REGULATION OF GENE EXPRESSION

(In Prokaryotes)

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INTRODUCTION

Gene regulation is the process of turning genes on and off. During early development, cells begin to take on specific functions. Gene regulation ensures that the appropriate genes are expressed at the proper times. Gene regulation can also help an organism respond to its environment.

The term gene regulation means that the level of gene expression can vary under different conditions

Genes that are unregulated are termed constitutive

- They have essentially constant levels of expression
- Frequently, constitutive genes encode proteins that are necessary for the survival of the organism

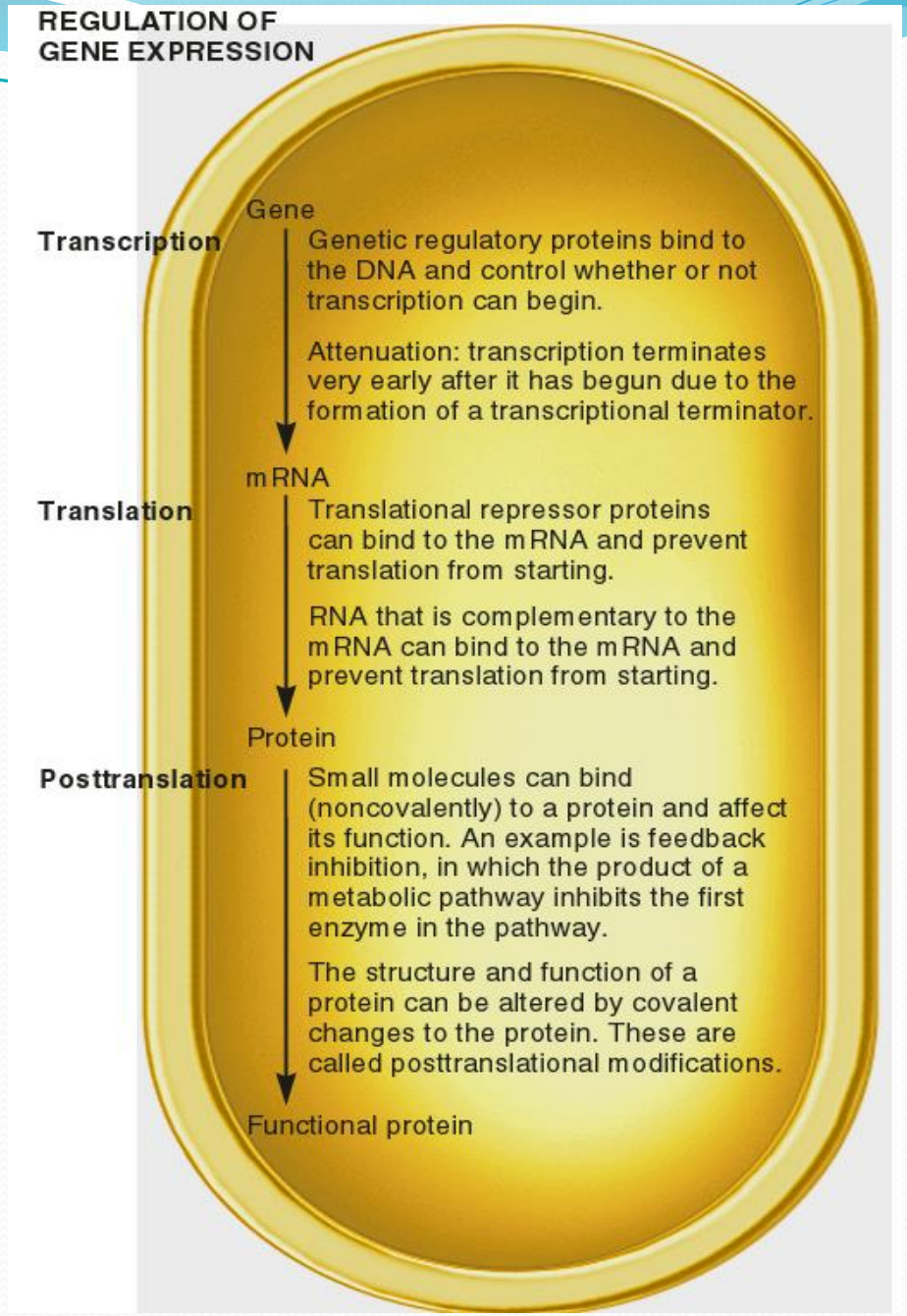
The benefit of regulating genes is that encoded proteins will be produced only when required

