

Department of Microbiology

University of Karachi

BS Four Year Program

Syllabus

Year & Sem.	Course Code	Course Title	Credit Hours	Marks
B.S. Microbiology First Year				
	301	General Microbiology – I	2 + 1	100
	302	General Microbiology – II	2 + 1	100
B.S. Microbiology (Subs. Courses) / Second Year				
	401	Microbial Systematics & Immunology	2 + 1	100
	402	Medical Microbiology	2 + 1	100
B.S. Microbiology (major) / Second Year				
	403	Microbial Taxonomy	2 + 1	100
	404	Applied Microbiology	2 + 1	100
	405	Medical Microbiology	2 + 1	100
	406	Fundamentals of Immunology	2 + 1	100
B.S. Third Year				
	501	Microbial Anatomy & Physiology	2 + 1	100
	502	Immunobiology	2 + 1	100
	503	Bacterial Genetics	2 + 1	100
	504	Biometrics	2 + 1	100
	505	General Mycology	2 + 1	100
	506	Medical Microbiology	2 + 1	100
	507	Soil Microbiology	2 + 1	100
	508	General Virology	2 + 1	100
	509	Environmental Microbiology and Public Health	2 + 1	100
	510	Marine Microbiology	2 + 1	100
	511	Diagnostic Chemistry of Microbial Diseases	2 + 1	100

Year & Sem.	Course Code	Course Title	Credit Hours	Marks
B.S. Fourth Year				
	601	Molecular Immunology	2 + 1	100
	603	Marine Microbiology	2 + 1	100
	608	Food Preservation Technology	2 + 1	100
	654	Microbial Technology	2 + 1	100
	611	Physiology of Fungi	2 + 1	100
	616	Diagnostic Virology	2 + 1	100
	617	Tissue Culture Technology	2 + 1	100
	619	Veterinary Microbiology	2 + 1	100
	648	Clinical Mycology	2 + 1	100
	649	Clinical Bacteriology	2 + 1	100
	629	Clinical Parasitology	2 + 1	100
	631	Animal Viruses	2 + 1	100
	632	Molecular Biology of Viruses	2 + 1	100
	634	Genetic Engineering	2 + 1	100
	637	Environmental Mutagenesis	2 + 1	100
	638	Molecular Mechanisms of Antimicrobial Agents	2 + 1	100
	641	Clinical Virology	2 + 1	100
	640	Advances in Soil Microbiology	2 + 1	100
	642	Bioinformatics and Protein Structure / Function	2 + 1	100
	643	Microbial Enzyme Technology	2 + 1	100
	644	Environmental Biotechnology	2 + 1	100
	645	Immuno-toxicology	2 + 1	100
	646	Infectious Disease Epidemiology and Public Health	2 + 1	100
	647	Food and Dairy Microbiology	2 + 1	100
	650	Clinical Immunology and Immunohaematology	2 + 1	100
	663	Molecular Pathogenesis	2 + 1	100
	664	Microbiology for Industrial Quality Assurance	2 + 1	100
	665	RNA World	2 + 1	100
	666	Probiotics: The Live Therapies	2 + 1	100
	651	Molecular Biology of Eukaryotes	2 + 1	100

BS FIRST YEAR

SEMESTER: **FIRST**
COURSE CODE: **MIC-301**
COURSE TITLE: **GENERAL MICROBIOLOGY-I (for major and subsidiary students)**
CREDIT HOURS: **2 + 1**

1. Microorganisms and their respective place in the living world.
2. Historical development of Microbiology and its scope.
3. Morphology and arrangement of bacterial cell.
4. Detailed anatomy of bacterial cells.
5. Differentiation between Prokaryotic & Eukaryotic cells.
6. Growth, nutrition, reproduction and methods of cultivation of bacteria.
7. General methods of study of microorganisms. Isolation and purification.
8. Control of microorganisms by physical and chemical agents.
9. Chemotherapeutic agents. Antibiotics and their mode of action on microorganisms.
10. Nomenclature and basis of classification of bacteria.
11. Introduction to viruses, fungi and protozoa.

Lab. pertaining to the above course

Recommended Books

1. Talaro, K.P. (2005) Foundations in Microbiology: Basic Principles 5th Ed., McGraw Hill.
2. Sullia, S. B. (2005) General Microbiology 2nd Ed., IBH & Oxford.
3. Bhatia, A. L. (2005) Handbook of Microbiology. TTPP.
4. Schaechite, (2006) Microbe. ASM Press.

BS FIRST YEAR

SEMESTER: **SECOND**
COURSE CODE **MIC-302**
COURSE TITLE: **GENERAL MICROBIOLOGY-II (for major and subsidiary students)**
CREDIT HOURS: **2 + 1**

1. Structure and chemical composition of nucleic acid. Role of RNA and DNA in protein synthesis.
2. Bacterial mutation and variation. Introduction to the genetical intermixing of bacteria including transformation, transduction and conjugation.
3. Introduction to metabolism and role of phosphorus in energy transfer. Glycolysis and TCA cycle.
4. Microbiology of water and wastewater. Water as a source of infection. Methods of water purification. Methods of wastewater treatment and disposal.

5. Introduction to food and Dairy Microbiology. Methods of analysis. Food spoilage and food preservation. Differentiation between food intoxication and food-infection.
6. Microbiology of soil with particular reference to nitrogen cycle.
7. An introduction to aeromicrobiology.
8. Introduction to Biostatistics; mean, mode, median, range, and standard deviation.

Lab. pertaining to the above course

Recommended Books

1. Cossart P., Boquet P., Normark S., & Rappuoli R. (2005) Cellular Microbiology, 2nd Ed., ASM Press.
2. Talaro, K. P. (2005) Foundations in Microbiology: Basic Principles 5th Ed., McGraw Hill.
3. Sullia, S. B. (2005) General Microbiology 2nd Ed., IBH & Oxford.
4. Cossartt, P., Boquet, P. and Rappuoli, R. (2005) Cellular Microbiology, 2nd Ed., ASM Press.

BS SECOND YEAR

SEMESTER: FIRST

COURSE CODE: MIC-403

COURSE TITLE: (MICROBIAL TAXONOMY) (for major students)

CREDIT HOURS: 2 + 1

MARKS: 80 + 20 (THEORY + LAB)

1. Basic concepts and aims of classification.
2. Classical and molecular basis of classification of prokaryotes and bacterial nomenclature.
3. Isolation, enrichment and maintenance procedures.
4. Classification of:
 - i) Actinomycetes (Focus on *Mycobacterium* and *Nocardia*)
 - ii) Spirochaetes (*Treponema*, and *Leptospira*).
 - iii) Enterobacteriaceae
5. Detailed classification of viruses, rickettsia, fungi and protozoa.
6. A brief introduction to *Mycoplasma* and *Chlamydia*.
7. An introduction to prions.

Lab. pertaining to the above course

Recommended Books

1. Geo F. Brooks, Stephen A. Morse, Janet S. and Butel (2001) Jawetz, Melnick, and Adelberg's Medical Microbiology McGraw-Companies.
2. Cliver, R. (2001) Foodborne Diseases. Morgan Kaufmann Publishers
3. Nigel J.J. Dimmock, Keith L. and Andrew E., (2001) Introduction to Modern Virology Blackwell Science, Inc.

BS SECOND YEAR

SEMESTER: FIRST

COURSE CODE: MIC-406

COURSE TITLE: FUNDAMENTALS OF IMMUNOLOGY (for major students)

CREDIT HOURS: 2 + 1

MARKS: 80 + 20 (THEORY + LAB)

1. Introduction: chronological development and scope of the science of immunology. Immune systems.
2. Immunity and immune responses: Definitions and types. Humoral and cellular mediators of immunity and their effector mechanisms. Immunity and their effector mechanisms. The reticulo-endothelial system (RES): its components and functions.
3. The immunogens: Definitions, parameters of immunogenicity, chemical nature, antigenic determinants, specificity and valency. The incomplete antigen and adjuvants. Modulation of antigens for preventive and therapeutic purposes.
4. Immunoglobulins: Introduction, classification and its basis. Classes and subclasses. Physico chemical properties of various diseases, antibody specificity, valence and basic structure.
5. Tissue antigens: The Allo-and Heterophile antigens – The ABO and Rh blood group systems, their genetic basis, inheritance and clinical significance.
6. HLA & MHC: their significance in tissue transplantation.
7. Introduction to antigen-antibody reactions. Types and mechanisms
8. Introduction to immunologic injury and protection. Role of antibody and T-cells against infection. Hypersensitivity – Its type and mechanisms. Autoimmune immunity against tumors and cancers.
9. Immunological products: therapeutic and preventive uses.
10. Introduction to AIDS.

Lab. pertaining to the above course

Recommended Books

1. Abbas, K., Lichtman and Jordan S Pober (2003) “Cellular and Molecular Immunology” .W.B.Saunders
2. Janeway – Travers (1999) Immunobiology. Current Biology Ltd. UK
3. Singleton, P. (2004) Bacteria in Biology, Biotechnology and Medicine 6th Ed., Wiley Publisher.
4. Polak, J. M. (2003) Introduction to Immunocytochemistry 3rd Ed., Bios Science Publisher.

BS SECOND YEAR: (for major students)

SEMESTER: SECOND

COURSE CODE: MIC-404 APPLIED MICROBIOLOGY

CREDIT HOURS: 2 + 1

MARKS: 80 + 20 (THEORY + LAB)

1. General survey of commercially important microorganisms including:
E. coli, *B. subtilis*, *Pseudomonads* spp. , *Xanthomonas* spp., *S. cerevisiae*,
Corynebacterium glutamicum, Streptomyces, Lactobacilli, Methanogens, *Zymomonas*,
Saccharopolyspora, *Aspergillus*, *Penicillium*, *Cephalosporium acremonium*
2. Introduction of primary and secondary metabolite production by microorganisms.
3. Screening, isolation, cultivation and maintenance of microorganisms of economic importance.
4. Techniques to increase useful metabolites by microorganisms such as:

Mutation, Protoplast fusion, Metabolic engineering, Transposition, Combinatorial biosynthesis,
Whole genome shuffling, Genome mining
5. Design. Operation and applications of different fermenters types used in the industry.
6. Microbial fermentations:
 - i. Organic acids: Citric, lactic and acetic acid.
 - ii. Organic solvents: Acetone, butanol and ethanol.
 - iii. Microbial enzymes: Amylases, glucose isomerase
 - iv. Amino acids: Lysine and glutamic acid.
 - v. Antibiotic: Penicillin, cephalosoprin.
7. Microbial biomass production and its uses.
8. Production of recombinant proteins by microorganisms.

