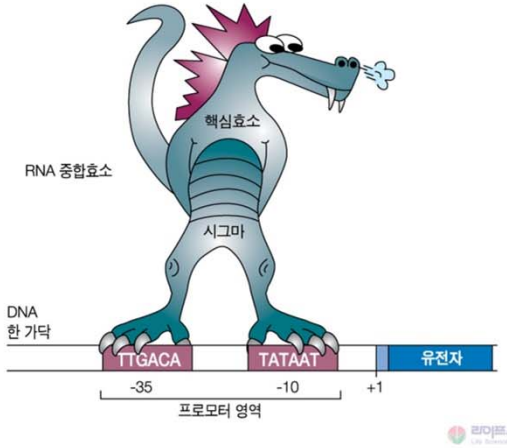
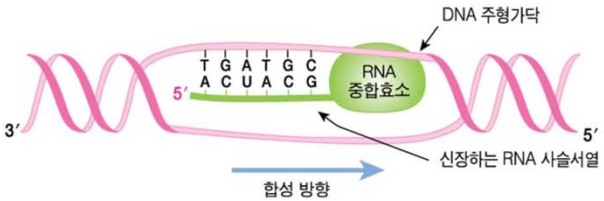
Chapter 4: Transcription of Genes

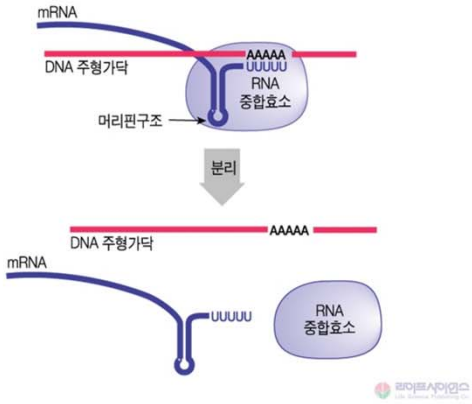
Transcription

Regulation of transcription

We know where and how the transcription occur…







Now, the question is **When** !

-> gene regulation

Turn on & Turn off of the genes

Microorganisms exhibit remarkable capacities to adapt to diverse environmental conditions. This adaptability depends in part on their ability to turn on and turn off the expression of specific sets of genes in response to changes in the environment

Turned on when the products of genes are needed..

Turned off when the products of genes are no longer needed..

At which step gene expression is regulated?

Gene expression in prokaryotes is regulated at several different levels.. However, the regulatory mechanisms with the largest effects on phenotype act at the level of transcription.

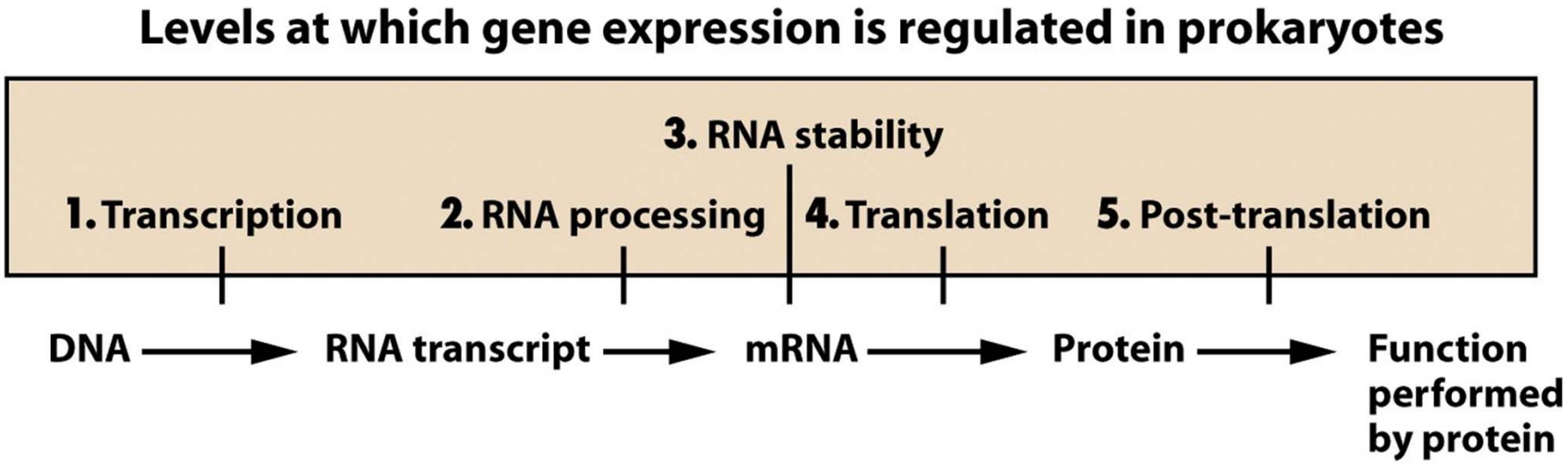


Figure 20-1 Principles of Genetics, 4/e

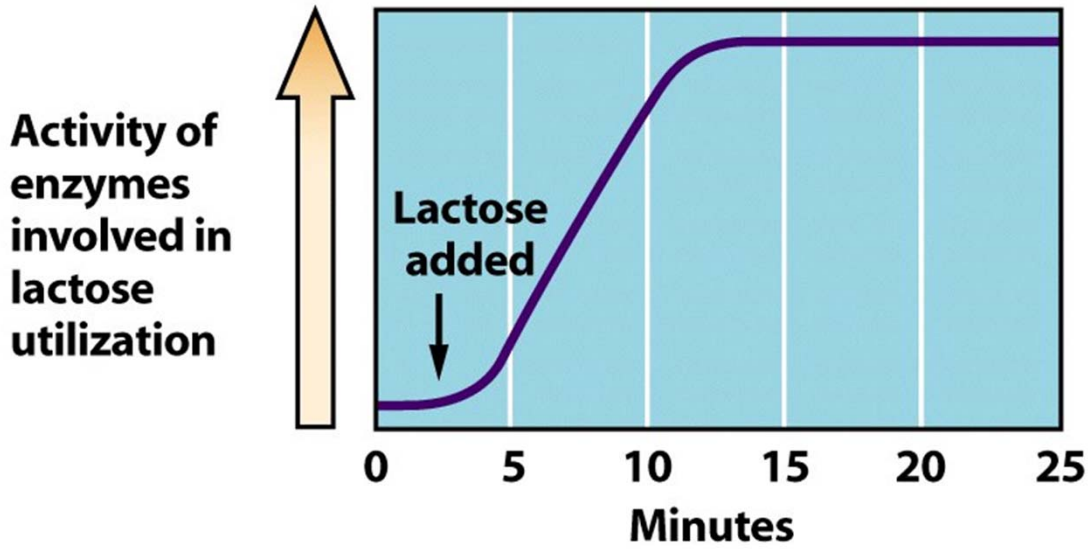
Some of the genes are expressed all the time…

In prokaryotes, genes that specify housekeeping function such as rRNA, tRNA, and ribosomal proteins are expressed constitutively

We are constitutive genes….

