbiology: Diagnostic Principles and Practice (ASM Press)
2. Manual of Molecular and Clinical Laboratory Immunology (ASM)
3. Microbial Genomics and Metagenomics – Online Courses (e.g., NCBI, Coursera)
4. Principles and Techniques of Biochemistry and Molecular Biology – Wilson and Walker

Water and Wastewater Treatment Processes

Course Title	:	Water and Wastewater Treatment Processes
Course Code	:	MIC756 / MIC856
Offered to	:	Undergraduate Students at Hazara University
Cr Hr.	:	3(3+0)
Pre-requisite	:	None

Course Objectives:

- To learn about importance of drinking water quality and treatment techniques
- To learn about the different methods of wastewater treatment
- To maintaining and enhancing river and ground water quality

Course Learning Outcome (CLOs)

After completing this course, the students will:

- To understand key challenges in water and wastewater treatment.
- To Identify contaminants in water and wastewater and evaluate treatment methods.
- Design and select appropriate treatment technologies for various water quality issues.

Course Contents:

- Introduction to water and wastewater treatment Processes: Overview of water and wastewater treatment, importance of water treatment, Global water challenges and the need for sustainable water management
- Classification of water: Types of water bodies, characteristics of surface water (rivers, lakes), groundwater, and fresh water sources. Difference between surface and fresh water. Sources of fresh water and its distribution. Pathogens and water borne diseases
- Water pollution and control: Types of water pollution, major water pollutants and sources. How to measure water quality, sources of water pollution, improving water quality (methods), control measures of water pollution.
- Sewage wastewater treatment: Introduction, importance of sewage treatment. Primary, secondary, tertiary and advanced treatment processes.
- Biodegradation of petrochemical waste: Introduction to petrochemicals, major concerns, degradation of hydrocarbons, microbial degradation, factors affecting degradation, evidence of biodegradation of hydrocarbons. Genetic engineering of biodegradative pathways.
- Drinking water treatment system: Coagulation, flocculation, sedimentation, filtration, disinfection (chlorination, UV, ozonation)
- Membrane bioreactor for wastewater treatment: Introduction, membrane and types. Process configuration, working theory, reuse potential of MBR effluent, advantages and drawbacks. Membrane biofouling and its control
- Sequential batch reactor for wastewater treatment: Introduction, reasons for providing SBR, SBR operating principle, Operation of SBR, advantages and limitations.
- Up flow sludge blanket reactor for wastewater treatment: Working principle of UASB, applications, advantages, design, and operation of the reactor
- Other biological methods: trickling filter, stirred tank reactor, fluidized bed bioreactor, Rotating Biological Contactors, anaerobic digestion, algal system

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to water and wastewater treatment processes
Week 2	Classification of water
Week 3	Water pollution and control
Week 4	Water pollution and control methods (continued)
Week 5	Sewage and wastewater treatment
Week 6	Sewage and wastewater treatment (continued)
Week 7	Biodegradation of petrochemical wastes
Week 8	Other biological methods for treatment
Week 9	**Midterm Examination**
Week 10	Membrane bioreactor for wastewater treatment
Week 11	Membrane biofouling and its control
Week 12	Sequential batch reactor for wastewater treatment
Week 13	Up flow sludge blanket reactor for wastewater treatment

Week 14	Other biological methods: Trickling filter, Fluidized bed bioreactor
Week 15	Other biological methods (continued)
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Bui, X.T., Chiemchaisri C., Fujioka T. & Varjani S. Water and Wastewater Treatment Technologies. Springer, Singapore.
2. Stensel, H.D., Burton, F.L., chobanoglous, G., Metcalf & & Eddy. Wastewater engineering: treatment and reuse. McGraw-Hill, Boston.
3. Bitton, G. Wastewater Microbiology. John Wiley & Sons.
4. Research and review articles on emerging water treatment technologies

Advanced Microbial Biofilms

Course Title	:	Advanced Microbial biofilms
Course Code	:	MIC764 / MIC864
Offered to	:	Graduate Students at Hazara University
Cr Hr.	:	3(3+0)
Pre-requisite	:	Fundamentals of Microbiology

Course Objectives:

- To understand the processes of biofilm formation, regulation, and dispersal.
- To explore the impact of biofilms in clinical, industrial, and environmental settings.
- To investigate therapeutic approaches to control and treat biofilm-related issues

Course Learning Outcome (CLOs)

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

- Identify the key factors involved in biofilm formation and control.
- Assess the role of biofilms in antimicrobial resistance and infections.
- Apply biofilm knowledge to design practical solutions in industrial, medical and environmental contexts.

Course Contents:

- Introduction to biofilms science: Definition and Significance of biofilms. Historical evolution of Biofilm research. Biofilm life cycle and impacts across various sectors. Ecological and Evolutionary Role of Biofilms.
- Genetic and molecular mechanisms: Regulatory pathways in biofilm formation, Environmental Influences on Biofilm Development, molecular Mechanisms of Adhesion and role of horizontal gene transfer.
- Extracellular Matrix (EPS) and Structural Components: Composition and Function of EPS in Biofilm Integrity. Biofilm architecture, role of Surface Proteins and Adhesins in Biofilm Formation.
- Signaling Molecules in Biofilm Regulation: Overview of Signaling Molecules (Autoinducers, Acyl homoserine lactones (AHLs) and c-di-GMP). Mechanisms of Signaling Molecules in biofilm formation, maturation and dispersal. Disruption of signaling pathways.
- Biofilm Dispersal Mechanisms: Triggers of biofilm dispersal. Mechanisms involved in biofilm dispersal. Clinical implications of biofilm dispersal for infection and treatment.
- Biofilm-Host Interactions and Clinical Implications: Immune Evasion Strategies in Biofilms. Case Studies on Biofilm-Related Infections and Treatment Challenges
- Industrial and Environmental Significance of Biofilms: Biofilms in Bioremediation, bioenergy production and Wastewater Treatment. Challenges Posed by Biofilms in Industry
- Biofilms in extreme and unique environments: Biofilms on Monuments, Sculptures, and Statues. Biofilms in deserts, jungles/forests, space and biofilms in the deep sea.
- Antimicrobial Resistance: Mechanisms of Biofilm-Associated Antimicrobial Resistance.
- Biofilm control strategies: Biological, chemical and physical strategies. Innovative Therapeutic Approaches for biofilm control

- Biofilm Engineering and Design: Engineering Biofilms for Beneficial Applications: Biosensors, Bioenergy Production and wastewater treatment. Design Principles for Biofilm-Based Reactors and Optimization and Scalability.
- Emerging Technologies in Biofilm Research: Application of Artificial Intelligence and Machine Learning in Biofilm Studies. Biofilm models for biofilm studies and advanced techniques to find novel compounds

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Biofilm Science
Week 2	Genetic and Molecular Mechanisms
Week 3	Extracellular Matrix (EPS) and Structural Components
Week 4	Signaling molecules in biofilm regulation
Week 5	Biofilm dispersal mechanisms
Week 6	Biofilm-Host Interactions and Clinical Implications
Week 7	Industrial and Environmental Significance of Biofilms
Week 8	Industrial and Environmental Significance of Biofilms (continued)
Week 9	**Midterm Examination**
Week 10	Biofilms in extreme and unique environments

Week 11	Antimicrobial Resistance and Biofilm Control Strategies
Week 12	Biofilm control strategies
Week 13	Biofilm control strategies (continued)
Week 14	Biofilm Engineering and Design
Week 15	Emerging Technologies in Biofilm Research
Week 16	**Final Examination**

Reference Books (Latest Editions):

5. Bakrudeen, A. Microbial Biofilms: Properties and Applications in the Environment, Agriculture, and Medicine. CRC press.
6. Lewandowski, Z. & Beyenal, H. Fundamentals of biofilm research. CRC Press.
7. Bjarnsholt, T., Jensen, P.Ø., Moser, C.E. & Høiby, N. Biofilm infections. Springer Publishing Company.
8. Lear, G. & Lewis, G.D. Microbial biofilms: current research and applications. Horizon Scientific Press.
9. Latest articles in the field of microbial biofilms.

MIC160 Microbial Physiology & Metabolism

Course Title : Microbial Physiology & Metabolism
Course Code : MIC160
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3 (2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To familiarizes the students with the cell structure and function relationship
- To understand the physiological processes of prokaryotic and eukaryotic cells

Course Learning Outcome (CLOs)

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

- Describe the key physiological and metabolic processes that regulate microbial growth,
  energy production, and survival.
- Analyze the metabolic pathways utilized by microorganisms under different environmental conditions.
- Apply microbial physiology and metabolism knowledge to understand how microorganisms adapt to various ecological niches.

