

# **CURRICULUM/SCHEME OF STUDIES**

## **BS MICROBIOLOGY**

## **BS Microbiology**

### **Background and Rationale**

Microbiology is the basis of all sciences. It is one of the largest and most complex of the biological sciences as it deals with many diverse biological disciplines. It deals with every aspects of microbe-human as well as animals and environmental interaction. It deals with future challenges such as finding new ways to combat disease. It involves in the creation of new drugs, vaccines and high-quality food and reduction of pollution in the environment. It is also used as vectors to treat the diseases and enhance agricultural productivity. So, it's the need of the hour to start the BS Microbiology degree in southern Punjab area because of its high importance in human life. It will provide the knowledge and future employment for the people of southern Punjab in the sector Food, Cosmetics, Medical, Agriculture, Pharmaceuticals Diagnostics, Sanitation, Quality control and Biosafety and Biosecurity.

### **Study Objectives**

BS Microbiology years (8 semesters) degree program to create highly skilled and knowledge students to contribute in the country to disease diagnosis of bacterial and viral infection in human as well as in animals.

### **UN's Sustainable Development Goal**

BS Microbiology will address the UN's Sustainable Development Goal No. 1, 3 and 4

Goal No 1. No Poverty

Goal No.3. Good health and well being

Goal No. 4. Quality Education

### **Online courses**

Free online available courses regarding MS Microbiology

- Introduction to Microbiology (Course Platform: Class Central, Cost: Free)
- Industrial Microbiology/ Biotechnology (**Course Platform:** Coursera, Cost: Free)
- Microbiology and Immunology (Course Platform: edX, Cost: Free)

**Available at:** <https://www.classcentral.com/tag/microbiology>

<https://www.coursera.org/courses?query=microbiology>

### **Eligibility**

Applicant must have F. Sc Pre-Medical with 50% of total marks

**Total Credit Hours: 135 Credit Hours Excluding Audit Courses**

### **Guideline for Program**

Fee/ Dues of the BS Microbiology will be applied according to MNS-UAM policy

**Major Courses**

<b>Course No.</b>	<b>Title of the Course</b>	<b>Credit Hours</b>
MICRO-301	Fundamentals of Microbiology	3(2-1)
MICRO-303	Molecular Cell Biology	3(2-1)
MICRO-302	Introduction to Mycology	2(1-1)
MICRO-304	Basic Immunology	3(2-1)
MICRO-306	General Virology	3(2-1)
MICRO-308	Basic Biotechnology	3(2-1)
MICRO-401	Introduction to Cell Culture	3(2-1)
MICRO-403	Genetic Engineering	4(3-1)
MICRO-402	Fundamentals of Microbial Genetics	3(2-1)
MICRO-404	Antimicrobial Resistance & Probiotics	2(1-1)
MICRO-406	Proteomics	2(1-1)
MICRO-408	General Bacteriology	3(2-1)
MICRO-501	Genetic Engineering	3(2-1)
MICRO-503	Applied Immunology	3(2-1)
MICRO-505	Marine and Fresh Water Microbiology	3(2-1)
MICRO-507	Soil Microbiology	3(2-1)
MICRO-509	Food and Dairy Microbiology	3(2-1)
MICRO-511	Bioinformatics and Protein Structure/ Function	3(2-1)
MICRO-502	Medical Microbiology	3(2-1)
MICRO-504	Systemic and Diagnostic Virology	3(2-1)
MICRO-506	Environmental Microbiology	3(2-1)
MICRO-508	Industrial Microbiology	3(2-1)
MICRO-510	One Health	3(2-1)
MICRO-512	Quality Control in Biologics	2(1-1)
MICRO-601	Pharmaceutical Microbiology	3(2-1)
MICRO-603	Introduction to Vaccinology	3(2-1)
MICRO-605	Diagnostic Microbiology	3(0-3)
MICRO-607	Biorisk Management (Biosafety and Biosecurity)	3(2-1)
MICRO-609	Bio-entrepreneurship	2(2-0)
MICRO-611	Emerging Issues in Microbiology	2(2-0)
UAM-611	Preparation of Research Project and Scientific Writing	2(1-1)
MICRO-612	Internship and Research Project	6(0-6)
	<b>Total Credit Hours</b>	<b>93</b>

**Minor Courses**

<b>Course No.</b>	<b>Title of Course</b>	<b>Credit Hours</b>
Zool-302	Animal Biodiversity	2(1-1)
PARA-402	Diagnostic Parasitology	3(2-1)
EPH-402	Epidemiology and Public Health	3(2-1)
BOT-401	Plant Diversity	3(2-1)

PATH-401	General Pathology	3(2-1)
PATH-402	Clinical Pathology	3(2-1)
<b>Total Credit Hours</b>		<b>17</b>

### Compulsory Courses

Course No.	Title of Course	Credit Hours
IS-302 / SSH-301	Islamic Studies <b>OR</b> Ethics (for Foreign/Non-Muslim Students)	3(3-0)
ENG-301	English Composition and Comprehension	3(3-0)
STAT-302	Introductory Statistics	2(2-0)
CS-301	Computer Appreciation and Application	3(2-1)
ENG-302	Communication and Presentation Skills	3(3-0)
ENG-401	Technical and business English Writing	3(3-0)
SSH-302	Pakistan Studies	2(2-0)
Biochem-301	Elementary Biochemistry	3(2-1)
Math-301	Elementary Mathematics	3(2-1)
<b>Total Credit Hours</b>		<b>25</b>

### Audit Courses

Course No.	Title of Course	Credit Hours
UAM-301	Social and Religious Tolerance	Audit
UAM-302	Citizenship Education and Community Engagement	Audit

## Scheme of Study

### 1<sup>st</sup> Semester

Course No.	Title of Course	Credit Hours
MICRO-301	Fundamentals of Microbiology	3(2-1)
MICRO-303	Molecular Cell Biology	3(2-1)
CS-301	Computer Appreciation and Application	3(2-1)
Biochem-301	Elementary Biochemistry	3(2-1)
ENG-301	English Composition and Comprehension	3(3-0)
Math-301	Elementary Mathematics	3(2-1)
<b>Total</b>		<b>18</b>

### 2<sup>nd</sup> Semester

Course No.	Title of Course	Credit Hours
MICRO-302	Introduction to Mycology	2(1-1)
MICRO-304	Basic Immunology	3(2-1)
MICRO-306	General Virology	3(2-1)
SSH-302	Pakistan Studies	2(2-0)
UAM-301	Social and Religious Tolerance	Audit
ENG-302	Communication and Presentation Skills	3(3-0)
MICRO-308	Basic Biotechnology	3(2-1)
IS-302/ SSH-301	Islamic Studies <b>OR</b> Ethics (for Foreign/Non-Muslim Students)	3(3-0)
<b>Total</b>		<b>19</b>

### 3<sup>rd</sup> semester

Course No.	Title of Course	Credit Hours
MICRO-401	Introduction to Cell Culture	3(2-1)
MICRO-403	Bacterial Cell Physiology	4(3-1)
STAT-302	Introductory Statistics	2(2-0)
PATH-401	General Pathology	3(2-1)
BOT-401	Plant Diversity	3(2-1)
UAM-302	Citizenship Education and Community Engagement	Audit
ENG-401	Technical and Business English Writing	3(3-0)
<b>Total</b>		<b>18</b>

**4<sup>th</sup> semester**

<b>Course No.</b>	<b>Title of Course</b>	<b>Credit Hours</b>
MICRO-402	Fundamentals of Microbial Genetics	3(2-1)
MICRO-404	Antimicrobial Resistance & Probiotics	2(1-1)
MICRO-406	Proteomics	2(1-1)
MICRO-408	General Bacteriology	3(2-1)
EPH-402	Epidemiology and Public Health	3(2-1)
PATH-402	Clinical Pathology	3(1-2)
PARA-402	Diagnostic Parasitology	3(2-1)
<b>Total</b>		<b>19</b>

**5<sup>th</sup> semester**

<b>Course No.</b>	<b>Title of Course</b>	<b>Credit Hours</b>
MICRO-501	Genetic Engineering	3(2-1)
MICRO-503	Applied Immunology	3(2-1)
MICRO-505	Marine and Fresh Water Microbiology	3(2-1)
MICRO-507	Soil Microbiology	3(2-1)
MICRO-509	Food and Dairy Microbiology	3(2-1)
MICRO-511	Bioinformatics and Protein Structure/ Function	3(2-1)
<b>Total</b>		<b>18</b>

**6<sup>th</sup> semester**

<b>Course No.</b>	<b>Title of Course</b>	<b>Credit Hours</b>
MICRO-502	Medical Microbiology	3(2-1)
MICRO-504	Systemic and Diagnostic Virology	3(2-1)
MICRO-506	Environmental Microbiology	3(2-1)
MICRO-508	Industrial Microbiology	3(2-1)
ZOOL-302	Animal Biodiversity	2(1-1)
MICRO-510	One Health	3(2-1)
MICRO-512	Quality Control in Biologics	2(1-1)
<b>Total</b>		<b>19</b>

**7<sup>th</sup> semester**

<b>Course No.</b>	<b>Title of Course</b>	<b>Credit Hours</b>
MICRO-601	Pharmaceutical Microbiology	3(2-1)
MICRO-603	Introduction to Vaccinology	3(2-1)
MICRO-605	Diagnostic Microbiology	3(0-3)
MICRO-607	Biorisk Management (Biosafety and Biosecurity)	3(2-1)
MICRO-609	Bio-entrepreneurship	2(2-0)
UAM-611	Preparation of Research Project and Scientific Writing	2(1-1)
MICRO-611	Emerging Issues in Microbiology	2(2-0)
<b>Total</b>		<b>18</b>

**8<sup>th</sup> semester**

<b>Course No.</b>	<b>Title of Course</b>	<b>Credit Hours</b>
MICRO-612	Internship and Research Project	6(0-6)
<b>Total</b>		<b>6</b>

## Course Contents

**MICR-301**

**Fundamentals of Microbiology**

**3(2-1)**

### Learning Objectives

During the course, students will be able to learn:

- Basics of microbiology
- Types and structures of Bacteria
- Microscopic Techniques to see bacteria
- Familiarize the learners with the field of Molecular and cell biology

### Theory

Introduction to the course: sharing of learning outcomes, microbiology and branches of microbiology, applied areas of microbiology; Difference between prokaryotes and eukaryotes; Historical development of microbiology and its scope; Microscopy: An outline of the principles and application of light microscopy; Bacterial cell morphology: size, shape and arrangements; Bacterial cell structures: cell wall of gram positive bacteria, cell wall of gram negative and acid fast bacteria, atypical cell wall, structures external to cell wall: Glycocylex, flagella, Pilli and fimbriae, cell membrane; Inclusion bodies; Sporogenesis; Bacterial taxonomy and nomenclature on basis of bacterial classification; Stains and staining: simple, differential, special; Bacterial growth: physical requirements including temperature, PH and osmotic pressure; Bacterial growth: Nutritional/chemical requirements including Carbon, nitrogen, and oxygen, hydrogen, sulphur, phosphorous, trace elements and growth factors; Culture media: chemically defined, complex, selective, differential and enriched media; Bacterial culture techniques: primary and subculture; Anaerobic growth requirements' media; Bacterial culture systems: open and closed; bacterial growth phases, preservation of bacteria, direct measurement of microbial growth: plate count, filtration and most probable number (MPN), indirect measurement of microbial growth: dry mass, turbidity and metabolic activity; Control of microorganisms: sterilization and related terms, physical methods including heat; high temperature, low temperature, osmotic pressure and high pressure, desiccation and radiations; Control of microorganisms: Chemical methods including principle and evaluation of disinfectants; Phenol and phenolics, aldehydes and halogens, bigaunides, alcohols, peroxigens, quarternary ammonium compounds (QACs), surface active compounds, heavy metals and food preservatives; Antibiotics: Mode of action of antibiotics on microbes, brief introduction of viruses, bacterial viruses (bacteriophages); Brief introduction of fungi: yeast and mold, brief introduction of protozoans, brief introduction of multicellular parasites, brief introduction of phycology.

### Practical

Introduction to lab equipment; Microscope: parts and use; Sterilization techniques, glass ware; Preparation of culture media; Culturing techniques: primary culture; spreading, swabbing, subculture streaking; Staining techniques: simple staining and negative staining, gram's staining and capsular staining, spore staining and flagellar staining; Measurement of bacterial cells (micrometry); Study of cell motility by hanging drop method; Study of colony morphology; Bacterial count: direct microscopic count, plate count, dry mass; Phenol co-efficient test.

### Suggested Readings

1. Aneja, K.R. 2016. Laboratory manual of Microbiology and Biotechnology. 1<sup>st</sup> Ed. Med Tech. Kurukshetra. Haryana. India.
2. Green M.R. and J. Sambrook. 2014. Molecular Cloning: a laboratory manual. 3<sup>rd</sup> Ed. Cold Spring Harbor Laboratory Press, New York, NY, USA.



3. Tortora, G.J., B.R. Funke and C.L. Case. 2016. Microbiology: an introduction 11<sup>th</sup>Ed. Pearson Education. Uttar Pradesh. India.
4. Vasanthakumari, R. 2014. Textbook of Microbiology. Wolters Kulwer, New Delhi, India.

### **MICRO-303**

### **Molecular Cell Biology**

**3(2-1)**

#### **Learning Objectives**

During the course, students will be able to:

- Familiarize the learners with the field of Molecular and cell biology
- Develop an in depth understanding of a living cell and its components
- Understand the molecular biology of the cellular processes
- Demonstrate working knowledge of key concepts and terminologies of molecular and cell biology

#### **Course contents:**

Introduction to cell biology: ultra-structure, chemical composition and functions of cell wall, cellular membranes; Cellular organelles (mitochondria, endoplasmic reticulum, golgi apparatus, lysosome, glyoxysome, nucleus, nuclear envelop, ribosomes; Physico-chemical properties of protoplasm; Chemical composition and molecular structure of chromosomes. molecular structure of genes and chromosomes; Histones; Introduction to molecular biology; DNA replication: general overview, prokaryotic mechanisms of DNA replication, eukaryotic Mechanisms of DNA replication; Transcription: general overview, transcription factors I, Transcription Factors II, prokaryotic mechanisms of transcription (details in Micro. Genetics), eukaryotic mechanisms of transcription, RNA polymerases I, II & II. RNA Polymerases II, RNA processing (Capping and poly A-tail), post transcriptional modifications (concept of Introns/ Exons); Regulation of gene expression (Enhancers and Silencers); Translation: general overview, translation in prokaryotes, cytosolic translation, translation on ER, glycosylated and secretory proteins processing; Mutations, chromosomal aberrations, DNA damage and Repair I, DNA damage and Repair II, DNA damage and repair III; Gene sequencing, cloning; Principles of recombinant DNA technology; Basic tools of rDNA Technology (basic introduction of restriction enzymes and plasmids); Role of recombinant DNA technology in economic development.

#### **Practical**

Correct use of Micropipettes; Calculations; Preparation of reagents; Staining of eukaryotic cells; Isolation and estimation of DNA; Genomic DNA Isolation from WBC and Spectrophotometric Estimation of DNA; visualization of Extracted DNA on Agarose Gel Electrophoresis; Genomic DNA Isolation from Bacterial cells; Estimation and Visualization of Genomic DNA Isolation from Bacterial cells; Isolation of total RNA of a eukaryotic cell; Estimation of RNA and its Visualization DNA replication by PCR and its visualization on Agarose gel; Study of different mitotic stages; Study of different mitotic stages; Karyotyping; Protein profile of cells by SDS-PAGE.

#### **Suggested Readings**

1. Ausubel, F.M., R. Brent, R.E. Kingston, D.D. Moore, J.G. Seidman, J.A. Smith and K. Struhl. 2020. Current Protocols in Molecular Biology. 1<sup>st</sup> Ed. McGraw Hill Science, New York, NY. USA.

2. Green M.R. and J. Sambrook. 2014. Molecular Cloning: a laboratory manual. 3<sup>rd</sup> Ed. Cold Spring Harbor Laboratory Press, New York, NY. USA.
3. Lodish, H., D. Baltimore, A. Berk, S.L. Ziprusky and J. Darne. 2013. Molecular Cell Biology. 7<sup>th</sup> Ed. University of California, Los Angeles, CA, USA.
4. Shelly, G.B. and G.A. Wagoner. 2011. Using Computers: A gateway to Information. Boyd and Fraser Publishers, CA, USA.
5. Weaver, R.F. 2011. Molecular biology. 5<sup>th</sup> Ed. McGraw Hill Education, New York, NY, USA.

### **CS-301 Computer Appreciation and Application**

**3(2-1)**

#### **Learning Objectives**

During the course, students will be able to:

- Understand the basic knowledge about computer and its parts.
- Understand the types of network and terminology related to computer.
- Use the computer in professional life.