Expression of some genes are induced…

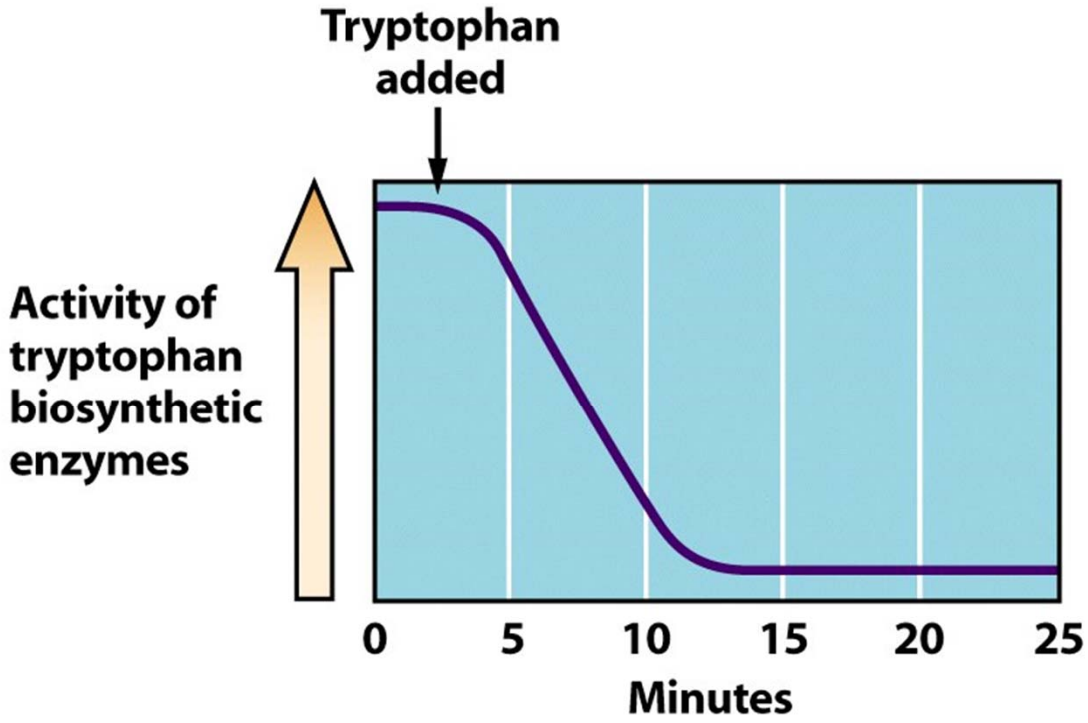
Genes that encode enzymes involved in catabolic pathways often are expressed only in the presence of the substrates of the enzyme; **their expression is induced..**



(a) **Induction of enzyme synthesis.**

Expression of some genes are repressed…

Genes that encode enzymes involved in anabolic pathways usually are turned off in the presence of the end product of the pathway; **their expression is repressed..**



(b) **Repression of enzyme synthesis.**

Positive and negative control of gene expression

The regulation of gene expression-**induction**, or turning genes on, and **repression**, or turning genes off can be accomplished by both positive control mechanism and negative control mechanism.

Both mechanisms involve the participation of **regulator genes** (**Transcription factor**) → genes encoding products that regulate the expression of other genes

Positive and negative control of gene expression

Positive control of gene expression:
The product of a regulator gene (**activator**) is required to turn on the expression of one or more structural genes

Negative control of gene expression:
The product of a regulator gene (**repressor**) is necessary to shut off the expression of structural genes

Positive and negative control of gene expression

Inducible system.

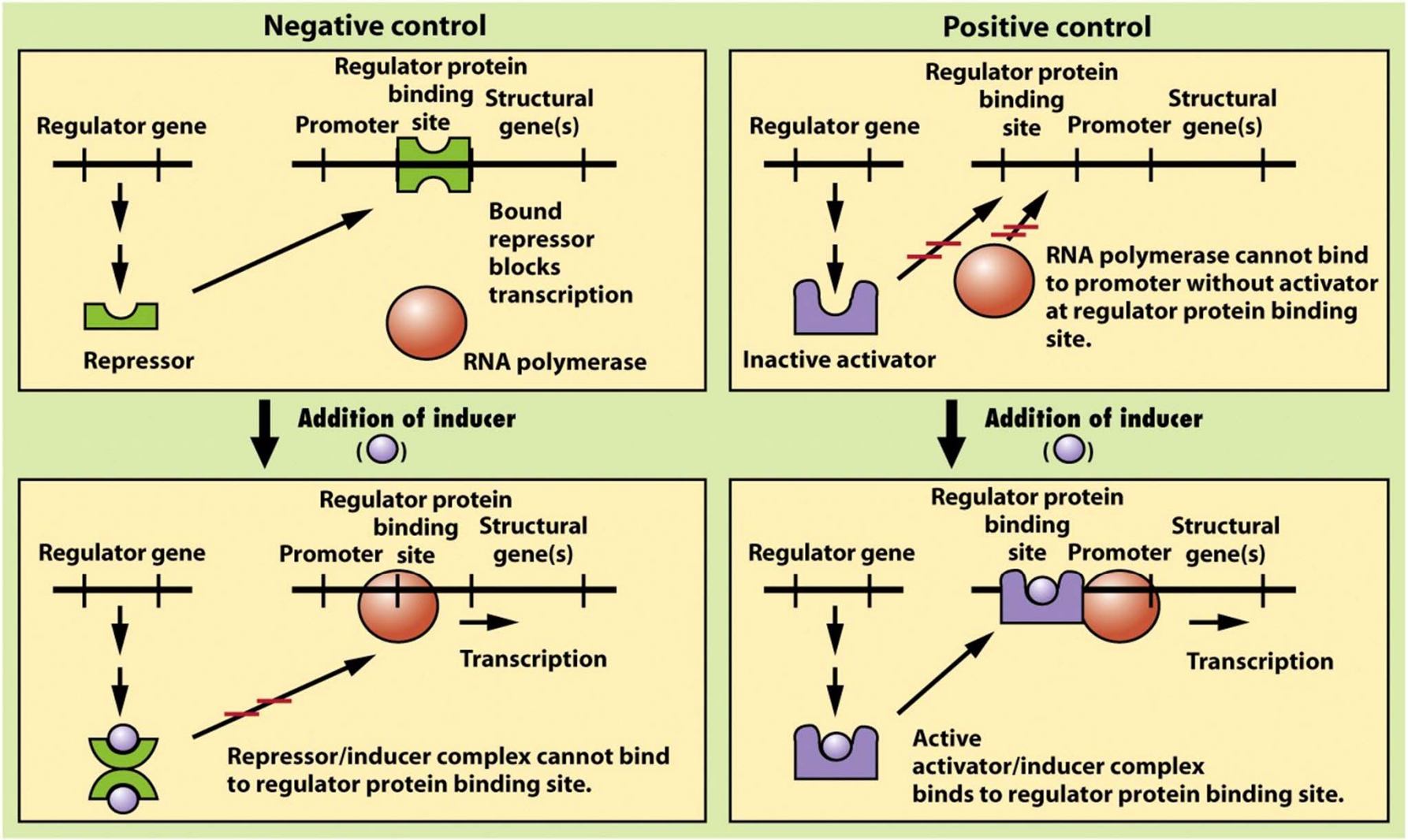


Figure 20-3a Principles of Genetics, 4/e

Positive and negative control of gene expression

Repressible system.