Course Contents:

- Introduction to Microbial physiology and metabolism: Overview of microbial physiology and metabolism, Prokaryotic vs. eukaryotic microbial physiology and the importance of these differences in metabolism.
- Microbial Cell structure: Basic structure and functions of microbial cells. Comparison of prokaryotic and eukaryotic cell structures.
- Chemical Composition of Microbial Cells: Key macromolecules: Proteins, lipids, carbohydrates, nucleic acids. Roles of these macromolecules in microbial life.
- Regulation of gene expression: Introduction, types of gene expression, Lac operon as model for regulation, Trp operon as model for regulation, gene expression in eukaryotes.
- Microbial metabolism: Introduction, catabolism, anabolism, metabolism of nucleic acid, proteins, carbohydrates and lipids
- Aerobic and anaerobic respiration and fermentation: Aerobic respiration, anaerobic respiration, fermentation, and fermented products
- Microbial enzymes: Classifications, mechanism of action, factors affecting enzyme action and inhibition
- Uptake (absorption) and secretion of molecules: Absorption and secretion, diffusion, osmosis, active and passive transport
- Stress responses: Introduction, envelope stress response, chemical stress response, heat shock response, cold shock response, general stress response

Practical

- Isolation of polysaccharides from bacteria
- Estimation of total proteins from bacteria
- Fermentation of glucose by yeast

- Effect of Temperature and shaking on microbial growth
- Biofilm formation on abiotic surface

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to microbial physiology and metabolism
Week 2	Microbial Cell Structure
Week 3	Chemical Composition of Microbial Cells
Week 4	Chemical composition of microbial cells (continued)
Week 5	Regulation of gene expression
Week 6	Regulation of Gene Expression (continued)
Week 7	Microbial Cell Metabolism
Week 8	Microbial Cell Metabolism (continued)
Week 9	**Midterm Examination**
Week 10	Aerobic, anaerobic respiration
Week 11	Fermentation
Week 12	Microbial enzymes

Week 13	Uptake and secretion of molecules, stress responses
Week 14	Stress responses in Microbes
Week 15	Stress responses in Microbes (continued)
Week 16	Final Examination

Reference Books (Latest Editions):

1. Willey, J., Sherwood, L., Woolverton, C.J. Prescott's Microbiology. McGraw-Hill Education.
2. Tortora, G.J., Funk, B.R., Case, C.C. Microbiology: An Introduction. Pearson Publisher.
3. Dubey, R.C., Maheshwari, D. K. A Textbook of Microbiology. S. Chand Publishers.
4. Robert F Weaver. Molecular Biology. McGraw-Hill.
5. Moat, A. G., Foster, J.W., Spector, M.P. Microbial Physiology. Wiley, John & Sons

MIC462 Microbial Biofilms

Course Title : Microbial Biofilms
Course Code : MIC462
Offered to : Undergraduate Students at Hazar University
Cr Hr. : 3(3+0)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To explain biofilm and its composition
- To describe methods used for analysis, quantification and control of biofilms
- To discuss the role of good and bad biofilms

Course Learning Outcome (CLOs)

Upon successful completion of the course, students should have:

- Understanding of bacterial biofilms and the environmental, industrial and healthcare problems related to complex microbial consortia
- Necessary skills for interpreting the outputs of modern techniques in biofilm research

Course Contents:

- Introduction to Microbial Biofilms: Introduction, biofilm growth and development, composition of a general biofilm, impacts of biofilms
- Biofilm growth and development: Developmental biology of biofilms, conditional film, reversible attachment, irreversible attachment, growth and recruitment of additional species, detachment and dispersal, advantages of living in biofilms
- Methods for analysing and quantification of biofilms: Microtitre plate assay, glass assay, flow cell, drip flow reactor, extraction of Extracellular polymeric substances (EPS), quantification of EPS, light microscopy of biofilms, Scanning Electron Microscopy, florescence microscopy
- Biofilm infections and biofouling: Human oral biofilms, skin infections, implant associated infections, infections of catheters, membrane biofouling, impact of biofouling, biofouling characterization, major causes of biofouling, factors affecting, biofouling control
- Productive Biofilms: Production of antimicrobials and bioenergy. Role in bioremediation, biosensors, and engineered biofilms
- Biofilm and antibiotic resistance: Introduction, causes; low antibiotic penetration, neutralization by enzymes, cells slow growth rate
- Quorum sensing in biofilms: Introduction, quorum sensing (QS) signalling molecules, bacterial quorum systems, role of QS in various fields
- Controlling Biofilms: Physical, chemical, and biological strategies

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures

- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Course Orientation/Introduction to Microbial Biofilms
Week 2	Biofilm growth and development
Week 3	Methods for analyzing and Quantification of Biofilms (continued)
Week 4	Methods for analyzing and Quantification of Biofilms (continued)
Week 5	Methods for analyzing and Quantification of Biofilms (continued)
Week 6	Methods for analyzing and Quantification of Biofilms
Week 7	Microbial Biofouling
Week 8	Biofilm infections (continued)
Week 9	Midterm Examination
Week 10	Biofilm infections
Week 11	Productive biofilms
Week 12	Biofilms and antibiotic resistance
Week 13	Quorum sensing in biofilms
Week 14	Biofilm control methods (continued)
Week 15	Biofilms control methods
Week 16	Final Examination

Reference Books (Latest Editions):

1. Bakrudeen, A. Microbial Biofilms: Properties and Applications in the Environment, Agriculture, and Medicine. CRC press.
2. Lewandowski, Z. & Beyenal, H. Fundamentals of biofilm research. CRC Press.
3. Bjarnsholt, T., Jensen, P.Ø., Moser, C.E. & Høiby, N. Biofilm infections. Springer Publishing Company.
4. Lear, G. & Lewis, G.D. Microbial biofilms: current research and applications. Horizon Scientific Press.
5. Muffler, K. & Ulber, R. Productive biofilms. Springer International publishing

Nutrition and Gut Microbiome

Course Title : Nutrition and Gut Microbiome
Course Code : MIC763 / MIC863
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To understand the role of microbiome in human health and disease
- To explain the conceptual framework and technologies for understanding how microbiome, particularly gut microbiome, influence human health and well-being

Course Learning Outcome (CLOs)

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

- Illustrate ecological principles of the human microbiome, and the importance of conservation of the global microbiomes of peoples from different human populations
- Explain that how microbiome living in gut interacts with brain and alters the behavior
- Use tools and strategies for studying the microbiome
- Assess the potential of the microbiota (probiotics) and diet (prebiotics) to achieve and maintain health

Course Contents:

- Introduction: what is Gut? Review of the digestive system
- The gut microbiome, its location, functions and development throughout the life span
- How diet shapes the composition of gut microbiota? Response of microbiota to diet and dietary components
- Nutrients that may affect the gut biome; practical ways to improve/modify the microbiota e.g., through dietary interventions
- The evolution of gut microbiota/microbiome and methods of its study
- How gut microbiota and its molecules/metabolites shape the health/disease conditions?
- Microbes and mood; How gut influences the feelings of stress, anxiety and depression?
- Animal models for studying the microbiome
- Antibiotics, prebiotics and probiotics
- Obesity and the microbiota/microbiome
- Microbiota/microbiome and diabetes
- The immune system and the microbiota
- Therapeutic and future challenges if the microbiome
- Importance of academic knowledge about microbiome for policy makers, medical scientists and industry

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions

- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction: what is Gut? Review of the digestive system
Week 2	The gut microbiome, its location, functions and development throughout the life span
Week 3	How diet shapes the composition of gut microbiota? Response of microbiota to diet and dietary components
Week 4	Nutrients that may affect the gut biome; practical ways to improve/modify the microbiota e.g., through dietary interventions
Week 5	The evolution of gut microbiota/microbiome and methods of its study
Week 6	How gut microbiota and its molecules/metabolites shape the health/disease conditions?
Week 7	Microbes and mood; How gut influences the feelings of stress, anxiety and depression?
Week 8	Animal models for studying the microbiome
Week 9	**Midterm Examination**
Week 10	Antibiotics, prebiotics and probiotics
Week 11	Obesity and the microbiota/microbiome
Week 12	Microbiota/microbiome and diabetes
Week 13	The immune system and the microbiota
Week 14	Therapeutic and future challenges if the microbiome
Week 15	Importance of academic knowledge about microbiome for policy makers, medical scientists and industry

Week 16	Final Examination

Reference Books (Latest Editions):

1. Ishiguro, Edward, Natasha Haskey, and Kristina Campbell. Gut microbiota: interactive effects on nutrition and health. Academic Press.
2. Kochhar, Sunil, and François-Pierre Martin. Metabonomics and gut microbiota in nutrition and disease. Springer.
3. Gibson, Glenn R., and Marcel B. Roberfroid. Colonic microbiota, nutrition, and health. Dordrecht: Kluwer Academic
4. Latest Articles in the field

MIC370 Food Microbiology

Course Title : Food Microbiology
Course Code : MIC370
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To study the mechanisms of food preservation and spoilage of food
- To review the role of microorganisms in production of some selected industrial products

Course Learning Outcome (CLOs)

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

- Explain the roles of microorganisms in food production, spoilage, preservation, and safety.
- Apply microbiological techniques to ensure food quality and prevent spoilage.
- Evaluate the impact of microbial activities on foodborne illnesses and public health.