#### **Theory:**

Overview of computer system: brief history of computers, uses and misuses, importance, future needs; Types of Computer: super, mainframe, minim, micro, desktop, notebook, personnel and workstation; Parts of Computer, CPU, control unit, arithmetic unit, memory; ROM and its types; RAM and its types; Flash memory and cash memory; Buses: data bus, address bus, control bus; Motherboard (circuit boards) Micro-processor and its types; Interacting with Computer; Input device, key board, mouse, track ball, touch screen, touch pads, barcode readers etc, output device: Monitors, types of monitors, printers: types of printers, plotters, storage devices: magnetic storage and optical storage hard disc, tape device, CD etc. Software: Types of software, system software, shareware, application software; Operating system; Network: uses and types of network LAN, WAN; Data communication over telephone lines; Modem, ISDN, DSL and high speed lines, internet: Working of internet, feature of internet: email, newsgroups, telnet, FTP, WWW, HTTP, online services, Addressing schemes: DNS, IP.

#### **Practical:**

Window operating system; Uses of MS Word procession; MS Excel (spreadsheets); Power point exercises and essential use of internet; E-mail and Surfing.

#### **Suggested Readings**

1. David, R. 2010. A Balanced Introduction to Computer Science. 3<sup>rd</sup> Ed. Pearson Education, 3<sup>rd</sup> Ed. Omaha, NE, USA.
2. Norton, P. 2004. Introduction to Computer. 7<sup>th</sup> Ed. McGraw-Hill Technology Education, New York, NY. USA.
3. Saeed, I., A. Raza and T. Mahmood. 2011. The Concept of Information Technology, IT Series Publishers, Lahore, Pakistan.
4. Shelly, G.B. and G.A. Wagoner. 2011. Using Computers: A gateway to Information. Boyd and Fraser Publishers. Boston, MA, USA.

**Learning Objectives**

During the course, students will be able to:

- Identify the cell and its organelles.
- Understand the basic information about basic ingredients of diet.
- Understand the structure and functions of macro-molecules.

**Theory:**

Cell structure and function: Structure, composition and functions of cell organelles; Biomembranes and their functions, cytoskeleton, pH, buffers, transport mechanisms across biological membranes, diffusion, osmosis and osmotic pressure; Enzymes: classification, nomenclature, characteristics, coenzymes, cofactors and prosthetic groups; Mechanism of enzyme action; Enzyme inhibition; Carbohydrates: Classification, characteristics, ring structures and isomerism; Aerobic and anaerobic oxidation of glucose; Biological functions of carbohydrates; Lipids: Composition and classification, structures of saturated and unsaturated fatty acids and their properties, characteristics of fats and oils. General metabolism of fats, beta oxidation of fatty acids; Proteins: Composition and classification, characteristics and classification of amino acids, molecules derived from amino acids, peptides and levels of structural organization of proteins; Physiological functions and general metabolism of proteins; Nucleic acids: Chemical composition and structures of DNA and RNA; Functions of DNA and different types of RNA in the cell; Extra-nuclear DNA and plasmids; Central Dogma and its significance; Introduction to replication, transcription and translation processes.

**Practical:**

Preparation of buffers of definite pH; Determination of pH value of biological fluids; Estimation of optical activity by polarimetry; Qualitative analysis of carbohydrates; Qualitative analysis of urine for albumin, acetone bodies and sugar; Estimation of glucose in biological fluids; Determination of acid, saponification and iodine values of fats/oils; Estimation of lactose and casein in milk.

**Suggested Readings**

1. Ahmad, M. 2009. Essentials of Medical Biochemistry. 8<sup>th</sup> Ed. Ilmi Book House, Urdu Bazar, Lahore. Pakistan.
2. Champe, P.C., R.A. Harvey and D.R. Ferrier. 2008. Biochemistry: Lippincott's Illustrated Reviews. 4<sup>th</sup> Ed. Lippincott Williams and Wilkins, New York, NY, USA.
3. Murray, R. K., D.A. Benderer, K.M. Botham, P.J. Kennelly, V.W. Rodwell and P.A. Weil. 2009. Harper's Illustrated Biochemistry. 28<sup>th</sup> Ed. McGraw Hill New York, NY, USA.
4. Nelson, D.L. and M.M. Cox. 2008. Lehninger Principles of Biochemistry. 4<sup>th</sup> Ed. Worth Publishers. New York, NY, USA.
5. Plummer, D.T. 2009. An Introduction to Practicals: Biochemistry. 3<sup>rd</sup> Ed. Tata McGraw-Hill Education (Pvt) Ltd, New Delhi, India.

**Learning Objectives**

During the course, students will be able to:

- Demonstrate proficiency in English grammar and comprehension skills
- Read, analyze and discuss reading with an understanding of structure and mechanics
- Develop competency in producing correct and error free piece of writing

**Theory**

Reading skills; effective reading habits, comprehension; How to Live to be 200 (Stephen Leacock; TV addiction (marie Winn), Writing skills; Principles of writing good english; Understanding composition process: word, sentence and paragraph level; Process of writing, observing, audience analysis, collecting, composing, drafting and revising, personal writing, descriptive writing; argumentative writing; Narrative writing; Expository writing; précis writing; Grammatical tools; Knowledge about parts of speech and their analysis, punctuation, dash, comma, semi colon, capitalization, presentation skills; Preparing effective presentations.

**Suggested Readings**

1. Eastwood, J. 2009. Oxford Practice Grammar. 3<sup>rd</sup> Ed. Oxford University Press, Karachi, Pakistan.
2. Mark, P. 2013. Presenting in English. Language Teaching Publications, Hove, UK.
3. Shah, S.S.A. 2006. Exploring the world of English. Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan.
4. Wren, P.C. and H. Martin. 2009. English Grammar and Composition. S. Chand & Compay Ltd. New Delhi, India.

**Math-301****Elementary Mathematics****3(2-1)****Learning Objectives**

During the course, students will be able to:

- Understand the basics of mathematics
- Learn important the mathematical designs/equations
- Solve mathematical questions and problems

**Theory**

Number System; Sets and Probability, basic definitions; Sets: algebra of sets; Venn diagram, the real number system; Factorial, Permutations and Probability, Polynomial equations; Finding roots of linear and quadratic equations; Quadratic formula, synthetic division; Application relating polynomial equation; Matrices: Basic definitions; Determinant of a square matrix inverse of a square matrix; Elementary row operations; Solution of system of linear equations with application; Curve tracing; Graph of line and parabola; Curve tracing on matlab; Trigonometry; Basic definitions, congruent triangles, similar triangles;

**Practical:**

Application of trigonometry in finding height and width etc. Differentiation; Basic definitions, limit and continuity; Differentiation by definition, differentiation using formulae; Graphical interpretation of continuity and derivative; Derivative a slope of tangent line; Differentials; Application of differentiation; Integration; Basic definitions; Integration of polynomials.

**Suggested Readings**

1. Anton, H. 1999. Calculus. 6<sup>th</sup> Ed. John Wiley & Sons, New York, NY, USA.
2. Kaufmann, J.E. 1987. College Algebra, and Trigonometry. PWS-Kent Company, Boston, Massachusetts. USA.
3. Kreyszig, E. 2000. Advanced Engineering Mathematics. 8<sup>th</sup> Ed. John Wiley and sons, New York City, NY, USA.
4. Thomas, G.B. 2002. Finney. Calculus and Analytical Geometry, 9<sup>th</sup> Ed. RoohaniAr Press Islamabad, Pakistan.

**SEMESTER 2****MICRO-302****Introduction to Mycology****2(1-1)****Learning Objectives**

During the course, students will be able to:

- Familiarize the learners with the basic concepts of fungi
- Diagnosis of common fungal infections
- Understand the fungal growth and structural characters
- Understand the toxic secondary metabolites of fungi in food and feed

**Theory**

Introduction to mycology and its significance characteristics of fungi: structure and function; Classification of fungi: structural development and reproduction in fungi including cell cycle; Unicellular fungi: The yeasts Growth requirements of fungi (physical and nutritional); Immunity to fungal infections; Mycoses: types and mode of transmission Mycoses: Types and mode of transmission; Opportunistic fungal infections; Diagnosis of fungal infections: cultural and

biochemical diagnosis of fungal infections; Serological and molecular; Antifungal agents (Classes, mechanism of action) and resistance to these antifungals mycotoxins mycotoxicosis.

### **Practical**

Introduction to mycology lab; Equipment Isolation techniques of fungi; Primary culture of fungi; Purification of fungi/sub culturing; Macroscopic identification: Immature and mature colony of fungi Microscopic characters: Cellophane tape and tease mount of fungi Microscopic characters: Slide culture: agar block and agar drop method fungal staining and permanent mount of fungi Identification of yeast; Negative staining and germ tube test dermatophytes; Potassium hydroxide (KOH) mount preparation Inoculum preparation; Antifungal susceptibility testing; Minimum inhibitory concentration of antifungal drugs determination; Log reduction of fungal spores; Mycotoxin production and extraction; Mycotoxin detection by thin layer chromatography (TLC).

### **Suggested Readings**

1. Alexopoulos C. J., C.W. Mims and M. Blackwell. 2017. *Introductory Mycology* 4<sup>th</sup> Ed. John Wiley and Sons, Hoboken, NJ, USA.
2. Devis, H.L. 2017. *Medically Important Fungi*. 5<sup>th</sup> Ed. ASM Press, Washington, NW, USA.
3. Aneja, K.R. 2016. *Laboratory manual of Microbiology and Biotechnology*: 1<sup>st</sup> edition; MedTech. New York, NY, USA.
4. Topley, W.W.C., S. Graham and Wilson. 2007. *Topley and Wilson's Microbiology and Microbial Infections*. 10<sup>th</sup> Ed. Wiley Library. New York, NY, USA.

**Learning Objectives**

During the course, students will be able to:

- Understand the immune response that work together to protect the host
- Understand immune-based diseases as either a deficiency of components or Excess activity as hypersensitivity

**Course Contents:**

Introduction, development and scope of immunology; Classification and types of immunity; Innate (nonspecific) immunity; Natural barriers of defense, phagocytes and complement system; Classical and alternate complement pathways; Acquired immunity; types, immune responses; Antigens: Essential features of antigens, epitope, and cross-reactivity; Macrophage and antigen processing and presentation, other antigen presenting cells, fate of foreign materials within the body; Cells and organs of the immune system (birds and animals) B and T lymphocytes, cell interactions, immuno-regulators, regulation of immune response, immune tolerance; Immunoglobulins: structure, chemical nature, classification, and antibody specificity; Major histocompatibility complex (MHC); Antigen processing by APCs; General properties of complement proteins and their activation; Hypersensitivity: types, mechanism of anaphylaxis and delayed type of hypersensitivity; Immunomodulations; Immunosuppression, immunostimulation and immunopotential; Autoimmunity, autoimmune diseases and tumour immunology; Transplant immunology; Immune response to various bacterial, viral and fungal diseases of man.

**Practical:**

An introduction to equipment used in immunology laboratory; Methods for the preparation of different antigens for serological tests; Hyper-immune sera preparation; Demonstration of sero-diagnostic tests; Agglutination reactions; Haemagglutination test; Haemagglutination Inhibition Test; Precipitation reactions; single diffusion test; Double diffusion test; Agar Gel Precipitation Test (AGPT), Complement fixation test (CFT); Fluorescent antibody technique (FAT); Radio immune assay (RIA); Virus Neutralization (VN); Enzyme Linked Immunosorbant Assay (ELISA); Demonstration of delayed hypersensitivity reaction.

**Suggested Readings:**

1. Jawetz M. and Adelbergs. 2001. Medical Microbiology. Geo F. Brooks, A. Stephen Morse, Janet Butel and Janet S. Butel. McGraw-Hill Companies. New York, NY, USA.
2. Roitt, I. 1994. Essential Immunology. 8<sup>th</sup> Ed. Blackwell Scientific Publications, London, UK.
3. Tizzard, I.R. 1999. Veterinary Immunology -An Introduction. 6<sup>th</sup>Ed. Saunders Co. London, UK.
4. Tortora, G.J., B.R. Funke and C.L. Case. 2016. Microbiology: an introduction 12<sup>th</sup> Ed, Pearson Education, London, UK.

**Learning Objectives**

During the course, students will be able to:

- Familiarize and the basic lay out of virology
- Overview and the nature, replication, host interactions, immunology of viruses
- Learn the process of isolation and purification/ concentration of viruses
- Summarize the techniques used to diagnose viruses

**Theory**

Introduction to the course; sharing of learning outcomes; The nature of viruses: Chemical composition of the virion; Viral nucleic acids in the virion; Viral proteins in the virion; Viral membrane lipids Milestone discoveries in virology with focus on emphasizing, why the discovery was significant; Introducing the technique that led to the discovery, how the discovery has changed the way we study viruses; Virus structure and components: Use of X-ray crystallography and electron microscopy to study virus morphology; Virus isolation and propagation: use of embryonating eggs and cell culture; Virus purification and concentration; determination of particle size (Theoretical aspects of various techniques used); Virus-host interaction-I: infection of cell with more than one viruses; exaltation Virus-host interaction-II: dormancy and reactivation; interference, mechanisms of haemagglutination, haemadsorption and elution; Virus replication-I; Introduction to virus replication and its various stages: adsorption-receptor/ligand, entry mechanisms, uncoating Virus replication-II: biosynthesis of virus components-transcription and translation Virus replication-III: assembly and release.

Replication of an RNA virus: Influenza Replication of a DNA virus; Herpes virus; Miscellaneous topics in viral replication; Oncogenic viruses, defective virus particles. Prions and viroids; Transducing viruses; Genetics and evolution of viruses-I: How viruses change in nature? Mutation; Viral recombination genetics and evolution of viruses-II; Virus-host recombination, viral genome sequence analysis, Evolution of viruses Virus classification (structural and functional); Use of phylogenetic comparisons to classify viruses Viral pathogenesis-I: Routes of infection of respiratory, enteric and arthropod-borne viruses; Viral pathogenesis-II:Dissemination in the host; Hematogenous and neural spread; Viral pathogenesis-III: Clinical signs; what cellular and tissue changes lead to production of clinical signs ; Viral pathogenesis-IV: Virus shedding and patterns of infection; Viral pathogenesis-V; Mechanism of persistence in individuals and communities; Virus Immunology-I: How viruses induce immunity; Immune evasion by viruses; Virus Immunology-II: Interferon properties, types, mode of action, biological significance, antibodies vs interferon; Laboratory Diagnosis of viral infections-I; Collection, preservation and transportation of samples (Theoretical aspects); Laboratory diagnosis of viral infections-II; Discuss principle, overview of technique and interpretations of results of each of the test; Detection of virus, viral antigens or nucleic acids; Laboratory diagnosis of viral infections-III; Diagnostic serology; Discuss principle; Overview of technique and interpretations of results of each of the test: ELISA; Immunofluorescence for antibody detection; Serum neutralization test; Laboratory Diagnosis of viral infections-IV: Diagnostic serology: Discuss principle, overview of technique, and interpretations of results of each of the test: Hemagglutination inhibition test; Complement fixation tests; Western blotting (immunoblotting) technique Antiviral chemotherapy-I; An overview of viral infections and strategies for interrupting virus replication.



Antiviral chemotherapy-II: an overview of various antiviral drugs and their modes of action with a focus on which step in the viral replication cycle they interfere; Viruses for use in cancer treatment and gene therapy Emerging issues in general virology.

### **Practical**

An introduction to equipment used in virology laboratory-I: describe principle, usage and pros and cons of using each instrument; Tissue grinder/ homogenizer, biosafety cabinet, egg incubator, cell culture incubator, ultracentrifuge; An introduction to equipment used in virology laboratory-II; Describe principle, usage and pros and cons of using each instrument: Thermocyclers, gel electrophoresis, DNA sequencer collection: transportation of morbid material-I; collecting clinical samples to preserve virus viability; virus transport media and its composition; Preparation of samples for virus isolation/culture-I; homogenization, clarification, methods to decontaminate clinical samples for virus isolation: treating with antibiotics and antimycotic, use of syringe filters; Preparation of clinical samples for virus isolation/culture-II: comparison of methods to decontaminate clinical samples for virus isolation; antibiotics/antimycotic verses syringe filter; advantages, disadvantages of each method; What to do if one method does not work; Proper labeling, cataloging and storage of homogenates (ultralow freezing) for future studies; Purification and concentration of Viruses-I: ultracentrifugation and precipitation; Purification and concentration of viruses-II: ultrafiltration; Cultivation of Viruses-I: preparation and inoculation: Embryonating egg inoculation; Cultivation of viruses-II: Cell culture; Demonstration of Cytopathic effects (CPE); Cultivation of viruses-III: animal inoculations, ethical issues related with bioassays; Demonstration of any other technique of interest; Demonstration of any other technique of interest; Visit to diagnostic laboratory/research institute; Visit to diagnostic laboratory/research institute

### **Suggested Readings:**

1. Edward, K., W. Martinez, J. Hewlett, C. David, Bloom and D. Camerini. 2007. Basic Virology. 3<sup>rd</sup> Ed. Wiley-Blackwell Science, Hobokin, NJ, USA.
2. Flint, J., V. Racaniello, G. Rall and M. Skalka. 2015. Principles of Virology: Molecular Biology, Pathogenesis and Control. 4<sup>th</sup> Ed. ASM Press, Washington DC, NW, USA.
3. Maclachlan, N. and E.J. Dubovi. 2016. Fenner's Veterinary Virology. 5th Ed. University of California, Davis, CA, USA.
4. Nigel J.D., Andrew, J. Easton and K.N. Leppard. 2016. Introduction to Modern Virology. 7<sup>th</sup> Ed. Wiley-Blackwell Science, Hobokin, NJ, USA.
5. Frederick, A. 2012. The Foundations of Virology: Discoverers and Discoveries, Inventors and Inventions, Developers and Technologies. Murphy Infinity Publishing, West Conshohocken, PA, USA.