Conti…

Gene regulation is important for cellular processes such as

1. Metabolism
2. Response to environmental stress
3. Cell division

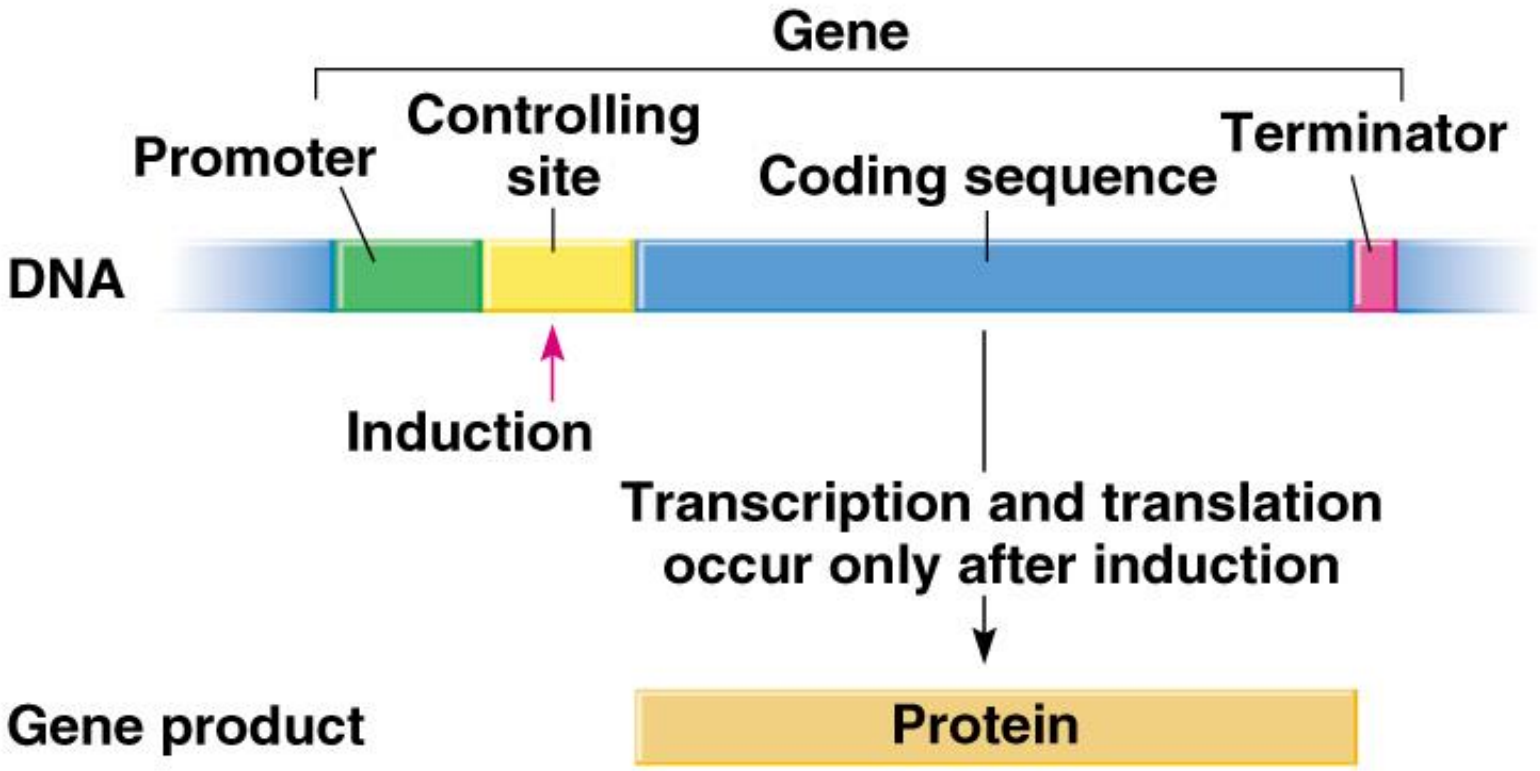
Regulation can occur at any of the points on the pathway to gene expression



FACTORS INFLUENCING GENE EXPRESSION.

- Nutritional status
- Environmental factors
- Hormone level
- Developmental stage