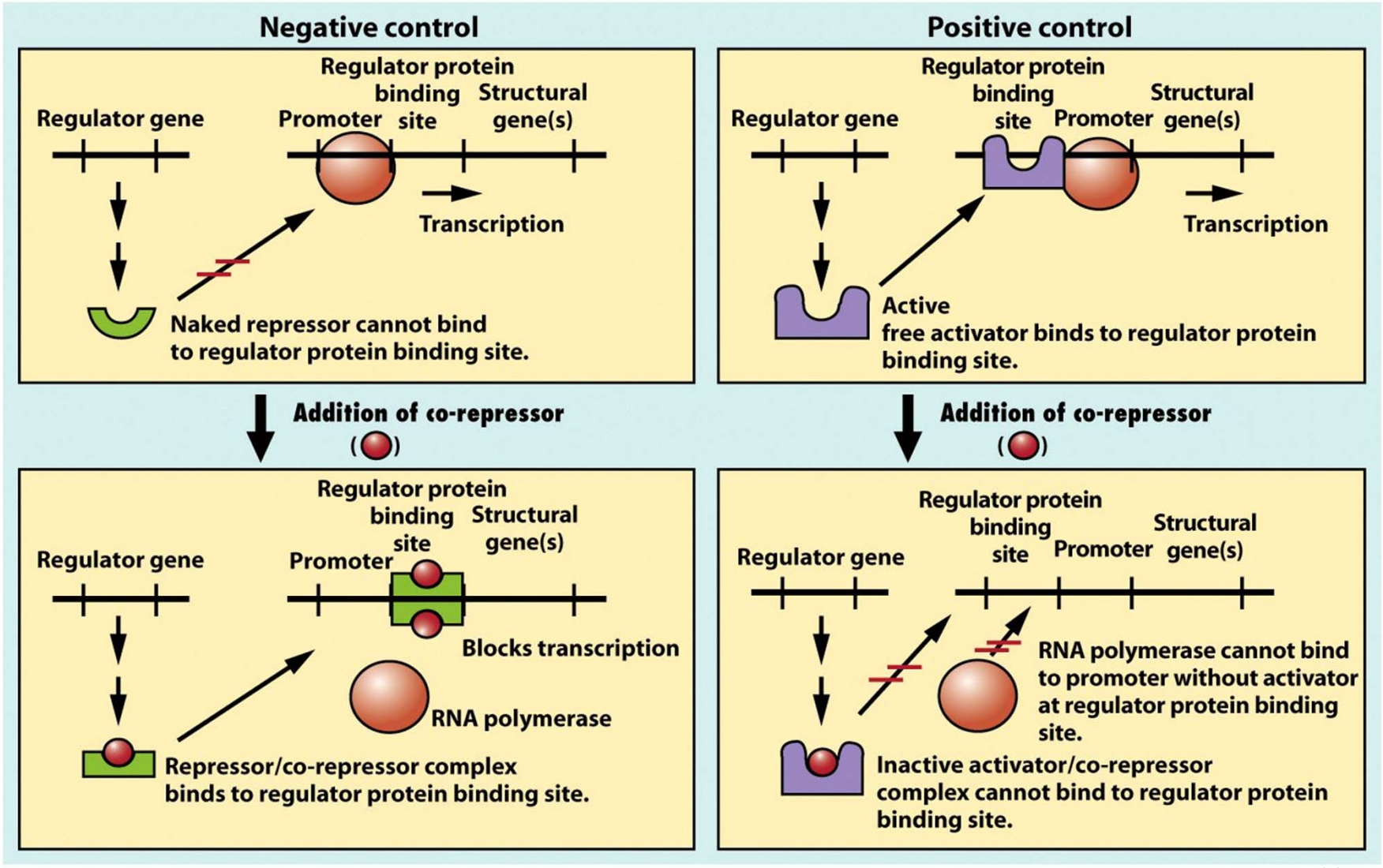


Figure 20-3b Principles of Genetics, 4/e

Regulation of gene expression by the operon mechanism

In prokaryotes, genes with related functions often are present in coordinately regulated genetic units called **operon**

In 1961, **Francois Jacob and Jacques Monod** proposed the operon model of gene regulation in bacteria. The model was based on their study of the genes (***lac* operon**) in *E. coli* that code for enzymes that affect the breakdown of lactose.

Operon: coordinately regulated units of gene expression

In prokaryotes, genes with related functions often are present in coordinately regulated genetic units called **operon**

In 1961, **Francois Jacob and Jacques Monod** proposed the operon model of gene regulation in bacteria. The model was based on their study of the genes (***lac* operon**) in *E. coli* that code for enzymes that affect the breakdown of lactose.