**Learning Objectives**

During the course, students will be able to

- Know two nation theory and its necessity.
- Know the Different clarities involved in revelation of Pakistan.
- Gain the knowledge about the brief history of Pakistan.

**Theory:**

Evolution of two nation concept in the sub-continent; Role of two nation theory in the creation of Pakistan; Ideology of Pakistan, founding fathers of Pakistan; Mujadid Alf Sani; Shah Waliullah; Sir Syed Ahmed Khan; Allama Iqbal; Quaid-e-Azam; Constitutional development in Pakistan, objective resolution; basic principle committee reports; Bogra formula; salient features of 1956 constitution; foreign policy of Pakistan ; determinants of Pakistan's foreign policy; different phases of Pakistan's foreign policy; Pakistan's relations with super powers, United Nations Organization; main organs; special agencies; Pakistan role in the UNO.

**Suggested Readings**

1. Allana, G. 2010. Our Freedom Fighters. Ferozsons Ltd, Lahore, Pakistan.
2. Amin, S. 2010. Pakistan's Foreign Policy, Oxford University Press, Karachi, Pakistan.
3. Hussain, A. 2010. Encyclopedia of Pakistan. Jahangir Book Depot, Lahore.
4. Khan, H. 2010. Constitutional and Political History of Pakistan. Oxford University Press, Karachi.

**Learning Objectives**

During the course, students will be able to:

- Understand fundamentals of English language, communication and presentation skills
- Communicate and present effectively and professionally
- Prepare effective presentations and deliver with confidence

**Course Contents**

The nature of communication: Types of communications; Effective communication and its barriers, verbal communication skills, 7Cs of communication, non-verbal communications; Characteristics, functions and types; Listening (audio aids TOEFL and IELTS Practice Tests); Presentation skills; Oral presentations, Persuasive presentations, Computer-based Presentations, Team communication; Negotiation Skills; Debate; Persuasive presentations on research report; Resumes; CV and covering letters; Interview taking; Meetings; Business letters, memos and minutes; Writing and presenting proposals; Class Presentations; Assignments to be given during the course; Letter writing; Proposal writing; Team writing; Sales brochure.

**Suggested Readings**

1. Eastwood, J. 2009. Oxford Practice Grammar. 3<sup>rd</sup> Ed. Oxford University Press, Karachi. Pakistan.
5. Mandel, S. 2011. Effective Presentation Skills: A Practical Guide Better Speaking, New York, NY, USA.
2. Shah, S.S.A. 2006. Exploring the world of English. Ilmi Kitab Khana, Urdu Bazar, Lahore. Pakistan.

**MICRO-308****Basic Biotechnology****3(2-1)****Learning Objectives**

During the course, students will be able to:

- Learn the basic concepts of biotechnology
- Understand the potentials of microorganisms and utilizations of beneficial microorganisms
- **Theory:**  
Introduction to history of biotechnology; Recombinant products expression and transgenic; Design of sterilization systems; Fermentation. ; Product recovery, waste treatment and safety; Biosensors: applications of biosensors, transducer technology principles of biosensors; Recombinant protein production; General aspects of heterologous protein expression; Bacterial expression systems-Escherichia coli and Bacillus subtilis; Saccharomyces cerevisiae as a system for expression of heterologous proteins; Expression in non-saccharomyces yeast species and filamentous fungi and microbial productions; Pharmaceuticals; Diagnostic proteins; Vaccines; Microbial toxins and insecticides.

**Practical:**

Isolation and screening microorganism; Screening for microbial extracellular metabolites; Enzymes and antimicrobial agents; Citric acid fermentation; Field trip to an industry with a large scale fermenter.

**Suggested Readings:**

1. Alex. 2010. Principles of Biotechnology. 4<sup>th</sup> Ed. Department of Biology, University of Waterloo, Ontario, Canada.
2. Baskar,C., S. Baskar, R.S.Dillon. 2012.Biomass Conversion: The Interface of Biotechnology, Chemistry and Materials Science Publisher: Springer-Verlag, New York, NY, USA.
3. Thiemann, W.J. and M.A. Palladino. 2012. Introduction to Biotechnology. 3rd Ed. Benjamin Cummings Publishers, New York, NY, USA.
4. Tourte, Y. and C. Tourte. 2005. Genetic Engineering and Biotechnology: Concepts, Methods, and Agronomic Applications Science Publishers, New York, NY, USA.

**SEMESTER 3****MICRO-401****Introduction to Cell Culture****3(2-1)****Learning Objectives**

During the course, students will be able to

- Learn about familiarize with the basic cell culture techniques
- Orient the students to cell culture
- Give hands on training on maintain cell culture

**Theory:**

History and application of cell culture; The eukaryotic cell: general structure and function, cell cycle, chromosomes, ploidy, karyotypes; Biology of cultures cells: cell adhesion molecules, cell proliferation, cell signaling and energy metabolism, primary and secondary cell culture,

sub-culture techniques for primary and secondary cell lines; Nutritional requirements; Growth and metabolism of cells, serum and growth control; Topo inhibition; Source substitutes; PH regulation; Selection of substrate for the growth of adherent cell line; Detection of bacterial and viral contamination in cell culture; Methods to decontaminate the cell system; Confirmation of cell line; Cell separation techniques; Early cell culture, cell types and morphology of cells in culture; Cell strains and establishment of cell lines; Transformed cells; growth control of mouse fibroblasts and malignancy; the normality of 3T3 fibroblasts cell lines from tumors; Genetics of cells in culture; Origin of mutant cell lines; Negative selection: heterokaryons, malignancy of hybrids; Differentiated, serum dependent normal cells; Role of cyclic nucleotides; 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; Tissue culture and virology; Applications of plant tissue culture.

**Practical:**

Laboratory layout for tissue culture work. Special instruments for tissue culture lab, preparation of glassware for tissue culture. Preparation of tissue culture media and other reagents; Harvesting of organs for tissue cultures: chicken embryonic liver, chicken muscles; Starting a primary culture (tissue digestion, cell count and cell culture); Preparation of monolayer of established cell line available in the lab; Harvesting, counting, storage and revival of cells; Cytopathic effect (CPE) of viruses on tissue culture; Biological titration of viruses (TCID<sub>50</sub>); Cryopreservation of cell line. Plant cell culture.

**Suggested Readings:**

1. Anonymous. 1999. Laboratory Manual for the Isolation and Identification of Avian Pathogens. 4<sup>th</sup> Ed. American Association of Avian Pathologists, Iowa State University Press, Ames, IA, USA.
2. Cann, A.J. 1999. Virus Culture-A Practical Approach. 3<sup>rd</sup> Ed. Oxford University Press, Oxford, UK.
3. Freshney, I.L. 2000. Culture of Animal Cells: 2<sup>nd</sup> Ed. A manual of basic techniques. John Wiley and Sons, New York, NY, USA.
4. Tortora, G.J., B.R. Funke, C.L. Case. 2016. Microbiology: an introduction 11<sup>th</sup> Edition, Pearson Education. New York, NY, USA.

**Path-401**

**General Pathology**

**3(2-1)**

**Learning Objectives**

During the course, students will be able to

- Gain knowledge about the different diseased condition and cell structure.
- Have knowledge about different histopathological techniques.
- Understand the different basic terminology.

**Theory**

Introduction, history and important terms of pathology; Adaptation: atrophy, metaplasia, hyperplasia, hypertrophy, hypoplasia, Cell Injury: Pathogenesis of cell injury, Hypoxic cell injury; Cell injury due to membrane damage; Reversible cell injury – cell swelling and hydropic change; Intracellular lipid accumulation; Lysozomal storage diseases, Types of necrosis (coagulative, caseous, liquefactive, fat, Zenker's necrosis, etc); Outcome of necrosis, autolysis, difference between autolysis and necrosis, Gangrene, difference between gangrene and necrosis;

Exogenous and endogenous pigments, melanin, ceroid, haemosiderin, lipofuscin and mineralization; Circulatory Disturbances: Hyperaemia, Congestion, Oedema, Haemorrhage, Embolism, Shock (hypovolaemic, haemorrhagic, septic), Inflammation: Causes, Inflammatory process and manifestation; Biochemical mediators: General features of mediators, Vasoactive amines (histamine and serotonin), Kinins, Arachidonic acid metabolites; Biochemical mediators: Complement system; Nitric oxide; Types of inflammatory exudates; Chronic Inflammation, Morphological Characteristics of neoplasia; Laboratory Diagnosis of neoplasia; Hypersensitivity reactions; Autoimmunity.

### **Practical**

Introduction to Pathology Lab; General rules for identification of gross changes in various organs/tissues; Preservation and fixation of morbid tissues; Preparation of microscopic slides (Tissue processing, embedding and staining); degenerative changes; Degenerative changes; Various types of infiltrations; Various types of infiltrations; Different types of necrosis; Different types of necrosis; Vascular disturbances; Vascular disturbances; Growth changes; Inflammatory changes in various organs; Inflammatory changes in various organs.

### **Suggested Readings:**

1. Cheville, N.F. 2006. Introduction to Veterinary Pathology. 3<sup>rd</sup> Ed. Iowa State Press, Ames, IW, USA.
  2. Dunlop, R.H. and C.H. Malbert. 2004. 3<sup>rd</sup> Ed. Veterinary Pathophysiology. Blackwell Publishers, Ames, IW, USA.
- McGavin, D.M. and J.F. Zachary. 2006. Pathologic Basis of Veterinary Disease. 4th Ed. Mosby Print, St. Louis, MO, USA.

## **MICRO-403**

## **Bacterial Cell Physiology**

**4(3-1)**

### **Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the basics bacterial cell structure, function and stress response
- Learn and identify basic components of cells
- Learn the bacterial cell functions in normal and stress conditions

### **Course Contents:**

Introduction to Bacterial cell physiology; E. coli as a model organism to understand bacterial cell physiology; Detailed organization of bacterial cell and its comparison with archaea and eukarya; Bacterial cell structures and their relationship with functions: Structures outer to cell membrane; Bacterial cell structures and their relationship with functions: Structures inner to cell membrane; Bacterial cell structures and their relationship with functions: Special structures; Chemical composition and biosynthesis of macromolecules in microbial cells; Biosynthesis of peptidoglycan; Biosynthesis of outer membrane; Genomic organization of prokaryotes, Biosynthesis of DNA; Biosynthesis of RNA; Biosynthesis of proteins; Bacterial growth and growth curve, Chemostats as an indispensable tool for physiological studies; Physical requirements for bacterial growth; Physical requirements for bacterial growth; Chemical requirements for bacterial growth; Nutritional types of bacteria; Photoautotrophs Chemoautotrophs; Uptake of nutrients for bacteria, Secretion of molecules in bacteria; Bacterial Metabolism: Carbohydrates metabolism: Glycolytic pathways (EMP Pathway), Carbohydrates metabolism- Glycolytic pathways (Pentose phosphate pathway), Carbohydrates metabolism: Glycolytic pathways (Entner

duoderauff pathway), Fates of pyruvic acid in bacteria; Anaerobic respiration; Bacterial fermentations: Acidic fermentations, Alcoholic fermentation, Metabolism of proteins in bacteria. Essential & Non-essential amino acids; Metabolism of nucleic acids in bacteria; Metabolism of fatty acids and lipids in bacteria and their importance for ruminants; Coordination of different metabolic pathways; Microbial enzymes; Classifications, chemistry, mechanism of action and inhibition of enzymes, enzyme activity and its determination; Stress response in bacteria; Paradigms of bacterial pathogenesis; Quorum sensing in bacteria; Bacterial physiology and its implications in genomic era; genomic, proteomic and traditional tools

**Practical:**

Preparation of different media and solutions; Preparation of growth curve by spectrophotometric method; Preparation of growth curve by viable count method; Optimization of physical factors for growth of bacteria; Optimization of chemical factors for growth of bacteria; Isolation of polysaccharides from bacteria; Estimation of total protein from bacterial cell; Isolation of lipids from bacteria; Isolation and purification of a bacterial enzyme; Determination of bacterial enzyme activity; Biochemical testing: catalase and oxidase test; IMViC test, Coagulase test blood agar hemolysis test; Biochemical testing: Starch Hydrolysis and gelatin hydrolysis test, Casein Hydrolysis, lipid hydrolysis; Biochemical testing: Carbohydrate fermentation test, Triple sugar iron agar test, urease production test; Nitrate reduction test; Biochemical testing: Use of API Kits; Identification of *E. coli* by biochemical testing; Identification of *Staphylococcus aureus* by biochemical test.

**Suggested Readings:**

1. Dawes and W. and I.W. Sutherland. 1991. Microbial Physiology. 2<sup>nd</sup>Ed. Blackwell, Hoboken, NJ, USA.
2. Gottschalk, G. 2012. Bacterial Metabolism 2<sup>nd</sup> Ed. Springer. New York, NY, USA.
3. Kim, B.H. and G.M. Gadd. 2008. Bacterial Physiology and metabolism. Cambridge University Press, London, UK.
4. Urquhart, G.M., J. Armour, J.L. Duncan, A.M. Dunn and F.W.Jennings. 2000. Veterinary Parasitology. 3<sup>rd</sup> Ed. Longman Scientific and Technical, London, UK.
5. York, A. 2017. Bacterial physiology: An inside job on metabolism. 11<sup>th</sup> Ed. London, UK

## اهداف و مقاصد

- 1:- طلبہ و طالبات کو قرآن وحدیث سے استفادہ کے قابل بنانا۔
- 2:- طلبہ و طالبات کے قلوب و اذہان میں قرآن وحدیث کی روح اور علم کو راسخ کرنا۔
- 3:- طلبہ و طالبات میں اسوۂ حسنہ المرسلین ﷺ کے اتباع اور حب رسول کا جذبہ پیدا کرنا۔
- 4:- اسلام کی بنیادی تعلیمات کا فہم آسان بنانا اور طلبہ کی اسلامی بنیادوں پر تربیت کرنا۔
- 5:- امت مسلمہ کو درپیش عصر جدید کے چیلنجوں سے طلبہ کو آگاہ کرنا۔
- 6:- طلبہ و طالبات میں مذہبی اور سماجی برداشت پیدا کرنا اور انتہا پسندی کی مذمت کرنا۔

## غیر مسلموں سے مسلمانوں کے تعلقات اور اسلامی تعلیمات

الاعراف: ۷، ۱۵۸

## قرآن کی روشنی میں غیر مسلموں سے تعلقات

(بیٹھوان درج ذیل قرآنی آیات کی روشنی میں پڑھایا جائے گا)

الاسراء: ۷۰، الانعام: ۷، الاعراف: ۷، الحجر: ۹۱، البقرہ: ۱۷۵، النمل: ۱۶، المائدہ: ۵، المائدہ: ۸۴، المائدہ: ۵، الحج: ۲۹، آل عمران: ۱۱۸، المائدہ: ۵، المائدہ: ۵۹، المائدہ: ۶۱-۶۳، التوبہ: ۲۹، التوبہ: ۵، التوبہ: ۹، التوبہ: ۲۸، التوبہ: ۳۳، التوبہ: ۹، التوبہ: ۸، التوبہ: ۸، التوبہ: ۱۱۰، الحج: ۱۵، المائدہ: ۸۵، آل عمران: ۳، الانبیاء: ۲۱، الاحزاب: ۲۱، ۳۳

## سنت نبوی ﷺ کی روشنی میں غیر مسلموں سے تعلقات

(اس عنوان کی تدریس میں درج ذیل احادیث اور واقعات سے مدد لی جائے گی)

الکشاف للبخاری: ۶۶۸/۳، بخاری: باب غزوہ ذات الرقاع، کتاب الاستیذان، باب ائدھ للشرکین، باب ائدھ من قس معاہدہ ائدھ جرم، باب شراب، ائدھ بانسیدہ، صحیح مسلم: باب فتح مکہ، سنن ابی داؤد: باب الرجل یموت لقریبہ مشرک، باب لمس الریح، باب فی تعصیر امل الذمۃ اذا اختلفوا، الجامع ترمذی: باب ما یاء فی مرعباء، باب ما یاء فی قبول بدایا الشرکین، تفسیر سورۃ الفتح، مستدرج بن خلیل: ص ۲۲۱/۳، ۲۷، مصنف عبد الرزاق: ص ۳۹۲/۱۰، ایضاً ص ۳۶۶/۶، تفسیر: شعب الایمان، ص ۵۱۸/۶، مکتب المدینہ: ص ۵۲۷، ابن ہشام: السیرت النبویہ، ص ۱۹۳-۱۹۷، شمسی نمائی: سیرۃ النبی، ص ۲۵۶-۲۵۷، عینی بن آدم القرظی: کتاب الفرائض، ص ۲۱۵، الامالیہ: ص ۸/۲، طبقات ابن سعد: ص ۱۱-۱۲، ص ۱۱۲۳-۱۱۲۴، ۳۵۷

