

## **BIO 1412: MOLECULAR BIOLOGY AND GENETICS** (2.5 CREDITS)

**Rationale:** Students need to understand that the long-term survival of organisms depends on the continuous division of their genetic material and cells and that variation among related individuals is very important to their environmental adaptation and evolution.

**Aims:** This course introduces DNA replication, transcription and translation and how gene expression is controlled. It also discusses genetic variation and its inheritance among organisms.

**Objectives: At the end of the course a student should be able to**

1. Explain the basic principles of molecular biology and genetics.
2. Describe the role of gene regulation in cellular function.
3. Explain the chromosomal theory of inheritance.
4. Discuss classical Mendelian and post-Mendelian genetics.

**Co-requisite:**           **BIO 1401: Biomolecules and Cells**

### **Course content**

**MOLECULAR BIOLOGY: DNA replication in prokaryotes:** Semi-conservative replication, Experiments of Stahl and Meselson; Leading strand and lagging strand DNA synthesis. **Transcription:** mRNA, tRNA and rRNA transcription in prokaryotes (Initiation, elongation and termination). Post transcriptional modifications of eukaryotic RNA primary transcripts. **Translation:** Protein synthesis; properties of the genetic code; Amino acid activation, initiation, elongation and termination. **Regulation of gene expression:** Significance; the Lac operon system; End product inhibition. **Types of gene mutation:** Deletions, insertions, substitutions; sickle cell anaemia as an example of a point mutation. **Mutagens:** Mutagenic effects; Chemical e.g. deamination and depurination; Physical e.g. dimerization; Biological e.g. mutation due to viral infection. **GENETICS: Chromosomal theory of inheritance:** Discovery of chromosomes, chromosomal structure (DNA, histones, nucleosomes), genes and alleles. **Cell division:** cell cycle, mitosis and meiosis. Chiasma formation and chromosomal recombination. **Genetics Introduction to genetics:** Definition and significance of genetics; key concepts in genetics: (e.g. phenotype, genotype, homozygote, heterozygote, dominance, incomplete dominance, codominance, recessive gene; P, F<sub>1</sub> and F<sub>2</sub> generations; test cross and back cross, etc.) **Mendelian Genetics:** Mendel's First and Second Laws; monohybrid cross, dihybrid cross, Test cross and back cross. Use of the Punnet square; the Chi-squared test. **Post-Mendelian Genetics:** Multiple alleles, lethal genes, polygenic inheritance (continuous and discontinuous variation), gene linkage. **Gene interactions:** Epistasis and modifications of Mendelian phenotypic ratios. **Sex determination and sex-linkage:** Inheritance of sex and sex-linked traits; colour blindness and haemophilia as examples of X-linked diseases in humans; hormonal effects on sex expression. **Chromosomal mutations:** Types of chromosomal mutations; Origins of chromosomal mutations; Human cytogenetic diseases.

**42 lectures**

## Suggested Practical Work

1. Characterization of cellular components.
2. DNA amplification by polymerase chain reaction.
3. DNA extraction.
4. Mitosis in plant cells.
5. Study of the behaviour of chromosomes during meiosis and fertilization using simulations.
6. Study of characters showing genetic variation in *Drosophila*.
7. Monohybrid crosses in *Drosophila*, maize and peas.
8. Chi-squared test.
9. Solving genetic problems I – Monohybrid crosses.
10. Solving genetic problems II – Dihybrid crosses.
11. Solving pedigree problems post-Mendelian genetics.

**Time allocation:** Three one hour lectures per week  
One hour tutorial per week  
One three hour practical session per week

**Assessment:** **Continuous Assessment – 50%**  
**Final Examination – 50%**

Task description	Weighting
Assignments	10%
Tests	20%
Practical reports	20%
One theory exam paper	50%

## Prescribed Reading

Solomon E.P. and Berg L.R. 1997. *The World of Biology*. 5th ed. Harcourt: Saunders College Publishing. ISBN 0039048657.

## Recommended Readings

Kent, M. 2000. *Advanced biology*. London: Oxford University Press.  
ISBN 0-19-914195-9.

Elliot, W. H. and Elliot D. C. 2004. *Biochemistry and Molecular Biology*. 3rd ed.  
Oxford: Oxford University Press. ISBN 0-19-927199-2.

Katongo, C. 2020. BIO 1412 Module. UNZA.