



Module

G01

Generic Foundational Course

An Introduction to Basic Molecular
and Microbial Biology

NGS Academy for the Africa CDC

Module

G01

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Module last updated:

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An Introduction to Basic Molecular and Microbial Biology

Suggested or approximate number of sessions	4
Suggested or approximate total learning time	10–12 hours
Target audience	All personas - wet laboratory personnel (i.e., scientists, laboratory technicians, etc.), dry laboratory personnel (epidemiologists, bioinformatics scientists, and bioinformaticians), and managerial personnel (i.e., HODs, laboratory managers, policymakers, etc.).
Delivery format	Lectures, videos
Level of the module	Introductory



Contributors

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Module description

This module provides an introduction to the basic biology of modern genomics and a brief overview of microbial biology, as it relates to pathogen surveillance and antimicrobial resistance (AMR). The basic concepts in this module are central to understanding the topics in the ensuing modules and courses. In this module, participants are introduced to the following topics and/or concepts:

- Essential terms and concepts in molecular biology
- The molecular structure and function of nucleic acids (DNA and RNA)
- The central dogma of molecular biology: replication, transcription, and translation
- Microbial characterisation through structure, morphology, and physiology
- The classification and typing of microorganisms according to their genome sizes and gene arrangements/structure
- Fundamental concepts underlying microbial metabolism
- Various metabolic processes utilised by different microorganisms
- The basic principles of microbial genetics: gene transfer mechanisms and genetic elements
- Sources or types of microbial genetic variation: mutations, recombination, and gene flow

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- The role of genetic variation in microbial evolution and adaptation
 - The diversity of microbial life and their ecological roles in various environments
 - The significance of microorganisms in nutrient cycling, symbiosis, and their impact on human health and disease
 - The basic principles of microbial pathogenesis
 - An overview of bacterial, viral, fungal, protozoan, microsporidium, and parasitic infections
 - Mechanisms of microbial virulence and host defence responses
 - The overlapping timescales of microbial pathogen evolution and infection transmission
 - The impact of microbial genetics on biotechnology, medicine, and environmental science
 - Recent advancements in microbial genetics: CRISPR-Cas systems and genome editing



Module learning outcomes

On completion of this module, the participants will have a basic knowledge of, or will be able to:

- Explain essential terms and concepts in molecular genetics
- Discuss the molecular structure of nucleic acids and their function
- Compare and contrast the processes of replication, transcription, and translation of the central dogma
- Characterise different microorganisms through their structure, morphology, and physiology
- Classify and identify different types of microorganisms according to their genome sizes and gene arrangements/structure
- Describe microbial genome sizes, gene arrangements, and transcriptional complexity
- Discuss the different metabolic processes utilised by various microorganisms
- Discuss the various gene transfer mechanisms utilised by different microorganisms
- Compare the different sources or types of genetic variation
- Describe the role of genetic variation in microbial evolution and adaptation
- Discuss the diversity of microbial life and their ecological roles in various environments
- Discuss the significance of microorganisms in nutrient cycling, symbiosis, and their impact on human, animal, and environmental health from a One Health perspective
- Discuss the basic principles of microbial pathogenesis
- Compare the various mechanisms of host infection by different microorganisms
- Describe different mechanisms of microbial virulence and host defence responses
- Discuss the range of mutation rates that occur in microbial genomes and their role in microbial pathogen evolution and infection transmission
- Discuss the role of microbial genetics in biotechnology, medicine, and environmental science
- Discuss the role of genome editing in microbial genetics