Lab. pertaining to the above course

Recommended Books

1. Barnum, S. R. (2005) Biotechnology: An Introduction 2nd Ed., Thomson Publisher.
2. Barredo, J. (2005) Microbial Processes and Products, Humana.
3. Demain, A. L. (1999) Manual of Industrial Microbiology and Biotechnology, ASM Press.
4. Munshi, M. (2004) Biotechnology: Applications and Carriers, Koganviva.
5. Mansi, E.M.T and Bryce, C.F.A. (1999). Fermentation Microbiology and Biotechnology, Taylor and Francis Francis
6. Demain, A.L., and Solomon, N.A. (1985). Biology of Industrial Microorganisms, The Benjamin / Cummings Publishing Company

BS SECOND YEAR

SEMESTER: SECOND

COURSE TITLE:

COURSE CODE: MIC-405 (MEDICAL MICROBIOLOGY) (for major students)

CREDIT HOURS: 2 + 1

MARKS: 80 + 20 (THEORY + LAB)

1. Introduction to medical microbiology with particular reference to host-parasite relationship.
2. Etiology, pathogenicity, clinical features, laboratory diagnosis, treatment, epidemiology, prevention and control of the following diseases:
3. Bacterial diseases:
Staphylococcal infection, toxic shock syndrome (skin and blood), Streptococci (sore throat and its complications), Typhoid, Bacillary dysentery, Cholera, Diphtheria, Tuberculosis, Tetanus, STD (Focus on gonorrhoea)
4. Viral diseases:
Measles, Influenza, Poliomyelitis, Rabies, Hepatitis A, B and C
5. Fungal diseases:
Dermatomycosis: including Tinea unguim, Tinea corporis and Tinea capitis
6. Protozoal diseases:
Amoebic dysentery, Giardiasis and Malaria

Lab. pertaining to the above course

Recommended Books

1. Joklik & Willet (2000) Zinssers' Microbiology, Appleton Century Crofts.
2. Volk (1996) Essential of Medical Microbiology, Lipincott Raven.
3. Jawetz (2004) Medical Microbiology, McGraw Hill.
4. Geo F. Brooks, Stephen A. Morse, Janet Butel, Janet S. Butel (2001) Jawetz, Melnick, and Adelberg's Medical Microbiology McGraw-Companies.

YEAR: SECOND
SEMESTER: FIRST
COURSE CODE: MIC-401 (for subsidiary students)
COURSE TITLE: MICROBIAL SYSTEMATICS AND IMMUNOLOGY
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. Importance of microbial systematic and classification
2. Basis and classification of Actinomycetes, Fungi, Protozoa and Viruses
3. An introduction to immunology
4. Types of immunity with specific reference to phagocytosis and complement system
5. Antigens: types and properties
6. Immunoglobulins: types and properties
7. Immunological products: therapeutic and preventive usage
8. Blood grouping and its significance (ABO and Rh system)
9. Antigen uses and antibody reactions: types and mechanisms
10. Introduction to autoimmunity and acquired immunodeficiency syndrome

Lab. pertaining to the above course

Recommended Books

1. Bassindale, (2005) Immunobiology: A Text Book, John Willey and Sons.
2. Geo F. Brooks, Stephen A. Morse, Janet Butel and Janet S. Butel (2001) Jawetz, Melnick, and Adelberg's Medical Microbiology McGraw-Hill Companies.
3. Cliver, R.(2001) Foodborne Diseases.Morgan Kaufmann Publishers.
4. Nigel J.J. Dimmock, Keith L. and Andrew E., (2001) Introduction to Modern Virology Blackwell Science, Inc.

YEAR: SECOND
SEMESTER: SECOND
COURSE CODE: MIC-402 MIC-401 (for subsidiary students)
COURSE TITLE: MEDICAL MICROBIOLOGY
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. Introduction to medical microbiology with particular reference to host-parasite relationship. Etiology, pathogenicity, clinical features, laboratory diagnosis, epidemiology, prevention and control of the following diseases:
2. Bacterial Diseases:
Staphylococci (skin and blood infection, toxic shock syndrome), Streptococci (sore throat and its complications), Typhoid, Bacillary dysentery, Cholera, Diphtheria, Tuberculosis, Tetanus, STD (Focus on Gonorrhoea)
3. Viral diseases:
Measles, Influenza, Rabies, and Hepatitis A, B and C

4. Fungal Diseases:
Dermatomycosis: including Tinea unguim, Tinea corporis and Tinea capitis
5. Protozoal Diseases:
Amoebic dysentery, Giardiasis and Malaria

Lab. pertaining to the above course

Recommended Books

1. Kayser, F. K. (2005) Medical Microbiology, Thieme Publisher.
2. Scheld, W. M., Armstrong, D. and Hughes, J. M. (1997), Emerging Infections, ASM Press.
3. Kathleen P.T. and Arthur T. (2001) Foundations in Microbiology: Basic Principles, McGraw-Hill Companies.

BS THIRD YEAR

<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-501
<u>COURSE TITLE:</u>	Microbial Anatomy and Physiology
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. Detailed organization of microbial cells
2. Chemical composition of microbial cells
3. Microbial growth and cell cycles
4. Growth factors and other nutritional requirements for microbial growth
5. Cell metabolism of protein-nucleic acid, fat and carbohydrate.
6. Introduction to microbial enzymes: Classifications, chemistry, mechanism of action and inhibition

Lab. pertaining to the above course

Recommended Books

1. Cossart, P., Boquest, P., Nomark, S. and Rappuoli, R. (2005). Cellular Microbiology 2nd Ed., ASM Press.
2. Fraser, C. M. (2004). Microbial Genome, Humana.
3. Synder, L. (2003). Molecular Genetics of Bacteria. 2nd Ed., ASM Press.
4. Spudich, J. A. (1997) Annual Review of Cell and Developmental Biology

<u>COURSE CODE:</u>	MIC-502
<u>COURSE TITLE:</u>	IMMUNOBIOLOGY
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. The immune system: organs constituting the immune system, their location in the human body and basic architecture.
2. The immunocompetent cells: their origin, surface markers, population and sub-populations. Immunological characterization and functions
3. Antibody induction and production: Cells involved in cellular sequence of events. Kinetics of antibody synthesis.
4. The role of T-cells and immunoglobulins in the immune response.
5. Cellular immune response and its characterization.
6. Immunologic memory: positive and negative selection. Phenomena of natural tolerance and energy
7. Manifestations of antigen-antibody reactions including precipitation, agglutination, Complement fixation and neutralization
8. Mechanism and applications of ELISA, RIA, immunofluorescence and immuno-blotting (advance serological tests).

Lab. pertaining to the above course

Recommended Books

1. Pier, G. B., Lyczak, J. B. and Wetzler, L. M. (2004). Immunology, Infection and Immunity, ASM Press.
2. K. Abbas, Lichtman and Jordan S Pober (2003) "Cellular and Molecular Immunology" .W.B.Saunders
3. Jamewau-Travers. (1999) Immunobiology. Current Biology Ltd. UK
Roitt, IM. and Delves, PJ (2001) Roitt's Essential Immunology. Blacwell Scientific Pub. London
4. Geo F. Brooks, Stephen A. Morse, Janet Butel and Janet S. Butel (2001) Jawetz, Melnick, and Adelberg's Medical Microbiology McGraw-Hill Company.

YEAR: **THIRD / FIRST**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-503**
COURSE TITLE: **BACTERIAL GENETICS**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. DNA structure and function
2. DNA replication: replicon origins, events that occur at the replication fork, the structure and function of DNA polymerases, and replication strategies
3. Gene structure and expression. Control of gene expression in prokaryotes: polycistrons transcriptional initiation and termination, the operon, catabolite repression and attenuation control
4. Protein synthesis -mRNA translation: Genetic code universality & non-universality, codon usage, sequence of events on ribosomes, ribosome structure-function relationships, organelle and archaeobacterial systems, post transcriptional and post translational modification (briefly in Eucaryotes).
5. DNA repair, mutagenesis and mutation suppression. Mutagenic agents and variations.
6. Genetic recombination: general recombination, site specific and illegitimate recombinations
7. Detailed study of gene transfer mechanisms: transformation, transduction, and conjugation, cross-phylogenetic intermixing.
8. Gene maps and gene mapping by conjugation, and transduction
9. Plasmids, insertion sequences and transposons
10. Introduction to genetic rearrangement.
11. Introduction to genetic engineering

Lab. pertaining to the above course

Recommended Books

1. Sinden, R. R. (2006). DNA Structure and Function, Ind/Elsevier.
2. Campbell, A. (2005). Annual Review of Genetics Vol. 39, Annual Review.
3. Higgins, N. P. (2004) Bacterial Chromosome, ASM Press.
4. Watson, J. D. et al. (2004) Molecular Biology of the gene 5th Ed. Pearson Education Ltd., India.

YEAR: **THIRD / FIRST**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-504**
COURSE TITLE: **BIOMETRICS**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to biostatistics and its scope in microbiology.
2. Collection of Primary and Secondary data and their editing.
3. Presentation of data: Tabulation, Classification, Visual Presentation (Diagrams and Graphs)
4. Measures of Central Tendency: Arithmetic Mean by direct and short-cut method, Geometric Mean, Harmonic Mean, Mode, Median, ED50 (LD50 in detail) Quantile.
5. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation by direct and short-cut methods. Variance, and its Coefficients.
6. Correlation: Simple correlation table, Rank Correlation, Partial and Multiple Correlation.
7. Regression and method of least square.
8. Probability: Concept of Probability, Laws of Probability.
9. Permutation and Combination.
10. Probability distributions: Binomial distribution, Normal distribution, Poisson distribution and their fitting in to observed data.
11. Sampling and Basic Design.
12. Hypothesis Testing.
13. Chi-square test, Students' t-test and Analysis of variance.

