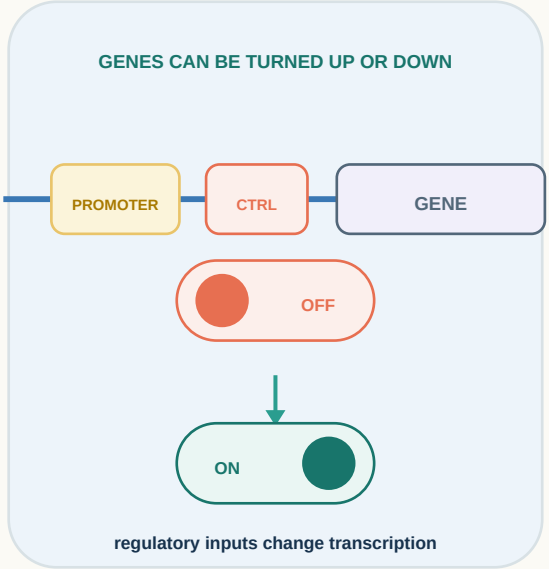
AP BIOLOGY | UNIT 6

TOPIC 6.5

Regulation of Gene Expression

Cells control when, where, and how strongly genes are expressed by combining regulatory DNA, proteins, and chromatin changes.



THE CORE CAUSAL CHAIN

SIGNAL
condition or cue

→

REGULATORS
proteins bind DNA

→

TRANSCRIPTION
increases or decreases

→

PHENOTYPE
cell function changes

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

1. Explain how DNA sequences and proteins regulate genes.
2. Compare constitutive and inducible expression.
3. Connect chromatin state with transcription and phenotype.

CENTRAL IDEA

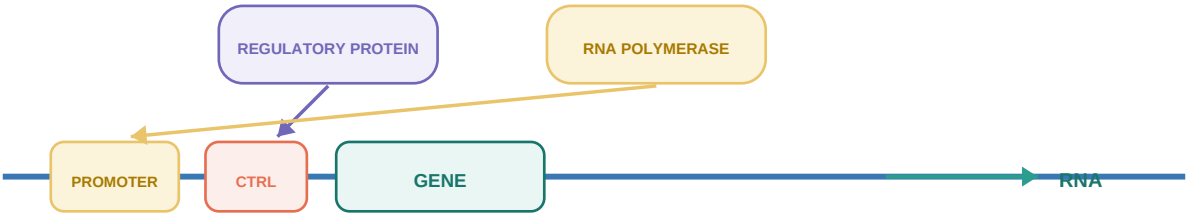
Regulation changes the amount and timing of RNA or protein produced without changing the information encoded in the gene itself.

1 DNA sequences and proteins control transcription

Regulatory proteins interact with promoters, operators, enhancers, silencers, and other DNA regions to change transcription rate.

THE CONTROL INTERFACE

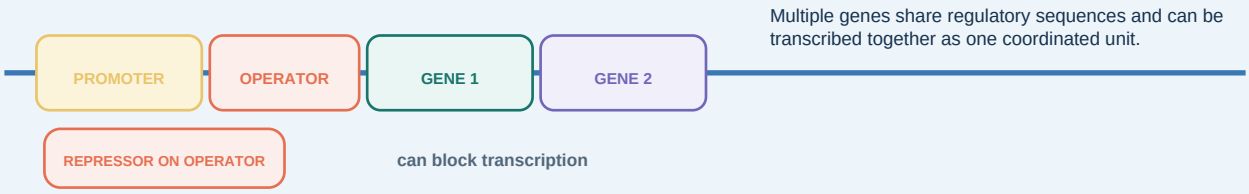
REGULATORY PROTEINS READ REGULATORY DNA



ACTIVATORS TEND TO INCREASE TRANSCRIPTION | REPRESSORS TEND TO DECREASE IT

COORDINATED PROKARYOTIC CONTROL

PROKARYOTIC OPERON



Multiple genes share regulatory sequences and can be transcribed together as one coordinated unit.

EXPRESSION PATTERNS

CONSTITUTIVE

The gene is expressed continuously because its product is routinely needed.

INDUCIBLE

The gene is turned on or increased in response to a signal or condition.

WHY REGULATE?

Cells conserve resources and respond to changing conditions by producing gene products only when and where they are useful.

2 Chromatin state changes gene accessibility

Chemical modifications to DNA or histones can alter transcription without changing the DNA base sequence.

EPIGENETIC CONTROL

OPEN CHROMATIN

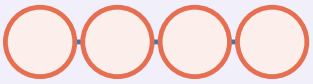
MORE ACCESSIBLE



DNA wrapped around histones

COMPACT CHROMATIN

LESS ACCESSIBLE



DNA wrapped around histones

COMMON MODIFICATIONS

HISTONE ACETYLATION

Often loosens chromatin and increases access for transcription machinery.

DNA METHYLATION

Often reduces transcription when methyl groups accumulate near regulatory regions.

FROM REGULATION TO PHENOTYPE

GENE ON/OFF → RNA AMOUNT → PROTEIN AMOUNT → CELL TRAIT

IMPORTANT

Epigenetic changes affect how DNA is used, not the order of its bases. Many marks are reversible and can respond to cell signals or conditions.

FINAL MAP

Regulatory sequences + regulatory proteins + chromatin state -> transcription level -> gene product -> phenotype.