## مطالعہ قرآن مجید کی ضرورت و اہمیت

- قرآن کریم سے متعلق موضوعات کے بارے میں آیات دی جائیں گی اور ان کی تشریح کی جائے گی۔
- (۱) ایمانیات (دلائل کا عقلی و نقلی مطالعہ)
  - (ب) توحید، رسالت، ملائکہ، کتب اور آخرت کے اثبات پر دلائل۔ عتق نبوت۔ ماموس رسالت عبادات
  - (ج) نماز، زکوٰۃ، روزہ، حج، جہاد
  - (د) فکرو تدریس اسلام کا تصور علم اور تصور اہمیت



- (د) خدمتِ خلق  
(ه) مؤمن کی صفات  
(و) دعوتِ دین کی ضرورت و اہمیت، نوعیت، امر بالمعروف، نہی عن المنکر  
(ز) کسبِ حلال

### قرآن کریم کی منتخب آیات

- (۱) البقرة (۲: آیات ۲۸۴-۲۸۶) اللَّهُ مَا فِي السَّمَوَاتِ وَمَا فِي الْأَرْضِ ..... عَلَى الْقَوْمِ الْكَافِرِينَ ه  
(ایمانیات)  
(۲) الحجرات (49: آیات 1-18) موضوع آداب نبوی، معاشرتی احکام  
(۳) المؤمنون (23: آیات 1-11) صفات مؤمنین  
(۴) الفرقان (25: آیات 63-77) موضوع آداب معاشرت  
(۵) الانعام (6: آیات 152-154) احکام  
(۶) الاحزاب (33: آیات 6-21-40-56-57-58) تخصصات نبوی  
(۷) النحل (59: آیات 18-19-20) فکر آخرت - عظمت قرآن  
(۸) القف (61: آیات 1-14) تفکر و تدبیر سے متعلق آیات - بشارت بعثت ختم المرسلین - دعوت اور اقامت دین  
(۹) حم اسجدہ (41: آیت 53) سَنُرِيهِمْ آيَاتِنَا فِي الْأَفَاقِ وَلِي نُنْفِيسَهُمْ حَتَّى يَسْمَعُوا أَنَّهُ الْحَقُّ ه  
(۱۰) آل عمران (3: آیات 190-191) "إِنَّ فِي خَلْقِ السَّمَوَاتِ وَالْأَرْضِ وَأَخْتِلَافِ اللَّيْلِ وَالنَّهَارِ لَآيَاتٍ لِّأُولِي الْأَلْبَابِ....."  
(۱۱) النحل (16: آیات 12-14) "وَسَخَّرْنَا لَكُمْ اللَّيْلَ وَالنَّهَارَ"، قرسن (31: آیت 20) "أَتَرَوْا اللَّهَ سَخَّرْنَا لَكُمْ مَّا فِي السَّمَوَاتِ وَمَا فِي الْأَرْضِ وَاسْمِعْ عَلَيْكُمْ نِعْمَهُ....."

### احادیث مبارکہ

- (۱) عن عبد الله قال : قال رسول الله ﷺ طلب كسب الحلال فريضة بعد الفريضة (بيهقي، شعب الإيمان) -  
(۲) عن ابي سعيد قال : قال رسول الله ﷺ التاجر الصدوق الأمين مع النبيين والصديقين والشهداء. (جامع ترمذی . سنن دارمی)  
(۳) عن ابن مسعود عن النبي ﷺ لا تنزل قد ما ابن آدم حتى يستل عن خمس عن عمره فيما افناه وعن شبابه فيما ابلاه وعن ماله من اين اكتسبه وفيما انفقه وما ذا عمل فيما علم (جامع ترمذی) -  
(۴) عن ابي هريرة قال : كان رسول الله ﷺ يقول : اللهم اني اعوذ بك من الاربعة من الاربعة : من علم لا ينفع، ومن قلب لا يخشع ومن نفس لا تشيع، ومن دعاء لا يسمع (مسند احمد، ابو داود، ابن ماجه) مشكاة المصابيح ج ۲ : ص ۲۳ حديث نمبر ۲۸۶۸) -  
(۵) عن علي قال : رسول الله ﷺ من ملك زاد او راحلة تبلغه الى بيت الله ولم يحج فلا عليه ان يموت يهوديا او نصرانيا وذلك ان الله تبارك وتعالى يقول ولله على الناس حج البيت من استطاع اليه سبيلا (جامع ترمذی) -  
(۶) عن ابن عباس ان النبي ﷺ قال اربع من اعطينهن فقد اعطى خيرا الدنيا والاخرة قلبا شاكرا او لسانا ذاكرا او بدنا على البلاء صابرا وزوجة لا تبغيه حوبا في نفسها وماله (سنن لساني) -  
(۷) عن ابي هريرة ان رسول الله ﷺ قال : اندرون ما المفلس؟ قالو : المفلس فينا من لا درهم له ولا متاع، قال : ان المفلس من امتي من ياتي يوم القيامة بصلاة وصيام وزكوة ، وياتي قد شتم هذا وقذف هذا واكل مال هذا وسفك دم هذا وضرب هذا، فيعطى هذا من حسناته وهذا من حسناته ، فان فئت حسناته قبل ان يقضى ما عليه اخذ من خطاياهم فطرحت عليه ثم طرح في النار -



- (۸) عن ابی ہریرۃؓ قال : قال رسول اللہ ﷺ من اتاه اللہ مالا فلم یؤد زکوٰۃ مثل ما لہ یوم القیامۃ شجاعاً اقرع لہ زببتان یطوقہ یوم القیامۃ ثم یأخذ بلہزم متیہ ( یعنی شدقیہ ) ثم یقول انا مالک وانا کنزک ثم تلا ولا یحسین الذین یبخلون بما اتہم اللہ من فضلہ ہو خیر الہم بل ہو شر الہم سیطوقون ما بخلوا بہ یوم القیامۃ ( صحیح بخاری ) -
- (۹) عن شبرمۃ بن معبدؓ قال : قال رسول اللہ ﷺ مروا الصبی الصلوۃ اذا بلغ سبع سنین واذ بلغ عشر سنین فاضر بواہ علیہا - اخرجہ ابو داود و الترمذی و لفظہ علموا الصبی الصلوۃ ابن سبع سنین و اضر بواہ علیہا ابن عشر -
- (۱۰) قال رسول اللہ ﷺ تجدون شر الناس یوم القیامۃ ذالو جہین الذی یتاہی ہو لاء بوجہ و ہو لاء بوجہ ( متفق علیہ ) -
- (۱۱) قال رسول اللہ ﷺ یجاء بالرجل یوم القیامۃ فیلقى فی النار فتندلق اقبانہ فی النار فیطحن فیہا کطحن الحمار برحاہ فیجتمع اهل النار علیہ فیقولون ، ای فلان ماشانک؟ الیس کنت تامرنا بالمعروف و تنہانا عن المنکر؟ قال کنت امرکم ولا اتیہ و انہا کم عن المنکروا تہ -
- (۱۲) عن ابی ہریرۃؓ قال : قال رسول اللہ ﷺ من سلك طریقاً یتلمس فیہ علماً سهل اللہ لہ بہ طریقاً الی الجنۃ ، و ما یجتمع قوم فی بیت من بیوت اللہ یطلون کتاب اللہ و یتدارسون بینہم الا نزلت علیہم السکینۃ و غشیتہم الرحمۃ و حففتہم الملئکۃ و ذکرہم اللہ فیمن عنده ، و من بطأہ عملہ لم یسرع بہ نسبہ ( مسلم ) -
- (۱۳) قال رسول اللہ ﷺ ان اتقل شی یوضع فی میزان المؤمن یوم القیامۃ خلق حسن ، و ان اللہ یغض الفاحش البلی ( ترمذی ابو الدرداء )
- (۱۴) عن عمر بن الخطابؓ قال : قال رسول اللہ ﷺ حین سئل عن الایمان ان تؤمن باللہ و ملائکتہ و کتبہ و رسلہ و الیوم الآخرہ و تؤمن بالقدر خیرہ و شرہ ( متفق علیہ ) -
- (۱۵) عن عباس بن عبدالمطلبؓ قال : قال رسول اللہ ﷺ ذاق طعام الایمان من رضی باللہ رباً و بالاسلام دیناً و بمحمد رسولاً -
- (۱۶) عن انسؓ قال : قال رسول اللہ ﷺ و الذی نفسی بیدہ لایومن عبد حتی یحب لا خیر ما یحب لنفسہ ( متفق علیہ ) -
- (۱۷) عن النعمان بن بشیرؓ قال : قال رسول اللہ ﷺ تری المؤمنین فی تراحمہم و تواضعہم و تعاطفہم کمثل الجسد ان اشتکی عضو تداہی لہ سائر الجسد بالسہر و الحمی ( متفق علیہ ) -
- (۱۸) عن ابن عمرؓ قال : قال رسول اللہ ﷺ بنی الاسلام علی خمس شہادۃ ان لا الہ الا اللہ و ان محمد عبده و رسولہ - و اقام الصلوۃ ایتاء الزکوٰۃ و الحج و صوم رمضان ( متفق علیہ ) -
- (۱۹) عن ابی سعید الخدریؓ عن رسول اللہ ﷺ قال من رای منکم منکراً فلیغیرہ بیدہ فان لم یستطع فبلسانہ فان لم یستطع فبقلبہ و ذالک اضعف الایمان ( رواہ مسلم ) -
- (۲۰) عن عبداللہ بن عمرؓ قال : قال رسول اللہ ﷺ الا کلکم راع و کلکم مسئول عن رعیتہ فالامام الذی علی الناس راع و هو مسئول عن رعیتہ و الرجل راع علی اهل بیئہ و هو مسئول عن رعیتہ و المرأۃ راعیۃ علی بیت زوجها و ولده و ہی مسئوۃ عنہم و عبد الرجل راع علی مال سیدہ و هو مسئول عنہ الا فکلکم راع و کلکم مسئول عن رعیتہ ( متفق علیہ ) -

## سیرت النبی صلی اللہ علیہ و آلہ وسلم

- (۱) مطالعہ سیرت النبی ﷺ کی ضرورت و اہمیت
- (۲) تزکیہ نفس اور تہذیب سیرت و شخصیت
- (۳) اقامت دین کا نبوی طریق - خلافت
- (۴) اجتماعیت و تشکیل معاشرت اور اسوہ حسنہ - اخوت و اتحاد و اوست
- (۵) قرآن مجید میں سیرت سرور عالم ﷺ کا بیان (۶) غزوات نبوی - مقاصد و حکمت

## تہذیب و اخلاق

تہذیب کا مفہوم، اسلامی تہذیب کی خصوصیات، حسن معاشرت، فضائل اخلاق، رد ذائل اخلاق۔  
 حقوق العباد - حقوق نسواں - تربیت اولاد - حلال و حرام - غیر مسلموں سے تعلقات - عدل - احسان - ایتائے ذی القربی - بنیادی انسانی حقوق

مجتہد الوداع۔ ماحولیات۔ قرآن حکیم کا یہود و نصاریٰ۔ مشرکین اور منافقین سے مکالمہ۔ تہذیب انسانی کے ارتقاء میں مسلمانوں کا کردار۔

## مجوزہ کتب

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☆ امام مالک، موطا امام مالک، دار الفکر، بیروت، 1989ء

☆ بخاری، محمد بن اسماعیل، صحیح بخاری، مکتبہ دارالسلام ریاض، 2008ء

☆ مسلم بن حجاج، صحیح مسلم، مکتبہ دارالسلام ریاض، 2008ء

☆ نسائی، احمد بن حشیب، سنن نسائی، مکتبہ دارالسلام ریاض، 2008ء

☆ ابوداؤد، سنن ابی داؤد، مکتبہ دارالسلام ریاض، 2008ء

☆ ترمذی، ابویسعی محمد عیسیٰ، جامع ترمذی، مکتبہ دارالسلام ریاض، 2008ء

☆ ابوبکر، عبدالرزاق بن ہمام، المصنف، تحقیق حبیب الرحمن، الکتب الاسلامی، بیروت لبنان

☆ بیہقی، حسین بن علی، شعب الایمان (۹۱۲۵) ادارہ تالیفات اشرفیہ، ملتان، سن

☆ یحییٰ بن آدم القرظی، کتاب الفرائض، مطبعہ الکلیہ العلمیہ لاہور

☆ احمد بن حنبل، مسند المطبوعہ السنیہ، مصر ۱۳۱۳ھ

☆ ابن کثیر، تفسیر ابن کثیر، مکتبہ قدوسیہ لاہور، 2003ء

☆ ذحیری، ابوالقاسم محمد بن عمر، الکشاف عن غرائب المعانی، دار احیاء التراث العربی، بیروت لبنان، سن

☆ سید مودودی، تفسیر القرآن، ادارہ ترجمان القرآن، لاہور، 2011ء

☆ ابن ہشام، السمرت البیہ، دار احیاء التراث العربی، بیروت لبنان، 1971ء

☆ شبلی نعمانی، سیرۃ النبی، المفصل ناشران و ناشران کلمنٹو

☆ ابن حجر، محمد بن عسقلانی، الاصاب، دار احیاء التراث العربی، بیروت لبنان، ۱۳۳۸ھ/۸/۲

☆ ڈاکٹر خالد علوی، اسلام کا معاشرتی نظام، المفصل ناشران کتب لاہور، 2008ء

☆ قاضی سلیمان منصور پوری، رحمۃ للعالمین، مکتبہ اسلامیہ لاہور، 2008ء

☆ صفی الرحمن، الریح الختم، المکتبہ السننویہ لاہور، 2011ء

☆ سید سلیمان ندوی، خطبات مدارس، ادارہ مطبوعات طیبہ لاہور، 1995ء

☆ مودودی، ابوالاعلیٰ، الجہاد فی الاسلام، ادارہ ترجمان القرآن لاہور، 2004ء

☆ مودودی، ابوالاعلیٰ، دینیات، ادارہ ترجمان القرآن لاہور، 2001ء

☆ خورشید احمد، اسلامی نظریہ حیات، شعبہ تصنیف و تالیف، جامعہ کراچی، 1997ء

☆ ڈاکٹر طاہر القادری، دہشت گردی اور فتنہ خوارج، منہاج القرآن پبلی کیشنز لاہور، 2015ء

☆ شیخ محمد بن صالح العثیمین، اسلام میں بنیادی حقوق، دارالسلام لاہور، 2011ء

☆ Hameedullah, (2001) Introduction to Islam, Sh. Ashraf Publishers, Lahore.

Marranci G. (2010), Muslim Societies and The Challenge of Secularization. Singapur: National University of Singapur.

**SSH-402**

**ETHICS**

**3(3-0)**

### **Learning Objectives**

During the course, students will be able to

- Understand Ethical teachings of world religions
- Learn Major theories of the moral standards

### **Theory**

Definition and scope of ethics: relation of ethics to psychology, metaphysics and relegation; A brief review of major theories of the moral standard: The standard as law; The standard as happiness; The standard as perfection. Promotion of Moral Values in society through family and various educational and cultural institutions; concept of good and evil; freedom and responsibility; various theories of punishment; Ethical teachings of world religions with special reference to Hinduism, Buddhism, Judaism and Islam; Hundred ethical precepts from the Quran and the sayings of the Holy Prophet (PBUH); Islam's attitudes towards minorities.

### **Suggested Readings**

1. Gaer, J. 1984. What the Great Religions Believe. The New American Library, New York, NY, USA.
2. Mackenzie, J.A. 1957. A Manual of Ethics, Latest editions University Tutorial Press Ltd., London, UK.
3. Mackenzie, J.A. 1957. A Manual of Ethics, Latest editions University Tutorial Press Ltd, London, UK
4. Sidgwick, H. 1963. The Methods of Ethics. MacMillan & Co. Ltd, London, UK.

**BOT-401**

**Plant Diversity**

**3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Understand the diversity of life (origin of Prokaryotes and eukaryotic diversity)
- Describe, classify and appreciate the biology and evolution of plant architecture
- Demonstrate the technical description of plants

### **Theory**

Introduction; Diversity of life; Prokaryotes and origin of metabolic diversity; Origin of eukaryotic diversity; Comparative study of life form, structure, reproduction and economic significance of Viruses (RNA and DNA types); Plant and colonization of land; Plant structure and growth; Methods of plant reproduction; Developmental mechanism and control systems of plants.