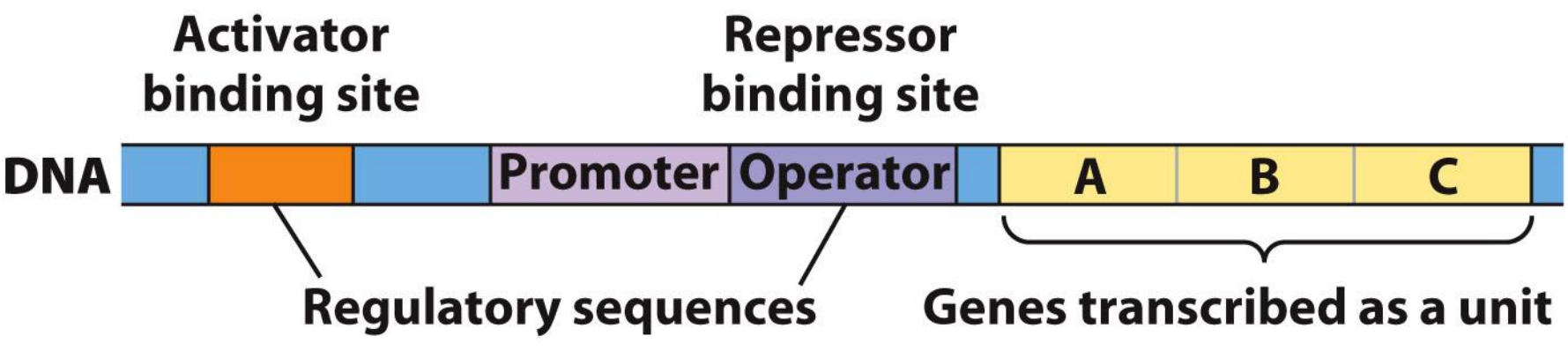
OPERON



Inducible genes are expressed only when induced

Many Bacterial Genes Are Transcribed And Regulated Together in an Operon

- An operon is a cluster of genes sharing a promoter and regulatory sequences.
  - Genes are transcribed together, so mRNAs are several genes represented on one mRNA (polycistronic).
- First example: the *lac* operon



TRANSCRIPTIONAL REGULATION

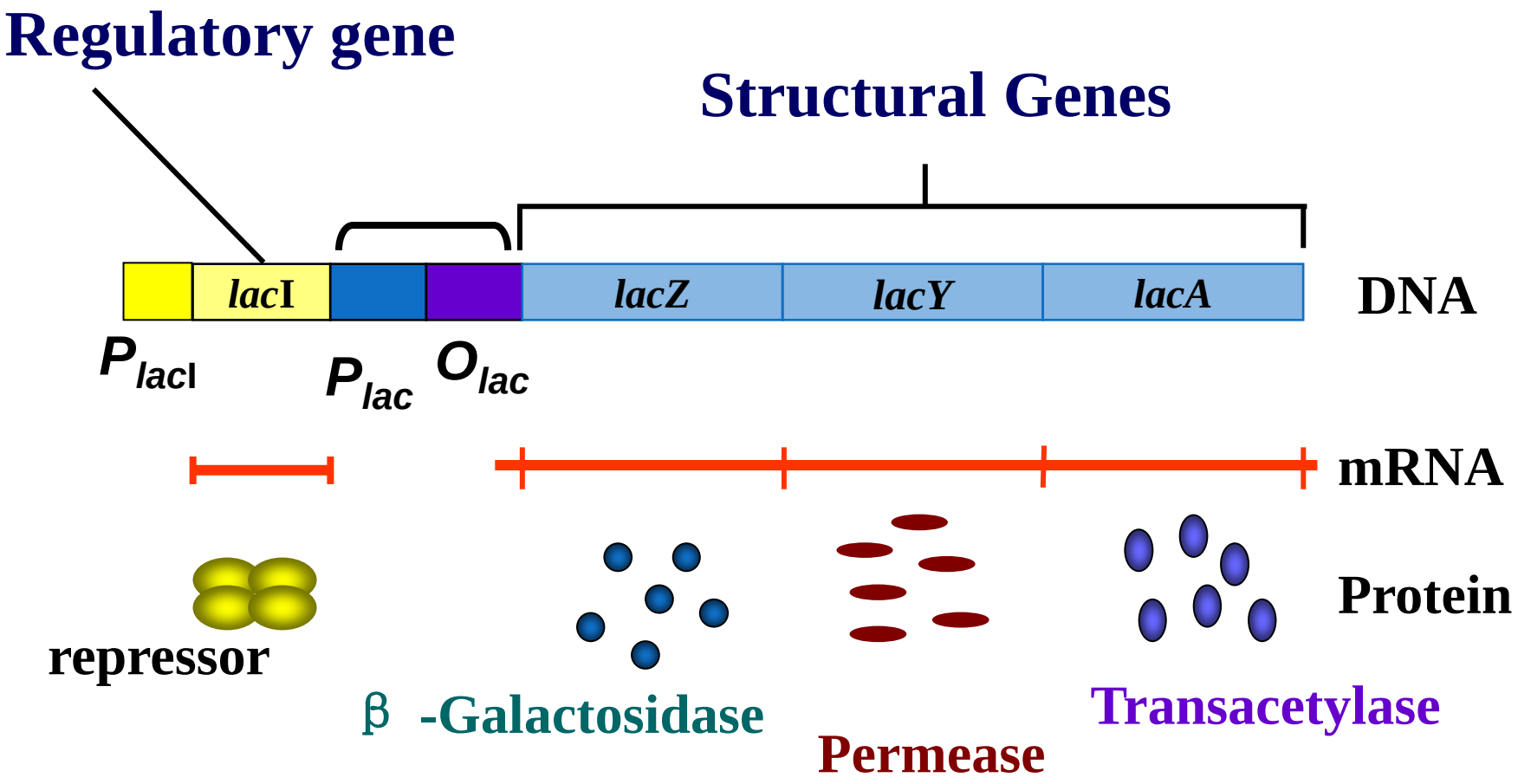
- The most common way to regulate gene expression in bacteria is at the transcriptional level
  - The rate of RNA synthesis can be increased or decreased
- Transcriptional regulation involves the actions of two main types of regulatory proteins
  - Repressors → Bind to DNA and inhibit transcription
  - Activators → Bind to DNA and increase transcription
- Negative control refers to transcriptional regulation by repressor proteins
  - Positive control to regulation by activator proteins