Operon: coordinately regulated units of gene expression

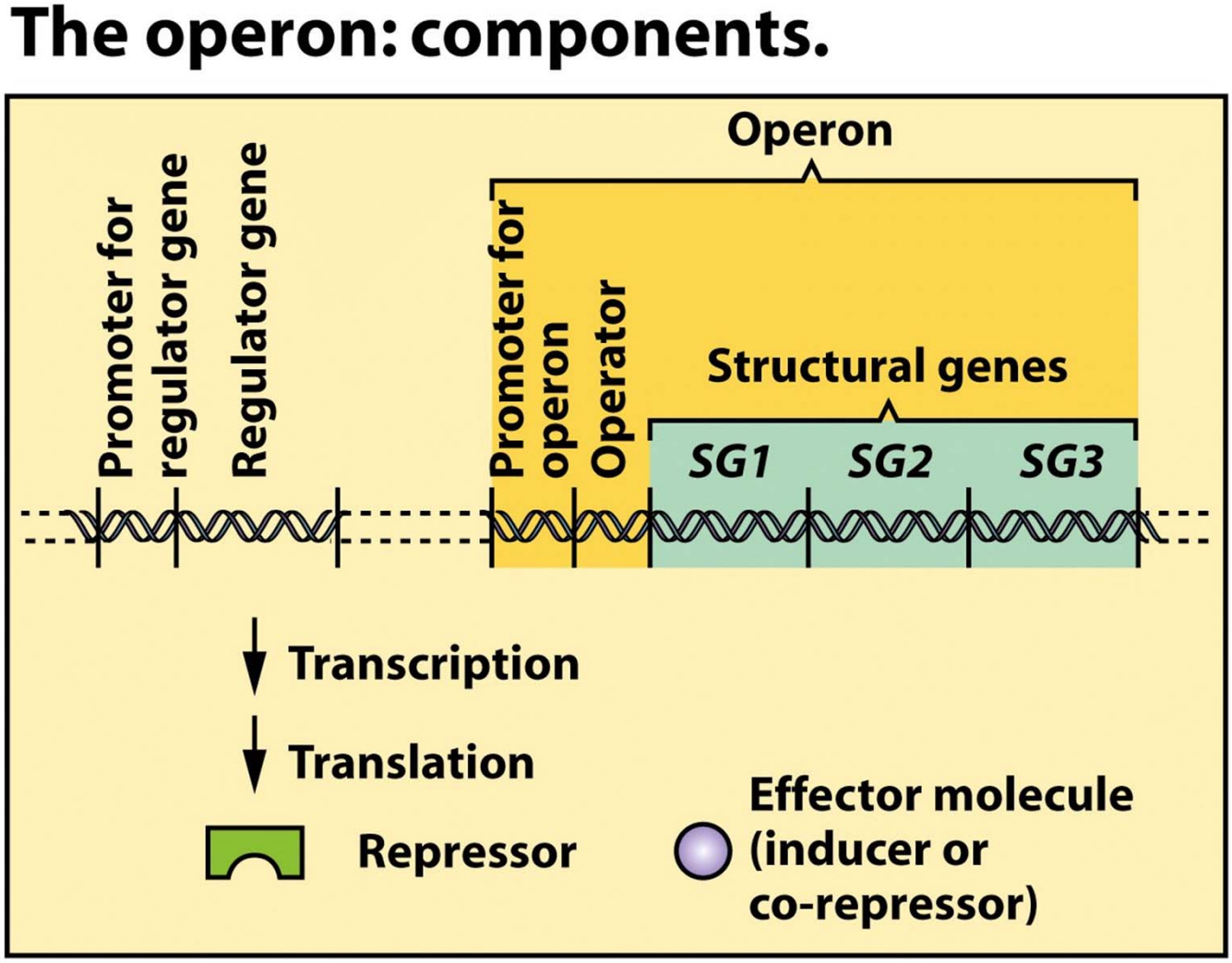


Figure 20-4a Principles of Genetics, 4/e

The operon: induction.

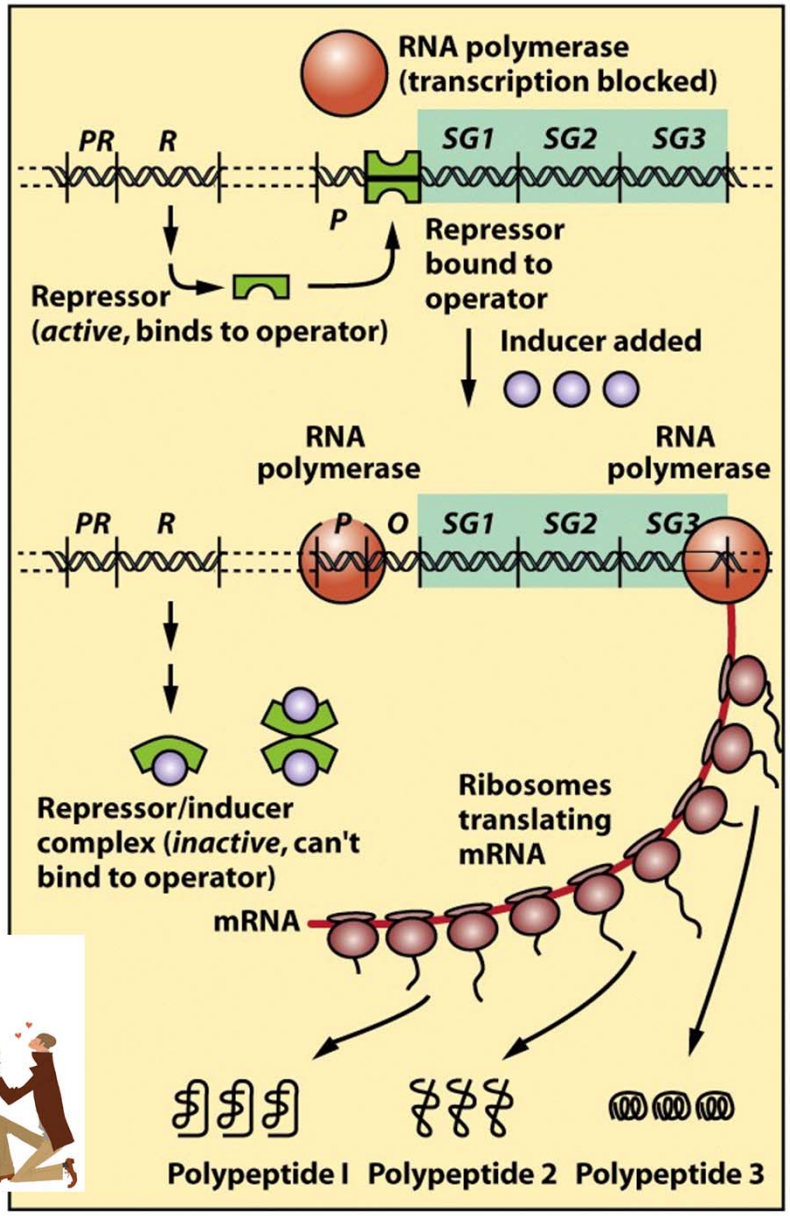


Figure 20-4b Principles of Genetics, 4/e
© 2006 John Wiley & Sons

The operon: repression.