Course Contents:

- Scope of food and dairy microbiology
- Factor affecting the growth of food microorganisms
- Introduction to meat, fish and dairy microbiology
- Microorganisms important in food industry & dairy industry
- Probiotics and Prebiotics
- The process of yogurt and cheese production
- Role of fermentation in different industrial processes
- Spoilage of food products
- Problem/Control of biofilm forming in food industry
- Technology of food processing; food preservation techniques
- Food borne diseases/pathogens

Practical

- Isolation of starter culture from cheese and yogurt
- Enumeration of bacteria from poultry meat
- Enumeration of bacteria from beef
- Enumeration of bacteria from milk, eggs and fish
- Detection of food pathogens

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Scope of food and dairy microbiology
Week 2	Factor affecting the growth of food microorganisms
Week 3	Introduction to meat, fish and dairy microbiology
Week 4	Microorganisms important in food industry & dairy industry
Week 5	Probiotics and Prebiotics
Week 6	The process of yogurt and cheese production
Week 7	Role of fermentation in different industrial processes (Continued)
Week 8	Role of fermentation in different industrial processes
Week 9	**Midterm Examination**
Week 10	Spoilage of food products (Continued)
Week 11	Spoilage of food products
Week 12	Problem/Control of biofilm forming in food industry
Week 13	Technology of food processing; food preservation techniques (Continued)
Week 14	Technology of food processing; food preservation techniques
Week 15	Food borne diseases/pathogens
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. James, G. Brennan Food Processing Handbook. Wiley, John and Sons, Incorporated.
2. Jay, J. M., Loessner, M. J. and Golden, D. A. Modern Food Microbiology. Springer Science, Inc., U.S.A.
3. Karl, R. and Matthews, M. P. Doyle Microbiology. ASM Press.
4. Doyle, M. P., Erickson, M.C. Imported Foods: Microbiological Issues and Challenges. ASM Press
5. Doyle, M.P., Buchanan, R.L. Food Microbiology: Fundamentals and Frontiers. ASM Press. Montville, T.J., Matthews, K.R., and. Kniel, K.E. Food Microbiology: an Introduction. ASM Press.

MIC471 Microbial Biotechnology

Course Title : Microbial Biotechnology
Course Code : MIC471
Offered to : Undergraduate Students at Hazar University
Cr Hr. : 3(2+1)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To describe the applications of microbiology and biotechnology in different fields
- To Demonstrate the role of microbes in industrial, agriculture, environment, and medical fields

Course Learning Outcome (CLOs)

On successful completion of the course, the students should have:

- Explain the principles and techniques of microbial biotechnology.
- Understand the applications of microbial biotechnology in the environment, industry, agriculture, and medicine.
- Apply microbial biotechnology to develop innovative solutions for global challenges.

Course Contents:

- Introduction to Microbial biotechnology: History, brief applications, and scope. Role of microbes in industrial, medical, agricultural and environmental applications
- Microbial strain engineering and host optimization: Host selection and optimization for biotechnological production, example of biofuel production.
- Metabolic engineering for product production: Overview of metabolic pathways and optimization strategies for enhanced metabolite production.
- Bioremediation and biomass utilization: Introduction, applicability, different approaches, different strategies, essential factors, and different systems
- Microbial Biocomposting: Introduction, why composting? benefits, different ways of composting, different phases of composting, factors affecting composting process, types of composting
- Fermentation and fermented food products: Fermentation, Techniques of fermentation, types of fermentation, advantages and disadvantages, contribution of fermented foods, fermentation products
- Biomonitoring and Biosensors: Introduction to biomonitoring and biosensors; components of a biosensor; types of biosensors; potential applications
- Genetic engineering and transgenic organisms: Introduction, brief history, genetically modified organisms (GMOs), Benefits of GMOs, issues of GMOs, GMOs labelling, safety and concerns of GMOs
- Cloning: Gene cloning; Introduction, cloning in nature, types of artificial cloning, gene cloning, reproductive cloning, therapeutic cloning, benefits of cloning, possible concerns
- Production of Microbial products: Antibiotics, bioinsecticides, biofertilizers, amino acids, vitamins, immobilized cells and enzymes, microbial bioplastics

Practical

- Immobilization of fungal cells for bioremediation

- Bioethanol production using *Saccharomyces cerevisiae*
- Production and estimation of proteins from bacteria
- Production and quantification of polysaccharides from bacteria
- Fermentative Production of microbial enzyme

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to Microbial Biotechnology
Week 2	Microbial strain engineering and host optimization
Week 3	Metabolic engineering for product production
Week 4	Bioremediation and biomass utilization
Week 5	Microbial biocomposting
Week 6	Fermentation and Fermentation products
Week 7	Fermentation and Fermentation products (continued)
Week 8	Biomonitoring and biosensing
Week 9	Midterm Examination
Week 10	Genetic engineering and transgenic organisms
Week 11	Genetic engineering and transgenic organisms (continued)

Week 12	Cloning
Week 13	Production of Microbial products (continued)
Week 14	Production of Microbial products (continued)
Week 15	Production of Microbial products (continued)
Week 16	Final Examination

Reference Books (Latest Editions):

1. R. C. Dubey. A Textbook of Biotechnology. S Chand Publisher.
2. Dubey, R.C., Maheshwari, D.K. A Textbook of Microbiology. S. Chand Publishers.
3. Glick, B. R. and Pasternak, J. A. Molecular Biotechnology: Principles and Application of Recombinant DNA. ASM press.
4. Dubey, R.C. Advanced Biotechnology. S. Chand Publishers.
5. Sanjai Saxena. Applied Microbiology. Springer (India).

MIC472 Microbial Enzyme Technology

Course Title : Microbial Enzyme Technology
Course Code : MIC472
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(2+1)
Pre-requisite : Introductory Biochemistry; Fundamentals of Microbiology

Course Objectives:

- To describe the nature, properties, and functions of enzymes
- To learn about the methods for enzyme production and purification, and their applications in food, environment, and medical sectors

Course Learning Outcome (CLOs)

On successful completion of the course, the students should be able to:

- Describe the basics of enzymology along with production and purification methods
- Demonstrate the applications of enzymes in food, environment, medical and household industries

Course Contents:

- Introduction to enzymes: Nature, structure, functions, sources, biosynthesis, and enzyme turnover
- Mechanisms of enzyme and its regulation: Mechanisms of enzyme reaction, reversible and irreversible changes, regulatory enzymes, control of metabolic pathways-feedback inhibition
- Purification and characterization of enzymes: Methods of enzyme purification, characterization of enzymes
- Enzyme immobilization: Methods of immobilizations, properties of immobilized enzymes, uses of free and immobilized enzymes in industries
- Enzyme reactors: Reactor design, batch reactor, membrane reactor, continuous flow reactor, fluidized bed reactor, fixed bed reactor
- Industrial enzymes production: Types, sources, fermentative production, and uses of industrial enzymes
- Applications of enzymes: Applications in quorum quenching, bioremediation, detergents, food industry, therapeutic applications

Practical

- Production of enzyme using fungal sources
- Production of enzyme using bacterial sources
- Measurement of enzyme activity
- Effect of temperature and pH on enzyme activity
- Immobilization of microbial enzyme

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures

- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Course Orientation/Introduction to Enzymes
Week 2	Mechanism of enzymes and its regulation (continued)
Week 3	Mechanism of enzymes and its regulation
Week 4	Enzyme immobilization (continued)
Week 5	Enzyme immobilization
Week 6	Enzyme reactors (continued)
Week 7	Enzyme reactors
Week 8	Industrial Enzymes production (continued)
Week 9	Midterm Examination
Week 10	Industrial Enzymes production (continued)
Week 11	Industrial Enzymes production
Week 12	Purification and characterization of enzymes (continued)
Week 13	Purification and characterization of enzymes
Week 14	Applications of enzymes (continued)
Week 15	Applications of enzymes
Week 16	Final Examination

Reference Books (Latest Editions):

1. Okafor and Okeke. Modern Industrial Microbiology and Biotechnology. CRC press.
2. Thatoi H. Microbial Fermentation and Enzyme Technology. CRC Press.
3. R. C. Dubey. A Textbook of Biotechnology. S Chand Publisher.
4. Dubey, R.C., Maheshwari, D.K. A Textbook of Microbiology. Chand Publishers.
5. Dubey, R.C. Advanced Biotechnology. S. Chand Publishers.
6. Sanjai Saxena. Applied Microbiology. Springer (India).

MIC374 Industrial Microbiology

Course Title: Industrial Microbiology

Course Code : MIC374

Offered to : Undergraduate Students at Hazara University

Cr Hr. : 3(2+1)

Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To learn about microorganisms of industrial importance
- To learn about the industrial microbial processing techniques and commercial utilization of microbes for the production of organic acids, organic solvents and fermentable products

Course Learning Outcome (CLOs)

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

- Describe the application of microorganisms in industrial processes and product development.
- Analyze the principles of microbial fermentation, bioprocessing, and biotechnology.
- Apply industrial microbiology techniques to optimize production and innovation in various sectors.

