



MOLECULAR BIOLOGY

MODULE DESCRIPTION/OVERVIEW

Recent advances achieved through the application of genomic and epigenomic approaches are reshaping the study of immune dysfunction and opening up new avenues for therapeutic interventions. Moreover, applying genomic techniques to resolve functionally important genetic variation between individuals is providing new insights into immune function in health. Epigenetic changes, such as DNA methylation, histone modifications, and noncoding RNAs, are involved in the pathogenesis of autoimmune diseases mainly by regulating gene expression..

This module provides the understanding of genetics and their role in immunomodulation and introduces the scientific background for molecular diagnosis and the principles of molecular biology laboratory practice. It describes the structures of nucleic acids and proteins, illustrates the fundamental mechanisms such as DNA replication, transcription and translation, posttranslational modification as well as DNA damage and repair. It also demonstrates the tools of molecular biology, such as PCR and sequencing including their principles, procedures and applications for the diagnosis of genetic diseases.

MODULE LEARNING OBJECTIVES

- 1) Demonstrate conceptual understanding of genetics and epigenetics .
- 2) Investigate the role of genetic mechanisms in modulating immune response in different diseases.
- 3) Recognize the DNA damage and repair mechanisms.
- 4) Acquire theoretical knowledge and hands-on skills in some molecular biology techniques.

Module Intended Learning Outcomes

Upon successful completion of this module, students will be able to:

A- **KNOWLEDGE AND UNDERSTANDING:** (REMEMBERING AND UNDERSTANDING)

- A1. Recall the structure and chemistry of nucleic acids and human genome.
- A2. Define the genes, alleles and phenotype.



- A3. Describe the processes of DNA replication, RNA transcription, translation and posttranslational modifications as well as their regulation mechanisms.
- A4. Describe the process of DNA damage, causes and different repair mechanisms.
- A5. Recall the types of genetic variations, mutations and their diagnostic importance.
- A6. Illustrate the impact of dysregulation of DNA repair mechanism in disease development and diagnosis.
- A7. State different types of non-coding RNA and their function.
- A8. Identify the concept of DNA recombination and cloning.
- A9. Describe the cell cycle and its regulation.
- A10. Discuss genetic disorders.
- A11. Explain the basic molecular mechanisms controlling cell growth, and proliferation.
- A12. Identify the molecular biology techniques and their applications in addressing issues related to different genetic and immunological diseases.

B- INTELLECTUAL SKILLS: (APPLICATION, ANALYSIS, SYNTHESIS, EVALUATION)

- B1. Correlate between the concept of the genotype and phenotype
- B2. Outline the different causes and types of mutations.
- B3. Apply principles of genetics and molecular biology knowledge in understanding and diagnosis of various diseases.
- B4. Demonstrate the principle of abnormal cell growth.
- B5. Formulate a research question properly.
- B6. Analyze and interpret results of molecular biology techniques in relation to health and disease.
- B7. Design DNA recombination and cloning experiment.
- B8. Evaluate the results of molecular experiments.



C- PROFESSIONAL SKILLS: (PRACTICAL SKILLS)

- C1. Demonstrate effective search strategies.
- C2. Practice relevant molecular tests for diagnosis of various diseases.
- C3. Practice critical thinking and problem-solving skills.
- C4. Efficiently perform different molecular techniques such as: nucleic acid extraction, PCR, etc.
- C5. Safely handle laboratory reagents and instruments used in the molecular biology lab.
- C6. Report laboratory findings in a complete informative way.
- C7. Develop new analytical methods and assess its efficacy for diagnostic purposes.

D- GENERAL SKILLS: (ATTITUDES AND COMMUNICATION SKILLS)

- D1. Display ability to successfully engage in written and oral communications with scientific community through effective scientific writing and presentation skills.
- D2. Develop self-learning tools to allow for continued education.
- D3. Develop skills of communication and interaction.
- D4. Demonstrate honesty, and integrity in experimental design, performance, and data analysis as well as reporting data with acceptable standards of reproducibility.
- D5. Use information technology to the benefit of professional practice.
- D6. Follow ethical, legal, and safety standards.
- D7. Appreciate honest scientific research.
- D8. value the teamwork and leadership

MODULE RESOURCES

Required Module Textbooks and Materials

- Basic Cell and Molecular Biology: What We Know & How We Found Out - 4e . Available at: <https://open.umn.edu/opentextbooks/textbooks/244>