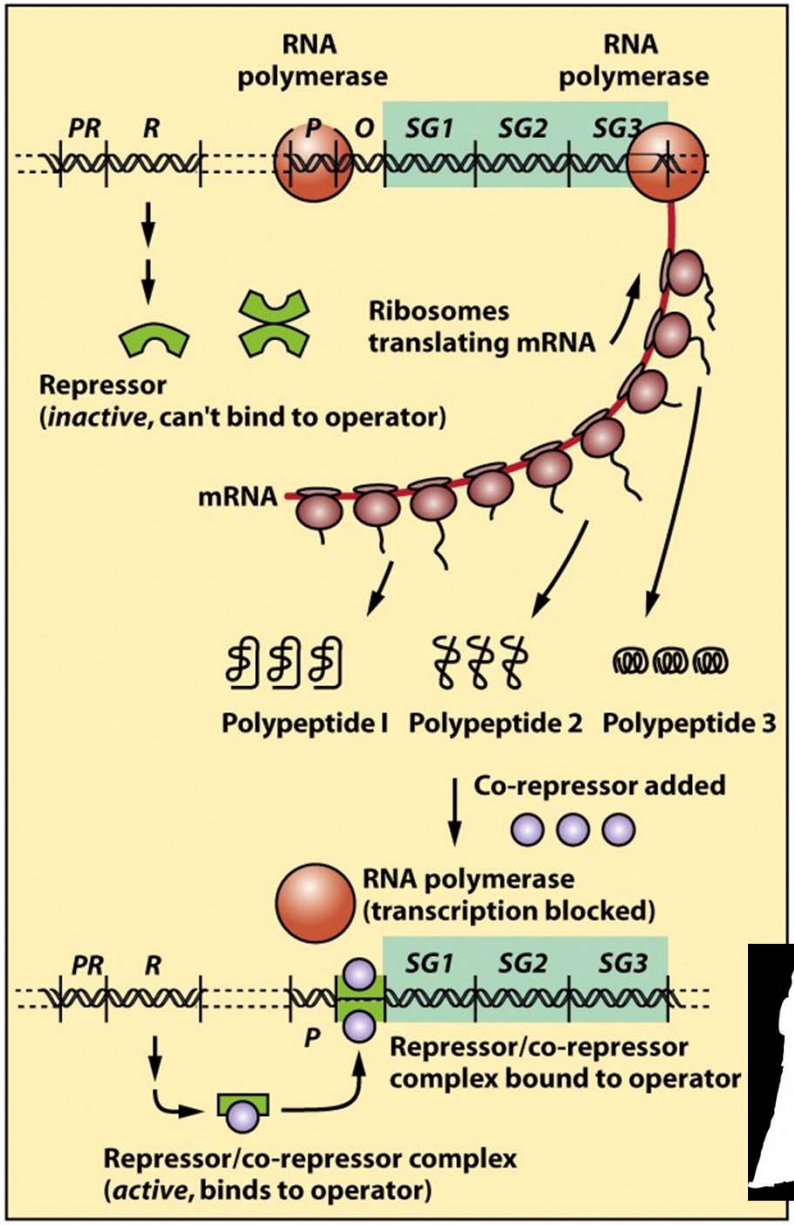
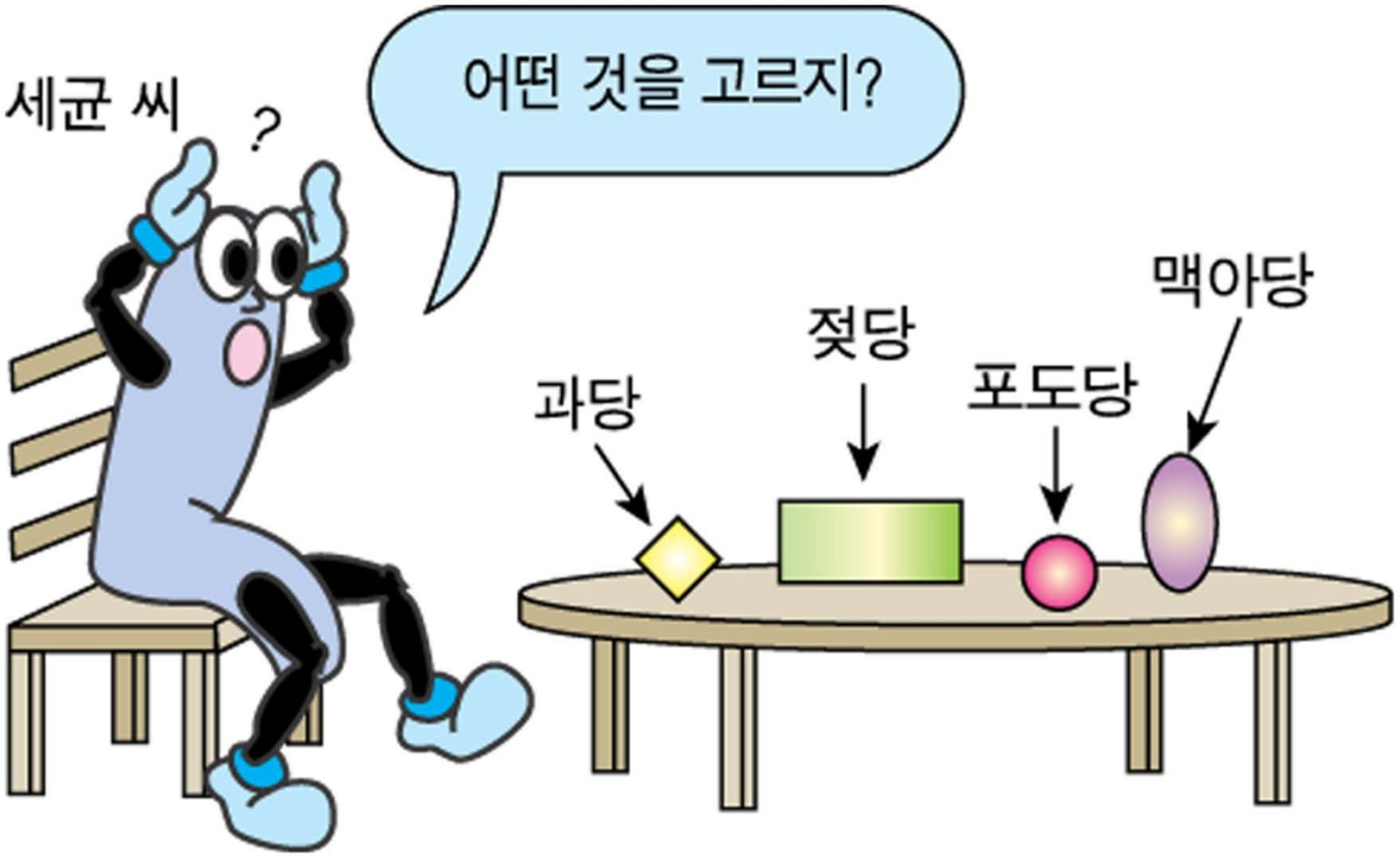


Figure 20-4c Principles of Genetics, 4/e
© 2006 John Wiley & Sons

Because of the pioneering work of Jacob and Monod, the *lac* operon is typically used to illustrate gene regulation in bacteria.