Lab. pertaining to the above course

Recommended Books

1. Stanton, A.G. (2001) Primer of Biostatistics. Wm. C. Brown Publishers.
2. Beth, D.D. and Robert, G.T (2000) Basic and Clinical Biostatistics. Appleton & Lange

3. Streiner, N. and Norman, G.R (2000) Biostatistics: The bare essentials B.C. Decker, Inc.
4. Rosner, B. (2000) Fundamentals of Biostatistics. Cole Pub. Co.

YEAR: THIRD / FIRST
SEMESTER: FIRST / SECOND
COURSE CODE: MIC-505
COURSE TITLE: GENERAL MYCOLOGY
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. An Introduction to Mycology.
2. Classification of fungi.
3. Fungal cell structure, Physiology of fungi.
4. Structural development and reproduction in fungi including cell cycle.
5. Metabolism of some economically important fungi.
6. Physical and nutritional factors affecting the growth of fungi.
7. Importance of fungi to humans.
8. An overview of fungal plant diseases and their economic importance.

Lab. pertaining to the above course

Recommended Books

1. Adhikary, S. (2006). Blue Green Algae: Survival Strategies Indiverse, TTPP.
2. Marshall Darly W. (1982). Algal Biology, Oxford Press.
3. Ernst, E. J. and Rogers, D. P. (2005) Antifungal Agents – Methods & Protocols. Methods in Molecular Medicine, Humana.
4. Ajello, L. and Hay, R. J. (1998) Medical Mycology Topley & Wilson's Microbiology & Microbial infections Vol.4, (9th ed), Oxford University Press.

YEAR: **THIRD / FIRST**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-506**
COURSE TITLE: **MEDICAL MICROBIOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction: Host-parasite interactions
2. Molecular mechanisms of pathogenicity
3. Chemotherapy and drug resistance.
4. Study of bacterial infections with emphasis on mechanisms of pathogenesis of the following groups:
Streptococcus (pneumonia), *Neisseria* (meningitis), *Pseudomonas*, *Proteus*, *Clostridia* (perfringens), *E. coli*, *Campylobacter*, *Aeromonas*, *Helicobacter*, *Legionella*, *Mycobacterium*, *Chlamydia*, *Mycoplasma*
5. Study of viral and rickettsial diseases with emphasis on mechanism of pathogenesis. Epidemic and endemic typhus, AIDS
6. HIV, Hepatitis, and Herpes virus.
7. Protozoa infections with emphasis on Leishmaniasis and Toxoplasmosis.
8. Pathogenesis of mycotic infections with particular reference to Mycetoma.
9. Classical small pox and newly emerging microbial pathogens.

Lab. pertaining to the above course

Recommended Books

1. Krishnasw (2006) Mast Cells: Methods and Protocols, Humana Publisher
2. Kayser, F. H. (2005). Medical Microbiology, Thieme Publisher
3. Scheld, W. M., Nurray, B. E. and Hughes, J. M. (2004) Emerging Infections 6, ASM Press
4. Kayser, F. H. (2005) Medical Microbiology, Thieme Publisher

YEAR: **THIRD / FIRST**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-507**
COURSE TITLE: **SOIL MICROBIOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Elements of soil formation and conservation.
2. Soil microbial population and methods of study with their advantages and disadvantages.
3. Role of microorganisms in mineral transformation with special and detailed emphasis on carbon and nitrogen transformations. Brief introduction to Sulphur and Phosphorus cycles.
4. Introduction to soil ecology. Plant-microbe & microbe-microbe interactions and their impact on soil fertility.
5. Biotechnological potentials of soil microorganisms.
6. Problems of salinity and waterlogging and the methods of their reclamation.
7. Microbial activities in saline and water - logged soils.
8. Importance of soil microbiology in the agricultural development of Pakistan.

Lab. pertaining to the above course

Recommended Books

1. Purohit, S. S. (2003) Agricultural Biotechnology, 2nd Ed., TTPP.
2. Mathews, G. (2006) Pesticide Health Safety with the Environment, Blackwell Scientific Inc.
3. Tate, RL (2000) Soil Microbiology. Wiley, John & Sons, Inc.
5. Jha, M. N. (1999) Agromicrobes: Current Trends in Life Sciences, TTPP.
6. David, M. Sylvia (1997) Principles and Applications of Soil Microbiology, Prentice Hall.
7. Nyle, C. Brady (2004) Nature and Properties of Soil, Maxwell, MacMillan International Ed., MacMillan Publishing Compnay.

YEAR: **THIRD / FIRST**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-508**
COURSE TITLE: **GENERAL VIROLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to virology
2. Structure and classification of viruses
3. Cell and tissue culture: various types of cell lines
4. Cultivation of plant, animal and insect viruses.
5. Diagnostic procedures for viral infections including isolation, identification and serology.
8. Introduction to bacterial viruses, functional and morphological groups.

9. Isolation and identification of phages from various sources, somatic and non-somatic (sex specific) phages. Modes of replication.
10. Introduction to microbial viruses other than bacteria.

Lab. pertaining to the above course

Recommended Books

1. Cann, A. J. (2005) Principles of Molecular Virology 4th Ed., Elsevier Publisher.
2. Alan J. Cann (2001) Principles of Molecular Virology, Academic Press.
3. Roizman, Griffin, Malcolm A. Martin, et al. (2001) Fundamental Virology Lippincott Williams & Wilkins.

YEAR: THIRD / FIRST
SEMESTER: FIRST / SECOND
COURSE CODE: MIC-509
COURSE TITLE: ENVIRONMENTAL MICROBIOLOGY & PUBLIC HEALTH
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. Introduction to environmental pollutants Microbiology and public health.
2. Aeromicrobiology: sources, survival, detection and control of air-borne microorganisms.
3. Microbiology of water: sources of microbial and other pollutants and elimination of pollutant bacteria from waters.
4. Water quality standards and significance of chemical and microbial indicators of pollution.
5. Microbiology of wastewater including disposal and treatment.
6. Detailed study of microbiology of food and dairy products.
7. Epidemiology and its principles.
8. Prevention and control of epidemic diseases.
9. Introduction to bioremediation.
10. Detailed study of environmental pollutants and their impact on public health.
11. Nosocomial infections.
12. Introduction to National Environmental Safety Standards.

Lab. pertaining to the above topics

Recommended Books

1. Thakur, Indu, Shekhar (2006) Environmental Biotechnology, I, K International Publishing Co.
2. Mohapatra, P. K. (2005) Textbook of Environment Biotechnology, I. K. International Publishing Co.
3. Sharma, P. D. (2005) Environmental Microbiology, Narosa Publications.
4. Kumara (2005) Microbial Pollution, APH Publisher.
5. Barredo, J. (2005) Microbial Processes and Products, Humana Publisher.

YEAR: **THIRD / FIRST**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-510**
COURSE TITLE: **MARINE MICROBIOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to marine microbiology
2. Zonation and stratification in marine environment
3. Movement of water in marine environment, and its impact on marine life
4. Laws of ecology with particular reference to marine ecosystem: environmental factors (biotic and abiotic) and their influence on microorganisms
5. Enumeration of bacteria: sampling and samplers, processing and enumeration.
6. Marine microorganisms: important groups and their role in food chain
7. Detailed study of biogeochemical cycling of Carbon, Nitrogen, Sulphur and Phosphorus
8. Beneficial and detrimental activities of marine microorganisms and their economic importance
9. Marine biotechnology and its impact on environment
10. Diseases of some common marine fauna

Lab. pertaining to the above course

Recommended Books

1. Dubey, S. K. (2005). Marine Biology, UBS Publisher.
2. Michael Bernard (2000) Fresh Water Prawn Culture, Blackwell Scientific Inc.
3. Munn, C. B. (2004) Marine Microbiology: Ecology and Applications, Bios Sciences.
4. Lalli, C. M. (1993). Biological Oceanography: An Introduction, Pergamon Publisher.

YEAR: **THIRD / FIRST**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-511**
COURSE TITLE: **DIAGNOSTIC CHEMISTRY OF MICROBIAL DISEASES**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. The concept of visually detectable and undetectable changes, direct and indirect evidences for the diagnosis of microbial diseases
2. Gastrointestinal function test: Test based on:
 - a) Salivary digestion:
Brief description of salivary digestion, role of saliva in prevention of dental diseases and digestion, Test based on salivary enzyme and its interpretation
 - b) Gastric digestion:

- Brief description of gastric digestion-test: 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
- c) Intestinal digestion:
Brief description of intestinal secretions, pancreatic enzymes and 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
- d) Intestinal absorption:
Brief description of intestinal absorption. Test and its interpretation: Xylose excretion test.
- 3) Role of gastrointestinal tract disturbances in the development of anemia
- 4) Kidney Function Tests:
- a) A brief description of kidney functions
- b) Tests and their interpretations:
Urine analysis: 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, Test for maximal tubular capacity: Concentration test, Dilution test
- 5) Liver Function Tests:
Brief description of liver functions (Circulatory, Excretory, Metabolic, Protective and Haematologic functions)
- a) 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 parts in carbohydrate metabolism: Galactose Tolerance Test, Excretion of injectables :Bromsulphthalein Retention Test, Detoxification Function: Hippuric acid synthesis
Brief description of tests based on Blood Ammonia, Prothrombin time, Serum enzyme activity (Transaminases, Alkaline phosphatases, lactic dehydrogenase)
6. Brief description of cerebrospinal fluid (CSF)

Lab. pertaining to the above course

Recommended Books

1. Coleman, W. F. and Tsongalis, G. J. (2005) Molecular diagnostics for the Clinical Laboratorian
2nd Ed. with CD-ROM, Humana Publisher.
2. Jros, T. O. and Fortina, P. (2005) Microassays in Clinical Diagnostics Method in Molecular Medicine, Humana Publisher.
3. Baron ,E.J. and Finegold, M. (1998) Bailey and Scott's Diagnostics Microbiology, 10th Edition The C.V. Mosby Company

4. Cheesbrough, M. (1998)District Laboratory Practice in Tropical countries Part I & II , Cambridge University Press, U.K.
5. Henry , J.B. and Day ,L. (1996) Clinical Diagnosis and Management by Laboratory Methods 19th Edition ,W.B. Saunders Co.

