

Molecular Basis of Inheritance — Assignment 2

Class 12 Biology · Higher-difficulty challenge set + integrated problems · Answer key included · Narayan Gurukul Academy

Instructions: (1) Attempt all questions; start with the topic-wise challenge set, then attempt the integrated (multi-topic) problems.
(2) Give all answers with correct SI units. $g = 10 \text{ m/s}^2$ unless stated.
(3) A final answer key is provided at the end — try the full set before checking it.

Part A — Topic-wise challenge questions

DNA Structure — The Watson-Crick Model

1. State Chargaff's rule.
2. What is meant by antiparallel strands?
3. Describe the Watson-Crick model of DNA.

DNA as the Genetic Material

1. Describe Griffith's transformation experiment.
2. Why is DNA more stable than RNA?
3. Describe the experimental proof that DNA is the genetic material.

Semi-Conservative Replication

1. What is the role of DNA polymerase?
2. Describe the Meselson-Stahl experiment.
3. Describe the process of DNA replication.

Transcription and mRNA Processing

1. Differentiate between the template strand and the coding strand.
2. What is mRNA processing?
3. Describe transcription in prokaryotes.

The Genetic Code

1. What is meant by the degeneracy of the genetic code?
2. Why is the genetic code called non-overlapping?
3. Describe the salient features of the genetic code.

Translation and the Lac Operon

1. What is the role of tRNA in translation?
2. Explain the induction of the lac operon.
3. Describe the process of translation.

Human Genome Project and DNA Fingerprinting

1. Mention two goals of the Human Genome Project.
2. What are the applications of DNA fingerprinting?
3. Explain the principle and applications of DNA fingerprinting.

Part B — Integrated problems (multi-topic)

1. Describe the process of DNA replication.
2. Explain the lac operon and its regulation.
3. Describe the Human Genome Project and its salient features.
4. Describe the process of transcription in prokaryotes and mRNA processing.
5. Describe the process of translation and the role of ribosomes.
6. State and explain the salient features of the genetic code.

Answer Key

DNA Structure — The Watson-Crick Model

Two antiparallel polynucleotide strands form a right-handed double helix; bases are inside, paired A=T (2 H-bonds) and G≡C (3 H-bonds); one turn = 3.4 nm with 10 bp; sugar-phosphate backbone outside.

DNA as the Genetic Material

Griffith's transformation showed a 'transforming principle'; Avery, MacLeod and McCarty proved it was DNA. DNA is more stable and has thymine, so it is a better genetic material.

Semi-Conservative Replication

Each new DNA molecule has one old and one new strand; proved by Meselson and Stahl using ^{15}N -labelled E. coli. DNA polymerase adds nucleotides $5' \rightarrow 3'$.

Transcription and mRNA Processing

RNA polymerase uses the template strand ($3' \rightarrow 5'$) to make mRNA. In eukaryotes, hnRNA is capped, tailed and spliced to form mature mRNA.

The Genetic Code

Triplet, degenerate, non-overlapping, comma-less, unambiguous and nearly universal; AUG is the start codon; UAA, UAG and UGA are stop codons.

Translation and the Lac Operon

Translation: ribosome reads mRNA codons, tRNA brings amino acids, peptide bonds form. Lac operon (z, y, a genes) is induced by lactose; the repressor (i gene) blocks the operator without lactose.

Human Genome Project and DNA Fingerprinting

HGP (1990–2003) sequenced the human genome (~3.1 billion bp, ~30,000 genes). DNA fingerprinting uses satellite DNA repeat variability for identification.

Integrated problems

1: Helicase unwinds, polymerase synthesises, ligase joins; semi-conservative. 2: Repressor binds operator; lactose induces the operon. 3: HGP goals — identify genes and store data. 4: Sigma factor binds the promoter; hnRNA → mRNA. 5: Initiation, elongation, termination. 6: Triplet and degenerate; AUG start; three stop codons.