### **Practical**

To study different parts of microscope; study of specimens like volvox; spirogyra; rhizopus; yeast; lichens; marchantia; funaria; adiantum; equistem; cyeas; pinus and few seasonal representatives of monocot and dicot angiosperms. Observation of prepared slides; transverse section of stem; leaf and roots of monocots and dicots. To perform Gram-staining of bacteria

## **Suggested Readings**

1. Judd, W.S., C.S. Campbell, E.A. Kellogg, P.F. Stevens, Donoghue. 2016. Plant Systematics– A Phylogenetic Approach (current edition). Sinauer Associates Inc. Publishers, NY, USA.
2. Raven, P.H., R.F. Evert, S.E. Eichorn. 2013. Biology of Plants, Worth. Inc.
3. Hussain, F. 2012. A Text Book of Botany and Biodiversity. Pak Book Empire.
4. Plant Physiology, L. Taiz, E. Zeiger, 5th edition (2011), Benjamin Cummings Publishing Co. Inc.

**ENG-401**

**Technical and Business English Writing**

**3(3-0)**

## **Learning Objectives**

This course will enable the students to:

- Understand the requirements and ethics of technical and business writing
- Work professionally to produce effective business documents incorporating verbal, visual, and multimedia materials as necessary
- Communicate effectively by analyzing audience, organizing documents, writing clearly and precisely with no grammar errors

## **Theory**

Introduction of business and technical english; Oral Communication; Reader-Centered Writing, Audience Analysis; Effective Communication; Defining Objectives; Planning Business Messages; Composing business Messages; Revising business Messages, Memorandums, Meeting Documents and Proposals, Letters; Writing Direct Requests, Writing Routine, Good-News and Goodwill Messages; Writing Bad-News Messages; Writing Persuasive Messages, Writing Short Reports; Planning Long Reports; Writing long reports, General reports, Empirical Research Report; Feasibility Reports; Progress Reports. Proposals; Instructions, Using Visual Aids; Creating Twelve Types of Visual Aids; Writing Specifications and Analysis Reports; How to avoid common writing problems; Language Review: The Paragraph; Sentences, Words and Punctuation; Writing Mechanics; Interviews; Planning interviews and conducting Meetings; Giving Speeches and Oral Presentations.

## **Suggested Readings**

1. Brown, B. W. 2009, Successful Technical Writing/Instructor's Guide, Goodheart-Willcox Publisher, South Holland.
2. Handford, M., M. Lisboa, A. Koester and A. Pitt. 2011. Business Advantage Upper-intermediate Student's, Cambridge University Press, New York, NY, USA.
3. Shahid, G.M. 2010. Business Communication and Report Writing. Rizwan Publishers, Faisalabad, Pakistan.
4. Shah, A.S. 2006. Exploring the World of English. Ilmi Kitab Khana, Lahore, Pakistan.

## SEMESTER 4

**MICRO-402                      Fundamentals of Microbial Genetics                      3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the basic of microbial genetics
- Learn about DNA replication, Transcription origins of replication
- Learn and build capacity of characterization and evaluation of genetic processes

### **Theory:**

Nucleic acids structure and functions; DNA replication: origins of replication, replication strategies, transcription; Control of gene expression in prokaryotes: polycistrons; Transcriptional initiation and termination, The introduction to operons, *Lac*-Operon, *Ara* operon, *Tryp*- Operon catabolite repression and attenuation control; Protein synthesis -mRNA translation: Degenerate code, codon usage, codon preference, Polarity of the genetic material of viruses, reverse transcription mechanism; Replication in bacteriophages- lytic cycle ( $\lambda$  phage); Lysogenic cycle ( $\lambda$  phage); Plasmids, episomes, transposons, Genetic recombination: generalized recombination; Site-specific recombination and illegitimate recombination, Gene transfer mechanisms and their role in evolution: Transformation, transduction, conjugation and cross-phylogenetic transfer; DNA mutagenesis and mutagenic agents: repair and mutation suppression; DNA damage and repair systems; gene mapping by conjugation and transduction; Circular chromosomal maps of bacteria; Yeast Artificial Chromosomes; Bacterial Artificial Chromosomes.

### **Practical:**

Introduction and learning outcomes; Preparation of media and reagents; Revival of organism containing plasmid (*E. coli*), Plasmid Prep (Mini preps), Agarose gel electrophoresis of isolated plasmid; Genomic DNA Isolation from Bacterial cells (gram positive bacteria, *Staphylococcus aureus*); Estimation and Visualization of Genomic DNA Isolation from Bacterial cells; Isolation of RNA from Virus (e. g. NDV, AIV, etc.); Estimation of RNA and its Visualization; Preparation of Competent cells by  $\text{CaCl}_2$ , Transformation; Plasmid Shedding, Conjugation; Site directed mutagenesis by PCR and its visualization on Agarose gel; Operon models- *Lac/Tryp* operon; Replica plating for sorting of mutants.

### **Suggested Readings**

1. Davis B. D. , R. Dulbecco, H. N. Eisen, H. Ginsberg and J. R Wood. 1990. McGraw-Hill Microbiology. 4th Ed. Harper and Row Publisher, New York, NY, USA.
2. Madigan, M.T., J.M. Martinko and J. Parker. 2017. Brock biology of microorganisms 14<sup>th</sup> Ed. New York, NY, USA.
3. Rolf W. 2000. Transcription regulation in lower prokaryotes. Oxford University Press.
4. Uldis N., E. Ronald and Yasbin. 2002. Modern Microbial genetics. Wiley, John & Sons, New York, NY, USA.
5. Willey, J., L. Sherwood and C.J. Woolverton. 2017. Prescott's Microbiology. 10<sup>th</sup> Ed. McGraw-Hill Education. New York, NY, USA.

**Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the basic of antimicrobials, antibiotics and probiotics
- Learn and identify causes of antibiotic resistance in microbes
- Learn and build capacity of characterization and evaluation of probiotic products

**Theory:**

Introduction to antimicrobials: antibiotics, antifungals, antivirals; Antibiotic resistance and need for alternative antimicrobials; Alternatives of antibiotics: plant extracts, nanoparticles, bacteriophages, bacteriocins, probiotics, prerequisites of probiotics Lactobacilli, Bifidobacteria, *Saccharomyces cerevisiae* and other potential probiotics; Strategies for probiotic development; Production and evaluation of probiotics, Nutritional and therapeutic benefits of probiotics in Human; Benefits of probiotics in poultry, aquaculture and livestock; Mechanism of action of probiotics; Survival of probiotics in different foods products etc. Legislation relating to products containing probiotics; Commercial developments in probiotics; Recent advances and future prospects of probiotics.

**Practical:**

Introduction to practical aspects of probiotics and antimicrobials; Antibiotic susceptibility testing of poultry and human pathogen by disk diffusion method; Determination of antimicrobial activity of medicinal plants/herbal products against antibiotic resistant bacteria, Isolation of probiotic bacteria (*Lactobacillus/Bifidobacterium/Streptococcus/Bacillus*) from a commercial probiotic product (Protexin/grow Big); Isolation of probiotic bacteria (*Lactobacillus/Bifidobacterium/ Streptococcus/ Bacillus*) from a fecal samples/ fermented foods etc. Preservation/storage of Probiotic strains; Identification of probiotic bacteria (*Lactobacillus*) by culture and biochemical methods; DNA Extraction from Probiotic bacteria, Identification of probiotic bacteria to genera/specie level (*Lactobacillus*) by PCR; Determination of resistance of lactobacilli to Low pH and Bile salts, Auto-aggregation and co-aggregation of potential Probiotics; Preparation of cell free supernatants of lactobacilli in MRS broth; Determination of antimicrobial activity of lactobacilli against pathogenic bacteria of poultry/human origin by well diffusion assay; Inhibition of salmonella of poultry/human origin by lactobacilli in co-culture experiments; Inhibition of urease producing bacteria (*Proteus spp.* ) of poultry origin by lactobacilli; Survival of probiotics in different foods i. e milk etc.

**Suggested Readings:**

1. Kenji, S. and A. Yokota. 2011. Lactic Acid Bacteria and Bifidobacteria: Current Progress in Advanced Research by Kenji Sonomoto and Atsushi Yokota. Caister Academic Press. Norfolk, UK.
2. Koen, V. and A.P. Carmo. 2015. Probiotics and Prebiotics: Current Research and Future Trends by Caister Academic Press, Norfolk, UK.
3. Madigan, M.T., J.M. Martinko and J. Parker. 2017. Brock biology of microorganisms 14<sup>th</sup> Ed. New York, NY, USA.
4. Willey, J., L. Sherwood and C.J. Woolverton. 2017. Prescott's Microbiology. 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.

**MICRO-406****Proteomics****2(1-1)****Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the basic strategy for the purification of proteins
- Carry out a multi-step purification procedure to isolate a single protein from a complex mix
- Study protein features useful in separation
- Demonstrate working knowledge of key concepts and terminology of separation techniques and principles

**Theory:**

Introduction to the course; Sharing of learning outcomes; Amino acids structure; Properties of amino acids; Classification of amino acids; Peptide linkage and proteins; Classification of proteins; Levels of organization of protein structure; Protein purification methods and strategies; Isolation of protein from different sources; Precipitation of proteins; Centrifugation techniques; Chromatography and its types; Gel filtration chromatography; Ion Exchange chromatography; Affinity chromatography; Monitoring of protein purification process.

**Practical**

Filtration; Precipitation with ammonium sulfate; Centrifugation; Dialysis; Fluorimetric and Spectrophotometric Assays, and gel filtration chromatography; Biochemical Assays; Plot gel filtration data; Ion exchange chromatography; Electrophoresis of proteins and detection in gels; SDS Polyacrylamide gel Electrophoresis of Proteins; Gradient SDS Polyacrylamide Gel Electrophoresis of Proteins; Protein Blotting.

**Suggested Readings:**

1. Madigan, M.T., J.M. Martinko and J. Parker. 2017. Brock biology of microorganisms. 14<sup>th</sup> Ed. Pearson, New York City, New York. USA.
2. Rosenberg, I.M. 2005. Protein Analysis and Purification (Bench Top Techniques). 2<sup>nd</sup> Ed. Published by Birkhauser. Boston, MA, USA.
3. Simon, R. 2001. Protein Purification Techniques. 2<sup>nd</sup> Ed. Oxford University Press, Oxford, England .
4. Willey, J., L. Sherwood and C.J. Woolverton. 2017. Prescott's Microbiology. 10<sup>th</sup> Ed. McGraw-Hill. New York, NY, USA.

**PATH-402****Clinical Pathology****3(1-2)****Learning Objectives**

During the course, students will be able to

- Learn about basics of clinical pathology
- Know preservation of pathological samples
- Learn diagnostic techniques of pathology

**Theory**

Organization, rules and regulations of a clinical pathology laboratory; Selection, collection, preservation and dispatch of morbid material for laboratory examinations; Evaluation of various blood components; Anemia; Leukemia; Exfoliative cytology; Fluid, electrolyte and acid-base balance; Plasma protein profile; Clinical enzymology; Liver function tests' kidney function tests; Histopathological techniques; Hematological procedures and interpretation of results; Urinalysis and faecal examination; Impression smears, staining, examination and interpretation;

Biochemical and functional tests of various organs (liver, kidney, thyroid, reproductive hormones); Exfoliative cytology and plasma protein profile; Immunohisto-chemical staining.

### **Practical**

Laboratory layout; Instruments of diagnostic laboratory; Haemoglobin estimation technique PCV (Microhematocrit and macrogematocrit); TEC, TLC, DLC, Platelets count; Reticulocyte count; ESR; Polycythemia; RBC indices and morphological classification of anemia; Hemoparasites; RBC abnormalities; Thalassemia; Hemoglobinopathies; Hematology analyzer and its working principle; Writing CBC reports; Hematological case studies; Urinalysis; RFT; LFT; Estimation of plasma proteins; Exfoliative cytology; Impression smear; Fecal examination; Histopathological technique (tissue preparation); Histopathological technique (staining); Histopathological interpretations; Estimation of reproductive hormones; Estimation of thyroid hormones; Immunohisto-chemical staining.

### **Suggested Reading**

1. Benjamin, M.M. 1978. Outline of veterinary clinical pathology. 3rd Ed. Iowa State University Press. Ames, IW, USA.
2. Fischbach, F.T. and M.B. Dunning. 2009. A manual of laboratory and diagnostic tests. Lippincott Williams & Wilkins. Philadelphia, PA, USA.
3. Stear, M.J. 2005. OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals (Mammals, Birds and Bees) 5<sup>th</sup> Ed. New York, NY, USA.

## **PARA-402**

## **Diagnostic Parasitology**

**3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Learn basic concepts of diagnostic parasitology
- Understand different techniques to diagnose parasites
- Know the types of parasites according to their morphology

### **Theory**

**Introduction to Parasitology; Basic terminology; Effects of Parasites on their host and their economic significance; Nomenclature and classification of parasites; Host and organ specificity; Host parasite relationships; Parasitic life cycles;** What are parasites and their types; Discussion on morphology: diseases produced, diagnosis, treatment & control of important parasites of public health significance/zoonotic importance; *Protozoa: Plasmodium, Babesia / Theileria, Leishmania, Trypanosoma*; Enteric Protozoa like coccidian protozoan (*Eimeria/isospora/cryptosporidium*); *Entamoeba*; *Giardia*; Helminths; Soil Transmitted Helminthes (*Ascarids, Hook Worms, Whip Worms*); Tape worms; Flukes and food transmissible helminthes; Arthropods; Maggots Producing flies; Ticks & Mites; Lice; Mosquitoes.

### **Practical**

Introduction to directional terms and terminology used most commonly in parasitology laboratory; **Methods for collection, preservation and examination of the sample for parasitological examinations;** Introduction to important equipment and reagents used for diagnosis of parasites. Qualitative examination of faecal/stool materials lab 1; Culture of Faecal materials; Isolation of Larvae from faecal materials; Collection, preservation and examination of blood for parasites lab. 1; Collection, preservation and examination of blood for parasites lab2; Examination of fecal samples for diagnosis of intestinal protozoa. Lab 1; Examination of fecal samples for diagnosis of intestinal protozoa lab 2; Examination of skin scraping and



identification of various insects lab. 1; Examination of skin scraping and identification of various insects lab. 2; Mosquitoes & Maggots producing flies Lab 1; Mosquitoes and maggots producing Flies; Lab 2.

### **Suggested readings**

1. Chiodini, P.L., A.H. Moody and D.W. Manser. 2011. Atlas of Medical Helminthology & Protozoology by 4<sup>th</sup> Ed. Churchill Livingstone, London, UK.
2. Garcia, L.S. 2016. Diagnostic Medical Parasitology. 6<sup>th</sup> Ed. John Wiley and Sons. Hoboken, NJ, USA.
3. Hendrix, C.M. and E.D. Robinson. 2016. Diagnostic Parasitology for Veterinary Technicians-E-Book. Elsevier Health Sciences. Amsterdam, Netherlands.
4. Jacobs, D., L. M. Fox, L. Gibbons and C. Hermosilla. 2015. Principles of Veterinary parasitology. John Wiley & Sons. Hoboken, NJ, USA.

## **EPH-402      Epidemiology and Public Health      3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Learn about calculation of risk factors and managing them.
- Gain knowledge about different terms and procedures related to Epidemiology.
- Co-relate and manage the diseases regarding public health.

### **Theory:**

Epidemiology: Orientation to epidemiology relevant definitions evolution of epidemiology types of epidemiology (conventional clinical molecular and environmental) in disease investigations and control; General concepts of epidemiology: Domains of clinical and population (Flock) medicine patterns of disease occurrence (endemic, sporadic, epidemic and pandemic); Population and its types; Koch's & Evan's postulates; Variables and their types; Association between variable; types of association; causal models of a disease; Formulation of causal hypothesis of a disease; Measures of disease frequency (point prevalence, period prevalence, cumulative incidence, incidence rate, mortality rate, case fatality rate, attack rate etc. ); Temporal and spatial distribution of diseases; Determinants/Risks Factors: Classification of determinants; Primary and secondary determinants, intrinsic and extrinsic determinants, Determinants associated with host, agent and environment; Interaction of determinants. Identification of Determinants/Risk Factors: Surveys; types of epidemiological studies; sampling methods and sample size consideration in epidemiological investigations; Cross sectional, case-control and cohort studies; Measurement of association between risk factor (s) and disease. Sources and transmission of Infection: Horizontal transmission: vertical transmission: maintenance of infection, vector of disease. Sero-epidemiology: Sero-diagnostic tests of poultry importance; measurement of geometric mean titre (GMT); flock immune profiles; parameters of evaluation of diagnostic test (sensitivity, specificity, predictive value, etc. ). Active and passive surveillance of trans-boundary poultry diseases. Poultry Health Economics and Productivity Schemes: Value of economic analysis; Structure of health productivity schemes and poultry health productivity schemes; Epidemiological data: Sources of data; Representation (coding) of data; Computerized technique for recording of data: Current data on livestock/Poultry population in Pakistan; Public Health: Components of poultry medicine and their relation to human health, human health cost of poultry diseases in developed

and subsistence economies of the world, the current and future role of veterinary medicine in combating hunger and malnutrition; An overview of veterinary public health services in developed and under developed countries; Zoonosis and their types (direct Zoonosis, cyclozoonosis, metazoonosis and saprozoonosis); important zoonotic diseases of poultry and their control; The role of veterinary profession in combating Zoonosis; The role of veterinary profession in producing safe human food, prevention of drug residues, implications and requirements of WTO agreement in relation to the food of poultry origin.