BS Fourth Year: BASIC DISCIPLINE

YEAR: FOURTH / FINAL
SEMESTER: FIRST / SECOND
COURSE CODE: MIC-601
COURSE TITLE: MOLECULAR IMMUNOLOGY
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. Molecular basis of immunogenicity and antigenic specificity: distinction and parameters, basis of immunodominance.
2. Immunochemical aspects of polysaccharide antigens of selective groups of microorganisms and their significance.
3. Structure and functions of human immunoglobulins: Sequence studies, genetic variants, three dimensional configurations and location of paratope in the molecules of IgG, IgM, and IgA Antibody diversity, maturation of B lymphocytes and expression of Immunoglobulin genes.
4. 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.
5. Human Leukocyte Antigens: classes, distribution, chemistry and basis of polymorphism.
6. Complement System: Chemistry, components, activation via classical and alternate pathway, complement genes , their expression and regulation.
7. Molecular basis of antigen antibody interactions: Chemical bonds involved, study and kinetics employing mono and polyvalent ligands. Quantitative measurements of antibody precipitation in an immune complex.

Lab. pertaining to the above course

Recommended Books

1. Polak, J. M. (2003) Introduction to Immunocytochemistry 3rd Ed., Bios Science Publications.
2. Sell, S. (2001) Immunology, Immunopathology and Immunity 6th Ed., ASM Press.
3. Abbas, K. Lichtman and Jordan Pober, S. (2001) “Cellular and Molecular Immunology”. W. B. Saunders.
4. Stites, D.P . Terr, A. I. and Parslow, T. J. (2001). “Immunology”. Appleton and Lange.
5. Glick, B.R. and Pasternak, J. J. (2001). “Molecular Biotechnology ”, ASM Press.
6. Journal of Immunology (2001 issues).

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-617**
COURSE TITLE: **TISSUE CULTURE TECHNOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. History and application of cell culture.
2. The eukaryotic cell; general structure and function, cell cycle, chromosomes, ploidy, karyotypes.
3. Nutritional requirements, growth and metabolism of cells.
4. Methodology of plant and animal cell and tissue culture.
5. Cell types and morphology of cells in culture.
6. Primary and secondary culture with special reference to chick embryo culture.
7. Cell strains and establishment of cell lines.
8. Establishment of fibroblast cultures, Chinese hamster, human and mouse cell lines. Lymphoid cell culture. Transformed cells, growth control of mouse fibroblasts and malignancy; the normality of 3T3 fibroblasts cell lines from tumors.
9. The external surface of cells in culture: chemical composition and biosynthesis of cell membrane. Chemical changes in transformed cell surfaces. Interaction of cell surfaces with lectin.
10. Genetic basis of mutant cell lines; origin of mutant cell lines. Negative selection: heterokaryons, malignancy of hybrids. Differentiated, serum dependent normal cells. Role of cyclic nucleotides
11. Introduction and application of stem cell technology.
12. Tissue culture and virology. Applications of cell culture technology

Lab. pertaining to the above course

Recommended Books

1. Smith R. (2000) Plant Tissue Culture. Academic Press.
2. Freshney, II. (2000) Culture of animal cells: A manual of basic techniques, Wiley, John & sons.
3. Masters, J.R. (2000) Animal cell culture. Oxford University Press.
4. Lanza. R.P. Lanza, B. and Atala, A (2001) Methods of tissue engineering. Academic Press Inc.
5. Doyle, A. and Griffiths, J.B. (1998) Cells and Tissue Culture: Laboratory procedures in biotechnology. Wiley, John & Sons.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-634**
COURSE TITLE: **GENETIC ENGINEERING**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction and scope.
2. *In vivo* genetic engineering: Mu mediated gene-fusion and transposition.
3. Potential of RP: Mu plasmids for *in vivo* genetic engineering.
4. Exchange of genes between lambda phage and Col E 1 factor.
5. Restriction and modification system.
6. Properties of restriction endonucleases, their occurrence and recognition sequences.
7. Assay procedures for restriction endonucleases and slab-gel electrophoresis. Practical uses of endonucleases and its role in genetic-engineering.
8. *In vivo* genetic-engineering cloning vehicles: plasmids, cosmids and phagemids, YAC and BAC etc. Vector development with reference to pBR 322 pSC 132.
9. Methods of nucleic acid isolation (DNA & RNA), DNA sequencing, PCR and its applications.
10. Cloning strategies: construction of chimera plasmids.
11. Expression systems for pro-and eukaryotes.

Lab. pertaining to the above course

Recommended Books

1. Benzhaf, W. (2006) Genetic Programming: An Introduction, Elsevier/India.
2. Singh, B. D. (2005) Genetic Analysis, Kalyani Publications.
3. Nana, S. (2004) Genetic Engineering, Domina Publications.
4. Singh, B. D. (2004) Molecular Biology & Genetic Engineering, Kalyani Publications.
5. Gary P. Stewart (2002) Basic Questions on Genetic Engineering. Kregel Publications.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC 642**
COURSE TITLE: **BIOINFORMATICS & PROTEIN STRUCTURE / FUNCTION**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to bioinformatics
2. Protein structure classification and super folds
3. Mechanisms of protein folding and folding pathways; role of chaperones in protein folding
4. Experimental techniques for characterizing membrane protein structure and function, or simple sequence analysis - use of hydropathy plots

5. Introduction to sequence databases; Comparing sequences against sequence databases, predicting protein coding regions, prediction of protein structure from sequence data.
6. Genome sequencing projects.
7. Bioinformatics and genome analysis.
8. Experimental methods for determining protein structure; A case study: proteases - function and mechanisms.

Practical Content

Although there are no formal practicals for this course, there will be optional practicals (Labs.) to demonstrate the use of Web based tools for Bioinformatics analysis and to allow students to practice using these computational tools for sequence analysis.

Recommended Books

1. Richard, J. Simpson (2005) Protein and Proteomics, I. K. International Publishing Co.
2. Suri, S. (2006) Bioinformatics, APH Publishers.
3. Kolchanov (2005) Bioinformatics of Genome Regulation and Structure, Springer.
4. Mahato, R. I. (2005) Biomaterials for Delivery and Targeting of Protein, CRC Press
5. Bueehler (2005) Bioinformatics Basics: Application in Biological Science, CRC Press
6. Ignacimut (2005) Basic Bioinformatics, Norosa Publisher

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC 665**
COURSE TITLE: **RNA WORLD**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to the world of RNA
2. Types of RNAs and their role
3. Transcription in:
 - i) Prokaryotes
 - ii) Eukaryotes
4. Secondary structures in RNA.
5. RNA recombination.
6. RNA in gene silencing and its suppression.
7. RNA regulation of gene expression.
8. Riboswitches: definitions, mode of action and function.
9. Viroids.

Practical contents

1. RT-PCR
2. Northern blot analysis

Recommended Books

1. Nellen W. and Hammann C. (2006). Small RNAs: Analysis and Regulatory Functions. 1st Edition, Springer Nature.
2. Perdeu GH, Heuvel JPV, Peters JM. (2007). Regulation of Gene Expression: Molecular Mechanisms. Humana Press Inc.
3. Jun M. (2006). Gene expression and regulation. Springer USA.
4. Dale JW and Park SF. (2010). Molecular genetics of bacteria. 5th Edition, Springer, Germany.
5. Dandekar T. (2002). RNA motifs and regulatory elements. 2nd Edition, Springer, Germany.

<u>YEAR:</u>	FOURTH / FINAL
<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-631
<u>COURSE TITLE:</u>	ANIMAL VIRUSES
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. Classification and structure of animal viruses
2. Mechanism of viral multiplication in host cell
3. One -step multiplication curve
4. Impact of viral infection on host cell.
5. Modes of replication of viral genome.
6. Maturation and release of animal viruses.
7. 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).
8. Interference with viral multiplication.
9. Interferon and chemotherapeutic agents.

Lab. pertaining to the above course

Recommended Books

1. Lieberman (2005) DNA Viruses: Methods and Protocols, Humana Publisher.
2. Cann, A. J. (2005) Principles of Molecular Virology 4th Ed., Elsevier/India.
3. Douglas, D. Bichman (2002) Clinical Virology, 2nd Ed., ASM Press.
4. hu, M. D. T. Human Retrovirus Protocols – Virology and Molecular Biology, Humana Publishers.

