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

Course Outline

Programme	BS	Course Code	MMG404	Credit Hours	3 (2+1)
Course Title	**RECOMBINANT DNA TECHNOLOGY**				

COURSE INTRODUCTION

This course covers the principles and applications of recombinant DNA technology, including DNA cloning, gene expression, and genetic engineering. It will also introduce the applications of recombinant DNA in agriculture, gene therapy, gene editing, and genetic medicines.

LEARNING OUTCOMES

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

1. Explain the principles and techniques of recombinant DNA technology
2. Analyze the applications of recombinant DNA technology in microbiology and biotechnology.
3. Apply recombinant DNA technology to manipulate and study genes for industrial, Health, and environmental research

COURSE CONTENT

Introduction to Recombinant DNA Technology: Overview of recombinant DNA technology, History and development of genetic engineering, Basic molecular biology concepts (DNA, RNA, proteins), Cloning: Principles of DNA cloning, Restriction endonucleases and DNA ligation - Vectors (plasmids, phages, cosmids) and cloning strategies, Gene Expression: Transcription and translation, Promoters, enhancers, and regulatory elements, Gene expression systems (prokaryotic and eukaryotic), Genetic Engineering: Site-directed mutagenesis and gene editing (CRISPR/Cas9), Gene targeting and knockouts, Transgenic organisms and gene therapy, Applications of Recombinant DNA Technology: Production of therapeutic proteins (insulin, growth hormone), Genetically modified crops and agricultural biotechnology, Gene therapy and genetic medicines.

*Additional Resources:
-Online articles and research papers
- Bioinformatics tools and software

PRACTICALS

1. DNA Extraction and Purification using various techniques.
2. Restriction Digestion and DNA Ligation: Perform restriction digestion on DNA samples using available enzymes (e.g., EcoRI, BamHI) and Ligate DNA fragments using DNA ligase
3. DNA Cloning: Clone a gene into a plasmid vector using restriction digestion and ligation Transform competent bacteria with the recombinant plasmid, Screen for recombinant clones using antibiotic selection and PCR.
4. Gene Expression: Analyze protein expression using SDS-PAGE and Western blotting Site-Directed Mutagenesis: Perform site-directed mutagenesis on a DNA sequence using PCR-based methods (e.g., QuikChange)

BOOKS RECOMMENDED

1. Brown, T. A. (2020). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.

2. Old, R.W. and Primrose, S.B. 2009. *Principles of Gene Manipulation, an Introduction to Genetic Engineering*, 5th edition, Blackwell Scientific Publications, U.S.A.
3. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2019). *Molecular biology of the gene.* 8TH Edition. Pearson.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). *Molecular biology of the cell.*6th Edition. Garland Science.
5. Sambrook, J., & Russell, D. W. (2019). *Molecular cloning: A laboratory manual. 4th Edition.*Cold Spring Harbor Laboratory Press.
6. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., & Struhl, K. (2015). *Current Protocols in Molecular Biology* . Wiley.
7. Snyder, L., & Champness, W. (2019). *Molecular Genetics of Bacteria.* American Society for Microbiology Press.
8. *Additional Resources:
   - Online articles and research papers
   - Laboratory manuals and protocols
   - Bioinformatics tools and software

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.

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Course Outline

Programme	BS (4 years)	Course Code	MMG405	Credit Hours	3(2+1)
Course Title	**MICROBIAL ECOLOGY**				

COURSE INTRODUCTION

This course will explore the interactions of microorganisms with each other and their environments. In this subject, students will examine microbial diversity, community dynamics, biogeochemical cycles, and the ecological roles of microorganisms in various ecosystems. This course is designed to understand the fundamental principles of microbial ecology and to analyze microbial interactions and their ecological significance.

LEARNING OUTCOMES

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

1. Understand the fundamental principles of microbial ecology
2. Analyze microbial interactions and their ecological significance
3. Explore the role of microorganisms in nutrient cycling and ecosystem functioning
4. Microbial sampling, isolation, and identification

COURSE CONTENT

Introduction to Microbial Ecology: Overview of microbial ecology and its importance, historical context; Microbial Diversity: Classification and phylogeny of microorganisms; Microbial Habitats and Communities: Distribution and activities of microorganisms in natural systems (air, water and soil), Biofilms and their ecological significance; Aquatic Microbial Ecology: Microbial life in freshwater and marine ecosystems, Planktonic and benthic microorganisms; Microbial Ecology in Extreme Environments: Microbial life in extreme habitats (polar regions, ocean vents), Adaptations of extremophiles; Microbial metabolism and energy flow in ecosystems; Ecological Methods in Microbiology: Sampling techniques for microbial communities, Molecular tools for microbial ecology (PCR, sequencing, metagenomics); Current Trends and Future Directions in Microbial Ecology: Advances in microbial ecology research, Ethical considerations in microbial research, Anthropogenic effects on microbial diversity, cycling and distribution of microbial communities, Future challenges in microbial ecology and environmental sustainability

PRACTICALS

Techniques to study microbial ecology, distribution of microbes in different ecological niche and their enumeration, role of microorganisms in nitrification, de-nitrification, ammonification, nitrogen fixation, study of physical factors on distributions of resistant genes/ marker in environment.

TEXTBOOKS AND READING MATERIAL

Willey, J. M., Sandman, K. M. & Wood, D. H. (2020). *Presscotts's Microbiology*, 11th edition, McGrawHill, U.S.A.

1. Madigan, M. T., Bender, K. S., Buckley, D. H., Brock, T. D., Sattley, W. M.,Stahl, D. A. (2019). *Brock Biology of Microorganisms*. Pearson, United Kingdom.
2. Atlas, R. M. & Bartha, R. (1997). *Microbial Ecology: Fundamentals and Applications*, 4th Edition, Addison-Wesley Pub. Co. U.S.A.
3. Barton, L. L. & McLean, R. J. C. (2019). Environmental Microbiology and Microbial Ecology. United Kingdom: Wiley.
4. Edwards, C. (1990). *Microbiology of Extreme Environments*, McGraw Hill, U.S.A.

ASSESSMENT

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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