Course Contents:

- Introduction to industrial Microbiology: Overview of Industrial Microbiology; scope, history and significance. Role of microbes in food, pharmaceutical, and environmental industries.
- Microbial Growth and Metabolism in Industrial Processes: Microbial growth, metabolic pathways. Application: Optimizing microbial growth for high yield in industrial fermentation (e.g., bioethanol production)
- Microbial Fermentation Technology: Principles of fermentation and its types (batch, fed-batch, continuous). Fermentation media and raw materials. Fermentation products production.
- Bioreactors: Design, operation and types. Optimization of large-scale production. Bioreactor applications.
- Upstream and Downstream Processing: Upstream processes: Inoculum preparation, fermentation media and scaling up for large-scale production. Downstream processing: Harvesting, separation, purification, and product recovery.
- Microbial Strain Improvement and Genetic Engineering: Methods for strain improvement: Mutagenesis, screening, and genetic modification.
- Microbial Enzyme Production and Applications: Production of industrial enzymes by microbes (e.g., amylase, lipase). Applications of enzymes in food, detergents, biofuels, and pharmaceuticals.
- Microbial Production of Biofuels and Biomass: Introduction to biofuels (bioethanol, biodiesel) and biomass utilization.
- Microbial Production of Pharmaceuticals: Microbial production of antibiotics and vaccines. Case study: Penicillin production and insulin production from genetically modified microbes.

- Regulatory and Safety Aspects in Industrial Microbiology: Biosafety levels, ethical issues, and regulations for industrial microbiology. Regulatory frameworks for GMOs and synthetic biology applications in industry.

Practical

- Bioreactor operation for microbial growth
- Industrially important Enzyme production
- Production of biofuel from microbial fermentation
- Production of Citric acid by fermentation

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to industrial microbiology
Week 2	Microbial Growth and Metabolism in Industrial Processes
Week 3	Microbial Fermentation Technology
Week 4	Microbial fermentation technology (continued)
Week 5	Bioreactors
Week 6	Upstream and downstream processing
Week 7	Microbial Strain Improvement and Genetic Engineering

Week 8	Microbial Strain Improvement and Genetic Engineering (continued)
Week 9	**Midterm Examination**
Week 10	Microbial Enzyme Production and Applications
Week 11	Microbial Enzyme Production and Applications (continued)
Week 12	Microbial Production of Biofuels and Biomass
Week 13	Microbial production of pharmaceuticals
Week 14	Microbial production of pharmaceuticals (continued)
Week 15	Regulatory and Safety Aspects in Industrial Microbiology
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Prescott S. C. Industrial Microbiology, Agrobios India
2. Naduka Okafor. Modern Industrial Microbiology and Biotechnology. Science Publisher.
3. Richard H. B. Julian E. D. et al. Manual of Industrial Microbiology and Biotechnology. ASM Press.
4. El-Mansi E. M. T. et al. Fermentation Microbiology and Biotechnology. CRC Press.
5. Pauline M. D. Bioprocessing Engineering Principles. Academic Press.
6. R. C. Dubey. A Textbook of Biotechnology. S Chand Publisher.
7. Dubey, R.C., Maheshwari, D.K. A Textbook of Microbiology. S. Chand Publishers.
8. Dubey, R.C. Advanced Biotechnology. S. Chand Publishers.

Viral Based Gene Therapy

Course Title	:	Viral Based Gene Therapy
Course Code	:	MIC744 / MIC844
Offered to	:	Graduate Students at Hazara University
Cr Hr.	:	3(3+0)
Pre-requisite	:	General Virology; Molecular Biology

Course Objectives:

- To provide knowledge about viral and non-viral systems used in gene therapy and discuss their advantages and challenges
- To discuss the latest research developments in viral based gene therapy

Course Learning Outcome (CLOs)

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

- Know basic concepts of gene therapy, technologies of gene transfer, therapeutic strategies, efficiency and safety issues
- Explain inherited and acquired diseases that could benefit from gene therapy
- Identify potential targets and approaches for gene therapy

Course Contents:

- Introduction: Fundamentals, nomenclature, chronology
- Fundamentals of gene transfer
- Viral based gene therapy, history, evolution and future
- Viral genomes and their modifications into viral vectors
- Application of viral vectors and development of gene therapy solutions.
- The use of AAV, Adenovirus, Retrovirus, Lentivirus, HSV in gene therapy
- Viral based gene therapy of infectious diseases: HIV infection
- Viral based gene therapy of ischemic diseases
- Non-viral gene transfer: Plasmids and DNA vaccines; Ballistic methods; Liposomes; Engineered zinc-finger nucleases
- Ablative strategies: Transduction of antisense constructs; Antisense oligonucleotides; Ribozymes; Intracellular antibodies; RNA interference
- Safety, Laws, Bioethical Concerns; Safety issues in preclinical and clinical gene therapy
- Mini Project: Design your own viral vector for the disease of your choice

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction: Fundamentals, nomenclature, chronology (Continued)
Week 2	Introduction: Fundamentals of gene transfer
Week 3	Viral based gene therapy, history, evolution and future
Week 4	Viral genomes and their modifications into viral vectors
Week 5	Application of viral vectors and development of gene therapy solutions.
Week 6	The use of AAV, Adenovirus, Retrovirus, Lentivirus, HSV in gene therapy (Continued)
Week 7	The use of AAV, Adenovirus, Retrovirus, Lentivirus, HSV in gene therapy (Continued)
Week 8	The use of AAV, Adenovirus, Retrovirus, Lentivirus, HSV in gene therapy
Week 9	**Midterm Examination**
Week 10	Viral based gene therapy of infectious diseases: HIV infection
Week 11	Viral based gene therapy of ischemic diseases
Week 12	Non-viral gene transfer: Plasmids and DNA vaccines; Ballistic methods; Liposomes; Engineered zinc-finger nucleases
Week 13	Ablative strategies: Transduction of antisense constructs; Antisense oligonucleotides; Ribozymes; Intracellular antibodies; RNA interference
Week 14	Safety, Laws, Bioethics Concerns; Safety issues in preclinical and clinical gene therapy
Week 15	Presentations of students' mini projects
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Seth, Prem. Adenoviruses: basic biology to gene therapy. Landes Bioscience

2. Herzog, Roland W., and Sergei Zolotukhin. A guide to human gene therapy. World scientific.
3. Xu, Ke. Viral Gene Therapy. BoD–Books on Demand

MIC475 Advances in Microscopy and Image Analysis

Course Title : Advances in Microscopy and Image Analysis
Course Code : MIC475
Offered to : Undergraduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Fundamentals of Microbiology; Introduction to Computing

Course Objectives:

- To develop the concept about different types of microscopies
- To improve skills for Image magnification, image resolution image analysis
- To examine detailed structures of cells in different perspectives

Course Learning Outcome (CLOs)

At the end of the course, the students will acquire the following abilities:

- Basic understanding of different type of microscopy
- Enhanced imaging analysis capabilities through different techniques and software
- Better understanding of the different cells after observing under microscope

Course Contents:

- Introduction to Microscopy
- Optical Microscopy; Types of Optical Microscopy
- Fluorescence Microscopy; Different advances in fluorescent microscopy, immune-FRET microscopy, confocal laser microscopy, electron tunneling microscopy
- Inverted Microscopy
- Electron microscopy
- Scanning Probe and Atomic force microscopy
- Total internal reflection fluorescence (TIRF)
- Microscopic image analysis by using different software.
- Institutional visits; Visit to different institute for hands on experience on different instruments

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %

- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to microscopy
Week 2	Optical Microscopy
Week 3	Types of Optical Microscopy (Continued)
Week 4	Types of Optical Microscopy
Week 5	Fluorescence Microscopy; Different advances in fluorescent microscopy (Continued)
Week 6	Fluorescence Microscopy; Different advances in fluorescent microscopy
Week 7	Inverted Microscopy
Week 8	Electron microscopy and types (Continued)
Week 9	**Midterm Examination**
Week 10	Electron microscopy and types (Continued)
Week 11	Electron microscopy and types
Week 12	Scanning Probe and Atomic force microscopy
Week 13	Total internal reflection fluorescence (TIRF)
Week 14	Microscopic image analysis by using different soft ware
Week 15	Visit to different institute for hands on experience on different instruments
Week 16	**Final Examination**

Reference Books (Latest Edition):

1. Michael, T. et al. Scanning Microscopy. Society of Photo Optical, Belgium.
2. Eaton, P. & West, P. Atomic Force Microscopy. Oxford University Press, U.S.A.
3. Gabriel Popescu. Nanobiophotonics. McGraw Hill.
4. Gabriel Popscu. Quantitative Phase Imaging of Cells and Tissue. McGraw-Hill.
5. John S., Curry A. & Eyden B. Diagnostic Electron Microscopy. Wiley.
6. David C. B. & Erdman N. Low Voltage Electron Microscopy: Principles and Application. Wiley.