<u>YEAR:</u>	FOURTH / FINAL
<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-632
<u>COURSE TITLE:</u>	MOLECULAR BIOLOGY OF VIRUSES
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. Morphology of viruses: symmetry in capsid architecture.
2. Viral morphogenesis and electron microscopy.
3. Lytic and transducing phages: Coliphage lambda, Mu and P1.
4. Exploitation of phages in genetic engineering and DNA recombinant technology. Phage genome vector development: cosmid, phasmids, charon series, Lox/Cre, polioma virus, YAC & BAC.
5. A general concept of viral vectors, Herpes, Retro, Polio and Baculo viruses.
6. Gene map and genetic regulation of lambda and P1 phages.
7. Life cycle of Mu, its physical and genetic map.
8. Mu mediated illegitimate recombination.
9. Phage packaging: effect of insertion and deletion on packaging.
10. Recombination: Campbell mode of Lambda integration. Site specific and illegitimate recombination
11. DNA topology: linking, twisting and writhing number
12. Enzymology of integration and recombination.
13. Application of Poisson distribution

Lab. pertaining to the above course

Recommended Books

1. Waldor, M. (2005) Phages: Their Role in Bacterial Pathogenesis, ASM Press.
2. Sidhu, S. S. (2005) Phage Display in Biotechnology and Drug Discovery, CRC Press.
3. Cann, A. J. (2005) Principles of Molecular Virology 4th Ed., Elsevier/India.
4. Ptashne, M. (2004) Genetic Switch: Phage Lambda Revised 3rd Ed., Cold Spring.
5. Primrose, S.B. & Twyman, R. M. (2006) Principles of Gene Manipulation and Genomic, Blackwell

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-638**
COURSE TITLE: **MOLECULAR MECHANISMS OF ANTIMICROBIAL AGENTS**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction; principles of antimicrobial therapy, chemical nature of antibiotics and producing microorganisms, biosynthesis etc., activity of different antibiotics including grouping, cross-resistance, MIC, MBC, agar diffusion factors, antibiograms, spectrum and interactions.
2. Principal classes of antibiotics employed in the treatment of bacterial infections.
3. Inhibitors of cell-wall synthesis molecular mechanism of action of β -lactam (penicillin, cephalosporins), vancomycin, bacteriocins and cycloserine.
4. Inhibitor of Cell-wall synthesis II pharmacology and adverse effects of penicillins.
5. Bacterial Inhibitors of protein synthesis; Aminoglycosides and their mode of action at the molecular level.
6. Bacteriostatic inhibitors of protein synthesis chloramphenicol, erythromycin, lincomycin, clindamycin, spectinomycin and tetracycline
7. Biochemical and genetic basis of microbial resistance to antibiotics.
8. Antimetabolite drugs and their mode of action
9. Antibiotics affect membrane permeability polymyxin B, colistin and gramicidin A
10. Antifungal Drugs
11. New quinolone antibiotics; DNA synthesis inhibitors.
12. Drugs that act on mycobacteria; isoniazid, rifampicin, ethambutol and others.
13. Drugs employed for the treatment of parasitic infections with their modes of action.
14. Antiviral drugs and their mode of action.
15. Vaccines and immuno-modulating agents and herbal medicines.

Lab. pertaining the above course

Recommended Books

1. White, D. G. (2005) Frontiers in Antimicrobial Resistance, ASM Press.
2. Bryskier, A. (2005) Antimicrobial Agents: Antibacterials and Antifungals, ASM Press.
3. Salyers, A. A. (2005) Revenge of the Microbes: How Bacterial Resistance is, ASM Press.
4. Bryskier, A. (2005) Antimicrobial Agents: Antibacterials and Antifungals, ASM Press.
5. Curevas, C. F. (2003) Multiple Drug Resistant Bacteria, Horizon Publisher.
6. Hooper, D. C. (2003) Quinolone Antimicrobial Agents 3rd Ed., ASM Press.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-643**
COURSE TITLE: **MICROBIAL ENZYME TECHNOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to enzymes: Nature, structure & function of enzymes. Protein structure (primary & secondary).
2. Biological role of enzymes, their sources and biosynthesis, enzyme turnover.
3. Multi-enzyme complexes.
4. Mechanisms and kinetics of enzyme reaction.
5. Regulatory enzymes and the control of metabolic pathways- feedback inhibition; allosteric enzymes.
6. Industrial enzymes: Fermentative production of industrial enzymes and their purification. Enzyme immobilization: methods, kinetics and properties. Uses of free and immobilized enzymes in industries
7. Analytical, clinical and therapeutic application of enzymes.
8. Techniques for enzyme purification. Ammonium sulphate, chromatographic techniques (size exclusion, ion exchange, affinity, HPLC, FPLC, PAGE, SDS-PAGE etc.).

Practical Contents

1. Lysozyme activity against *Micrococcus* Sp.
2. Inhibition of lysozyme by heat and metallic salts
3. Effect of pH on lysozyme
4. Effect of lytic factor (protein) of *S. fecalis* 064 on *S. fecalis* 2400
5. Inhibition of lytic factor
6. Protein purification by ammonium sulfate precipitation.
7. Protein purification by gel chromatography.
8. Protein estimation by Biuret method and Lowry method
9. Effect of various amino acids on the growth of *S. fecalis* and *E. coli*
10. Effect of supplement metabolites in minimal medium on *E. coli* (Growth kinetics)

Recommended Books

1. Breslow, R. (2005) Artificial Enzymes, Wiley Sons Pub.
2. Simpson, R. J. (2005) Purifying Proteins for Proteomics, I. K. International Publishing Co.
2. Aguilar, M. I. (2004) HPLC of Peptides & Proteins: Methods & Protocols, Humana Publisher.
3. Bull, A. T. (2004) Microbial Diversity & Bioprospecting, ASM Press.
5. Barredo, J. L. (Latest Edition) Microbial Enzymes & Biotransformations, Humana Publisher.
6. Thiel, T. (2002) Biotechnology DNA to Proteins, McGraw Hill Company.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-651**
COURSE TITLE: **MOLECULAR BIOLOGY OF EUKARYOTES**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Eukaryotic genome organization.
2. Introduction to model organisms for use in eukaryotic molecular and cellular biology: Use of yeasts as models: *Saccharomyces cerevisiae* and *Schizosaccharomyces pombe*.
3. Technique used in genome mapping, using YACs.
4. Transformation systems.
5. Generation and analysis of mutations (Mendel's laws of inheritance).
6. Cell lineage and genome sequence.
7. Use of mouse as a model organism for human genetic diseases.
8. Techniques for gene mapping and positional cloning.
9. Transgenic and gene knock-out studies: case studies illustrating the interrelationship of different model organisms.
10. Transposable genetics elements: eukaryotic retrotransposons and mobile DNA elements.
11. Signal transduction.
12. Introduction to reverse genetics.

Practical Contents

Practical training related to Karyotyping, segregation and gene knock out studies.

Recommended Books

1. Lewis, R. (2005) Human Genetics: Concepts & Applications (Latest Ed.), McGraw Hill.
2. Humphory (2005). Cell Cycle Control: Mechanism and Protocol (Latest Ed.), Humana Publisher.
3. Gorson, S. L. (2005) Principle of Clinical Cytogenic 2nd Ed. Humana Publisher.
4. Deshmukh (2003) Cytogenetics and Evolution (Latest Ed.), Dominnat Press.
5. Jackson, J. F. (2003) Genetic Transformation of Plants (Latest Ed.), Springer Publisher.

BS Fourth Year: CLINICAL AND DIAGNOSTIC MICROBIOLOGY

YEAR: FOURTH / FINAL
SEMESTER: FIRST / SECOND
COURSE CODE: MIC-611
COURSE TITLE: PHYSIOLOGY OF FUNGI
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. Comprehensive comparison of eukaryote and prokaryote cells at molecular level
2. Structure of eukaryote cell with reference to their chemistry and function.
3. Cultivation and growth of fungi
4. Nutrients uptake: Active, Passive transport and Pinocytosis.
5. Metabolism: Carbon, Nitrogen and Vitamin metabolism. Role of essential elements (metallic and non-metallic ions).
6. Bioenergetics: electron transport chain, energy conservation and oxidative phosphorylation.
7. An introduction to fungal biotechnology: Use of fungi and actinomycetes in biotechnology.
8. Immobilized enzymes.

Lab. pertaining to the above course

Recommended Books

1. Paul Matsudaria (2003). Molecular Cell Biology, W. H. Freeman & Company.
2. Talbot, N. (2001). Molecular and Cellular Biology of Filamentous Fungi, Oxford Press.
3. J. W. Deacon (2001). Modern Mycology, Blackwell.
4. Richard P. Oliver and Micheal Schweizer, (1999). Molecular Fungal Biology, Cambridge Press.

YEAR: FOURTH / FINAL
SEMESTER: FIRST / SECOND
COURSE CODE: MIC-629
COURSE TITLE: CLINICAL PARASITOLOGY
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. An introduction to human parasitic infections.
2. An overview of classification of human parasites
3. Etiology, molecular mechanism of pathogenesis, life cycle, symptomatology, lab. diagnosis, epidemiology, treatment, prevention and control of infections caused by the following parasites:

Protozoa

Entamoeba histolytica, *Giardia lamblia*, *Plasmodium spp.*, *Blastocystes hominis*, *Trypanosoma spp.*, *Leishmania spp.*, *Toxoplasma gondii*, *Trichomonas vaginalis*.

Helminthes

Ascaris lumbricoides, *Enterobius vermicularis*, *Trichuris trichiura*, *Ancylostoma duodenale* and *Necator americanus*, *Wucherria bancrofti*
Taenia solium, *Taenia saginata*, *Echinococcus granulosus*, *Hymenolepsis nana*,
Schistosoma haematobium, *Fasciola hepatica*

4. Rapid and molecular diagnostic methods for protozoal infections.
5. A brief introduction to new and emerging parasitic infections.

Lab. pertaining to the above course content

Recommended Books

1. Cheng, T. C. (2006) General Parasitology, 2nd Ed., Ind/Elsevier.
2. Nataro, P. James (2000) Persistent Bacterial Infection, ASM Press.
3. Ichipujani (2002) Medical Parasitology 3rd Ed., Taypee Publisher.
4. Ozcel, M. A. (1999) Parasitology for the 21st Century, CABI Publisher.