- Anon, 2020. Biomolecules - Nucleic Acids. Available at: <https://chem.libretexts.org/@go/page/91077> [Accessed February 22, 2022]. <https://www.vanderbilt.edu/AnS/Chemistry/Rizzo/Chem220b/Ch28.pdf>
- Wakim, S., & Grewal, M. (2021, September 4). Genetics of Inheritance. Butte College. Available at: <https://bio.libretexts.org/@go/page/16762>
- Elston, Robert C et al. "Genetic terminology." Methods in molecular biology (Clifton, N.J.) vol. 850 (2012): 1-9. doi:10.1007/978-1-61779-555-8_1
- Chaudhry R, Khaddour K. Biochemistry, DNA Replication. 2021 May 9. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. PMID: 29489296.
- Al About NM, Basit H, Al-Jindan FA. Genetics, DNA Damage and Repair. 2021 Aug 11. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. PMID: 31082132. <https://pubmed.ncbi.nlm.nih.gov/31082132/>
- Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell. 4th edition. New York: Garland Science; 2002. DNA Repair. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK26879/>
- Genetic Alliance; The New York-Mid-Atlantic Consortium for Genetic and Newborn Screening Services. Understanding Genetics: A New York, Mid-Atlantic Guide for Patients and Health Professionals. Washington (DC): Genetic Alliance; 2009 Jul 8. CHAPTER 1, GENETICS 101. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK115568/>
- Mercadante AA, Dimri M, Mohiuddin SS. Biochemistry, Replication and Transcription. 2021 Aug 27. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. PMID: 30986011. <https://pubmed.ncbi.nlm.nih.gov/30986011/>
- Chen, L. and Kashina, A., 2021. Post-translational Modifications of the Protein Termini. Frontiers in Cell and Developmental Biology, [online] 9. Available at: <https://www.frontiersin.org/articles/10.3389/fcell.2021.719590/full>
- Housman, Gali; Ulitsky, Igor (January 2016). "Methods for distinguishing between protein-coding and long noncoding RNAs and the elusive biological purpose of translation of long noncoding RNAs". Biochimica et Biophysica Acta (BBA) - Gene Regulatory Mechanisms. 1859 (1): 31–40. doi:10.1016/j.bbagr.2015.07.017. ISSN 0006-3002. PMID 26265145
- Chen J. The Cell-Cycle Arrest and Apoptotic Functions of p53 in Tumor Initiation and Progression. Cold Spring Harb Perspect Med. 2016 Mar 1;6(3):a026104. doi: 10.1101/cshperspect.a026104. PMID: 26931810; PMCID: PMC4772082.
- Hirschhorn, J., Lohmueller, K., Byrne, E. et al. A comprehensive review of genetic association studies. Genet Med 4, 45–61 (2002). <https://doi.org/10.1097/00125817-200203000-00002>
- Zhang F, Lupski JR. Non-coding genetic variants in human disease. Hum Mol Genet. 2015 Oct 15;24(R1):R102-10. doi: 10.1093/hmg/ddv259. Epub 2015 Jul 7. PMID: 26152199; PMCID: PMC4572001. <https://pubmed.ncbi.nlm.nih.gov/26152199/>
- Mishra M, Tiwari S, Gomes AV. Protein purification and analysis: next generation Western blotting techniques. Expert Rev Proteomics. 2017



Nov;14(11):1037-1053. doi: 10.1080/14789450.2017.1388167. Epub 2017
Oct 13. PMID: 28974114; PMCID: PMC6810642.
<https://pubmed.ncbi.nlm.nih.gov/28974114/>

Optional Module Textbooks and Materials

- National Research Council (US) Committee on Developmental Toxicology. Scientific Frontiers in Developmental Toxicology and Risk Assessment. Washington (DC): National Academies Press (US); 2000. 5, Human Genetics and the Human Genome Project. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK225676/>
- Prioleau MN, MacAlpine DM. DNA replication origins-where do we begin? Genes Dev. 2016 Aug 1;30(15):1683-97. doi: 10.1101/gad.285114.116. PMID: 27542827; PMCID: PMC5002974.
- Lewis T, Dimri M. Biochemistry, DNA Repair. 2021 Jul 31. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. PMID: 32809398. <https://pubmed.ncbi.nlm.nih.gov/32809398/>
- <https://www.ebi.ac.uk/training/online/courses/human-genetic-variation-introduction/what-is-genetic-variation/>
- <https://www.nature.com/scitable/topicpage/regulation-of-transcription-and-gene-expression-in-1086/>
- Translation & Post-translational Processes. (2019, June 23). <https://bio.libretexts.org/@go/page/20349>
- Molecular Diagnostics, 3e: Fundamentals, Methods, and Clinical Applications. Lela Buckingham, Philadelphia : F.A. Davis Company, 2019.
- Karin Knisely, “A student handbook for Writing in Biology”, 4th Edition. 2013.

ASSIGNMENTS AND GRADING SCHEME

GRADING SYSTEM

Diagnostic: assessment before the course

Formative: quizzes, presentations, interactive discussions throughout the course, DOPS

Summative: at the end of the course



- Written exam: MCQ, problem solving, true or false, extended matching and modified essay questions for assessment of knowledge and intellectual skills.
- Practical exam: to assess practical and general skills in addition to intellectual skills in the form of OSPE .

GRADING POLICY

Grades can be based on the following:

Practical presentations and assignments	20 %
Exams	70 %
Class attendance/participation	10 %
Total Points	

MODULE POLICIES

LATE ASSIGNMENTS

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CLASSROOM PROTOCOL

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DISSABILITY

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IMPORTANT DATES TO REMEMBER

MODULE SCHEDULE

Week	Topics, Readings, Assignments and Deadlines
	Structure and chemistry of nucleic acids
	Human genome: genes, alleles and genotypes
	DNA Replication