Advanced Food Microbiology

Course Title : Advanced Food Microbiology
Course Code : MIC776 / MIC876
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Food and Dairy Microbiology

Course Objectives:

- To familiarize students with the advances and revolutions made in the Food Microbiology
- To describe the pathogenesis of food borne viruses and bacteria
- To understand the mechanism of fermentation

Course Learning Outcome (CLOs)

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

- Comprehensively explain in detail the pathogenesis of food borne microorganism
- Explain the rationale of fermentation and its importance in food industry
- Demonstrate the importance of quality assurance in food safety
- Independently design food-oriented research projects

Course Contents:

- An Introduction to food safety, security and microbiology; Pakistan and global perspectives
- Global epidemiology of food borne diseases
- Mechanism of pathogenesis of foodborne viruses; human caliciviruses and Rota viruses
- Viruses that cause hepatitis, Hepatitis A and E viruses
- Viruses that cause neurological disease: polio virus and enterovirus
- Mechanism of pathogenesis of foodborne bacteria; *Salmonella, E. coli, Campylobacter, Shigella and Listeria*
- Role of toxins in food borne intoxication/infections, structure, function and mechanism of action of toxins (enterotoxins, neurotoxins)
- Food Spoilage: Ecology and physiology of food-associated spoilage and pathogenic microorganism
- Biofilms in the Food Industry: Health aspects and control Methods
- An introduction to food fermentation; Microbiology and physiology of dairy and vegetable fermentations
- Genetic engineering for food fermentations
- Technology of food processing; Preservatives and agents for improving the quality, shelf-life and optic properties of foods
- Principles and methods of food preservation; Microbiology of preserved foods
- Preserved food Packaging and related microbial problems

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions

- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	An Introduction to food safety, security and microbiology; Pakistan and global perspectives
Week 2	Global epidemiology of food borne diseases
Week 3	Mechanism of pathogenesis of foodborne viruses; human caliciviruses and Rota viruses
Week 4	Viruses that cause hepatitis, Hepatitis A and E viruses,
Week 5	Viruses that cause neurological disease: polio virus and enterovirus
Week 6	Mechanism of pathogenesis of foodborne bacteria; *Salmonella, E. coli, Campylobacter, Shigella and Listeria*
Week 7	Role of toxins in food borne intoxication/infections, structure, function and mechanism of action of toxins (enterotoxins, neurotoxins)
Week 8	Food Spoilage: Ecology and physiology of food-associated spoilage and pathogenic microorganism
Week 9	**Midterm Examination**
Week 10	Biofilms in the Food Industry: Health aspects and control Methods
Week 11	An introduction to food fermentation; Microbiology and physiology of dairy and vegetable fermentations
Week 12	Genetic engineering for food fermentations
Week 13	Technology of food processing; Preservatives and agents for improving the quality, shelf-life and optic properties of foods
Week 14	Principles and methods of food preservation; Microbiology of preserved foods

Week 15	Preserved food Packaging and related microbial problems
Week 16	**Final Examination**

Reference Books (Latest Edition):

1. James, G. Brennan Food Processing Handbook. Wiley, John and Sons, Incorporated.
2. Jay, J. M., Loessner, M. J. and Golden, D. A. Modern Food Microbiology. Springer Science, Inc., U.S.A.
3. Karl, R. and Matthews, M. P. Doyle Microbiology. ASM Press.
4. Doyle, M . P., Erickson, M.C. Imported Foods: Microbiological Issues and Challenges. ASM Press
5. Doyle, M.P., Buchanan, R.L. Food Microbiology: Fundamentals and Frontiers, Fourth Edition. ASM Press.
6. Montville, T.J., Matthews, K.R. and Kniel, K.E. Food Microbiology: an Introduction. ASM Press.

Advanced Immunology

Course Title : Advanced Immunology
Course Code : MIC734 / MIC834
Offered to : Graduate Students of Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : General Immunology

Course Objectives:

- To build upon a basic level of knowledge of the immune system
- To provide the basic scientist with an enhanced learning of immunological concepts that are relevant to a wide range of biological fields
- To understand the scope of topics worldwide in recent Immunology research

Course Learning Outcome (CLOs)

At the end of the course students will acquire the following abilities:

- Critical understanding of the major topics on immunological research like innate and acquired immune responses; complement system, cellular and molecular mechanisms of immunity; antigen processing and presentation; tissue-specific immune responses; immune-mediated pathologies; and vaccination
- Development of interest for selection of a potential field/topic for research in immunology

Course Contents:

- Basic concepts of Immunology
- Molecular mechanisms of complement activation, biological effects of complement and complement regulators
- Antigen processing and presentation
- Immune Receptors and signal transduction
- Lymphocyte Development
- Antigen Receptor Gene Rearrangement
- Immunological tolerance and autoimmunity
- Activation of T-Lymphocytes
- Differentiation and function of CD4+ T-Cells
- B-Cell Activation and antibody production
- Effector mechanism of humoral immunity
- The preparation and applications of monoclonal antibodies
- Vaccines and herd immunity

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Revision of the basic concepts on Immunology
Week 2	Molecular mechanisms of complement activation, biological effects of complement and complement regulators
Week 3	Antigen processing and presentation
Week 4	Immune Receptors and signal transduction
Week 5	Lymphocyte Development
Week 6	Antigen Receptor Gene Rearrangement
Week 7	Immunological tolerance and autoimmunity
Week 8	Activation of T-Lymphocytes (Continued)
Week 9	**Midterm Examination**
Week 10	Activation of T-Lymphocytes
Week 11	Differentiation and function of CD4+ T-Cells
Week 12	B-Cell Activation and antibody production
Week 13	Effector mechanism of humoral immunity
Week 14	The preparation and applications of monoclonal antibodies
Week 15	Vaccines
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Abbas, A. K., Lichtman, A. H. & Pillai, S. Cellular and Molecular Immunology. Elsevier Health Sciences.
2. Murphy, K. & Weaver, C. Janeway's immunobiology. New York, United States: Garland Science; Taylor & Francis Group.
3. Owen, J. A., Punt, J. & Stranford, S. A. Kuby immunology, New York, USA, WH Freeman and Company.

Advanced Medical Microbiology

Course Title : Advanced Medical Microbiology
Course Code : MIC717 / MIC 817
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Fundamentals of Microbiology; Medical Microbiology

Course Objectives:

- To understand pathogenesis of microorganisms
- To learn detailed mechanism of infection and molecular mechanism of pathogenesis
- To have a deeper understanding of the role of various virulence factors in microbial pathogenesis

Course Learning Outcome (CLOs)

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

- Comprehend the distinct mechanisms of pathogenesis adopted by different pathogens
- Apply the knowledge to prevent and control the infectious cycle
- Design projects based on drug development against novel therapeutic targets

Course Contents:

- Micro-organisms and Infectious diseases: a historical perspective
- Antibiotics and the development of resistance. Staphylococcus aureus as an example for stepwise development of antibiotic resistance
- Virulence factors. How to measure virulence. How can virulence factors be identified?
- Host susceptibility to infection – the case for TB, herpes and others
- Evading the immune system. Avoiding antibodies and complement, surviving phagocytosis by PMN and Macrophages
- Bacterial toxins and disease. The case for DT, Cholera, Shiga, Pertussis, Botulinum, Anthrax
- Role of secretion systems in microbial pathogenesis
- The Plague – disease and molecular pathogenesis
- Mycobacterium tuberculosis – the white death and other mycobacteria
- Clostridial disease, and C. difficile in particular: more infectious, more resistant, and more toxic
- Etiology and Molecular Mechanisms of *Candida albicans*, *Histoplasma capsulatum*
- HIV and it's virulence pathways: the road to AIDS
- Microbiome and its significance
- Micro-organisms and carcinogenesis; Micro-organisms and autoimmunity.
- Whole Genome Sequencing & Pathogen Genomics

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures

- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Micro-organisms and Infectious diseases: a historical perspective
Week 2	Antibiotics and the development of resistance. Staphylococcus aureus as an example for stepwise development of antibiotic resistance
Week 3	Virulence factors. How to measure virulence. How can virulence factors be identified?
Week 4	Host susceptibility to infection – the case for TB, herpes and others
Week 5	Evading the immune system. Avoiding antibodies and complement, surviving phagocytosis by PMN and Macrophages and more
Week 6	Bacterial toxins and disease. The case for DT, Cholera, Shiga, Pertussis, Botulinum, Anthrax
Week 7	Role of secretion systems in microbial pathogenesis
Week 8	The Plague – disease and molecular pathogenesis
Week 9	**Midterm Examination**
Week 10	Mycobacterium tuberculosis – the white death and other mycobacteria
Week 11	Clostridial disease, and *C. difficile* in particular: more infectious, more resistant, and more toxic
Week 12	Etiology and molecular mechanisms of *Candida albicans*, *Histoplasma capsulatum*
Week 13	HIV and it's virulence pathways: the road to AIDS
Week 14	Microbiome and its significance; Micro-organisms and carcinogenesis; Micro-organisms and autoimmunity
Week 15	Whole Genome Sequencing & Pathogen Genomics

Week 16	Final Examination

Reference Books (Latest Editions):

1. Cowan, S. T., Steel, K. J., Barrow, G. I and Feltham, R. K. A. Cowan and Steel's Manual for the Identification of Medical Bacteria. Cambridge University Press.
2. Hawkey, P and Lewis, D. Medical Bacteriology: A Practical Approach., Oxford University Press, U.K.
3. Mims, C., Dockrell, H., Goering, R., Roitt, I Wakelin, D. and Zuckerman, M. Medical Microbiology. Mosby Co.
4. Murray, P. R., Rosenthal, K. S., Pfaller, M. A. and Rosenthal, K. S. Medical Microbiology. Elsevier Health Science, N.Y.
5. Murray, Baron, Pfaller, Tenover, Yolken. Manual of Clinical Microbiology. ASM Press USA.
6. Brooks, G., Carroll, K.C., Butel, J., Morse, S. Jawetz Melnick& Adelbergs Medical Microbiology. McGraw-Hill Companies.