**Practical:**

Epidemiology: Computerized and manual recording of epidemiological data and their analysis; Calculating the association of a risk factor with a disease in cohort and case-control studies.; Investigation of a point source and propagative disease outbreaks; Construction of appropriate frequency polygons or histograms of temporal data Exercise in random and nonrandom sampling and calculation of appropriate sample size in a given epidemiological situation; Sample size in relation to inferential statistics, concept of power, bias and its type. Diagnostic tests for the detection of antibody titers against diseases of poultry. Evaluating the economic impact of a veterinary practice through partial and capital budgeting and decision analysis; Public Health: Microbiological examination of poultry meat and eggs for potential human health pathogens; Diagnostic technique for common Zoonotic diseases of poultry; Detection of antibiotic residues in poultry meat and eggs; Visits to poultry processing plant to examine the procedures of meat inspection.

**Suggested Readings**

1. Gordis, L. 2009. Epidemiology. 4<sup>th</sup> Ed. Saunders Elsevier, Philadelphia, PA, USA
2. Martin, W., A. Meek and P. Willeberg. 1987. Veterinary Epidemiology, Principles and Methods. Iowa State University Press, Ames, IW, USA.
3. Rothman, K.J. and G. Sander. 1998. Modern Epidemiology. 2<sup>nd</sup> Ed. Lipponcott Williams and Wilkins, London, UK.
4. Thrusfield, M. 2007. Veterinary Epidemiology. 3<sup>rd</sup> Ed. Blackwell Publishers, Hoboken, NJ, USA.

**MICRO-408**

**General Bacteriology**

**3(2-1)**

**Learning Objectives**

During the course, students will be able to

1. Learn about bacterial infections of animals and birds.
2. Learn about symptoms, diagnosis, epidemiology and control of veterinary infections.
3. Get the technical skills and theoretical knowledge required for laboratory diagnosis

**Theory:**

The clinical spectrum of bacterial diseases; Study of major animal bacterial diseases in Pakistan; Morphology, cultural characteristics, biochemical activities, antigenic properties, toxins, association with animal diseases; Diagnosis and immunoprophylaxis; Genera/groups: aerobic G+ve cocci, *Streptococcus*, *Staphylococcus*, *Facultative anaerobic G-ve rods: Escherichia, Salmonella, Proteus, Klebsiella, Enterobacter, Yersinia, Pasteurella, Haemophilus*; Aerobic non-spore forming G+ve rods: *Corynebacterium, Listeria*, Acid-fast bacteria: *Mycobacterium, Nocardia*. Aerobic G+ve spore forming rods: *Bacillus*. Anaerobic G+ve spore forming rods: *Clostridium, Dermatophilus*; Anaerobic G-ve rods: *Actinomycetes*. Aerobic and anaerobic spirochaetes: *Borrelia, Leptospira, Treponema*.

Aerobic/Microaerophilic G-ve helical rods: *Campylobacter*; Aerobic G-ve rods and cocci: *Actinobacillus*, *Brucella*, *Pseudomonas*, *Burkholderia*, *Bordetella*, *Chlamydia*; Aerobic cell wall free bacteria; *Mycoplasma*.

**Practical:**

Collection, preservation and submission of specimens for laboratory diagnosis of bacterial infections; Specimen selection, direct microscopy. Isolation of microbes; Identification of microbes (colony characteristics); Staining techniques; Identification of microbes (biochemical tests); Antibiotic sensitivity (Diffusion method); Animal inoculation tests of microbes; Mode of immunization of birds, Mode of immunization of animals, Serological tests; A study tour to a diagnostic lab/research institute.

**Suggested Readings:**

1. Mettenleiter, T.C. and F. Sobrino. 2008. *Animal Viruses: Molecular Biology*. Caister Academic Press, London, UK.
2. Madigan, M.T., J.M. Martinko and J. Parker. 2017. *Brock biology of microorganisms* 14<sup>th</sup> Ed. New York, NY, USA.
3. Quinn, P. J. , B. K. Markey, F.C. Leonard, P. Hartigan and S. Fanning. 2012. *Veterinary Microbiology and Microbial Disease*. 1<sup>st</sup> Ed. Blackwell Science Ltd, New York, NY, USA.
4. Songer, J. and K. Post. 2009. *Veterinary Microbiology: Bacterial and Fungal Agents of Animal Disease*. 1<sup>st</sup> Ed. Wiley, John & Sons, Incorporated. New York, NY, USA.
5. Willey, J., L. Sherwood and C.J. Woolverton. 2017. *Prescott's Microbiology*. 10<sup>th</sup> Ed. McGraw-Hill, New York, NY, USA.

## SEMESTER 5

**MICRO-501**

**Genetic Engineering**

**3(2-1)**

**Learning Objectives**

During the course, students will be able to

1. Develop skills of the students in understanding the basics of Genetic engineering
2. Illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences
3. Expose students to application of recombinant DNA technology in different branches of Biotechnology

**Course Contents:**

The basic principles of gene Cloning and DNA analysis; Vehicles for gene cloning. Properties of prokaryotic and eukaryotic cloning vectors; Purification of DNA from living cells, Manipulation of purified DNA: Nucleic acid modifying enzymes; Restriction endonucleases. Cloning strategies; Introduction of DNA into living cells; Selectable and screening markers. Construction of genomic and cDNA libraries; Study of gene location and structure: Probe labeling and hybridization; Restriction mapping; Expression systems; DNA and RNA fingerprinting; Applications of recombinant DNA technology in Agriculture sector; Applications of recombinant DNA technology in animal sector; Impact of gene cloning in medicine; Site directed mutagenesis.

**Course Contents for Practical:**

Methods of nucleic acid isolation (DNA & RNA); Electrophoresis; DNA amplification. Gene cloning, Growing and harvesting a bacterial culture; Plasmid and genomic DNA isolation, Restriction Digestion; Competent cells preparation; Ligation; Transformation; Screening of transformed cells; Vector construction; Use of Bioinformatics software.

### **Suggested Readings:**

1. Alberts, B., D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. 2002. Molecular Biology of the cell. 4<sup>th</sup> Ed. Garland Science; New York, NY, USA.
2. Joanne, W. 2017. Prescott's Microbiology. 10<sup>th</sup> Edition. McGraw-Hill Education. New York, NY, USA.
3. Primrose, S.B. and Twyman. 2013. Principles of Gene Manipulation, An Introduction To Genetic Engineering. 3<sup>rd</sup> Ed. Blackwell Science Publication. Hoboken, NJ, USA.
4. Sandhya, M. 2008. Genetic Engineering Principles and Practice. 4<sup>th</sup> Ed. Rajiv Beri for Macmillan India Publications, New Delhi, India.

## **MICRO-503**

## **Applied Immunology**

**3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the applied concept of immunology
- Identify various forms of antigens including bacterial, viral, tumor, etc
- Differentiate the mechanisms of immune response against various antigen types
- Describe mechanisms of hypersensitivities, their role in autoimmune disorders and Body's mechanisms to handle the related problems.

### **Theory:**

Overview of immune system; Immunoregulation; Transplantation immunology: Alloantigens, effector mechanisms of alloantigen rejection, prevention and treatment of allograft rejection, blood transfusion, bone marrow transplantation; Cancer Immunology: General features of tumor immunity, tumor antigens, immune response to tumors, evasion of immune responses by tumors and immunotherapy for tumors; Hypersensitivity and autoimmunity: types and effector mechanisms of hypersensitivity, pathogenesis of autoimmunity and their treatment; Immunotolerance: factors affecting immunotolerance etc. Immunity to microbes (bacteria and viruses).

### **Practical:**

Introduction to directional terms and terminology used most commonly in immunology laboratory; Measurement of humoral immune response by slide agglutination, Measurement of humoral immune response by HI; Measurement of humoral immune response by Direct ELISA; Measurement of humoral immune response by Indirect ELISA; Measurement of humoral immune response by Direct Sandwich ELISA; Measurement of humoral immune response by Indirect Sandwich ELISA; Measurement of humoral immune response by Competitive ELISA; Measurement of humoral immune response by CFT, Measurement of humoral immune response by IHA; Measurement of humoral immune response by AGPT; Measurement of humoral immune response by serum neutralization, Measurement of cell

mediated immunity MTT assay; Delayed type hypersensitivity response; Development of in vitro model for studying immune response

### **Suggested Readings:**

1. Abbas, A.K., H.L. Andrew and S.P. Jordan. 1991. Cellular and Molecular Immunology. W. B. Saunders Co. London. UK.
2. Roitt, I.M. 1988. Essential Immunology. 6<sup>th</sup> Ed. ELBS/Blackwell Scientific Publications, London, UK.
3. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton Prescott's Microbiology, 10<sup>th</sup> Ed. New York, NY, USA.
4. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. New York, NY, USA.

**MICRO-505**

**Marine and Fresh Water Microbiology**

**3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the basics of fresh and marine water microbiology
- Identify the microbiological and chemical quality of water involving its monitoring, testing techniques from both national and international standards.
- Understand the situation of water quality and its pollution in Pakistan.
- Understand the marine environment particularly the chemical and physical factors, microbial habitats, their role in natural processes and effects on human environment.

### **Theory**

Importance of microbiological and chemical quality of drinking water, Water quality monitoring and surveillance; Monitoring and evaluation strategy, Microbiological and chemical techniques for testing drinking water; National water standard and WHO standard, Water pollution of domestic industrial and agriculture water; Ground water availability in different parts of the country; Quality of ground water, clean drinking water for the nation; Establishment of water purification plants and water testing laboratories, Training of manpower for the water testing laboratories; Ultimate goal is to provide safe drinking water for the nation; Microbes in the marine environment (Introduction, chemical and physical factors, microbial habitats), the role of microbes in ocean processes including cycling, productivity, photosynthesis, eutrophication; Symbiotic association of marine microbes; Marine microbes and human society.

### **Practical**

Introduction to water testing; Sampling methods for bacteriological testing (WHO standards), Water quality testing: Physical tests for color, odor, turbidity and pH (WHO standards); Water quality testing: Physical tests for total dissolved solids (TDS), total suspended solids (TSS) and total solids (TS); Water quality testing: Chemical tests, Biological Oxygen Demand (BOD) for water and waste water samples, Water quality testing: Biological tests; Most probable number (MPN) for coliform bacteria (Presumptive test), Water quality testing: Biological tests, Most probable number (MPN) for coliform bacteria (Confirmed test); Water quality testing: Biological tests, Most probable number (MPN) for coliform bacteria (Completed test), Standard Plate Count (SPC) for Tap water samples; Standard Plate Count (SPC) for surface water samples, Quantitative analysis of water; The membrane filter method; Enumeration of indicator organisms from different drinking water samples; Enumeration of heterotrophic bacteria by pour and spread plate

techniques for water samples, Enumeration of indicator organisms from different bottled water samples; Enumeration of biofilm forming bacteria in pipes, Water quality tests in labs (scopes, range, perform and interpretation of test results); Laboratory experience of basic principles of microbiological and chemical analysis of water; Isolation and identification techniques for water analysis.

**Suggested Readings:**

1. Gerhard, G. 1994. Aquatic Microbiology. John Wiley & Sons, Inc. New York, NY, USA.
2. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw Hill education, New York. NY, USA.
3. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. ASM Press, 4<sup>th</sup> Ed. New York, NY, USA.

**MICRO-507**

**Soil Microbiology**

**3(2-1)**

**Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the basic lay out of the soil structure and the role on microbes in the soil ecosystem.
- Understand the ecological interaction of microorganisms.
- Examine the major kinds of interactions of microorganisms within microbial domains and across the other domains of life.
- Understand and learn biofertilizers

**Theory:**

Elements of soil formation and conservation; Soil microbial population and methods of study with their advantages and disadvantages; Role of microorganisms in mineral transformations with special and detailed emphasis on Carbon and Nitrogen transformations; Brief introduction to Sulphur and Phosphorus; Soil microbial ecology and rhizosphere; Plant-microbe interactions, microbe-microbe interactions, and their impact on soil fertility and formation of compost and humus; Biotechnological potentials of soil microorganisms; Importance of the subject in the agricultural development of Pakistan; Problems of salinity and water logging and the methods of land reclamations; Microbial remediation: salt, heavy metals and pesticides; Biofertilizers; Mycorrhiza.

**Practical**

Soil sampling and determination of temperature and pH of soil; Analysis of soil microbes by buried slide technique; Formation of Winogradsky column, Isolation of different microbes from soil samples; Demonstration of nitrogen fixation; Demonstration of ammonification; Demonstration of nitrification; Demonstration of denitrification, Isolation of phosphate solubilizing bacteria, Isolation of sulfate reducing bacteria, Isolation of antibiotic producing bacteria (actinomycetes and Bacillus) from rhizosphere soil; Plant growth promotion by rhizospheric bacteria and phytohormone production; Reduction of heavy metals by bacteria, Microbial reduction of pesticides; Isolation of genomic DNA from soil and detection through PCR amplification (metagenomics).

**Suggested Readings:**

1. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.

2. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. New York, NY, USA.
3. Robert, L. 2002. Soil Microbiology. 2<sup>nd</sup> Ed. John Wiley and Sons. New York, NY, USA.
4. Paul, E. 2014. Soil Microbiology, Ecology and Biochemistry; 4<sup>th</sup> Ed. Academic Press. New York, NY, USA.

## MICRO-509

## Food and Dairy Microbiology

3(2-1)

### Learning Objectives

During the course, students will be able to

- Familiarize the learners with the role of microbes in production, spoilage and preservation of food, and food borne infections and intoxications
- Determine microbial quality of food
- Ensure production of food with better microbial quality

### Theory

Scope and importance of food microbiology; Microorganisms (bacteria, molds, yeast and virus) important in food; Factors affecting the growth of microbes in food: Intrinsic and extrinsic factors; Microbiology of food and food products: milk, meat, fish, shellfish, eggs, fruits and vegetables; Residues of drugs and pesticides in milk, meat, fish, shellfish, eggs and their effect on human health; Fermented foods: Yogurt, Cheese, Sauerkraut, Pickles. Starter cultures, their biochemistry and genetics. Control of contaminating microbes in food industries; Standards regarding microbial control and quality of food: ICMSF, WHO, FAO, HACCP, GMP, cGMP; Quality control of raw foods and food products. Sanitation and cleaning in food industries. Role of microbes in food spoilage; Food preservation techniques and their limitations; Food intoxications and poisoning: *S. aureus*, *C. botulinum*, *C. perfringens*, *B. cereus*, Mycotoxins, *E. coli*, *Salmonella*, *Shigella*, *Campylobacter spp.*, *Listeria monocytogenes*, *Vibrio spp.* and *Yersinia enterocolitica*. Food borne protozoa, Food borne viruses; Recent advances in food industries.

### Practical

Collection, transportation and microbiological samples; Introduction to food and dairy microbiology; Sampling plans and sample collection; Homogenate preparation and serial dilutions; Standard plate count/ Aerobic plate count; Microbiological assessment of milk by resazurin dye reduction test and methylene blue reduction test, Isolation of *Salmonella* from meat sample (Pre Enrichment and Enrichment); Identification of *Salmonella* (Selective Plating); Identification of *Salmonella* (Staining and Biochemical Identification), Enumeration of coliforms in water by MPN method (Presumptive Test); Determination of *E. coli* in water (Confirmed and Completed Test); Total coliform count and total *E. coli* count in water by membrane filtration technique; Total psychrophilic count in ice cream, Total yeast and mold count in flour by dilution method; Total yeast and mold count in grains by direct plating method (with and without surface decontamination), Isolation of *E. coli* from food sample (Pre Enrichment and Enrichment); Identification of *E. coli* by selective plating and biochemical identification; Isolation and identification of *E. coli* O157:H7, Thermotolerant count and preliminary incubation count of milk, Standard plate count and total coliform count in milk, Investigating a food sample for *Clostridium perfringens* food



poisoning (Presumptive Testing: Enumeration of *Clostridium perfringens* in food sample), Investigating a food sample for *Clostridium perfringens* food poisoning (Confirmed and Completed Test); Checking milk for chemical adulterants; Checking milk for chemical adulterants; Checking milk for the presence of antibiotics (beta lactams and tetracyclines), Isolation and purification of starter culture from yogurt; Preparation of yogurt using the starter culture isolated; Isolation of bacteriophages from yogurt; Bacteriophage assay, Isolation of starter culture from cheese, Isolation of starter culture from cheese, Preparation of cheese

### **Suggested Readings:**

1. Bacteriological Analytical Manual. 1998. Food and Drug Administration Bureau of Foods. Published and distributed by Association of Official Analytical Chemists, New York, NY, USA.
2. Joanne W., L.Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. New York, NY, USA.
3. Luck, E., M. Jager and S.F. Laichen. 2000. Antimicrobial food additives: Characteristics, uses, effects. 2<sup>nd</sup> Ed. Springer-Verlag, New York, NY, USA.
4. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. 4<sup>th</sup> Ed. ASM Press, New York, NY, USA.