<u>YEAR:</u>	FOURTH / FINAL
<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-638
<u>COURSE TITLE:</u>	MOLECULAR MECHANISMS OF ANTIMICROBIAL AGENTS
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

12. Introduction; principles of antimicrobial therapy, chemical nature of antibiotics and producing microorganisms, biosynthesis etc., activity of different antibiotics including grouping, cross-resistance, MIC, MBC, agar diffusion factors, antibiograms, spectrum and interactions.
13. Principal classes of antibiotics employed in the treatment of bacterial infections.
14. Inhibitors of cell-wall synthesis molecular mechanism of action of β -lactam (penicillin, cephalosporins), vancomycin, bacteriocins and cycloserine.
15. Inhibitor of Cell-wall synthesis II pharmacology and adverse effects of penicillin and others.
16. Bacterial Inhibitors of protein synthesis; Aminoglycosides and their mode of action at the molecular level.
17. Bacteriostatic inhibitors of protein synthesis chloramphenicol, erythromycin, lincomycin, clindamycin, spectinomycin and tetracycline.
18. Biochemical and genetic basis of microbial resistance to antibiotics.
19. Antimetabolic drugs and mode of action.
20. Antibiotics affect membrane permeability polymyxin B, colistin and germicidin A.
21. Antifungal Drugs
22. New quinolone antibiotics; DNA synthesis inhibitors.
16. Drugs that act on mycobacteria; isoniazid, rifampicin, ethambutal and others.
17. Drugs employed for the treatment of parasitic infections with their mode of action.

18. Antiviral drugs and their mode of action.
19. Vaccines and immunomodulating agents and herbal medicines.

Lab. pertaining the above course

Recommended Books

1. White, D. G. (2005) Frontiers in Antimicrobial Resistance, ASM Press.
2. Bryskier, A. (2005) Antimicrobial Agents: Antibacterials and Antifungals, ASM Press.
3. Salyers, A. A. (2005) Revenge of the Microbes: How Bacterial Resistance is, ASM Press.
4. Bryskier, A. (2005) Antimicrobial Agents: Antibacterials and Antifungals, ASM Press.
5. Curevas, C. F. (2003) Multiple Drug Resistant Bacteria, Horizon Publisher.
6. Hooper, D. C. (2003) Quinolone Antimicrobial Agents 3rd Ed., ASM Press.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-641**
COURSE TITLE: **CLINICAL VIROLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. An introduction to clinical virology and Immunology
2. Molecular mechanisms of pathogenicity and virulence.
3. Mechanisms of spread of virus in the human host.
4. Patterns of viral diseases.
5. Immune response and resistance to viral infections. Viral infections in patients with detective immunity.
6. Clinical, pathological and diagnostic aspects of the following viral infections:
Adeno virus, Corona virus, Rhino virus, Paramyxo viruses, Orthomyxo viruses, Gastroenteritis viruses, Parvo virus, Pox virus, Papova virus, Herpes virus, Hepatitis A, B, D, E, Lassa virus and Rabies viruses, Arleo-viruses. Some exotic and dangerous infections caused by Filo virus (Ebola Marburg), Arena viruses (Lassa and LCM), Prions and spongiform encephalopathy.
7. Resurgence and emerging viral infections.
8. Control of viral diseases by immunization, different generations of vaccines, their properties and efficacy.
9. Antiviral Chemotherapy.

Practical contents

1. Maintenance of cell lines for cultivation of viruses
2. Collection and processing of clinical samples for isolation of viruses by:
Tissue culture techniques, immunoassays; ELISA, latex agglutination, immunochromatography, hemagglutination (HA), hemoagglutination inhibition, IFT – Direct and Indirect
3. Virus neutralization assay, study of cytopathic effects due to *in-vitro* growth of viruses in tissue culture

4. Immunohistochemical assays for detection of viral antigens in infected tissues.
5. Detection of viruses by molecular techniques including PCR, RT-PCR and Real Time PCR, *In situ* Hybridization, SDS-PAGE, Western – blotting.
6. Influenza virus culture in embryonated eggs; Detection of virus growth by haemagglutination and haemagglutination inhibition (HAI) tests, Poliomyelitis virus and the plaque assay.
7. Isolation of structural proteins of viruses, identification by IF, Western Blot, Southern and Northern Blot, *In situ*-hybridization and Microarray to study viral products produced in infected cells.

Recommended Books

1. Speeter, S., R. L., Hodinka, and S. A., Young, (2000) Clinical Virology Manual 3rd Ed., ASM Press.
2. Libman, H. (1999) HIV Infection: A Clinical Manual 2nd Ed., ASM Press.
3. Smith, R. A. (1988) HIV & Other Highly Pathogenic Viruses, Academic Press.
4. Morson, M. A. (2004) Hand Book of Cancer Vaccines, Humana Publishers.

YEAR: FOURTH / FINAL
SEMESTER: FIRST / SECOND
COURSE CODE: MIC-645
COURSE TITLE: IMMUNO-TOXICOLOGY
CREDIT HOURS: 2 + 1
MARKS: 80 + 20 (THEORY + LAB)

1. Introduction to environmental toxicants (physical and chemical).
2. Effects on host immune system, disease predisposition and mechanisms of immunotoxicity of environmental chemicals and drugs, metals, alkylating agents, occupational hazardous materials, industrial compounds, pesticides and ionizing radiations.
3. Allergic responses to pesticides, chemicals, foods, drugs, plants and animal products.
4. Evaluation of immunotoxicologic potentials of different chemicals and drugs.
5. Immunosuppression through biological and chemical agents.
6. Genetical and toxicological basis of graft *vs.* host reactions.
7. Tumour immunology: tumour induction, regression and immunotherapy.
8. Introduction to toxicogenomics.

Practical Contents

1. Specific and non-specific immune-pharmacological changes due to exposure to environmental pollutants – chemicals, gases, pesticides, allergens and other toxic agents on immunocompetent cell function, T-cell subsets, serum IgG, IgM, IgA and IgE levels.
2. Antigen antibody reaction, lymphocyte blast transformation in response to PHA.
3. Immunotoxicological studies in animals and industry workers exposed to heavy metals.
4. Effect on pro-inflammatory and regulatory cytokines production.

5. Phagocytosis, and proliferation of cells, auto-reactivity and allergic response in workers exposed to various pollutants
6. Study of the immune-modulatory effect of toxic pollutants and susceptibility to various viral, bacterial and fungal infections.

Recommended Books

1. Shevne, G. C. (2005) Drug Discovery Handbook, Wiley Publisher
2. Keohavon (2005) Molecular Toxicology Protocols, Humana Publisher
3. R. K. Chandra (2002) Nutrition, Immunity and Illness in the Elderly. Pergamon Press.
4. Gooi and Chapel (2002) Clinical Immunology: A Practical Approach. The Practical Approach Series, ASM Press
5. Noel Rose - Friedman and Fahey (2002) Manual of Clinical Laboratory Immunology. ASM Press

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-646**
COURSE TITLE: **INFECTIOUS DISEASE EPIDEMIOLOGY & PUBLIC HEALTH**
CREDIT HOURS: **2+1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to epidemiology.
2. Bionomics: human ecology and etiology of pathogenic organisms.
3. Epidemiologic considerations in disease process.
4. Analytical and experimental epidemiology.
5. Epidemiology of communicable diseases:
Agents, reservoir, host and route of transmission.
6. Epidemiology of non-communicable diseases.
7. Quality of health:
Nutritional and immune status and predisposing factors.
8. Diseases cycle:
Chicken pox, measles, rota virus infections, mumps, influenza and common cold and prevailing pandemics and epidemics.
9. Surveillance, prevention, control and eradication of disease.
10. Data collection of infectious disease cases, antibiotic resistance profile of infectious agents.
11. Environmental health and health education, sanitation and hygiene.
12. Status of health services in Pakistan and comparison with other countries.

Practical Contents

1. Epidemiological survey of seasonally occurring URT infections.
2. Determination of bacteriological quality of fresh fruits and vegetables sold in local markets.

3. Analysis of the microbial quality of meat and poultry.
4. Survey of quality of municipal water supply.
5. Determination of antibiotic susceptibility pattern of the community based pathogens.
6. Use of molecular techniques in outbreak investigation.

Recommended books:

- a) Statistical models in epidemiology (1993) by Dwyer.
- b) Prevention effectiveness (1996) by Haddix.
- c) Genetics and public health in 21st century (2000) by Koury, Burke and Thomson.
- d) Public health and human ecology by J.M. Last.
- e) Epidemiology, biostatistics and preventive medicine by J. Jekel, J.G. Elmore and D.L. Katz.
- f) WHO bulletin, Geneva (1993) by R. Beaglotude, R. Benita and Kjellstra.
- g) Fundamentals of Microbiology by I.E. Alcamo.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-648**
COURSE TITLE: **CLINICAL MYCOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to clinical mycology
2. Host-parasite interactions
3. Study of the following human diseases with reference to etiology, molecular mechanism of pathogenesis, symptomatology, immunology, lab. diagnosis, epidemiology, therapeutic considerations, prevention and control:
 - a) Systemic Mycoses: Actinomycosis, nocardiosis, candidiasis, histoplasmosis, geotrichosis, aspergillosis and zygomycosis.
 - b) Cutaneous and sub-cutaneous mycosis; sporotrichosis, cryptococcosis, tinea versicolor, and tinea nigra.
4. An overview of the following diseases:
Blastomycoses, coccidioidomycosis, chromoblastomycosis, dermatomycoses, white and black picdra.
5. Prophylaxis and chemotherapy
6. A brief introduction to emerging mycotic infections

Practical Contents

1. Microscopic study, cultural isolation characterization and identification of fungal elements using
different clinical samples:
 - (a) Pus
 - (b) HVS
 - (c) Different body fluids

- (d) Tissue samples
2. Isolation and characterization of *Nocardia* species from soil samples
 3. Isolation and characterization of *Histoplasma capsulatum* from pigeon droppings
 4. Inocula preparation and standardization for antifungal susceptibility testing.
 5. Antifungal susceptibility testing using macro and micro-dilution technique.
 6. Pure culture study of Dermatophytes
 7. Differentiation of Dermatophytes
 8. Pure culture study of Dermatophytes
 9. Differentiation of *T. mentagrophytes* and *T. rubrum* by Hair Performance Technique and urease test.
 10. Isolation and identification of dermatophytes from clinical samples i.e. skin, hair and nails.
 11. Isolation of *Cryptococcus neoformans* from pigeon's.

