Module 13: Regulation of Gene Expression

Keys to Success & Study Guide

Learning Objectives

By the end of this module, you should be able to: 1. **Explain** the organization and regulation of prokaryotic operons (lac and trp). 2. **Identify** the multiple levels of eukaryotic gene regulation (chromatin to protein). 3. **Differentiate** between types of DNA mutations and predict their effect on the protein product. 4. **Discuss** the implications of epigenetic inheritance.

Key Terminology Checklist

Define these terms in your own words to ensure mastery. - [ ] **Promoter**: Region where RNA polymerase binds. - [ ] **Operator**: The "On/Off Switch" segment of DNA. - [ ] **Repressor**: A protein that binds to the operator and blocks attachment of RNA polymerase. - [ ] **Epigenetics**: Changes in organism caused by modification of gene expression rather than alteration of the genetic code. - [ ] **Mutagen**: A chemical or physical agent that causes mutation. - [ ] **Barr Body**: A dense object lying along the inside of the nuclear envelope in female mammalian cells, representing an inactivated X chromosome.

Concept Check

1. Efficiency Strategy

- **Question**: Why do bacteria use operons?
- **Deep Dive**: Bacteria often need to make 5 different enzymes to digest one sugar. Instead of having 5 separate switches, they group the genes together under ONE switch (Promoter/Operator). It's efficient. Turn one key, start 5 engines.

2. The Tighter the Spool...

- **Question**: How does chromatin structure affect expression?

- **Deep Dive**: DNA is wrapped around **Histones**.
    - Tightly wrapped (Heterochromatin) = **OFF** (Enzymes can't reach it).
    - Loosely wrapped (Euchromatin) = **ON**.
    - Adding Acetyl groups looses the spool (Turns ON). Adding Methyl groups tightens it (Turns OFF).

3. Mutation Math

- **Question**: What is a point mutation?
- **Deep Dive**: Changing ONE letter.
    - **Silent**: CGA -> CGG (Both code for Arg). No effect.
    - **Missence**: CGA -> CCA (Arg -> Pro). Fold might change.
    - **Nonsense**: CGA -> UGA (Arg -> STOP). Protein is cut short (disastrous).

4. The Calico Cat

- **Question**: Describe why Calico cats have their unique color pattern.
- **Deep Dive**: The gene for orange/black fur is on the X chromosome. In a female (XX), one X shuts down randomly in every cell during development.
    - Patch 1: "Black X" active.
    - Patch 2: "Orange X" active.
    - Result: Mosaic pattern.

Study Tips

- **Lac vs Trp**:
    - **Lac**: Digestive. Default **OFF**. Inducible (Turn on when milk arrives).
    - **Trp**: Building. Default **ON**. Repressible (Turn off when you have enough amino acids).
- **Frameshift Analogy**:
    - Sentence: THE CAT ATE THE RAT.
    - Delete C: THE ATA TET HER AT... (Complete nonsense).