Module assessments

Module practical: Not applicable

Module quiz: Assessment questions available



Module resources

- [NIH | NLM Glossary - Essential terms and concepts in molecular biology](#)
- [JECH | Glossary article - Basic molecular genetics for epidemiologists](#)
- [NIH | NHGRI Glossary - Talking Glossary of Genomic and Genetic Terms](#)
- [NIH | NLM Article - Molecular genetics made simple](#)
- [Springer Link Chapter - Basics of the Molecular Biology: From Genes to Its Function](#)
- [NIH | NLM Paper - The Discovery of the Double Helix, 1951-1953 | Francis Crick - Profiles in Science](#)
- [Nature Education Article - Molecular structure of nucleic acids: A structure for deoxyribose nucleic acid](#)
- [NIH | NLM Paper - Defining the Genetic Coding Problem, 1954-1957](#)
- [Academia Article - Crick, F. H. C. \(1958\) On protein synthesis](#)
- [NIH | NLM Paper - Deciphering the Genetic Code, 1958-1966](#)
- [NIH | NLM Article - General Nature of the Genetic Code for Proteins](#)
- [NIH | NLM Article - Central Dogma of Molecular Biology](#)
- [Nature Video - The Central Dogma](#)
- [Oxford Academic \(Oxford University Press\) Video - DNA Replication](#)
- [US CDC Video Series - Core Science
 - \[Basic Molecular Biology: Basic Science – DNA Replication\]\(#\)
 - \[Basic Molecular Biology: Basic Science – RNA Structure\]\(#\)
 - \[Basic Molecular Biology: Basic Science – Bacterial Transcription\]\(#\)](#)
- [Oxford Academic \(Oxford University Press\) Video - Transcription](#)
- [Oxford Academic \(Oxford University Press\) Video - Translation](#)
- [Nature Education Article - Translation: DNA to mRNA to Protein](#)
- [NIH | NLM Article - Classification, identification and typing of micro-organisms](#)
- [NIH | NLM Article - The Basics of Structure, Morphology, and Physiology as They Relate to Microbial Characterization and Attribution](#)
- [Springer Link Chapter - Metabolomics: A Microbial Physiology and Metabolism Perspective](#)
- [Nature Reviews Article - Coordination of microbial metabolism](#)
- [ASM Journals Article - DNA transfer between two different species mediated by heterologous cell fusion in Clostridium coculture](#)
- [Royal Society Publishing Article - Selfish, promiscuous and sometimes useful: how mobile genetic elements drive horizontal gene transfer in microbial populations](#)
- [ScienceDirect Article - Microbial interactions: ecology in a molecular perspective](#)
- [NIH | NLM Article - Microbes and Environment](#)
- [NIH | NLM Article - Microbiota in health and diseases](#)
- [ScienceDirect Article - Impact of the microbiome on human, animal, and environmental health from a One Health perspective](#)
- [IJHSR Article - Microbial Pathogenesis](#)
- [NIH | NLM Article - Host-Pathogen Interactions: Basic Concepts of Microbial Commensalism, Colonization, Infection, and Disease](#)
- [Nature Reviews Article - The damage-response framework of microbial pathogenesis](#)

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- [ASM Training Videos - Training in Infectious Disease Applications of NGS](#)
 - [Review of Pathogen Genomics: Viruses, Bacteria, Fungi, and Parasites - Part 1](#)
 - [Review of Pathogen Genomics: Viruses, Bacteria, Fungi, and Parasites - Part 2](#)
 - [Specifics of Eukaryotic Genomics](#)
 - [Specifics of Bacterial Genomics](#)
 - [Introduction to Clinical Virology and Viral Genomics](#)
 - [Merck Manuals - Overview of Bacteria](#)
 - [NIH | NLM Article - Bacterial Infections: Overview](#)
 - [Merck Manuals - Bacterial infections and defences](#)
 - [Merck Manuals - Overview of Viral Infections](#)
 - [Merck Manuals - Types of Viral Disorders](#)
 - [Merck Manuals - Overview of Fungal Infections](#)
 - [NIH | NLM Article - Fungal infections in humans: the silent crisis](#)
 - [Merck Manuals - Overview of Intestinal Protozoan and Microsporidia Infections](#)
 - [NIH | NLM Book chapter - Protozoa: Pathogenesis and Defenses](#)
 - [US CDC Webpage - Parasites](#)
 - [Merck Manuals - Approach to Parasitic Infections](#)
 - [Royal Society Publishing Article - Darwin review: the evolution of virulence in human pathogens](#)
 - [ASM Training Videos - Training in Infectious Disease Applications of NGS](#)
 - [Molecular Evolution and Community Outbreak](#)
 - [NIH | NLM Article - What is mutation? A chapter in the series: How microbes “jeopardize” the modern synthesis](#)
 - [ScienceDirect Article - Evolutionary changes in mutation rates and spectra and their influence on the adaptation of pathogens](#)
 - [PNAS Article - The comparative genomics of viral emergence](#)
 - [SpringerOpen Article - The genome editing revolution: review](#)
 - [NIH | NLM Article - Genome-Editing Technologies: Principles and Applications](#)
 - [ScienceDirect Article - CRISPR-based gene editing technology and its application in microbial engineering](#)
 - [NIH | NLM Article - Advances in Accurate Microbial Genome-Editing CRISPR Technologies](#)



References

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- OpenAI. (2024). Gemini response on learning objectives for an introduction to basic genetics and microbial biology modules. Retrieved July 29, 2024, from Gemini
 - OpenAI. (2024). ChatGPT 4o mini response on learning objectives for an introduction to basic genetics and microbial biology module. Retrieved July 29, 2024, from ChatGPT
 - OpenAI. (2024). ChatGPT 4o mini response on shortening or rephrasing the module overview (of G01) to 3 sentences but keeping an academic tone. Retrieved November 18, 2024, from ChatGPT



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