Grade 12 Life Sciences: DNA & Genetics Study Guide

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Free Study Resources for South African Matric Learners

1. DNA Structure

DNA (Deoxyribonucleic Acid) is a double helix made up of nucleotides. Each nucleotide has:
- A deoxyribose sugar
- A phosphate group
- A nitrogenous base (A, T, G, or C)

Base Pairing Rules (Chargaffs Rules)

- Adenine (A) pairs with Thymine (T) - 2 hydrogen bonds
- Guanine (G) pairs with Cytosine (C) - 3 hydrogen bonds
- % A = % T; % G = % C in any double-stranded DNA

2. DNA Replication

Semi-conservative replication: each new DNA molecule contains one original strand and one new strand.

- Helicase unwinds and separates the double helix
- DNA polymerase adds new complementary nucleotides (5->3 direction)
- Leading strand: synthesised continuously; Lagging strand: synthesised in Okazaki fragments
- DNA ligase joins Okazaki fragments together

3. Protein Synthesis

Transcription (nucleus)

DNA -> mRNA
- RNA polymerase unwinds DNA and reads the template strand
- mRNA is built from RNA nucleotides (A, U, G, C) - Uracil (U) replaces Thymine
- mRNA leaves nucleus through nuclear pores

Translation (ribosome)

mRNA -> Protein
- mRNA attaches to ribosome
- tRNA brings amino acids; each tRNA has an anticodon matching the mRNA codon
- Amino acids are joined by peptide bonds
- Start codon: AUG (methionine); Stop codons: UAA, UAG, UGA

Codon	3 bases on mRNA
Anticodon	3 bases on tRNA (complementary to codon)
Amino acid	specified by each codon (genetic code)

4. Genetics: Mendelian Inheritance

- Dominant allele: expressed when at least one copy is present (capital letter)
- Recessive allele: only expressed when two copies present (lowercase letter)
- Homozygous dominant: AA; Homozygous recessive: aa; Heterozygous: Aa
- Phenotype: observable trait; Genotype: genetic make-up

Monohybrid Cross (Punnett Square)

Aa x Aa -> 1AA : 2Aa : 1aa (genotype ratio 1:2:1)

Phenotype ratio: 3 dominant : 1 recessive

5. Mutations

Types of Gene Mutations

- Substitution: one base replaced by another (e.g. sickle cell anaemia)
- Insertion: extra base added -> frameshift -> all subsequent codons change
- Deletion: base removed -> frameshift

Chromosomal Mutations

- Deletion: segment of chromosome lost
- Duplication: segment repeated
- Inversion: segment reversed
- Translocation: segment moves to another chromosome
- Non-disjunction: chromosomes fail to separate -> Down syndrome (trisomy 21)

TIP A frameshift mutation (insertion or deletion) has the most severe effect on a protein because it changes EVERY codon downstream from the mutation site.