Molecular Mechanism of Diseases

Course Title : Molecular Mechanism of Diseases
Course Code : MIC724 / MIC824
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Molecular Biology; Fundamentals of Microbiology

Course Objectives:

- To understand fundamental principles of human diseases
- To stud underlying molecular basis or 'molecular mechanisms' of the disease process in humans

Course Learning Outcome (CLOs)

Upon course completion, students will be able to:

- Explain molecular mechanisms that underlie chronic human disease and research topics in the areas of inflammation and immunopathology
- Demonstrate an understanding of essential concepts of human health and disease, including cell death, inflammation, and genetic and epigenetic mechanisms
- Describe how these essential concepts relate to the pathogenesis of common and important respiratory diseases, neoplastic diseases, reproductive disorders, metabolic disorders, and circulatory diseases
- Recognize and describe how knowledge of physiologic and pathophysiologic processes can be used in the investigation, prevention, and management of disease

Course Contents:

- Infectious diseases, General mechanism of disease development
- Immunopathogenesis (Hypersensitivity and Autoimmunity Immunodeficiency
- Inflammation, Fibrosis
- Signaling and Pathogenesis of cancer
- Cardiac Diseases
- Hepatic Diseases
- Neurodegenerative Diseases
- Genetic Diseases
- Metabolic Disorders Obesity; Diabetes Mellitus

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies

- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction to the course Infectious diseases, General mechanism of disease development (Continued)
Week 2	Infectious diseases, General mechanism of disease development
Week 3	Immunopathogenesis (Hypersensitivity and Autoimmunity Immunodeficiency (Continued)
Week 4	Immunopathogenesis (Hypersensitivity and Autoimmunity Immunodeficiency (Continued)
Week 5	Immunopathogenesis (Hypersensitivity and Autoimmunity Immunodeficiency
Week 6	Inflammation, Fibrosis (Continued)
Week 7	Inflammation, Fibrosis
Week 8	Signaling and Pathogenesis of cancer (Continued)
Week 9	**Midterm Examination**
Week 10	Signaling and Pathogenesis of cancer
Week 11	Cardiac Diseases
Week 12	Hepatic Diseases
Week 13	Neurodegenerative Diseases
Week 14	Genetic Diseases
Week 15	Metabolic Disorders Obesity; Diabetes Mellitus

Week 16	Final Examination

Reference Books (Latest Editions):

1. V. Kumar, R.A.K. Abbas & J. Aster. Robbins Basic Pathology. Saunders & Co. Philadelphia.
2. V. Kumar, A.K. Abbas, N. Fausto and J. Aster. Robbins and Cotran Pathologic Basis of Disease. Elsevier Saunders
3. Kenneth Murphy. Janeway's Immunobiology. Garland Science, Taylor & Francis Group, LLC.

Advanced Virology

Course Title : Advanced Virology
Course Code : MIC745 / MIC845
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : General Virology

Course Objectives:

- To familiarize students with the advances and revolutions made in the Virology
- To describe how viruses interact with cells
- To understand the ways that the viruses persist in host cells

Course Learning Outcome (CLOs)

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

- Comprehensively explain in detail how virus structure and replication related to the pathogenesis of medically important viruses
- Explain the design of and use of appropriate molecular techniques for the diagnosis for viral disease
- Integrate data from phylogenetic analysis of viral evolution and its application to epidemiology of disease outbreaks
- Explain the rationale of current anti-viral treatment strategies with particular reference to immunodeficiency viruses

Course Contents:

- Viral classification, nomenclature, taxonomy
- Viral strategies for attachment and entry
- Viral strategies for replication, using as examples: herpes, pox, picorna-, orthomyxo-, reo- and retroviruses
- Viral strategies for pathogenesis
- Basic Immune Response to Viral Infection
- Viruses and Immune Evasion
- The Role of the Microbiota in Virus Infections
- Viral latency: epidemic and endemic persistence in populations
- Viral evolution, as seen in influenza, HIV
- Emerging viruses and strategies to combat them; COVID, Ebola virus, MERS, ZIKA virus, Congo Hemorrhagic Fever
- Medically important viruses, including viruses and cancer, HIV/AIDS
- Defective viruses
- Mechanism of action of antivirals and antiviral resistance
- Detection of viruses
- Prion Diseases
- Virology and Public Health
- Sexually transmitted viruses
- Viruses as gene delivery vectors (Viral based gene therapy)

Teaching Methodology:

- Student-centered teaching through communicative approach

- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning
- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Viral classification, nomenclature, taxonomy
Week 2	Viral strategies for attachment and entry
Week 3	Viral strategies for replication, using as examples: herpes, pox, picorna-, orthomyxo-, reo- and retroviruses
Week 4	Viral strategies for pathogenesis
Week 5	Basic Immune Response to Viral Infection
Week 6	Viruses and Immune Evasion
Week 7	The Role of the Microbiota in Virus Infections
Week 8	Viral latency: epidemic and endemic persistence in populations
Week 9	**Midterm Examination**
Week 10	Viral evolution, as seen in influenza, HIV
Week 11	Emerging viruses and strategies to combat them; COVID, Ebola virus, MERS, ZIKA virus, Congo Hemorrhagic Fever
Week 12	Medically important viruses, including viruses and cancer, HIV/AIDS
Week 13	Defective viruses; Mechanism of action of antivirals and antiviral resistance

Week 14	Detection of viruses; Prion Diseases
Week 15	Virology and Public Health; Sexually transmitted viruses; Viruses as gene delivery vectors
Week 16	**Final Examination**

Reference Books (Latest Editions):

a. Mahy, B.W.J., & Van Regenmortel, M.H.V. Encyclopedia of Virology. Elsevier
b. Cann, A. J. Principles of Molecular Virology. Academic Press.
c. Robert, W. Molecular Biology. McGraw-Hill Sciences
d. Ralf G. Dietzgen, R.F., and Ivan V. Kuzmin, I.V. Rhabdoviruses: Molecular Taxonomy, Evolution, Genomics
e. Caister. Ecology, Host-Vector Interactions, Cytopathology and Control Academic Press. USA.

Advanced Forensic Microbiology

Course Title : Advanced Forensic Microbiology
Course Code : MIC777 / MIC877
Offered to : Graduate Students at Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Fundamentals of Microbiology

Course Objectives:

- To identify the methodologies used to determine the microbial signature of infectious agents
- To understand the concept of Thanatomicrobiome
- To discuss the microbiologic indicators used in determining drowning as a cause of death

Course Learning Outcome (CLOs)

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

- Discuss the role of forensic microbiology
- Apply the role of microorganism in forensic analysis
- Compare and contrast the use of diatoms and fecal bacteria in determining drowning and SIDS as a cause of death.

Course Contents:

- Basics of microbial forensics and its evolution
- Advances in techniques used determine the microbial signature of infectious agents.
- Types and identification of microbial organisms of forensic significance.
- History, current, and future use of microorganisms as physical evidence
- Diatoms and their application in forensic science
- Thanatomicrobiome
- Application of microbial traces in postmortem interval evaluation
- Microbial impacts in postmortem toxicology
- Arthropod–microbe interactions on vertebrate remains
- Soil bacteria as trace evidence; grave soil microbial composition.
- Introduction to forensic serology; Role of lectins in forensics
- HLA system: Its applications in paternity testing, pitfalls of HLA system
- Sudden infant death syndrome and forensics microbiology
- The case of drowning and role of forensics microbiology
- Crimes involving microorganisms; bioterrorism
- Perspectives on the future of forensic microbiology

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- Multimedia-based lectures
- Computer-facilitated lessons and strategies
- Classroom dynamics through maximization of interactive learning

- Field visits to incorporate hands-on experience

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Basics of microbial forensics and its evolution
Week 2	Advances in techniques used determine the microbial signature of infectious agents
Week 3	Types and identification of microbial organisms of forensic significance.
Week 4	History, current, and future use of microorganisms as physical evidence
Week 5	Diatoms and their application in forensic science
Week 6	Thanatomicrobiome
Week 7	Microbial impacts in postmortem toxicology
Week 8	Application of microbial traces in postmortem interval evaluation
Week 9	**Midterm Examination**
Week 10	Arthropod–microbe interactions on vertebrate remains
Week 11	Soil bacteria as trace evidence; grave soil microbial composition.
Week 12	Introduction to forensic serology; Role of lectins in forensics; HLA system: Its applications in paternity testing, pitfalls of HLA system
Week 13	Sudden infant death syndrome and forensics microbiology
Week 14	The case of drowning and role of forensics microbiology
Week 15	Crimes involving microorganisms; bioterrorism; Perspectives on the future of forensic microbiology
Week 16	**Final Examination**

Reference Books (Latest Edition):

5. Carter, David O., et al. Forensic microbiology. John Wiley & Sons.
6. Bruce Budowle, Steven E. Schutzer, Roger G. Breeze. Microbial Forensics. Elsevier
7. Amorim, Antonio, and Bruce Budowle. Handbook of forensic genetics: biodiversity and heredity in civil and criminal investigation. World Scientific
   National Research Council. Science needs for microbial forensics: developing initial international research priorities.