The *lac* Operon Reveals Many Principles of Gene Regulation

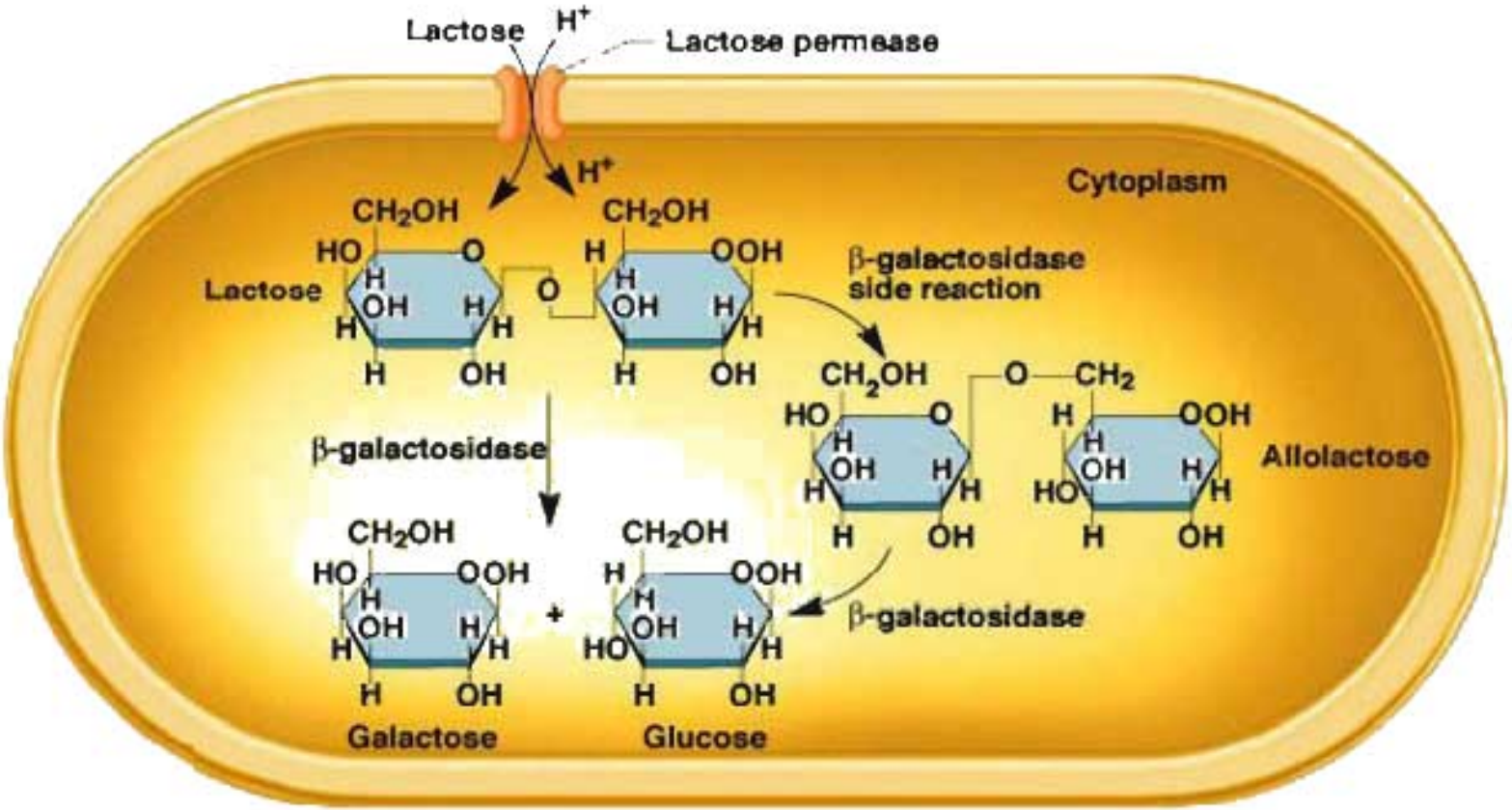
- Work of Jacob and Monod – 1960
- Shows how three genes for metabolism of lactose are regulated together as an operon:
  - *β*-galactosidase (lacZ)
    - cleaves lactose to yield glucose and galactose
  - lactose permease (galactoside permease; lacY)
    - transports lactose into cell
  - thiogalactoside transacetylase (lacA)
- Thet rely on negative regulation via a repressor.

