Lab 6: The Central Dogma — From DNA to Protein

BIOL-8

Name: _____ **Date:** _____

Name: _____ **Date:** _____

Objectives

By the end of this lab, you will be able to:

- **Model DNA replication** by determining complementary strands.
- **Perform transcription** by converting a DNA template strand into an mRNA sequence.
- **Perform translation** by decoding mRNA codons into an amino acid chain.
- **Trace the flow of genetic information** from DNA → RNA → Protein (the Central Dogma).
- **Use a codon table** to identify amino acids.
- **Simulate a mutation** and observe its effect on the final protein.

Introduction

The **Central Dogma of Molecular Biology** describes the flow of genetic information in living cells:

DNA (Nucleus) —> **mRNA** (Nucleus → Cytoplasm) —> **PROTEIN** (Ribosome)

In this lab, you will follow a gene through these steps to see how a sequence of DNA bases becomes a functional protein.

Key Terms:

Term	Definition
Nucleotide	Building block of DNA/RNA (base + sugar + phosphate)
Complementary base pairing	A pairs with T (DNA) or U (RNA); G pairs with C

Term	Definition
Codon	Three-nucleotide sequence on mRNA that codes for an amino acid
Start codon	AUG — signals the beginning of translation (Methionine)
Stop codon	UAA, UAG, UGA — signals the end of translation

Part 1: DNA Replication

Background

Before a cell divides, it must copy its DNA. **Helicase** unzips the strands, and **DNA Polymerase** builds new ones.

Procedure

1. Below is a **Template Strand** of DNA.
2. Determine the **Complementary New Strand**.
3. Remember the base pairing rules for DNA:
    - **A** pairs with **T**
    - **C** pairs with **G**

Template Strand (3' to 5'):
`T A C A A G T T T G C A C C G A T T`

Complementary New Strand (5' to 3'):

1. If the template strand has 20% Adenine (A), what percentage of Thymine (T) would be in the new strand?

2. Why is it important for DNA to be copied accurately before a cell divides?

3. Which enzyme acts as the "builder" to add new nucleotides?

Part 2: Transcription — DNA → mRNA

Background

RNA Polymerase reads the DNA template and builds a single-stranded **mRNA** message to send to the ribosome.

Important Difference: RNA does not have Thymine (T). Instead, it uses **Uracil (U)**.

- DNA **A** pairs with RNA **U**
- DNA **T** pairs with RNA **A**

Procedure

1. Use the same **DNA Template** from Part 1.
2. Transcribe it into **mRNA**.

DNA Template: `TAC AAG TTT GCA CCG ATT`

mRNA Sequence:
5'— _____ —3'

4. Where in the eukaryotic cell does transcription occur?

5. How is the structure of RNA different from DNA? (List at least two differences)

6. If a DNA strand reads `A-T-G`, what will the mRNA read?

Part 3: Translation — mRNA → Protein

Background

The ribosome reads mRNA in triplets called **codons**. **tRNA** molecules bring the matching amino acids to build the protein chain.

Procedure

1. Look at your **mRNA sequence** from Part 2.
2. Group the bases into **triplets (codons)**.
3. Use a **Codon Table** to find the amino acid for each triplet.
4. Write the final amino acid sequence below.

Polypeptide Chain (Protein):

_____ – _____ –
_____ – _____ –
_____ – _____

(Note: If you encounter a STOP codon, write "STOP" and do not add more amino acids)

7. What is the very first amino acid in almost every protein? (Hint: Look at the start codon)

8. What is the job of tRNA (transfer RNA)?

9. How many bases make up one codon?

Part 4: Mutation Simulation

Background

A **mutation** is a change in the DNA sequence. Even a single base change can alter the protein.

Procedure

1. Let's simulate a **Point Mutation**.
2. Look at the **4th Codon** of the original DNA Sequence: `GCA`
    - Originally, this transcribed to mRNA `CGU`, which coded for **Arginine (Arg)**.
3. **Change the DNA base C to T**, so the codon becomes `GTA`.
4. Determine the new mRNA codon and the new amino acid.

Original DNA Codon: `GCA` -> **Amino Acid:** Arginine (Arg)

Mutated DNA Codon: `GTA`

New mRNA Codon:

New Amino Acid:

10. Did this mutation change the amino acid sequence?

11. What might happen to the protein's function if its shape changes?

12. Are all mutations bad? Explain why or why not.

Conclusion

13. Summarize the flow of information in the Central Dogma:

14. Why do you think the cell uses an intermediate (mRNA) instead of using DNA directly for protein synthesis?

End of Lab 6