Recommended Books

1. Baron, E.J., L. R., Peterson, and S. M., Finegold , (2002) Bailey and Scott's Diagnostic Microbiology, The C.V. Mosby Company.
2. Cheesbrough, M. (2000) District Laboratory Practice in Tropical countries Part II Cambridge University Press.
3. Wittner, M. (1999) The Microsporidia and Microsporidiosis, ASM Press.
4. L. Ajello and R. J. Hay (1998). Topley and Wilson's Microbiology and Microbial infections. Vol. 4 Medical Mycology 9th Ed. Oxford University Press.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-649**
COURSE TITLE: **CLINICAL BACTERIOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. An introduction to clinical bacteriology
2. Hazards and safety in clinical bacteriology laboratory
3. Normal flora and normal defenses of respective systems, possible pathogens and possible infections, predisposing factors, collection, transportation and processing of following specimens for laboratory diagnosis
4. Upper respiratory tract: Throat swab, nasal swab, nasopharyngeal aspirates, ear swab
5. Lower respiratory tract: Sputum, trans-tracheal aspirates, pleural effusion
6. Eye swab
7. Skin swab, burns, tissue biopsies
8. Specimens from Pus, wounds, abscess, transudate and exudate
9. Joints and bones: Synovial fluid, bone marrow
10. Gastrointestinal tract system including liver and gall bladder: Gastric lavage, vomit, bile, peritoneal fluid, rectal swab, faeces
11. Urinary tract system: Urine

- General approaches, immuno-potential, specific and non-specific methods of achievements, Immunosuppression, methods of achievement.
5. Immunodiagnostic technique:
Types, basis and mechanisms, Applications in health and disease
 6. Introduction to principles of immuno-hematology and transfusion therapy
 7. The major human histocompatibility complex:
Nomenclature, genetic organization, tissue distribution, structure and function, typing procedures and role in transfusion and transplantation therapy
 8. Blood transfusion practices:
Perfusion testing, special consideration according to age, surgery massive transfusion
 9. Transfusion therapy:
Indications and contra-indications for RBCs, platelets, granulocytes, fresh frozen plasma, cryo-precipitated anti-hemophilic factors, clotting factors and other plasma component transfusion
 10. Hazards of blood transfusion, management of warm and cold autoantibody problems and complications of transfusion

Labs. pertaining to the above topics

Recommended books:

- a) Basic and clinical immunology by Stites and Terr.
- b) Immunology: an introduction by Ian R. Tizard.
- c) Essentials of clinical immunology by Helen Chapel and Mausel Haeney.
- d) Introduction to immunology by John W. Kimball.
- e) Immunology by Janes Kuby.
- f) Basic and applied immunohematology by K.D. Blaney and P.R. Howard.
- g) Introduction to immunohematology by N.J. Bryant.
- h) Immunohematology: principles and practice by E.D. Quinley.
- i) Manual of clinical laboratory immunology by E.C. Rossi and T.L. Simon.

<u>YEAR:</u>	FOURTH / FINAL
<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-663
<u>COURSE TITLE:</u>	MOLECULAR PATHOGENESIS
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. Host-microbial interactions and intracellular survival.
2. Microbial adhesins, virulence factors and toxins.
3. Mosaicism in genomes and pathogenicity islands.
4. Signal transduction.
5. Two component system.
6. Microbial quorum sensing.
7. Genetic regulation of bacterial virulence factors.
8. Non coding RNAs.

9. Bacterial secretion systems and their types.
10. Biofilm formation.
11. Current approaches to study molecular pathogenesis.

Practical content:

1. PCR and RT PCR techniques
2. Southern blot analysis
3. Restriction fragment length polymorphism
4. Analysis of bacterial biofilm

Recommended books

1. Wilson BA, Winkler M, Ho BT. (2019). Bacterial Pathogenesis: A Molecular Approach, 4th Edition. Wiley Publishers.
2. Romeo T. (2008). Bacterial Biofilms. Current Topics in Microbiology and Immunology, Springer.
3. Winans SC, Bassler BL. (2008). Chemical Communication among Bacteria. Wiley Publishers.
4. Kudwa IT, Cornick NA, Plummer PJ, Zhang Q, Nicholson T, and Bannantine JP. (2016). Virulence Mechanisms of Bacterial Pathogens, 5th Edition. ASM Press.
5. Sansonetti P. (2010). Bacterial Virulence: Basic Principles, Models and Global Approaches. Wiley Publishers.

B.S. (Fourth Year) APPLIED AND ENVIRONMENTAL MICROBIOLOGY

<u>YEAR:</u>	FOURTH / FINAL
<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-603
<u>COURSE TITLE:</u>	MARINE BACTERIOLOGY
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. Introduction to marine bacteriology
2. Influence of hydro-geochemical cycling on marine ecosystem
3. Microbial food web; microbial loop; microbial gardening
4. Method of sample processing and analysis of specimens from marine environment (deep sea, off shore on shore)
5. Case studies:
 - Role of bacteria in a high productivity areas e.g., mangrove swamps, in deep oceans (under high pressure) near hydrothermal vents (Sulphur bacteria). Methanobacteria with reference to hydrocarbon production and improvement.
 - Involvement of bacteria and cyanobacteria in nitrogen fixation and carbon budget.
6. Biotechnology:
 - Pharmaceutical compounds, antibiotics, antiviral and anti-tumor compounds, enzyme surfactants; other potentially useful microbial products (proteins for biomass, quorn product).
7. Role of marine bacteria in controlling:
 - Environmental pollution (Bioremediation)
 - Hydrocarbon degradation (Petroleum products)
9. Bacteriology of healthy plants, vertebrates and invertebrates
10. Diseases of invertebrates and vertebrates

Lab. pertaining to the above course

Recommended Books

1. Dubey, S. K. (2005) Marine Biology, Ind / UBS Publisher.
2. Munn, C. B. (2004) Marine Microbiology: Ecology and Applications, Bios Sciences
3. Sumich, J. H. (2004) Introduction to the Biology of Marine Life 8th Ed., WCB Publishers
4. Levinton, J. (2001) Marine Biology: Function, Biodiversity and Ecology, 2nd Ed., Oupusa Publisher

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-608**
COURSE TITLE: **FOOD PRESERVATION TECHNOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Principles and methods of food preservation
2. Microbiology of preserved foods
3. Food processing and preservation technologies.
4. Preservative agents for improving the quality, shelf-life and organoleptic properties of foods
5. Neutralizing, stabilizing, firming agents, coating and wrapping agents.
6. Packaging and packaging problems

Lab. pertaining to the above course

Recommended Books

1. Steele Sr., J. L. and Marth, E. H. (2001) Applied Dairy Microbiology. Marcel Dekker
2. Molins, RA. (2001) Food irradiations: Principles and applications. Wiley, John & Sons
3. Luck E., Jager and M laichen, S. F. (2000). Anti microbial food additives: Characteristics, uses and effects. Springer-Verlag, NY, Inc.
4. Jay, J. M. M. (2000) Modern Food Microbiology. Aspen Publishers

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-619**
COURSE TITLE: **VETERINARY MICROBIOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Study of major microbial diseases of animals in Pakistan.
2. Etiology, Symptomatology, Immunology, Epidemiology, Lab. diagnosis, control and prevention of the following diseases:
Bacterial diseases; Tuberculosis, Anthrax, Brucellosis , John's Disease, Bovine Mastitis, Salmonellosis (including Pullorum)
Viral diseases; Rabies, Foot and Mouth disease, New castle, Infections laryngotracheitis, Fowl pox, Sore mouth of sheep and goats, Avian influenza, Infectious bursal disease, Hydropericardium syndrome
3. An overview of protozoal and helminthic infectious diseases of livestock.
4. Importance of Zoonotic diseases.
5. New and emerging infectious diseases of livestock.
6. Quarantine and international control of animals / live stock.

Lab. pertaining to the above course

Recommended Books

1. Quinn, P.J., Leonard, F.C. and Markey, B.K. (2002) Veterinary Microbiology and Microbial diseases. Blackwell Science Inc.
2. Kornerup, A. and Hansen, K. (1999) Handbook of laboratory animal Bacteriology. CRC Press, LLC.
3. Garvin, M. L. (1995) Infectious Waste Management. A Practical Guide Lewis Publishers, Inc.
4. Wayne, L. T. (1995) Biohazardous Waste: Risk Assessment, Policy and Management. Lewis Publishers, Inc.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-637**
COURSE TITLE: **ENVIRONMENTAL MUTAGENESIS**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. The eukaryotic cell
2. Mutagenesis, carcinogenesis, somatic theory of cancer
3. Chemistry of carcinogenesis
4. Perturbation of recognition systems
5. Anti-carcinogens, metabolic basis of chemotherapy
6. Basis of radiation therapy
7. Cellular transformation
8. Viral oncogenesis
9. Cancer as problem in gene expression and differentiation
10. Search for new anti-carcinogens

Labs. Pertaining to the above course

Recommended Books

1. Dhawan A., Kumar, A., Shanker, R., Dobrovolsky, V.N. (Editors) (2017). Mutagenicity: Assays and Applications. Elsevier Science
2. Ernest, H.Y., Walderico, M.G.(Editors) (2012). Mutation, Cancer and Malformation. Springer, USA
3. Friedberg, E.C., Walker, G.C., Siede, W., Wood, R.D., Schultz, R.A., Ellenberger, T. (Editors). (2006). DNA Repair and Mutagenesis. ASM Press, USA
4. Karp's Cell and Molecular biology (9th edition)
5. Molecular biology of Cell (4th edition) by Bruce Albert et al.
6. Molecular Cell biology by Lodish et al. (9th edition)
7. Molecular biology by Freifelder.

