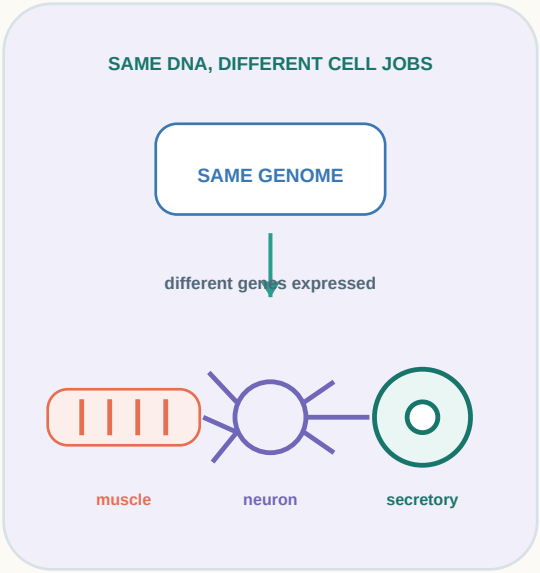
AP BIOLOGY | UNIT 6

TOPIC 6.6

Gene Expression and Cell Specialization

Specialized cells usually contain the same genome but activate different gene programs, producing different RNAs, proteins, structures, and functions.



THE CORE CAUSAL CHAIN

CELL SIGNALS → developmental cues

FACTORS BIND → regulatory DNA

GENE PROGRAM → selected genes on

SPECIALIZATION → structure and function

BY THE END, YOU SHOULD BE ABLE TO...

1. Explain how cells with the same DNA become different.
2. Connect transcription factor binding to gene activity.
3. Describe positive, negative, and small-RNA regulation.

CENTRAL IDEA

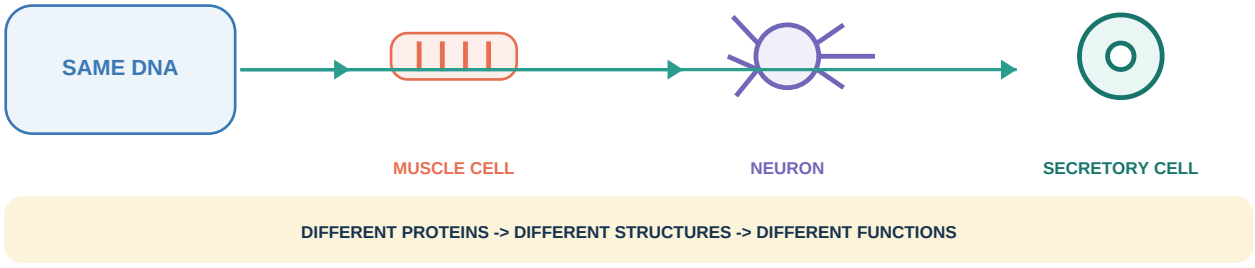
Cell identity depends on differential gene expression: each specialized cell uses only part of the shared genetic information at a given time.

1 Differential expression creates specialized cells

Cells with the same DNA produce different RNAs and proteins because different regulatory factors activate different gene sets.

SAME GENOME, DIFFERENT OUTPUT

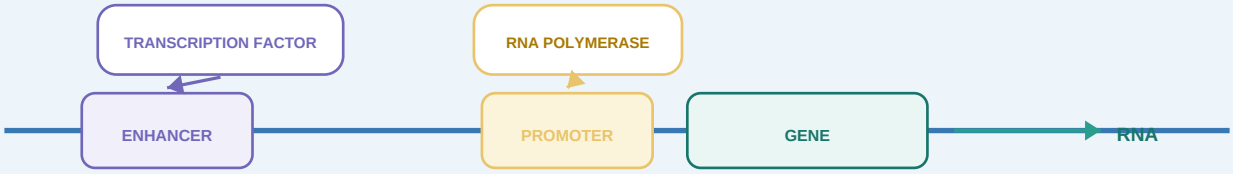
A SHARED GENOME SUPPORTS DIFFERENT EXPRESSION PROFILES



DIFFERENT PROTEINS -> DIFFERENT STRUCTURES -> DIFFERENT FUNCTIONS

TRANSCRIPTIONAL CONTROL

TRANSCRIPTION FACTORS CONNECT SIGNALS TO GENES



promoter recruits transcription machinery; enhancer-bound factors can raise transcription

POSITIVE AND NEGATIVE CONTROL

POSITIVE REGULATION

Activators help recruit or stabilize transcription machinery, increasing expression.

NEGATIVE REGULATION

Repressors or other negative regulators block binding or reduce transcription.

KEY RESULT

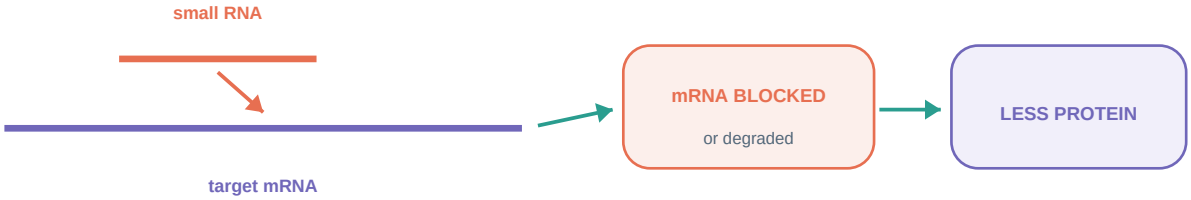
A cell's active transcription factors help select the gene-expression program that supports its specialized role.

2 Gene expression is controlled at several layers

Transcriptional regulators choose many cell-specific genes, while RNA-based mechanisms fine-tune individual messages.

POST-TRANSCRIPTIONAL FINE-TUNING

SMALL RNA CAN REDUCE EXPRESSION AFTER TRANSCRIPTION



POST-TRANSCRIPTIONAL CONTROL FINE-TUNES HOW MUCH PROTEIN IS MADE

A MULTILAYER CONTROL SYSTEM

1 DNA ACCESS

Chromatin state determines whether regulatory DNA is reachable.

2 TRANSCRIPTION

Promoters, enhancers, and factors control RNA production.

3 RNA CONTROL

Small RNAs and RNA stability change protein output.

FROM DEVELOPMENTAL SIGNAL TO SPECIALIZED CELL



coordinated changes in expression build a stable specialized phenotype

DO NOT CONFUSE

Specialized cells usually do not lose genes. They differ mainly in which genes are active and how strongly those genes are expressed.

FINAL MAP

Same genome + different regulatory inputs -> different gene products -> specialized cell structure and function.