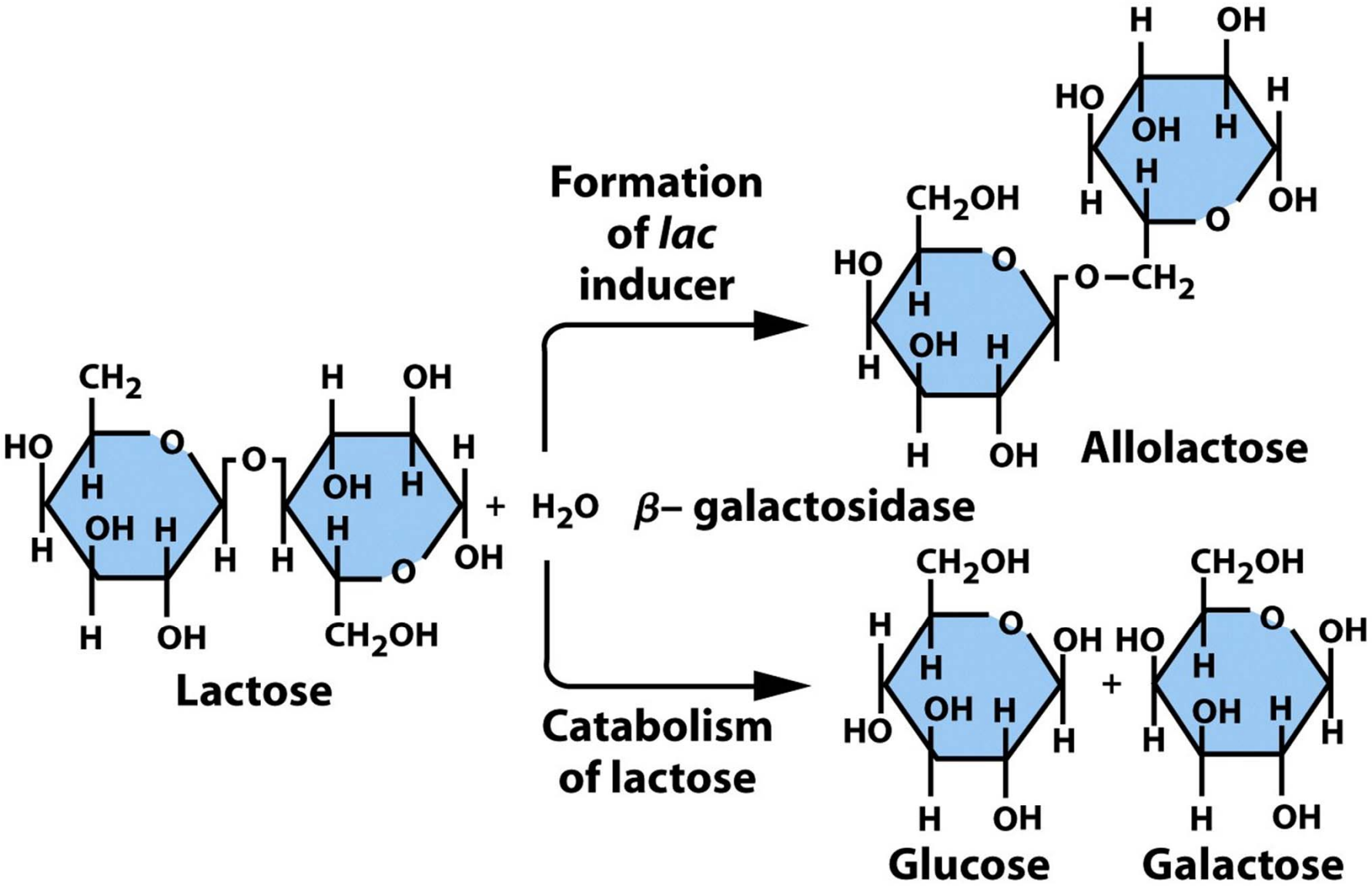


Figure 20-6 Principles of Genetics, 4/e

Background activity of operon is essential for induction of the lac operon

Because of the pioneering work of Jacob and Monod, the *lac* operon is typically used to illustrate gene regulation in bacteria.

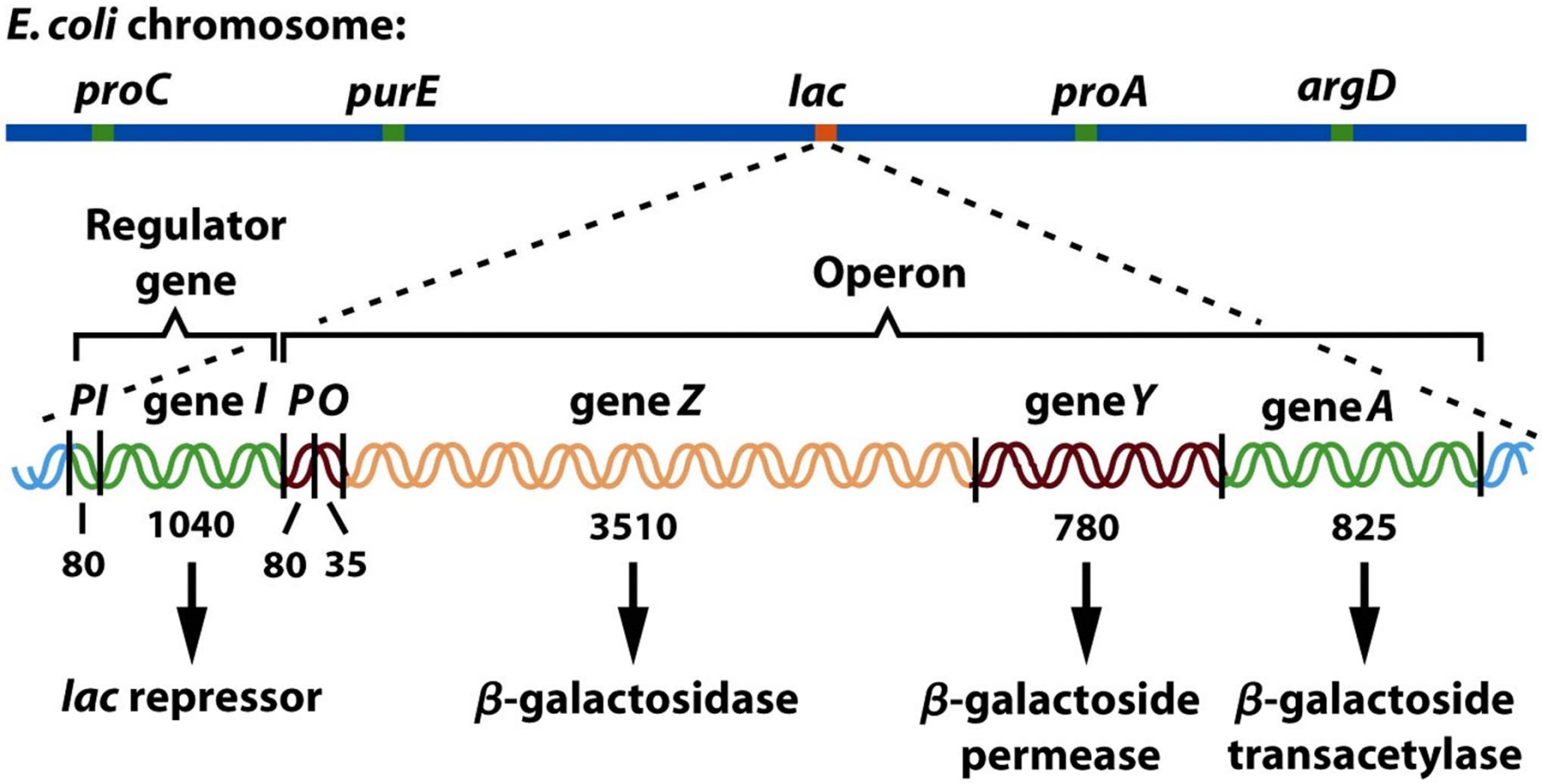
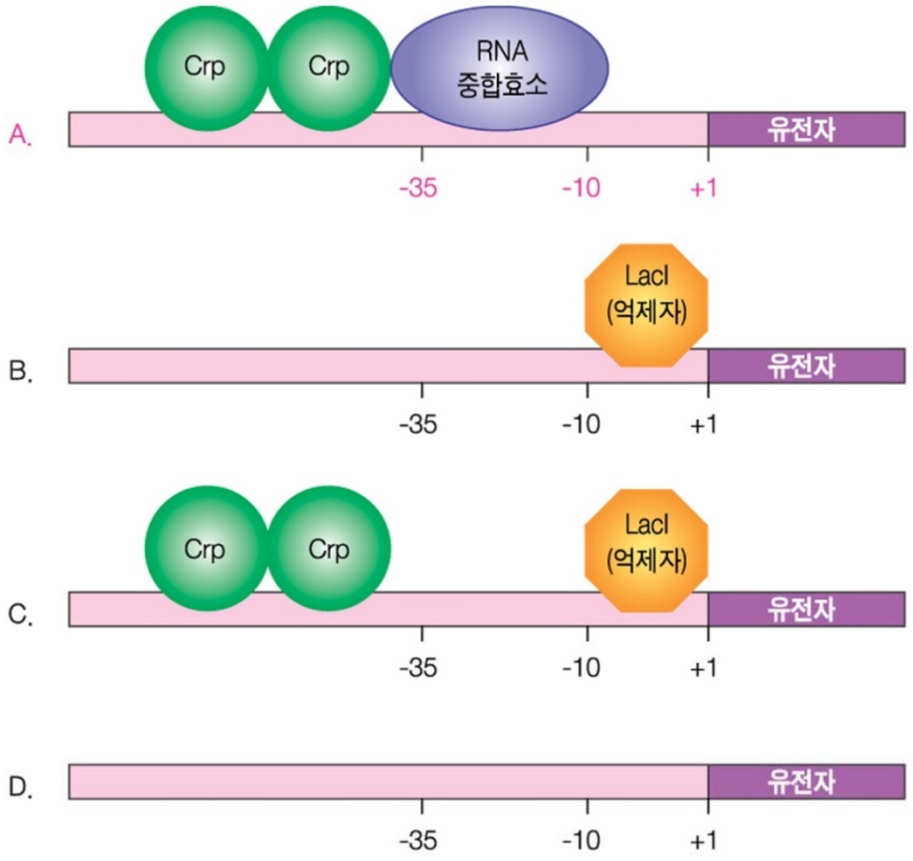