Infection Biology of Emerging and Re-emerging Microbial Diseases

Course Title : Infection Biology of Emerging and Re-emerging Microbial Diseases
Course Code : MIC716 / MIC816
Offered to : Graduate students of Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Medical Microbiology

Course Objectives:

Main learning objectives of the course are:

- To describe and analyze the ecological, environmental, microbial, host and social factors contributing to the emergence and re-emergence of infectious diseases in humans
- To develop the ability in assessing the factors that lead to the emergence of contemporary emerging infectious disease events and evaluating the options for their control
- To critically evaluate the role of the "One health concept" and its role in preventing emergence of, and response to novel infectious diseases
- To develop and justify public health response plans to deal with contemporary emerging infections

Course Learning Outcome (CLOs)

At the end of the course students will become able to:

- Describe the environmental, ecological, social, microbial and host factors associated with the emergence of infectious diseases in humans
- Analyze the ecological and biological factors that lead to the emergence and spread of emerging and re-emerging infectious diseases and critically evaluate the options available for control
- Review the strategies and challenges for pathogen eradication and the concept of biosecurity

Course Contents:

- Introduction: Emerging and Re-emerging disease
- Overview on the origins and pathogens causing emerging and re-emerging infectious diseases
- Factors contributing to the emergence/re-emergence of infectious diseases
- Important examples and infection biology of Emerging infectious diseases of 21st century: HIV, Ebola Fever, Zika, SARS, MERS, Swine flu Influenza A (H1N1), Highly Pathogenic Avian Influenza (H5N1 & H7N9), Monkeypox, Covid-19 Pandemic, Any other recently emerged infection
- Examples and infection biology of Emerging Food borne & Water borne diseases: Entero hemorrhagic *E. coli*, *V. cholerae*, *Campylobacter* species, Creutzfeldt-jakob disease (vCJD)/Bovine spongiform encephalopathy
- Important examples and infection biology of re-emerging infectious diseases: Tuberculosis, Malaria, Dengue fever/DHF, Chikungunya, Multi-resistant pathogens, Any other recently re-emerged infection

- Control of Emerging and Re-emerging microbial diseases
- Summary and discussion on emerging and re-emerging infectious diseases

Teaching Methodology:

- Student-centered teaching through communicative approach
- Situational learning through lectures, classroom activities, and practice sessions
- White board & multimedia-based lectures
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction: Emerging and Re-emerging disease
Week 2	An overview of Emerging and Remerging Infections
Week 3	Factors contributing to the emergence/re-emergence of infectious diseases
Week 4	Important examples and infection biology of Emerging infectious diseases of 21st century Continued)
Week 5	Important examples and infection biology of Emerging infectious diseases of 21st century Continued)
Week 6	Important examples and infection biology of Emerging infectious diseases of 21st century Continued)
Week 7	Important examples and infection biology of Emerging infectious diseases of 21st century
Week 8	Examples and infection biology of Emerging Food borne & Water borne diseases (Continued)
Week 9	**Midterm Examination**
Week 10	Examples and infection biology of Emerging Food borne & Water borne diseases

Week 11	Important examples and infection biology of re-emerging infectious diseases (Continued)
Week 12	Important examples and infection biology of re-emerging infectious diseases (Continued)
Week 13	Important examples and infection biology of re-emerging infectious diseases
Week 14	Control of Emerging and Re-emerging microbial diseases
Week 15	Summary and discussion on emerging infectious diseases
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Hacker, J., & Heesemann, J. Molecular infection biology: interactions between microorganisms and cells. John Wiley & Sons, Inc.
2. Hasnain, S. E., Ehtesham, N. Z., & Grover, S. Mycobacterium tuberculosis: molecular infection biology, pathogenesis, diagnostics and new interventions. Springer.
3. Bayry, J. Emerging and Re-emerging Infectious Diseases of Livestock. Springer.
4. McLean, A. R., May, R. M., Pattison, J., & Weiss, R. A. SARS: a case study in emerging infections. Oxford University Press.
5. Castillo-Chavez, C., Blower, S., Van den Driessche, P., Kirschner, D., & Yakubu, A. A. Mathematical approaches for emerging and reemerging infectious diseases: models, methods, and theory. Springer Science & Business Media.
6. Lu, Y., Essex, M., & Roberts, B. Emerging Infections in Asia. Springer.

Host-Pathogen Interactions

Course Title : Host-Pathogen Interactions
Course Code : MIC733 / MIC833
Offered to : Graduate students of Hazara University
Cr Hr. : 3(3+0)
Pre-requisite : Fundamentals of Microbiology; General Immunology

Course Objectives:

Main learning objectives of the course are:

- To explore host-pathogen interactions and examining the relationships from both host and pathogen perspectives
- To provide an in-depth knowledge and understanding of pathogenesis of bacterial, fungal, viral and parasitic pathogens and host responses to these pathogens

Course Learning Outcome (CLOs)

At the end of the course, the students will:

- Have a detailed knowledge of specific host-pathogen interactions enabling them to explain the interface between pathogens and their hosts
- Have a comprehensive understanding of host-pathogen dynamics, patterns of disease ecology, and host-pathogen co-evolution

Course Contents:

- Introduction: Microbes-Host relationship and its types, why some microbes are pathogens while others are not?
- Microbial transmission, invasion, virulence and basic mechanisms of pathogenesis
- Complex and dynamic host-pathogen interactions from the perspective of a variety of pathogenic organisms including:
    - Viruses
    - Bacteria
    - Fungi
    - Chlamydiae
    - Rickettsiae
    - Eubacteria
    - Actinomycetales
    - Spirochaetes
    - Protozoa
    - Helminths
- Host susceptibility and barriers
- Host defense against pathogenic microorganisms
- Evasion of host defenses, survival and replication of the microbes
- Pathology directly related to infection and infection-induced immune injury
- Commensal host-microbe interactions that influence pathogenesis
- Host-microbe co-evolution and beneficial microbes
- The model systems employed in host-microbe interaction research

Teaching Methodology:

- Student-centered teaching through communicative approach

- Situational learning through lectures, classroom activities, and practice sessions
- White board & multimedia-based lectures
- Classroom dynamics through maximization of interactive learning

General information:

- Late, missing, or plagiarized work will carry no credit.

Marks Distribution: (existing mark distribution can be used).

- Quizzes - 10%
- Assignments/ Presentation or case study - 10 %
- Midterm Examination - 30%
- Final Examination - 50%

Week-Wise Distribution:

Week#	Topic to be covered
Week 1	Introduction: Microbes-Host relationship and its types, why some microbes are pathogens while others are not?
Week 2	Microbial transmission, invasion, virulence and basic mechanisms of pathogenesis
Week 3	Complex and dynamic host-pathogen interactions from the perspective of a variety of pathogenic organisms (Continued)
Week 4	Complex and dynamic host-pathogen interactions from the perspective of a variety of pathogenic organisms (Continued)
Week 5	Complex and dynamic host-pathogen interactions from the perspective of a variety of pathogenic organisms (Continued)
Week 6	Complex and dynamic host-pathogen interactions from the perspective of a variety of pathogenic organisms
Week 7	Host susceptibility and barriers
Week 8	Host defense against pathogenic microorganisms
Week 9	**Midterm Examination**
Week 10	Evasion of host defenses, survival and replication of the microbes
Week 11	Pathology directly related to infection and infection-induced immune injury
Week 12	Commensal host-microbe interactions that influence pathogenesis
Week 13	Host-microbe co-evolution and beneficial microbes

Week 14	The model systems employed in host-microbe interaction research (Continued)
Week 15	The model systems employed in host-microbe interaction research
Week 16	**Final Examination**

Reference Books (Latest Editions):

1. Medina, C. and López-Baena, F.J. Host-Pathogen Interactions: Methods and Protocols. SpringerLink
2. Unden, G., Thines, E., Schuffler, A. and Selzer, P.M. Host - Pathogen Interaction: Microbial Metabolism, Pathogenicity and Antiinfectives. Wiley
3. Cirillo, J.D. and Ying Kong. Tuberculosis Host-Pathogen Interactions. SpringerLink

Latest research articles

ANNEXURE-II

REVISED SCHEME OF STUDIES FOR BS MLT

BS Medical Lab Technology

PROGRAM DESCRIPTION:

The Bachelor of Science in Medical Laboratory Technology (BS MLT) program is structured to develop skilled and knowledgeable medical laboratory professionals. This program is designed to provide students with a solid foundation in clinical laboratory sciences, preparing them for essential roles in diagnostic laboratories, healthcare institutions, and research settings.