## **MICRO-511**

## **Bioinformatics and Protein Structure/ Function**

**3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Learn the details of proteins structure and their bioactive configuration.
- Learn about computational analysis of proteins structure and functions
- Learn about computational tools for protein and nucleic acid analysis.

### **Theory**

Amino acids and their properties; Protein structure classification and super folds; Mechanisms of protein folding and folding pathways; Role of chaperones in protein folding; Experimental techniques for characterizing membrane protein structure and function; A case study: proteases - function and mechanisms; Simple sequence analysis - use of hydropathy plots; Introduction to sequence databases; Comparing sequences against sequence databases; Predicting protein coding regions; Prediction of protein structure from sequence data; Genome sequencing projects; Protein, protein docking; Experimental methods for determining protein structure; Protein domains; Bioinformatics and genome analysis

### **Practical**

Demonstration of the use of web based tools for Bioinformatics analysis; BLAST, SWISSPROT etc.

### **Suggested Readings:**

5. Bujnicki, J.B. 2009. Prediction of Protein Structures, Functions and Interactions. 2<sup>nd</sup> Ed. Wiley, John & Sons, Incorporated. New York, NY, USA.
6. Jeremy, W.D., V.S. Malcolm and P. Nicholas. 2011. From Gene to Genome. 1<sup>st</sup> Ed. Wiley Library. New York, NY, USA.
7. Kanwal, S., S. Nishat and I.M. Khan. 2012. Bioinformatic Approach to Structure and Function of Protein. Lambert Academic Publishing, Saarbrücken, Germany.

8. Peirce, M.J. and R. Wait. 2010. Membrane Proteomics: Methods and Protocols. 1<sup>st</sup> Ed. Springer-Verlag, New York, NY, USA.
9. Rigden, D. J. 2010. From Protein Structure to Function with Bioinformatics. 1<sup>st</sup> Ed. Springer-Verlag, New York, NY, USA.

## SEMESTER 6

### MICRO-502      Medical Microbiology      3(2-1)

#### Learning Objectives

During the course, students will be able to

- Familiarize the learners with the concept of Medical Microbiology
- Identify various host-parasitic relationships in human illnesses.
- Differentiate the various human diseases using the knowledge of microbiology
- Describe mechanisms of disease production by various bacteria, viruses, parasites and fungi in human body.

#### Theory

Introduction to identification techniques in medical microbiology; Host-parasite interactions; Basic concepts of epidemiology; Microbial virulence: factors responsible; Determinants of pathogenicity and molecular mechanisms of pathogenesis; Study of etiology, epidemiology, pathogenesis, immunology; Lab. diagnosis, treatment; Prevention and control of the following microbes and parasites of human importance:

#### A. Bacteria:

*Streptococcus, Staphylococcus, Niesseria, Pseudomonas, Corynebacterium, Bordetella, Vibrio, Clostridium, Bacillus, Campylobacter, Aeromonas, Helicobacter, Legionella, Mycobacterium, Actinomycetes / Nocardia, Chlamydia and Mycoplasma* etc.

#### B. Virus:

General characteristics of viruses; Classification of viruses; Oncogenic Viruses; DNA viruses; RNA Viruses, Rabies, Hepatitis, Avian Influenza (Bird Flu); Acquired Immune Deficiency Syndrome (AIDS) Chemotherapy of viral Diseases.

#### C. Fungi:

Aspergillosis, Candidiasis, tinea (tinea pedis and tinea capitis), etc.

#### Practical

Collection and transportation of clinical samples: infections of ear, nose, throat, eye, GIT, urogenital tract and bone; Isolation and identification of selected pathogens. Antibiotic assays by disc diffusion methods and dilution method; Agglutination test (Widal test); Precipitation tests; Other sero-diagnostic tests; Microscopic study of *Leishmania, Entamoeba, Plasmodium*

#### Suggested Readings:

1. Brooks, G.F., J.S. Butel and S.A. Morse. 2004. Medical Microbiology. McGraw Hill Education. New York, NY, USA.
2. Gupte, S. 2010. The Short Textbook of Medical Microbiology: (including Parasitology), Jaypee Brothers, Medical Publishers, Haryana, India.
3. Joanne W., L.Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.

4. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. 4<sup>th</sup> Ed. ASM Press, New York, NY, USA.

## MICRO-504

## Systemic and Diagnostic Virology

3(2-1)

### Learning Objectives

During the course, students will be able to

- Familiarize the learners with the basic lay out of systemic virology
- Develop an in-depth understanding of viruses of human and animal health significance
- Identify and isolate a specific virus in a diagnostic lab
- Maintain biosafety in a diagnostic lab.

### Theory

Description including morphology, cultivation, physico-chemical characteristics, isolation and identification of viruses; Immunity and disease association of following (RNA/DNA) viruses with detailed description of at least one model virus representing each family: DNA viruses families: *Adenoviridae*, *Papovaviridae*, *Parvoviridae*, *Herpesviridae*, *Poxviridae*, *Pleolipoviridae*, *Hepadnaviridae*, *Circoviridae*, RNA viruses families: *Birnaviridae*, *Cystoviridae*, *Partitiviridae*, *Reoviridae*, *Picornaviridae*, *Caliciviridae*, *Togaviridae*, *Arenaviridae*, *Flaviviridae*, *Orthomyxoviridae*, *Paramyxoviridae*, *Bunyaviridae*, *Rhabdoviridae*, *Filoviridae*, *Coronaviridae*, *Astroviridae*, *Bornaviridae*, *Arteriviridae*, *Retroviridae*; Unclassified groups: Scrapie, Bovine and other spongiform encephalopathies, viroids; Rickettsia and Rickettsial diseases.

### Practical

Hemagglutination (HA) and Hemagglutination inhibition (HI); Indirect Hemagglutination (IHA); Precipitation; ELISA, FAT, Haemadsorption, VN; Demonstration and preparation of viral antigens; Virus titration; Determination of EID<sub>50</sub> or TCID<sub>50</sub>; Preservation and storage of viruses (ultralow temperature, freeze-drying); PCR-based detection of DNA viruses; PCR-based detection of RNA viruses; General sketch for isolation and identification of viruses from diseased animals; Virus titration; Determination of EID<sub>50</sub> or TCID<sub>50</sub>; Preservation and storage of viruses (ultralow temperature, freeze-drying); PCR-based detection of DNA viruses.

### Suggested Readings:

1. Edward, K.W., J.H. Martinez, C.B. David and D. Camerini. 2007. Basic Virology. 3<sup>rd</sup> Ed. Wiley-Blackwell Science, New York, NY, USA.
2. Flint, J., V. Racaniello, G. Rall and A.M. Skalka. 2015. Principles of Virology: Molecular Biology, Pathogenesis and Control. 4<sup>th</sup> Ed. ASM Press, DC, USA.
3. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.
4. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. ASM Press, New York, NY, USA.

**Learning Objectives**

During the course, students will be able to

- Familiarize the learner environmental problems and their remediation by microbes
- Understand the role of microbial activities on biochemical and geologic processes.
- Determine the role of microorganisms in pollution and its remediation
- Learn about diversified environmental implications on public health

**Theory**

Introduction to environmental microbiology and its significance especially in Pakistan; Air, aquatic and terrestrial environments and their pollutants; Significance and impact of pollutants on human health, and agricultural and livestock production; Microbiology of atmospheric, aquatic and terrestrial ecosystems and extremes environment; Microbes and climate change; Biotransformations of heavy metals/inorganic pollutants i.e chromium, arsenic, mercury; Biodegradation of organic pollutants i. e polyromantic hydrocarbons, polychlorinated biphenyls, BTEX, pesticides, chloroflourocarbons; Wastewater treatment technologies: sewage treatment, industrial wastewater treatment; Polluted sites in Pakistan and their remediation by microbes; Possible use of microbes/microbial metabolites in detection of environmental pollutants and climate change (biosensors).

**Practical**

Environmental samples collection and processing; Methods of soil sampling, methods of air sampling, methods of water sampling, enumeration and isolation of microbes from different environments bacteria; Enumeration and isolation of microbes from different environments: fungi, enumeration and isolation of microbes from different environments: protozoans, isolation of chromium resistant microbes; Screening for chromium resistant microbes, chromium reduction of industrial waste water by chromium reducing microbes; Screening for pesticide resistant microbes; Identification of pesticide degrading microbes; Effect of physicochemical factors on biodegradation of pesticides; Screening for oil degrading microbes, identification of oil degrading microbes; Effect of physicochemical factors on biodegradation of oil.

**Suggested Readings:**

1. Alan, H., and M. G. Evans 2000. Environmental Microbiology. 1st Edition, ASM Press, New York, NY, USA.
2. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.
3. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. ASM Press, New York, NY, USA.
4. Tortora, G.J., B.R. Funke and C.L. Case. 2016. Microbiology an Introduction; 11<sup>th</sup> edition; Pearson Education. New York, NY, USA.

**Learning Objectives**

During the course, students will be able to

- Familiarize the learners with role of microbes in production of industrially important microbes
- Understands the screening and selection strategies for isolation of industrially important microbes
- Understand the fermentation process and industrially important productions by microbial fermentation

**Theory**

Introduction to industrial microbiology; Criteria for screening and selection of microbes producing industrial products/ novel metabolites; Primary screening of microbes producing industrial products/ novel metabolites; Secondary screening of microbes producing industrial products/ novel metabolites; Physico-chemical optimization of industrially important microbes; Sources, Preservation, storage and revival of industrial strain, Fermentation and its types, Batch Culture and its Kinetics, Fed-Batch Culture and its Kinetics Continuous Culture and its Kinetics Fermentation: Upstream processing: Strain Improvement, Fermentation: Upstream processing: Production media Fermentation: Upstream processing: Selection of fermenter, Fermentation: Upstream processing: industrial sterilization, Fermentation: Fermentation Process; Downstream processing, Fermentation: Fermentation Processing: Product Purification techniques, Microbial production of antibiotics: Penicillin, Microbial production of organic acids: Acetic acid. Microbial production of organic acids: Citric acid; Production of Ethanol by microbial actions Microbial production of enzymes: Microbial production of enzymes: Cellulases, Production of vitamins; Production of amino-acids: Lysine; Production of amino-acids: Glutamic acid. Biogas Production; Production of biodegradable Plastics; Single cell protein production; Bioleaching of industrially important metals; Role of microbes in biomining; Role of microbes in leather, paint and textile industries

**Practical**

Screening of antibiotic producing microbes with crowded plate technique; Auxanography screening for vitamins/ amino acid producing microbes; Study of effects of pH, temperature, oxygen, macro and micro minerals on the growth of various microorganisms during fermentation; Storage and revival of industrial strains; Strain Improvement techniques: Mutagenesis; Replica Plating for mutants selection; In silico fermenter Design and Industrial layout. HPLC; To study the growth characteristics of *P. notatum*, *Aspergillus niger*, and *Saccharomyces cerevisiae*; Production of Penicillin by flask culture; Production of citric acid. Production of ethanol by flask culture; Ethanol Production with *S. cerevisiae*; Production of phytase; Production of bioplastics; Industrial Tour

**Suggested Readings**

1. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.
2. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. ASM Press, New York, NY, USA.
3. Tortora, G.J., B.R. Funke and C.L. Case. 2016. Microbiology an Introduction; 11<sup>th</sup> Ed. Pearson Education, New York, NY, USA.

**Zool-302****Animal Biodiversity****2(1-1)****Learning Objectives**

During the course, students will be able to

- Basic terminology and knowledge of Biodiversity.
- Various approaches to conserve biological diversity.
- Techniques for estimation of population of wild

**Theory:**

Biodiversity and its importance; Biodiversity vs Agriculture - A paradox in the mind of people; Levels of biodiversity: Genetic, species and ecosystem level; Factors contributing towards loss of biodiversity; Assessing the value of biodiversity; Various approaches to conserve biological diversity.

**Practical:**

Study of morphological characters and identification of culture able fish species of Pakistan; Use of different organic and inorganic fertilizers in fish culture; Techniques for estimation of population of wild birds and small mammals; Visit to a local wetland to observe migratory and resident birds and report writing.

**Suggested Readings**

1. Hart, P. and J.D. Reynolds. 2008. Handbook of Fish Biology and Fisheries. Volume 2. Blackwell Science Ltd. New York, NY, USA.
2. Hosetti, B.B. 2005. Concepts in Wildlife Management. 1<sup>st</sup> Ed. Daya Publishing House, New Delhi, India.
3. Sharma, O.P. 2009. Handbook of Fisheries and Aquaculture. 2<sup>nd</sup> Ed. Agrotech Publishing Academy, Udaipur, India.

**MICRO-510****One Health****3(2-1)****Learning Objectives**

During the course, students will be able to:

- Design and analysis of basic data related to different diseases.
- The basic concept of One Health and principles of Epidemiology related to disease transmission and control.

**Theory**

Concept of one health; History of one Health; One health and climate change; Introduction to environmental Health; Introduction to epidemiology; Scope of epidemiology and history, Epidemiological triad and natural history of disease, disease transmission, types of epidemiology, measures of disease occurrence: incidence, prevalence, morbidity, mortality etc. causality and causal factors of disease, Concept of determinants and deterrent in Epidemiology. Types of epidemiological studies, cross-sectional, cohort, case-control. Sampling methods: sample size calculation, sampling error, sampling bias; Methods of data collection and types of data, antibiotic resistance profile of infectious agents. Diagnostic testing, reliability, accuracy and validity of screening tests, predictive value; Hypothesis testing, statistical inferences of data (p-values, confidence interval etc); Disease patterns in community and social diversity. Molecular epidemiology: biomarkers etc. introduction to experimental epidemiology, clinical trial and community trials; Surveillance, types and uses of surveillance especially focusing One Health concept; Analysis and interpretation of surveillance data; Global health; Rationale,

strategies and concepts of control and eradication of diseases; Designing of questionnaire; Effect of climate and vector-borne diseases; Life style patterns and vector-borne disease. Bio-terrorism; Evaluation of control programs; Hands on training of computer software for epidemiology

### **Practical**

Basic terminology; Determinants of health-related states; Data collection & types of data. Measurement of morbidity; Exercises for calculation of incidence and prevalence; Vital statistics; Modes and tools of data collection; Questionnaire development. Measures of association; Case control studies. cohort study; Hypothesis testing and statistical inferences. Screening and diagnostic testing; Investigation and control of an epidemic; Sampling techniques and their application in various study designs; Identifying emerging one health issues and their control

### **Suggested Readings:**

1. Joanne W., L.Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. New York, NY, USA.
2. John, M. L. 2000. A Dictionary of Epidemiology. 4<sup>th</sup> Ed. Oxford University Press, Oxford, England
3. Moeller, D.W. 2011. Environmental Health. 4<sup>th</sup> Ed. Harvard University Press. New York, NY, USA.
4. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. New York, NY, USA.

## **MICRO-512**

## **Quality Control in Biologics**

**2(1-1)**

### **Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the applied concept of Quality control for Biologics
- Understanding the importance and underlying principles of Quality Control tests
- Understanding the importance and underlying principles of Quality Assurance tests
- Understanding the process quality control measures
- Understanding the development of SOP for vaccine production

### **Theory**

Overview of immune system; Quality control in biological units; Quality control in biological units; Quality assurance; Biosafety/biosecurity brief; ISO standards/CWA. SOP Vaccine production; BMR preparation; Designing a biological unit; Visit to a biological unit

### **Practical:**

Hands on training of drawing a map of a biological production unit; Preparation of BMR sheet; Environmental monitoring of production unit; Confirmation of seed vaccine virus; Biological titration of vaccine virus; Sterility of vaccine by direct method, Sterility of vaccine by indirect method; Testing the purity of viral vaccine; Testing the purity of bacterial vaccine; Testing the safety of live vaccine; Testing the potency and efficacy of vaccine; Generation of quality control testing report.

### **Suggested Readings:**

1. Animal, U.S. 2002. Veterinary Biologics: 2<sup>nd</sup> Ed. Use and Regulation, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, New York, NY, USA.
2. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.
3. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. ASM Press, New York, NY, USA.