Figure 20-5 Principles of Genetics, 4/e

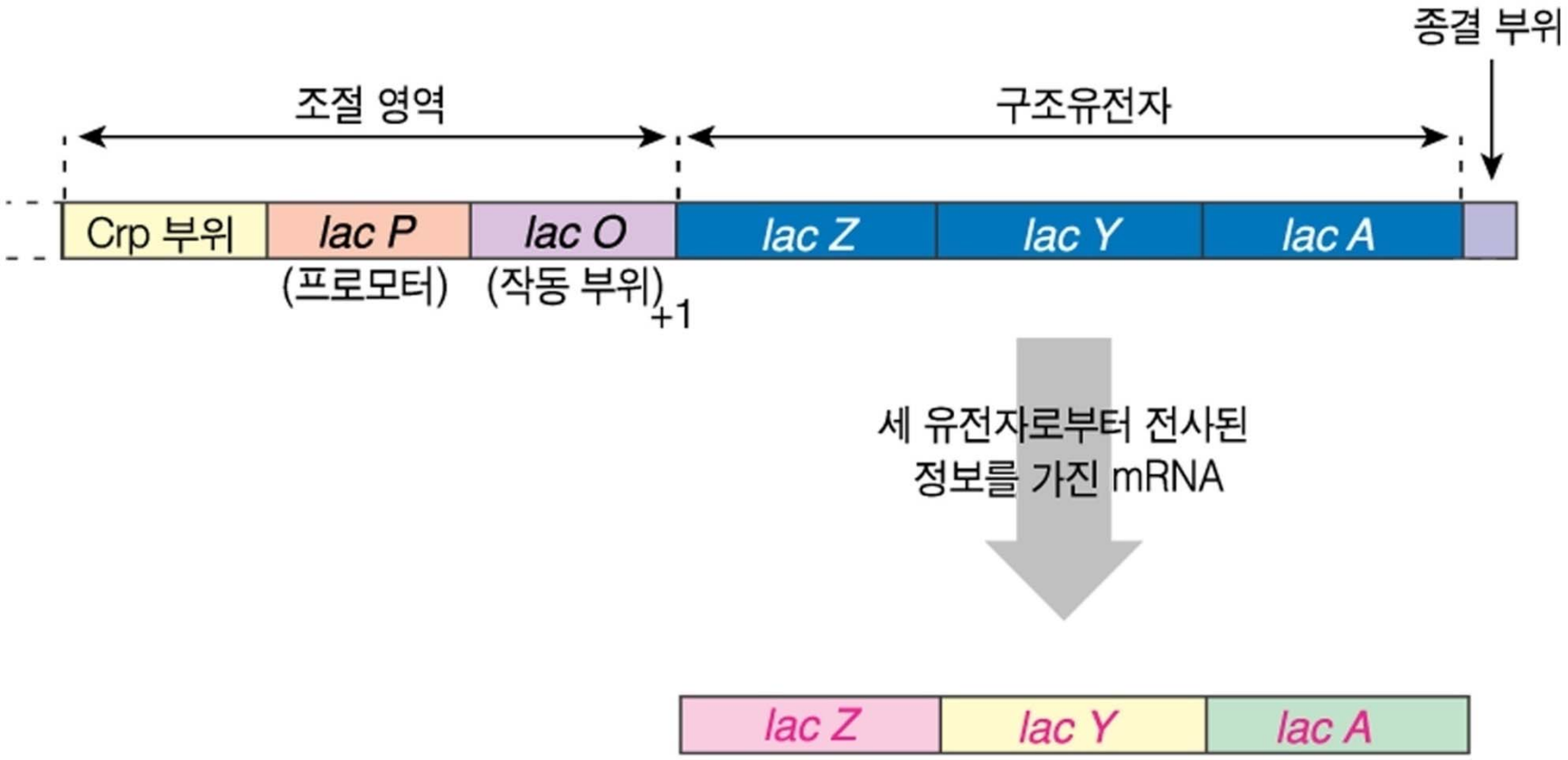
Lac operon is a negative inducible and catabolite repressible system



	Crp 단백질	억제자	RNA 중합효소	켜짐 또는 꺼짐
A	존재	부재	결합	켜짐
B	부재	존재	결합하지 않음	꺼짐
C	존재	존재	결합하지 않음	꺼짐
D	부재	부재	결합하지 않음	꺼짐

Lac operon is a negative inducible and catabolite repressible system

The three structural genes in the lac operon are transcribed at high levels only in the presence of lactose and the absence of glucose



Lac operon is a negative inducible and catabolite repressible system

The three structural genes in the lac operon are transcribed at high levels only in the presence of lactose and the absence of glucose