The Regulation of *lac* Operon

1. Organization of *lac* operon



(a) Organization of DNA sequences in the *lac* region of the *E.coli* chromosome



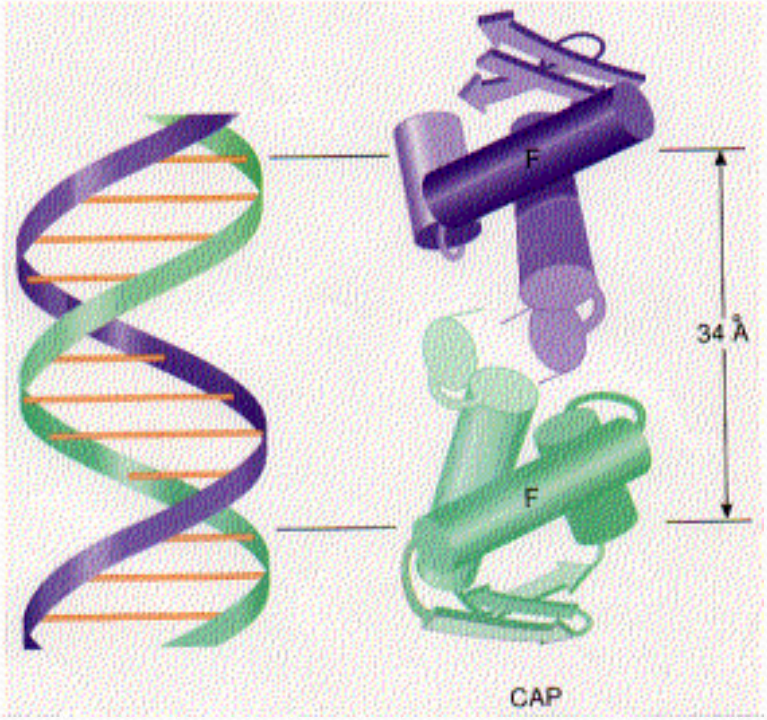
(b) Functions of lactose permease and β-galactosidase

