Institute of Microbiology and Molecular Genetics
Faculty of Life Sciences
University of the Punjab, Lahore

Course Outline

Programme	BS	Course Code	MMG312	Credit Hours	3(2+1)
Course Title	**CYTOGENETICS**				

COURSE INTRODUCTION

Cytogenetics is a branch of genetics that studies the structure, function, and behavior of chromosomes. This course is designed to provide undergraduate students with a comprehensive understanding of chromosome biology, chromosomal aberrations, and the techniques used in cytogenetic analysis. The course will combine theoretical knowledge with hands-on laboratory experience.

LEARNING OUTCOMES

On the completion of the course, the students will be able to:

1. describe the structure and function of chromosomes, including their organization, replication, and role in inheritance.
2. gain experience with cytogenetic techniques such as karyotyping, fluorescence in situ hybridization (FISH), and comparative genomic hybridization (CGH), and apply these methods in laboratory settings.
3. develop the skills to analyze and interpret cytogenetic data, including identifying normal and abnormal karyotypes, understanding the clinical significance of findings, and making informed decisions based on cytogenetic results.
4. learn the role of cytogenetics in diagnosing genetic disorders, prenatal testing, and cancer genetics, and understand how cytogenetic analysis contributes to patient care and personalized medicine.

COURSE CONTENT

Overview of cytogenetics: History and scope; Chromosome structure and function: DNA, histones, nucleosomes, chromatin organization; Cell cycle and mitosis; Chromosome morphology; Chromosome classification; Chromosome Number and Variation; Ploidy; Aneuploidy; Chromosomal syndromes; Structural abnormalities; Isochromosomes, ring chromosomes, dicentric chromosomes; Mechanisms of chromosomal aberration formation; Clinical significance of chromosomal abnormalities; Human sex chromosomes: Structure and function; Mechanisms of sex determination: X and Y chromosomes, SRY gene; Sex chromosome abnormalities; Chromosome staining; Chromosomal changes in cancer; Techniques in prenatal diagnosis; Chromosomal evolution: Karyotype evolution in different species; Comparative cytogenetics: Chromosome painting, FISH in evolutionary studies; Case studies in human and primate cytogenetics.; Ethical considerations in prenatal testing and genetic counseling; Legal aspects of cytogenetic testing; Social implications of cytogenetic research and testing

PRACTICALS

Microscopy and Chromosome Observation; Introduction to light microscopy; Preparation and observation of onion root tip cells to study mitosis; Blood sample collection and culture; Chromosome preparation from peripheral blood lymphocytes; Preparation of karyotypes from human metaphase spreads; Analysis of normal and abnormal karyotypes; Chromosome Banding

Techniques; FISH protocol: Probe preparation, hybridization, and analysis; Comparative Genomic Hybridization (CGH)

TEXTBOOKS AND READING MATERIAL

1. Gersen, S. and Martha B. Keagle, M. B., (2013). *The Principles of Clinical Cytogenetics*. Springer, New York
2. Gardner, R.J.M., and Amor, D.J., (2018*). Gardner and Sutherland's Chromosome Abnormalities and Genetic Counselling*. Oxford University Press
3. Lau, Y. F. (2003). *Molecular Cytogenetics: Protocols and Applications*. Humana Totowa, NJ.
4. Liehr, T.(2022). *Cytogenetics and Molecular Cytogenetics*. CRC Press.
5. Miller, O. J., and Therma, E, (2001). *Human Chromosomes*. Springer New York, NY.
6. Liehr, T. (2021). *Cytogenomics*. Academic press.
7. García-Velasco, J.A., and Seli ,E., 2020.*Human Reproductive Genetics,* Academic Press.
8. Klug, W.S., Cummings, M.R., Spencer, C.A., & Palladino, M.A. (2021). *Essentials of Genetics*, 10th Edition, Prentice Hall, NJ.

ASSESSMENT

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on activities, short tests, projects, practicals, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on a term paper, research proposal development, fieldwork, report writing, etc.

Institute of Microbiology and Molecular Genetics
Faculty of Life Sciences
University of the Punjab, Lahore

Course Outline

Programme	BS	Course Code	MMG313	Credit Hours	3(2+1)
Course Title	MEDICAL VIROLOGY				

COURSE INTRODUCTION

This course introduces the advances concepts of viral pathogenesis in humans and animals coupled with control of viral infections through vaccines and antivirals. Through theoretical and lab work, students will study in-depth details of viral diseases; pathogenesis, transmission, treatment and prevention. Overall, students will be able to understand how viruses cause diseases and ways of their prevention and treatment.