8. A Text book of Modern Toxicology by Hodgson (4th edition)
9. Environmental Toxicology by David A. Wriath

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-664**
COURSE TITLE: **MICROBIOLOGY FOR INDUSTRIAL QUALITY ASSURANCE**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction and scope of microbiology in food, hospitals, pharmaceuticals and other industries
2. Microbial contamination and hazards
3. Principles and methods of sterilization and disinfection at mass scale
4. Evaluation of sterilization and disinfection procedures
5. Significance, validation and calibration of laboratory equipments
6. Standard operating protocols (SOPs) for industries
7. Importance of quality assurance and monitoring
8. ISO certification and accreditation
9. Hazard analysis and critical control point system (HACCP)
10. Package design and maintenance of product integrity

Practical contents:

1. Determination of microbial quality of various end products
2. Microbiological assays for antibiotics and vitamins
3. Limus amoebocyte lysate assay (LAL test)
4. Sterility, pyrogenicity and and toxicity testing

Recommended Books

1. Hugo and Russell's Pharmaceutical Microbiology (2004) 7th edition, Wiley-Blackwell
2. Rosamund M. Baird, Norman A. Hodges and Stephen P. Denyer (2000) Handbook of microbiological quality control in pharmaceuticals and medical devices Taylor and Francis
3. Hewitt, W. (2004) Microbiological Assay for Pharmaceutical Analysis: A Rational Approach Interpharm/CRC
4. Eaton, A.D. (2005) Standard methods for the examination of water and waste water (21st edition) Centennial edition

<u>YEAR:</u>	FOURTH / FINAL
<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-666
<u>COURSE TITLE:</u>	PROBIOTICS: THE LIVING THERAPIES
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. Introduction to probiotics: the natural healers.
2. Historical perspective and development/evolution of probiotics.
3. General guidelines for the use of probiotics.
4. Type of probiotics and their varied health benefits.
5. Probiotics and synbiotics: the mode of action.
6. Factors affecting viability of probiotic bacteria in food.
7. Role of probiotics in immunomodulation.
8. Probiotics as food supplements: the side effects/demerits.
9. Mode of action of probiotics: antibacterial and antiviral activities.
10. Probiotics and anti-cancer therapy.
11. Probiotics as infant nutrition. Custom probiotics-high potency *Acidophilus* and *Bifidus*.
12. Role of probiotics for the control of GIT disorders and hypercholesterolemia.
13. Future prospects of probiotics.

Practical contents

1. Isolation, identification and characterization of the representative probiotic bacteria from the relevant courses (GIT, infant oral swab, fermented milk products).
2. Study of the deterrent effects of probiotics and their metabolites on the GIT pathogenic microorganisms.
3. Study of the growth promoting probiotic metabolites on the GIT pathogenic microorganisms.
4. Enumerative role of *Bifidobacteria* in varied age group individuals.
5. Chemical nature based studies of the metabolites of the probiotics.

Recommended Books

1. Liong M. (2011). Probiotics: Biology, Genetics and Health Aspects. Springer-Verlag, Berlin Heidelberg.
2. Miller AA and Miller PF. (2011). Emerging Trends in Antibacterial Discovery: Answering the call to Arms. Caister Academic Press.
3. Pagninia et al. (2010). Probiotics Promote Gut Health Through Stimulation of Epithelial Innate Immunity. PNAS 107(1): 454-459.
4. Gupta V and Garg R. (2009). Probiotics. Indian J. Med. Microbiol. 27:202-209.
5. Tannis A. (2008). Probiotics Rescue: How You Can Use Probiotics to Fight Cholesterol, Cancer, Super Bugs, Digestive Complaints and More. John Wiley and Sons, Canada.
6. Tannock GW. (2005). Probiotics and Prebiotics: Scientific Aspects. Caister Academic Press.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-654**
COURSE TITLE: **MICROBIAL TECHNOLOGY-II**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to: Microbial biotechnology and scope of fermentation biotechnology in Pakistan.
2. Principles of Biochemical Engineering: Large-scale microbial fermentation, principles and problems, introduction to downstream processing, Case studies: Industrial alcohol production from sugar cane; Citric acid production.
3. Growth and Development of Microorganisms in Bioreactors:
Quorn(r) myco-protein, a product produced by continuous flow fermentation. Continuous culture technologies for strain improvements
4. Strain Development: Isolation and identification of industrially important microorganisms. A spectrum of approaches for microbial strain development
5. Case study: Amino acid biosynthesis in *Corynebacterium glutamicum*.
6. Metabolic Control Analysis: Principles and means of rational strain development.
Case study: Tryptophan biosynthesis in *Neurospora crassa*

Lab. pertaining to the above course

Recommended Books

1. Rajavaidya (2006) Industrial Applications of Microbiology, APH Publishers.
2. Naidu, C. K. (2006) Applied Biotechnology, TTPP.
3. Herren, R. V. (2005) Introduction to Bioinformatics: Theoretical/Practical, Ind/Thomson
4. Glick, B.R.(2003)Molecular Biotechnology: Principles and Application of Recombinant DNA, ASM Press
5. Garci, I. S. (2007) Diagnostic Medical Parasitology, 5th Ed., ASM Press

<u>YEAR:</u>	FOURTH / FINAL
<u>SEMESTER:</u>	FIRST / SECOND
<u>COURSE CODE:</u>	MIC-640
<u>COURSE TITLE:</u>	ADVANCES IN SOIL MICROBIOLOGY
<u>CREDIT HOURS:</u>	2 + 1
<u>MARKS:</u>	80 + 20 (THEORY + LAB)

1. Introduction: agricultural microbiology and field management technology.
2. Soil ecology: kinetics of ecosystems and ecosphere.
3. Interactions: dynamics and interaction of microbial population in rhizosphere, rhizoplane and phylloplane.
4. Soil hydrology: different forms of water present in the soil, their physico-chemical and biological properties.
5. Soil colloidal system: its significance in soil.
6. Organic matter and its role in soil processes, detailed study of cation-exchange capacity of the soil: its role in the availability and uptake of the nutrients.
7. Composting and its role in enhancing soil fertility.
8. Bio-fertilizers
9. Microbe mediated nutrient uptake and losses. Recent advances in N uptake and losses from soil. Phosphorus and role of mycorrhiza in P solubilization Effective microorganisms (EM).
10. Biological control: bio-insecticides / fungicides.

Practical Contents

1. Detailed Study of microorganisms involved in nutrient cycling (C, N, P & S).
2. Isolation and characterization of microorganisms isolated from rhizosphere.
3. Study of associative and antagonistic relationship among soil microorganisms.
4. Isolation of symbiotic and non-symbiotic microorganisms from root nodules and soil respectively.
5. Bench scale and pilot scale studies for evaluating the natural materials as bio-fertilizer and naturally occurring microorganisms as bio-pesticides
Composting using different waste materials bulking agents.

Recommended Books

1. Rajvaidya (2006) Agricultural Applications of Microbiology, APH Publisher.
2. Mathews (2006) Pesticide Health Safety and the Environment, Blackwell Scientific Inc.
3. Purohit, S. S. (2003). Agricultural Biotechnology, TTPP Publishers.
4. JHA, M. N. (1999) Agromicrobes: Current Trends in Life Sciences, TTPP Publishers.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-644**
COURSE TITLE: **ENVIRONMENTAL BIOTECHNOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Introduction to environmental biotechnology.
2. Microbiological techniques for pollution control.
3. Role of microorganisms in the production of food and fodder products.
4. Chemical and bio-pesticides: environmental consequences.
5. Microbial degradation of toxic and poorly degradable (recalcitrants) compounds.
6. Bioremediation of environment contaminated with wood preservatives, petroleum products, hydrocarbons fuels, and industrial wastes.
7. Bioaccumulation of heavy metals and phytoremediation.
8. Applications of recombinant microorganisms in reducing environmental pollution, possible hazards, ethical and safety concerns.

Practical Contents

To study the gradual adaptation pattern of microorganisms to environmental pollutants – In vivo and In vitro studies.

Biodegradation of environmental pollutants using different microorganisms.

Metal accumulation by microorganisms.

Quantitative analysis as well as transmission electron microscopy (TEM) of the samples.

Development of experimental model for the use of microorganisms from different environments bioremediation studies (use of resistant and susceptible strains).

Recommended Books

1. Purojit, V. (2005) Biotechnology & Other Sciences, TTPP
2. Jordening (2005) Environmental Biotechnology: Concept, Wiley.
3. Spencer, J. F. (2004) Environmental Biotechnology: Methods and Protocols, Humana.
4. Evans, G. M. (2003) Environmental Biotechnology: Theory and Applications, Wiley.
5. Schmauder, H.P. (1997). Methods in Biotechnology, Tyler and Francis Publishers.

YEAR: **FOURTH / FINAL**
SEMESTER: **FIRST / SECOND**
COURSE CODE: **MIC-647**
COURSE TITLE: **FOOD & DAIRY MICROBIOLOGY**
CREDIT HOURS: **2 + 1**
MARKS: **80 + 20 (THEORY + LAB)**

1. Scope of food and Dairy Microbiology
2. World food problems and their means of alleviation
3. Microorganisms important in food milk and milk products.
4. Composition of milk with emphasis on micronutrients.
5. Principles of food spoilage and their preservation.
6. Sources of contamination of milk.
7. Dairy processes.
8. Spoilage and preservation of milk and milk dairy products.
9. Problems of milk production in tropical countries.
10. Food hygiene, control and inspection.
11. Quality control in food and dairy industries.
12. Recent advances in food and dairy industry.

Practical Contents

Isolation, screening and identification of microorganisms from different food, milk and water samples.

Examination of microorganisms on normal and spoiled fruits and vegetables.

Study of microbial spoilage of canned and bottled foods (meat, fish and dairy products).

Diagnosis of spoilage of various foods. Selective and enrichment techniques for isolating microorganisms.

Assessment of the load of coliform bacteria in food samples.

Methylene blue reduction test for the suitability of pasteurized milk for consumption.

Recommended Books

1. Shetly, K. (2006) Food Biotechnology 2nd Ed., CRC Press.
2. Adams, M. R. (2000) Food Microbiology, RSC Press.
3. Renner, E. (1989) Micronutrients in milk and milk based food products. Elsevier Applied Science.
4. Robinson, R. K. (1983) Dairy Microbiology I & II. Applied Science Publishers.
5. Lampert, L. M. (1985) Modern Dairy Products. Chemical Publishing Company.