Spanning eight semesters, the curriculum offers a well-rounded and progressive educational experience, covering core areas such as clinical chemistry, hematology, microbiology, immunology, histopathology, molecular diagnostics, and blood banking. Emphasis is placed on the development of both theoretical knowledge and practical laboratory skills through extensive hands-on training using modern diagnostic tools and techniques.

The BS MLT program focuses on real-world applicability, with specific relevance to Pakistan's public health and medical diagnostic sectors. Students are trained to accurately perform, analyze, and interpret laboratory tests critical to patient care and disease prevention. Special attention is given to maintaining quality assurance, laboratory safety, and adherence to ethical standards in medical practice.

Graduates of this program will be well-equipped to contribute to clinical diagnostics, public health surveillance, biomedical research, and healthcare management. They will be prepared for employment in hospitals, diagnostic laboratories, research institutions, and pharmaceutical industries, as well as for pursuing advanced degrees in clinical or biomedical sciences both locally and internationally.

Objectives:

1. To prepare a cadre of health technologists and workers who can effectively assist senior health professionals in the delivery of quality health services.
   2. To prepare paramedic workers for all levels of the health care delivery system from primary to the tertiary level.

   3. To introduce and impart standard technical education with new modern techniques, within the fields of medical technologies, by replacing the conventional methods of pre-service training (certificate level).

   4. To provide paramedical workers a status and recognition in the health care delivery system through improving their capacity along with increasing awareness of their responsibilities, authority and job description.

   5. To equip paramedical staff with modern skills and the latest technical knowledge and bring them at par with other national and international levels.

PROGRAM STRUCTURE:

The Bachelor of Science in Medical Lab Technology is structured in accordance with the provisions of the HEC Undergraduate Education Policy and comprises of 124-136 credit hours spread over 8 regular semesters, at minimum. Summary of the program including the model scheme of study is given below.

Minimum Credit Hours	134
General Education	32 credit hours (13 courses)
Interdisciplinary / Allied Courses	24 credit hours (8 courses)
Discipline Specific Foundation Courses/Major	60 credit hours (20 courses)
Elective	12 credit hours (4 courses)
Internship	3 credit hours
Capstone	3 credit hours

SEMESTER 1		
S. No	**Category**	**Credit Hours**
1	Major I	3
2	Interdisciplinary I	3
3	Quantitative Reasoning – I *	3
4	Natural Science **	3
5	Functional English *	3
6	Applications of Information & Communication Technologies (ICT)*	3
TOTAL CREDIT HOURS: 18		

SEMESTER 2		
S. No	**Category**	**Credit Hours**
1	Major II	3
2	Interdisciplinary II	3
3	Islamic Studies* (Ethics for non-Muslim students)	2
4	Quantitative Reasoning – II*	3
5	Social Sciences***	2
6	Expository Writing*	3
TOTAL CREDIT HOURS: 16		

SEMESTER 3		
S. No	**Category**	**Credit Hours**
1	Major III	3
2	Major IV	3
3	Interdisciplinary III	3
4	Interdisciplinary IV	3
5	Arts & Humanities****	2
6	Pakistan Studies*	2
7	Entrepreneurship*	2
TOTAL CREDIT HOURS: 18		

SEMESTER 4		
S. No	**Category**	**Credit Hours**
1	Major V	3
2	Major VI	3
3	Major VII	3

4	Interdisciplinary V	3
5	Civics & Community Engagement*	2
6	Ideology & Constitution of Pakistan*	2
TOTAL CREDIT HOURS: 16		

SEMESTER 5		
S. No	**Category**	**Credit Hours**
1	Major VIII	3
2	Major IX	3
3	Major X	3
4	Major XI	3
5	Major XII	3
6	Interdisciplinary VI	3
TOTAL CREDIT HOURS: 18		

SEMESTER 6		
S. No	**Category**	**Credit Hours**
1	Major XIII	3
2	Major XIV	3
3	Major XV	3
4	Major XVI	3
5	Major XVII	3
6	Interdisciplinary VII	3
TOTAL CREDIT HOURS: 18		

SEMESTER 7		
S. No	**Category**	**Credit Hours**
1	Major XVIII	3
2	Major XIX	3
3	Elective – I****	3
4	Elective – II****	3
5	Internship	3
TOTAL CREDIT HOURS: 15		

SEMESTER 8		
S. No	**Category**	**Credit Hours**
1	Major XX	3
2	Interdisciplinary VIII	3
3	Elective – III*****	3
4	Elective – IV*****	3
5	Capstone	3
TOTAL CREDIT HOURS: 15		

*HEC designed model courses may be adopted.

**Any course in the broader category of “Natural Science” may be offered having relevance to the nature of the degree program.

*** Any course in the broader category of “Social Science” including but not limited to a course of Psychology, Sociology, Anthropology etc., may be offered.

**** Any course in the broader category of “Arts & Humanities” including but not limited to a course of regional or international language such as Chinese, Arabic, French, Spanish etc. or any other course such as Philosophy, History etc., may be offered.

*****Any advanced course in the field of Medical Lab Technology may be offered as an elective, where required in the above scheme as per available academic and faculty resources. Credit combination (reflecting balance of theory and lab/field work) would be arranged in accordance with the nature of the course.

Area/Field Specialization and Course Codes Assigned to MLT Courses

Area of Specialization	Specialization Code	Subjects Falling in the area	Course Code
Fundamental	0	Fundamentals of Clinical Lab	MLT100
		Human Physiology and Anatomy-I	MLT101
		Human Physiology and Anatomy-II	MLT202
		Basic Pharmacology	MLT203
		Biomedical Ethics	MLT204
		Clinical Lab Management and Quality Control	MLT205
		Laboratory Instrumentation and Analytical Techniques	MLT206
Pathology	1	General Pathology	MLT210
		Molecular Pathology	MLT311
Molecular/Forensic	2	Forensic Science	MLT420
		Recent Trends in Molecular Diagnostics	MLT421
Hematology/Serology	3	Clinical Hematology-I	MLT230
		Clinical Hematology-II	MLT331
		Serology	MLT332
		Blood Banking and Transfusion Medicine	MLT333
Chemistry/Biochemistry of Blood	4	Chemical Pathology-I	MLT240
		Chemical Pathology-II	MLT341
		Clinical Endocrinology	MLT442
Cytology/Histology	5	Cytology and Histology	MLT450
		Histotechniques	MLT451
		Cytogenetics	MLT452
Microbiology Courses		Introduction to Microbiology	MIC100
		Virology	MIC240
		Mycology	MIC201
		Immunology	MIC230
		Bioethics, Biosafety & Biosecurity	MIC210
		Clinical & Diagnostic Microbiology	MIC311
		Clinical Parasitology	MIC314
		Diagnostic Virology	MIC342
		Diagnostic Chemistry for Microbial Diseases	MIC415

	Management of Infectious Waste	MIC419
	Advances in Microscopy and Image Analysis	MIC475

Codes For Internship and Capstone

S. No.	Title of Course	Course Code
1	Internship	MLT491
2	Capstone	MLT499

List of Interdisciplinary Courses

S. No.	Title of Course	Course Code
1	Introduction to Microbiology	MIC100
2	Immunology	MIC230
3	Bioinformatics	Relevant Department
4	Scientific Inquiry & Research Methods	Relevant Department
5	Molecular Biology	Relevant Department
6	Cell Biology	Relevant Department
7	Principles of Biochemistry	Relevant Department
8	Virology	MIC240
9	Mycology	MIC201
10	Advances in Microscopy and Image Analysis	MIC475

List of Major Courses

S. No.	Title of Course	Course Code
1.	Bioethics, Biosafety & Biosecurity	MIC210
2.	Human Physiology and Anatomy-I	MLT101
3.	Human Physiology and Anatomy-II	MLT202
4.	Pathology & Microbiology-I	MIC304
5.	Pathology & Microbiology-II	MIC305
6.	Clinical & Diagnostic Microbiology	MIC311
7.	Clinical Parasitology	MIC314

8.	Diagnostic Virology	MIC342
9.	Antimicrobial Agents & Resistance	MIC412
10.	Diagnostic Chemistry for Microbial Diseases	MIC415
11.	Fundamentals of Clinical Lab	MLT100
12.	Basic Pharmacology	MLT203
13.	Biomedical Ethics	MLT204
14.	Clinical Lab Management and Quality Control	MLT205
15.	General Pathology	MLT210
16.	Clinical Hematology-I	MLT230
17.	Chemical Pathology-I	MLT240
18.	Laboratory Instrumentation and Analytical Techniques	MLT206
19.	Molecular Pathology	MLT311
20.	Clinical Hematology-II	MLT331
21.	Serology	MLT332
22.	Blood Banking and Transfusion Medicine	MLT333
23.	Chemical Pathology-II	MLT341
24.	Clinical Endocrinology	MLT442
25.	Management of Infectious Waste	MIC419
26.	Cytology and Histology	MLT450

List of Elective Courses

S. No.	Title of Course	Course Code
1	Diagnostic Virology	MIC342
2	Epidemiology & Public Health	MIC418
3	Forensic Science	MLT420
4	Recent Trends in Molecular Diagnostics	MLT421
5	Histotechniques	MLT451
6	Cytogenetics	MLT452