LEARNING OUTCOMES

On the completion of the course, the students will be able to understand:

- Basic and advanced concepts of designing vaccines against viruses and anti-virals
- How viral evolution leads to emerging viral diseases
- Pathogenesis, transmission, prevention/treatment of viral infections
- How viruses cause cancers

COURSE CONTENT

Vaccines: introduction to vaccines, history, concept of immunization and herd immunity, types of vaccines, Antivirals: methods for anti-viral discovery, antiviral targets, types of antiviral screening, antiviral resistance, Virus evolution and emergence: drivers of viral evolution, Quasispecies concept, selection, error threshold, genetic bottleneck, convergent forces for disease emergence, stable, interactions of host and viruses in context of evolution, zoonosis, emerged viral diseases, Mechanisms of Pathogenesis: Modelling human viral infections, stages and patterns of viral infections, Molecular mechanisms of viral persistence, regulation of latency and reactivation, slow, transforming and abortive infections, measuring viral virulence, immunopathology of viral diseases, immunosuppression, Molecular Mimicry and tolerance, Viral transformation and Oncogenesis: transformed cells, cell cycle control, oncogenic viruses, insertional mutagenesis, viral transforming genes, mechanisms of viral transformation

PRACTICALS

Chick embryo inoculation;Enzyme Linked Immunosorbent Assay (ELISA); Haemagglutination Inhibition (HI); Haemagglutination (HA); Precipitation; Cytopathic effects; Fluorescent Antibody Test (FAT); Polymerase Chain Reaction (PCR)

TEXTBOOKS AND READING MATERIAL

1. Flint, S.J., Vincent, R.R., Glenn F. R., Anna, M.S., & Lynn W. E. (2020). *Principles of Virology*, 5th Edition, ASM Press, United states.
2. Flint, S.J., Vincent, R.R., Glenn F. R., Anna, M.S., & Lynn W. E. (2015). *Principles of Virology*, 4th Edition, ASM Press, United states.
3. John B. C. and Venetia, A. S. (2013). *Virology Principles and Applications*, 2nd Edition, John Wiley & Sons Ltd, England, United Kingdom.
4. Jennifer, L. (2016). *Essential Human Virology*, Academic Press, United Kingdom.
5. Teri, S. (2017). *Understanding Viruses*, 3rd Edition, Jones and Bartlett Learning, Burlington MA, United States.
6. John B.C. & Venetia, A.S. (2013). *Virology, Principles and Applications*, John Wiley and Sons Ltd, England, United Kingdom
   Dimmock, N.J., Easton, A.J. and Leppard, K.N. (2016). *Introduction to Modern Virology*, 7th Edition, John Wiley and sons Ltd, England, United Kingdom

ASSESSMENT

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on activities, short tests, projects, practicals, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork, report writing etc.

Institute of Microbiology and Molecular Genetics
Faculty of Life Sciences
University of the Punjab, Lahore

Course Outline

Programme	BS	Course Code	MMG314	Credit Hours	3(2+1)
Course Title	**DNA DAMAGE, REPAIR AND CARCINOGENESIS**				

Course Introduction

This course provides an in-depth exploration of the molecular mechanisms underlying DNA damage, the various repair pathways that cells employ to maintain genomic integrity, and how failures in these processes contribute to carcinogenesis. The course will integrate fundamental concepts of molecular biology with the latest research in cancer biology to help students understand the relationship between DNA damage, repair mechanisms, and cancer development.

Learning Outcomes

On the completion of the course, the students will:

1. Describe the types of DNA damage and the cellular mechanisms for detecting and repairing them.
2. Differentiate between the major DNA repair pathways (e.g., nucleotide excision repair, base excision repair, mismatch repair, and homologous recombination).
3. Explain how defects in DNA repair mechanisms can lead to genomic instability and carcinogenesis.
4. Analyze the roles of tumor suppressor genes and oncogenes in DNA damage responses.

COURSE CONTENT

The course content provides an in-depth exploration of DNA damage and repair mechanisms, focusing on the molecular processes that maintain genomic integrity. It examines various types of DNA damage, such as double-strand breaks and crosslinking, and the cellular pathways that repair these damages, including nucleotide excision repair, base excision repair, and homologous recombination. The course also explores the connection between defective DNA repair mechanisms and the development of cancer, emphasizing the roles of oncogenes and tumor suppressor genes. Additionally, students will study cancer epidemiology, analyzing global and regional cancer trends, risk factors, and the impact of these factors on public health.

PRACTICALS

The lab practicals will include key techniques such as the MTT assay to measure cell viability and cytotoxicity, the Scratch Wound Assay to study cell migration, and 2D/3D cell cultures to model cancer cell behavior. Students will also perform DNA damage and repair assays to analyze the integrity and repair efficiency of DNA. These practicals provide hands-on experience with essential methods in cancer research, preparing students for advanced work in molecular biology and oncology.

TEXTBOOKS AND READING MATERIAL

1. Weinberg, R. A. (2013). *Biology of Cancer*, 2nd Edition. Garland Science, New York, United States.
2. International Agency for Research on Cancer (2024). *Cancer Epidemiology*. Retrieved from GCO.
3. National Cancer Institute (2024). *DNA Repair Pathways and Cancer*. Retrieved from NCI.

4. Vaughan, P. 2000. *DNA Repair Protocols: Prokaryotic Systems*, Humana Press, N.J.
5. Nickoloff, J. A. and Hoekstra, M. F. 2001.*DNA Damage and Repair: Advances from Phage to Humans,* Humana Press, N.J.

ASSESSMENT

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on activities, short tests, projects, practicals, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork , report writing etc.

**ONE COURSE WILL BE OFFERED AS ELECTIVE-I DEPENDING UPON THE FACILITITES AND FACULTY AVAILBLE