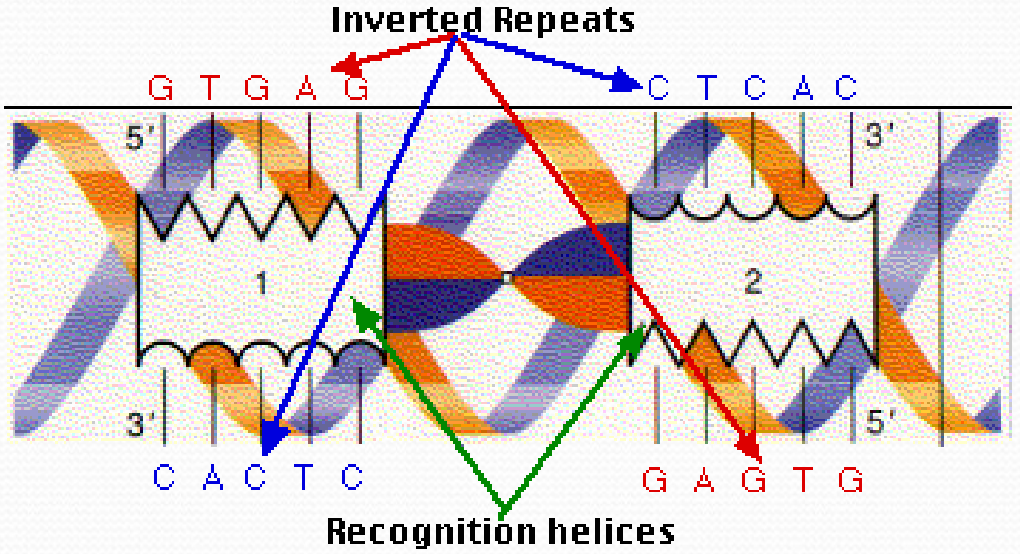
POSITIVE CONTROL OF *LAC* OPERON

cAMP

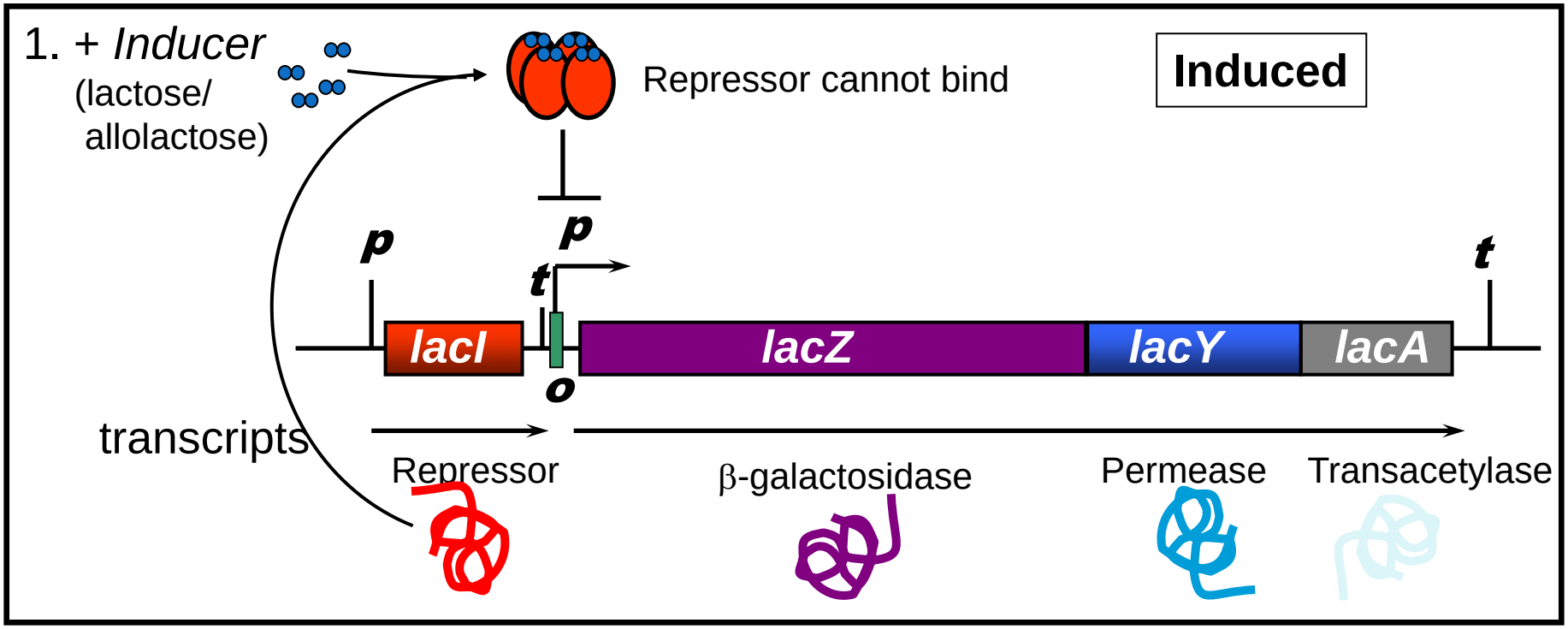
CAP (catabolite activator protein)

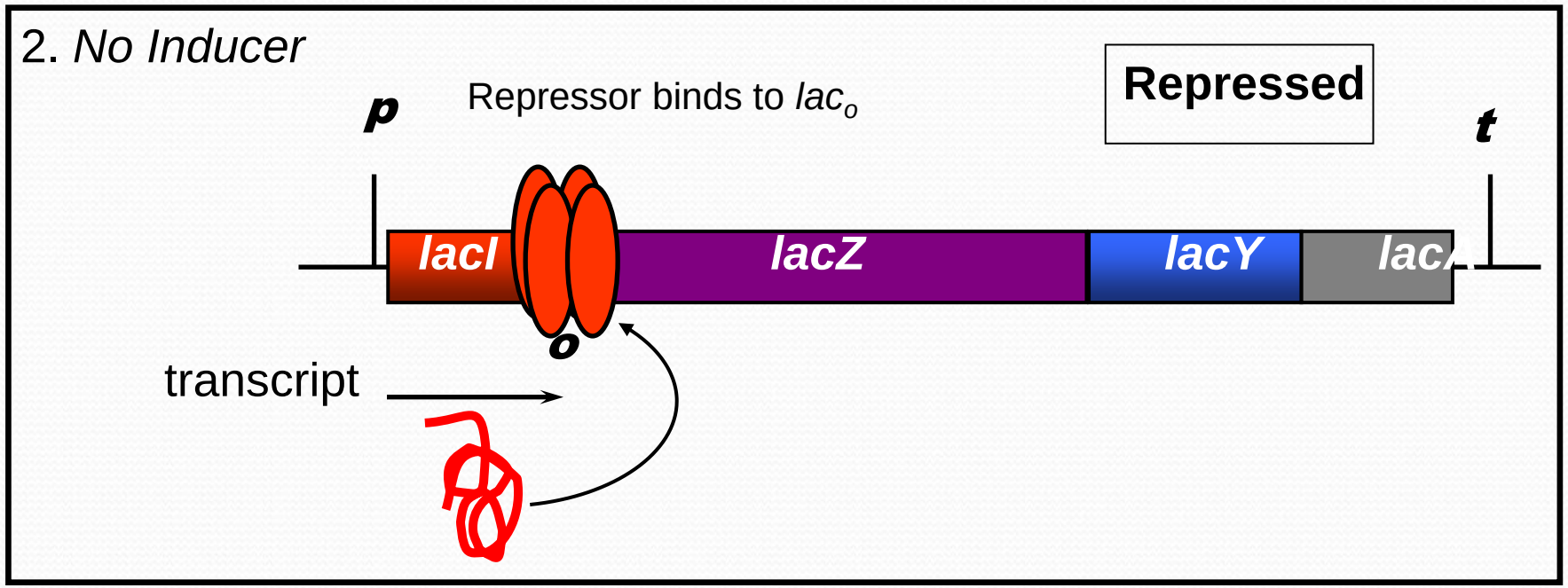
or cAMP receptor protein (CRP)