## **SEMESTER 7**

### **MICRO-601 Pharmaceutical Microbiology 3(2-1)**

#### **Learning Objectives**

During the course, students will be able to

- Understand the significance of microbes in pharmaceutical productions
- Learn and identify causes, sources and control of microbial contamination in sterile and non-sterile pharmaceutical production
- Learn to determine the microbial quality of pharmaceutical products
- Understand mechanism, efficacy and spectrum of antibiotics and disinfectants
- Learn about antibiotics, their mechanism of action, spectrum and resistance
- Learn about mechanism, efficacy and procedures to choose disinfectants in pharmaceutical industries

#### **Theory**

Introduction to pharmaceutical microbiology; Microbiological aspects of pharmaceutical industry; Sterile and non-sterile pharmaceutical production; Sources, causes and effects microbial contaminations in pharmaceutical production; Microbial spoilage and preservation of pharmaceutical products; Sterilization procedures and sterility; Depyrogenation and pyrogen testing; Quality assurance in pharmaceutical industries, cGMP, HACCP, USP, BP; Antimicrobial agents: mechanisms of action of antibiotics; Synthetic anti-infection agents. Bacterial resistance to antibiotics; Antibiotic susceptibility testing. Chemical disinfectants; Antiseptics and preservatives; Evaluation of disinfectants; Choice of disinfectants in pharmaceutical production; Pharmaceutical biotechnology; Additional application of microorganisms in the pharmaceutical science.

#### **Practical**

Area monitoring in pharmaceutical industry (air monitoring by passive sampling); Area monitoring in pharmaceutical industry (monitoring of surfaces and working personnel). Determination of bio-burden of non-sterile products; Sterility testing of parenteral preparations LAL test (Semi- quantitative endotoxin determination); Pyrogen testing (in rabbits). Bioassay of amoxicillin. 3H<sub>2</sub>O; Bioassay of vitamins; Bio validation of autoclave by spores of *B. Stereothermophilus*; Antibiotic sensitivity by Kirby Bauer disk diffusion method; Antibiotic sensitivity by agar dilution method; Antibiotic sensitivity by broth micro-dilution method (MIC and MBC); Determination of efficacy of disinfectants by phenol co-efficient method (suspension test); Determination of efficacy of disinfectants by a carrier test (efficacy of a soap/mouth



wash/or any other pharmaceutical preparation); Determination of efficacy of disinfectants by capacity test; Determination of efficacy of disinfectants by in use test.

### **Suggested Readings**

1. Denger, S.P., N.A. Hodges and S.P. Gorman 2004. Pharmaceutical Microbiology. Blackwell Scientific Publi. Oxford, UK.
2. Denyer, S. 2013. Pharmaceutical Microbiology. 8<sup>th</sup> Edition. Willy Blackwell Publishers.
3. Groves, M. J. 2005. Pharmaceutical Biotechnology. CRC Press
4. Kokare, C.R. 2008. Pharmaceutical microbiology-principles and applications. Nirali Prakashan Journal, Volume 3.
5. Madigan, M., K.S. Bender, D.H. Buckley, W.M. Sattley and D.A. Stahl. 2017. Brock Biology of Microorganisms.15th Ed. New York, NY, USA.

## **MICRO-603**

## **Introduction to Vaccinology**

**3(2-1)**

### **Learning Objectives**

During the course, students will be able to

- Acquire in-depth knowledge about vaccines (mechanisms of action, efficacy, side effects, vaccination programs)

### **Theory**

History and importance of vaccination; Biology of antigen / Immunogen/ Antigen purification techniques including BMR and SOP; Importance; Seed development; Seed management and seed cross matching; Fermentation technology in vaccine production (batch and continuous system; Handling and storage of vaccines; Adjuvants and general SOP for QC and QA of vaccine; Different methods for bacterial and viral antigen quantification; In-process and Final Batch QC testing. Adjuvant and immuno-potentiators properties: mode of action; Inactivants; mode of action. Evaluation of vaccine quality and reactions to vaccines; Vaccine administration (route) and its importance and vaccination schedule. Users require means of biologic production unit/ Immunotherapeutic agents; Vaccine registration: requirements and procedures; Products for passive immunity: hyperimmune sera, colostrum and colostrum immunoglobulins; Type of viral vaccines and their mode of mechanism; Production and QC of hepatitis – B vaccine (Recombinant vaccine); Production and QC of measles vaccine (Killed vaccine); Production and QC of Influenza vaccine. Production and QC of Polio vaccine (Live vaccine) Production and QC of Tetanus vaccine; Production and QC of live typhoid vaccine; Production and QC of conjugated DPT vaccine, Production and QC of HS vaccine; Production and QC of FMD vaccine; Production and QC of Theileria and Babesia vaccine (Protozoa vaccine); Production and QC of Coccidial vaccine; Factor associated with host in vaccine failure; Factor associated with vaccine production and QC in vaccine failure; Factor associated with transport and storage in vaccine failure; Vaccines for mucosa immunity.

### **Practical**

Layout of a biological production facility; Preparation of killed vaccines; Preparation of live attenuated vaccines; Preparation of subunit vaccines; Preparation of toxoid; Bioreactor based immunogen production; Determination of EID<sub>50</sub>. Determination of TCID<sub>50</sub>; Determination of ALD<sub>50</sub>. MTT assay; Thymidine uptake assay. Measurement of 146S protein of FMD vaccine through UV spectrophotometer; Treatment of ND infected birds with immune yolk. Evaluation

of vaccine by testing sterility, safety, potency and efficacy; Evaluation of vaccine by testing sterility, safety, potency and efficacy; Study visit to vaccine production facility.

**Suggested Readings:**

1. Joanne W., L. Sherwood and J. Christopher. 2017. Woolverton, Prescott's Microbiology, 10<sup>th</sup> Ed. McGraw-Hill Education, New York, NY, USA.
2. Snyder, L. and W. Champness. 2013. Molecular genetics of bacteria. American Society for Microbiology. 4<sup>th</sup> Ed. ASM Press, New York, NY, USA.
3. Madigan, M., K.S. Bender, D.H. Buckley, W.M. Sattley and D.A. Stahl. 2017. Brock Biology of Microorganisms. 15<sup>th</sup> Ed. Pearson Education, London, UK.
4. Robinson, A., G.H. Farrar and C.N. Wiblin. 1996. Vaccine Protocols. Humana Press, Totowa, NJ. USA.

**MICRO-605**

**Diagnostic Microbiology**

**3(0-3)**

**Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the practical aspects of diagnostic microbiology
- Identify various bacterial, viral and fungal pathogens
- Diagnose various diseases using laboratory diagnostic tests
- Interpret the diagnostic test results

**Theory**

Isolation and laboratory confirmation of microbial pathogens; Sterilization and disinfection; Collection, transportation and processing of samples for bacterial, fungal and viral isolation; How to develop diagnostic investigation approach; Connecting with client to understand disease situation at the community/farm; Conventional techniques for bacterial identification; culture and sensitivity; Advanced techniques for bacterial identification: Bacterial Identification Systems: API strip, Sensititer; Biolog, Vitek; Preparation of media for bacteria, fungi and animal cells; Isolation and identification of bacterial pathogens. Isolation and identification of fungal pathogens; Enumeration of microbes by direct and indirect methods; Techniques for Micrometry and staining of microbes; Cultivation of microbes (aerobic and anaerobic bacteria, molds); Virus culture in various host systems: animal inoculation, chicken embryo inoculation, cell culture and laboratory animals. Biological titration of microorganisms: LD<sub>50</sub>, EID<sub>50</sub>, TCID<sub>50</sub>; Detection of Mycotoxins and their inactivation. Culture sensitivity testing to determine efficacy of antimicrobial agents. Serological techniques (HI, AGPT, CFT, ELISA, FAT, VN, etc); Molecular techniques (Extraction of nucleic acid; PCR; Electrophoresis, Blotting; Cell culture technique. cultivation of viruses.

**Practical**

Introduction to directional terms and terminology used most commonly in diagnostic microbiology laboratory; Sterilization (dry heat, Moist heat, filtration, various forms of radiations) and disinfection; Antiseptics and disinfectants with their types; Determination of Phenol coefficient; Collection, transportation and processing of samples for bacterial isolation, Collection, transportation and processing of samples for fungal isolation. Collection, transportation and processing of samples for viral isolation; How to develop

diagnostic. investigation approach; Connecting with client to understand disease situation at the community/farm; Conventional techniques for bacterial identification; culture and sensitivity; Advanced techniques for bacterial identification: Bacterial Identification Systems: API strip, Sensititer; Biolog, Vitek; Preparation of media for bacteria. Preparation of media for fungi. Preparation of media for animal cells; Isolation and identification of bacterial pathogens (*E. coli*); Isolation and identification of bacterial pathogens (*Salmonella*); Isolation and identification of bacterial pathogens (*Pasteurella*); Isolation and identification of bacterial pathogens (*Staphylococcus*); Isolation and identification of bacterial pathogens (*Streptococcus*); Isolation and identification of bacterial pathogens (*Listeria*); Isolation and identification of bacterial pathogens (*Pseudomonas*); Isolation and identification of bacterial pathogens (*Clostridium*); Isolation and identification of fungal pathogens; Enumeration of microbes by direct methods (Total Bacterial Count); Enumeration of microbes by direct methods (Total Viable Count by Pour Plate method); Enumeration of microbes by direct methods (Total Viable Count by Spread Plate method); Enumeration of microbes by indirect methods; Techniques for Micrometry and staining of microbes; Cultivation of microbes (aerobic and anaerobic bacteria, molds) Virus culture in various host systems: animal inoculation, chicken embryo inoculation, cell culture and laboratory animals; Biological titration of microorganisms: LD<sub>50</sub>, EID<sub>50</sub>, TCID<sub>50</sub>; Detection of Mycotoxins and their inactivation; Culture sensitivity testing to determine efficacy of antimicrobial agents; Serological techniques (HI); Serological techniques (AGPT). Serological techniques (CFT); Serological techniques (ELISA); Serological techniques (VN). Molecular techniques (Extraction of nucleic acid); Molecular techniques (Preparation of cDNA); Molecular techniques (PCR); Molecular techniques (electrophoresis); Molecular techniques (Northern blotting); Molecular techniques (Western blotting); Molecular techniques (Southern blotting); Cell culture technique; Cultivation of viruses; Interpreting results and relating to clinical picture; Issuing laboratory results (legal aspects of lab report).

#### **Suggested Readings:**

1. Cappuccino G. and N. Sherman. 2002. Microbiology - A Laboratory Manual. 6<sup>th</sup> Ed. Anybook limited, Lincoln, UK.
2. Collins C.H., P.M. Lyne and J.M. Grange. 2000. Microbiological Methods. 8<sup>th</sup> Ed. Butter Worth Heinemann, Oxford, UK.
3. Freshney I.R. 1997. Animal Cell Culture. 3<sup>rd</sup>Ed. I. R. L. Press, Oxford, London.
4. Scopes, R.K. 2013. Protein purification: principles and practice. Springer Science & Business Media. Berlin, Germany.
5. Voet, D., J.G. Voet and C.W. Pratt. 2016. Fundamentals of biochemistry: life at the molecular level. Wiley Press, New York, NY, USA.

**MICRO-607**

**Biorisk Management (Biosafety & Biosecurity)**

**3(2-1)**

#### **Learning Objectives**

During the course, students will be able to

- Familiarize the learners with the basic concept of biosafety and biosecurity
- Understand the good lab practices while working in a lab
- Understand the concept of biorisk management system and its implementation
- Familiarize with basic ppe's and their use in performing scientific tasks

- Capacity building of the students for developing and implementing a biosafe culture in our organization

### **Theory**

Introduction: Basic definitions; Biosafety; Biosecurity, Biorisk, UVAS policy; Biorisk management basics: Bioethics; Introduction to dual use research of concern; Biorisk characterization and evaluation; Biosafety risk assessment; Biosecurity risk assessment; Biorisk mitigation strategies; Introduction to incident management and response; Administrative controls for biorisk mitigation; Human performance for biorisk management in the laboratory; Developing and validating standard operating procedures (SOPs); Hazard and Risk Communication in the laboratory; Good laboratory work practices, Personal protective equipment; Decontamination; Biological Waste disposal; Laboratory Biosecurity, Field biosecurity; Shipping infectious substances and biological specimens; Laboratory building systems; Laboratory design best practices; Laboratory design process; Biosafety risk characterization; Biosafety risk mitigation; Writing and communicating biorisk management policy; Considerations for training in biorisk management; Establishing and maintaining worker health program, Incident response planning and preparation; Incident response & investigation); Incident response evaluation & improvement; Measurement and analysis of biorisk management system performance; Establishing and using performance indicators; Revising and improving a biorisk management system based on performance result.

### **Practical**

Biosafety cabinet introduction and use; Biosafety cabinet introduction and use, Personal protective equipment; Anthrax powder, Biosafety risk characterization; Biosafety risk mitigation; Dual use equipment of concern; Communication in biorisk management role play exercise; Standard operating procedures; Spill management, Needle stick injury management; Hand washing; Waste Management and waste disposal; Shipment of biological specimen; Preparation of spill kit; Preparation of first aid box; Controlling of laboratory sharps.

### **Suggested Readings**

1. Global biorisk management curriculum (GBRMC)
2. WHO Laboratory Safe Manual 2004
3. WHO Laboratory Biosecurity Guidance 2006

**MICRO-609**

**Bio-Entrepreneurship**

**2(2-0)**

### **Learning Objectives**

During the course, students will be able to

- Understand the significance of microbes in pharmaceutical productions
- Learn and develop different business plans in the field of microbiology and biotechnology in era of knowledge bases economy
- Learn the determine the viability/components and skills to run a successful bio-enterprise

### **Theory**

Introduction to entrepreneurship and bioentrepreneurship; Content, definitions and theoretical approaches; Framework for necessary factors for enterprise development; Qualities of a successful entrepreneur; Entrepreneurial environment; Personality traits of the entrepreneur, motivation, and demographics; Similarities and

differences between entrepreneurs and managers; Early stage entrepreneurial activity and established entrepreneurship; Developing a business idea. Evaluation of a business plan; Implementation of business idea; Business Plan; Startups strategy; Analysis of market and competition; Finance & accounting program of startups; Marketing program of startups; Small business. Family business; Bioentrepreneurship & innovation; Economic exploitation of inventions. Patents license; Financing & support of startups; Scope and spectrum of bio entrepreneurship in Pakistan; Model of Pakistan poultry industry; Development of in silico small business plan and evaluation of plans of peers.

### **Suggested Readings**

1. Deakins D.M. and M. Freel. 2014. Entrepreneurship & small business. McGraw Hill Higher Education, New York, NY, USA.
2. Kritiki F.A. 2007. Entrepreneurship and new value creation. Cambridge University Press,
3. Lowe R. and S. Mariott. 2006. Enterprise: Entrepreneurship & Innovation. Burlington, Butterworth Heinemann Oxford, UK.
4. Salavou E. 2013. Innovation and change in entrepreneurship. McGraw Hill Higher Education, New York, NY, USA.
5. Sarri K. and A. Trihopoulou (2008). Female entrepreneurship. McGraw Hill Higher Education, New York, NY, USA.

## **UAM-611 Preparation of Research Project and Scientific Writing 2(1-1)**

### **Learning Objectives:**

During the course, Students will be able to:

- Learn about basics of Scientific writing
- Learn about Research project writing

### **Theory**

Basics of Scientific writing, skills; Various written skills of Scientific paper, manuscript; How to write research project its basic parts; Reference writing for books, research papers and conferences; How to improve written skills and abilities; Consulting the relevant literature, Planning and essentials of research plan.

### **Practical**

Training of the student in study and evaluation of problems of livestock industry and to find their solutions through research; Practical: Identification of research problem; Execution of project; Data collection, analysis, formulation of tables & figures and interpretation of results & discussion, conclusion, recommendations; Report writing, submission and presentation.

### **Suggested Reading:**

1. Anonymous.1999.Instructions to Authors. Amer. Soc. Hort. Sci. Alexandria, Virginia.
2. Brown, B.W. 2009. Successful Technical Writing/Instructor's Guide, Goodheart-Willcox Publisher
3. Hardesty, R.E. 2010. Technical and Business Writing for Working Professionals, Xlibris Corporation, Bloomington, IN, USA.
4. Petersen, R.G. 1994. Agricultural Field Experiments—Design and Analysis. Marcel Dekker, Inc. New York, NY, USA.

## **MICRO-611 Emerging Issues in Microbiology 2(2-0)**

## **Learning Objectives**

During the course, students will be able to

- Appropriate amount of independent study
- Understand the basic principles of how to keep them updated on emerging issues in microbiology
- Ability to understand and explain scientific literature/research paper to peers

## **Theory**

Emerging seasonal and pandemic influenza virus infections; Respiratory Coronaviruses; Enterovirus 71; Ebola virus, Zika virus; Hepatitis viruses; Hantavirus, Nipah virus; Antimicrobial resistance; Tuberculosis; Any other emerging pathogen.

## **Suggested Reading:**

1. Madigan, M., K.S. Bender, D.H. Buckley, W.M. Sattley and D.A. Stahl. 2017. Brock Biology of Microorganisms. 15<sup>th</sup>Ed. New York, NY, USA.
2. Scopes, R.K. 2013. Protein purification: principles and practice. Springer Science & Business Media, Berlin, Germany.
3. Voet, D., J.G.Voet and C.W. Pratt. 2016. Fundamentals of biochemistry: life at the molecular level. Wiley Library. New York, NY, USA.

## **SEMESTER 8**

**MICRO-610**

**Internship and Research Project**

**6(0-6)**