. Negative contral of *lac* operon




2. No Inducer
Repressor binds to lac$_o$
Repressed
p
t
lacI
lacZ
lacY
lacA
o
transcript

Combined Effects of Glucose and Lactose on the *lac* Operon

- When lactose is low, repressor is bound:

  →inhibition

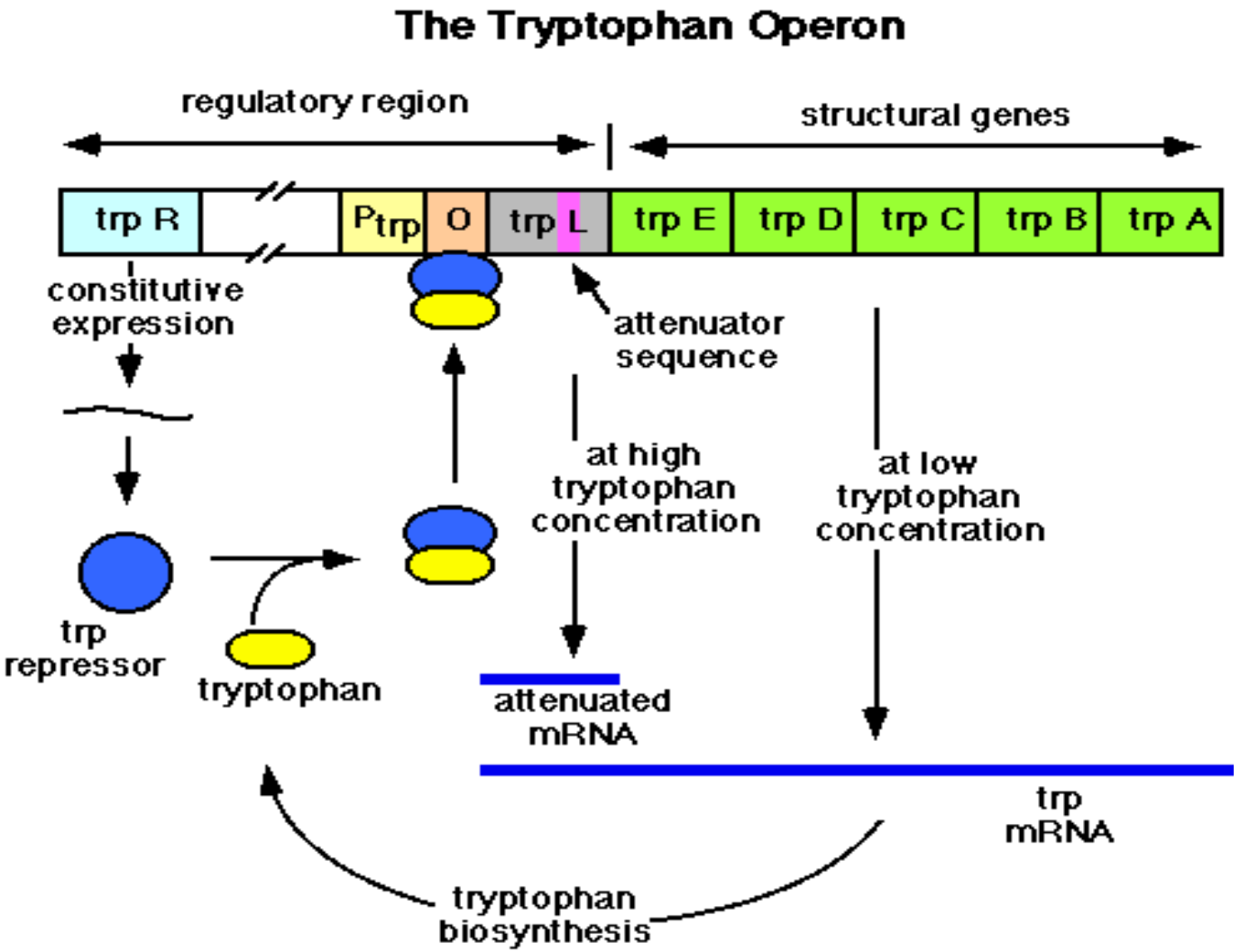
- When lactose is high, repressor dissociates
  →permitting transcription

- When glucose is high, CRP is not bound and
  →transcription is dampened

- When glucose is low, cAMP is high and CRP is bound →activation

The Regulation of *trp* Operon

Organization of *trp* operon



The *Trp*-Operon

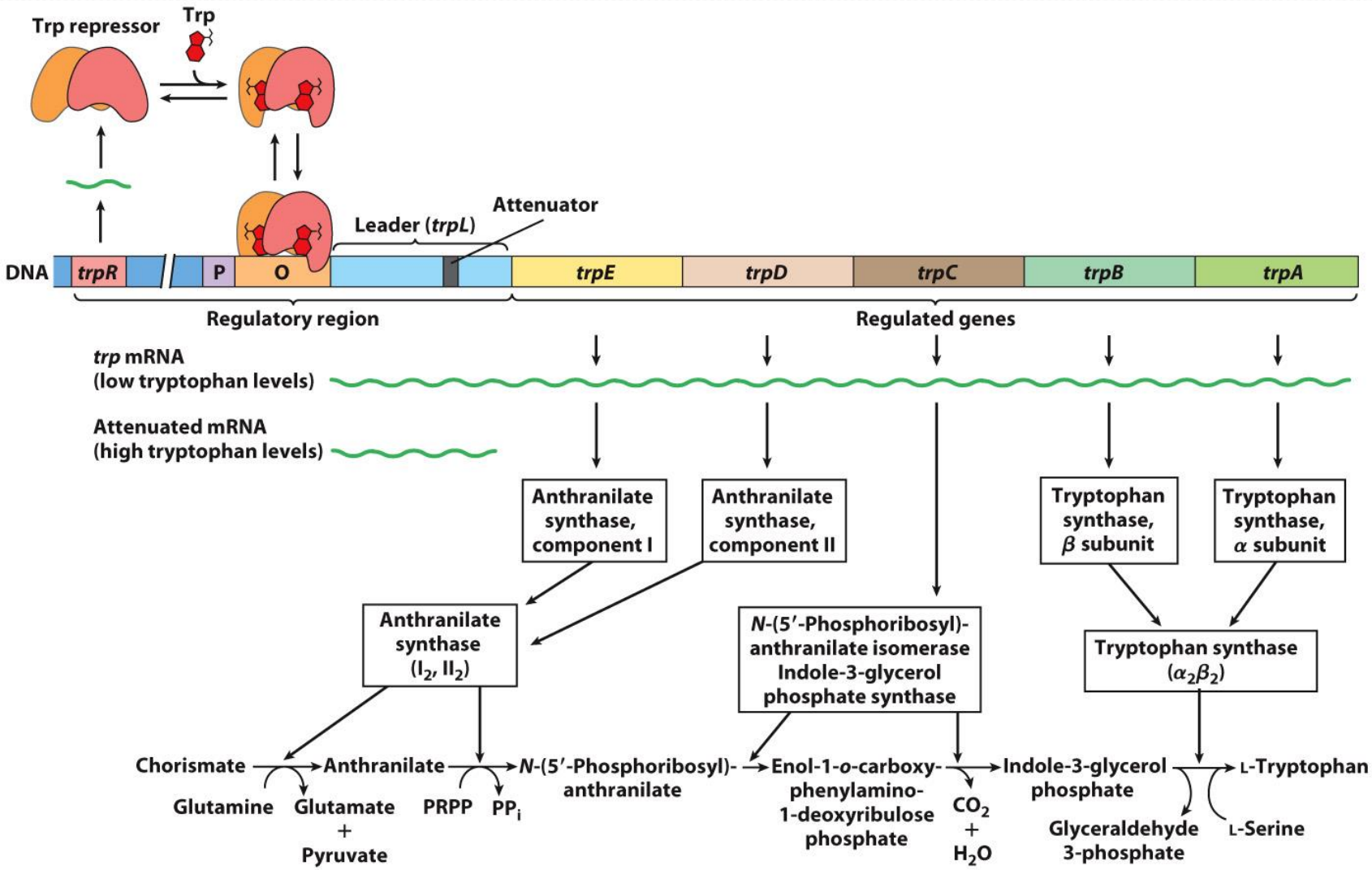


Figure 28-19

Lehninger Principles of Biochemistry, Seventh Edition

THANKS