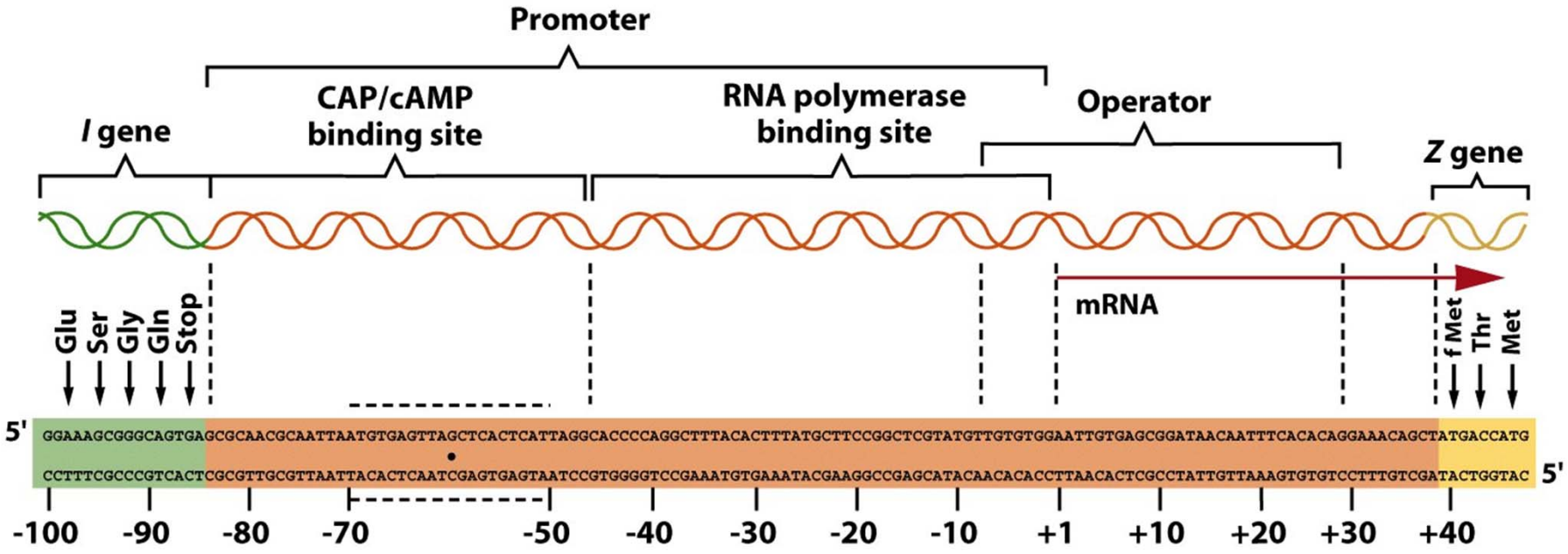
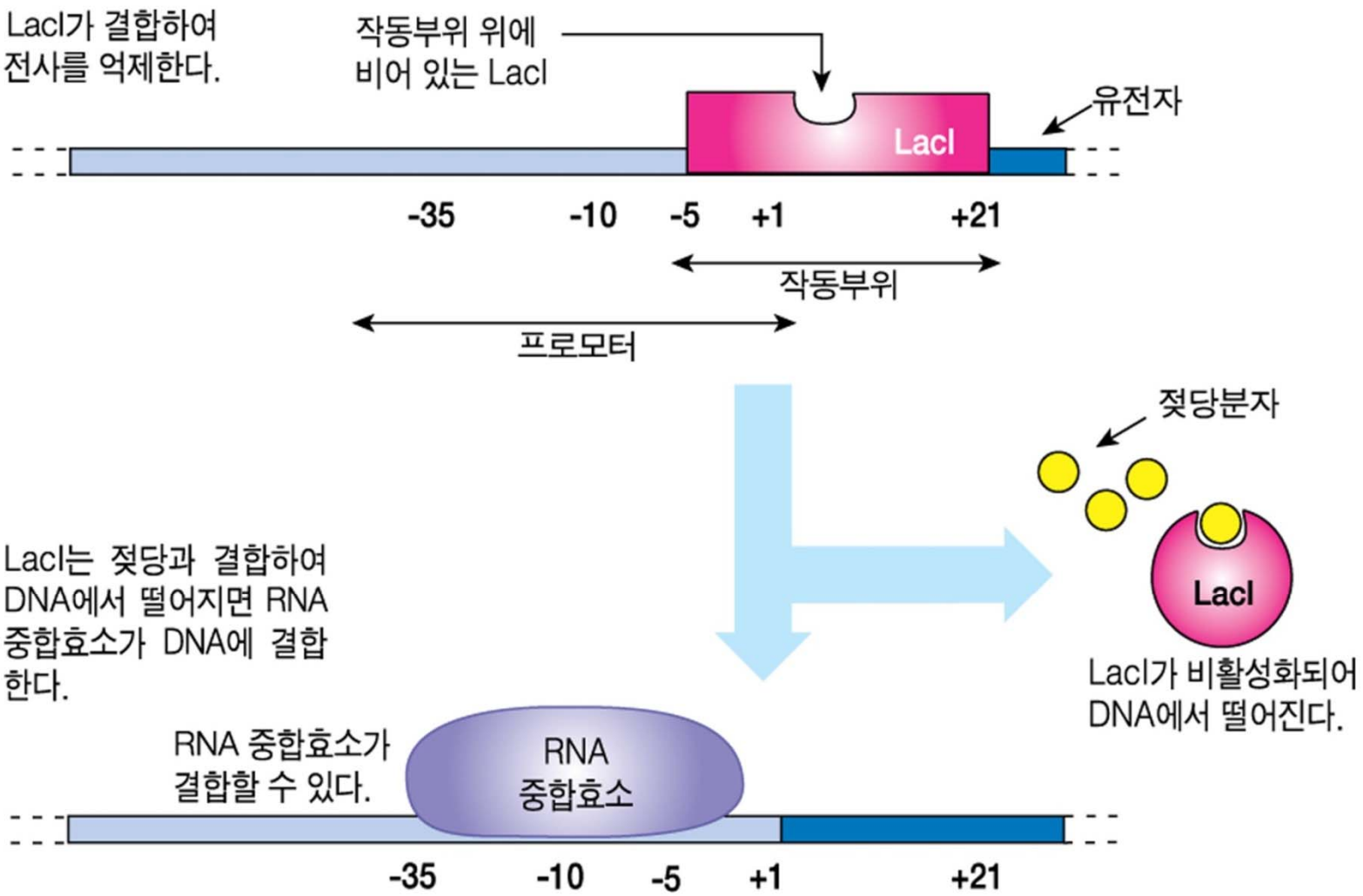


Figure 20-10 Principles of Genetics, 4/e

Negative inducible system

In the absence of lactose, the lac repressor (LacI) binds to the lac operator and prevents RNA polymerase from initiating transcription

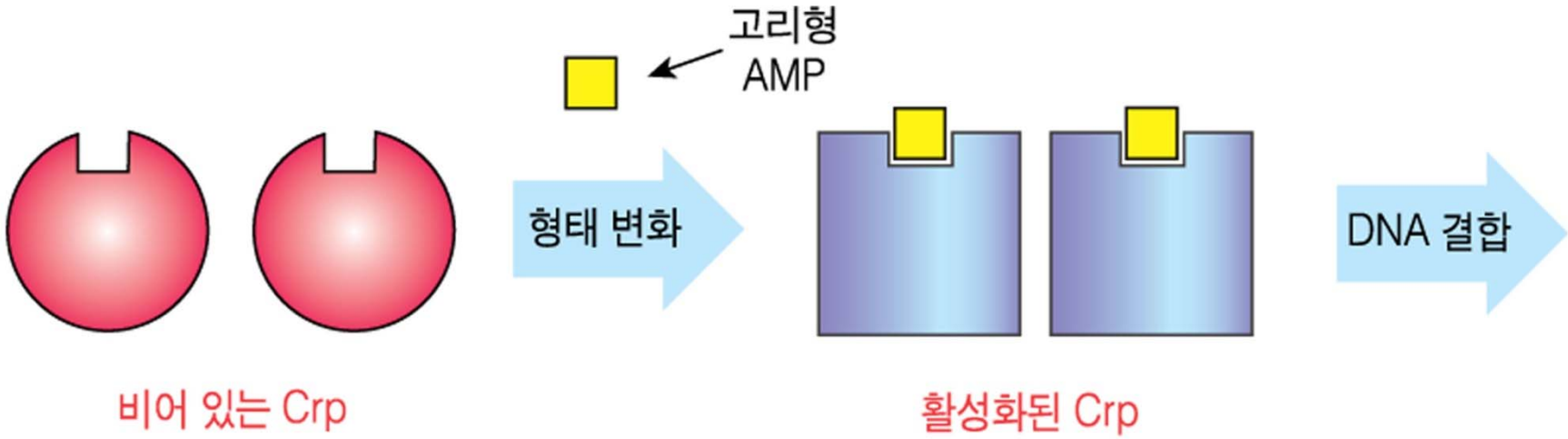


Catabolic repressible system

In the presence of glucose, the Crp (activator) fails to form Crp/cAMP complex that exerts positive control over the transcription

High concentrations of glucose cause sharp decreases in the intracellular concentration of cAMP

Cyclic adenosin-3',5'-monophosphate (cAMP)
-effector molecule



Cyclic AMP Receptor Protein
(=catabolite activator protein, CAP)

Glucose prevents the activation of adenylcyclase

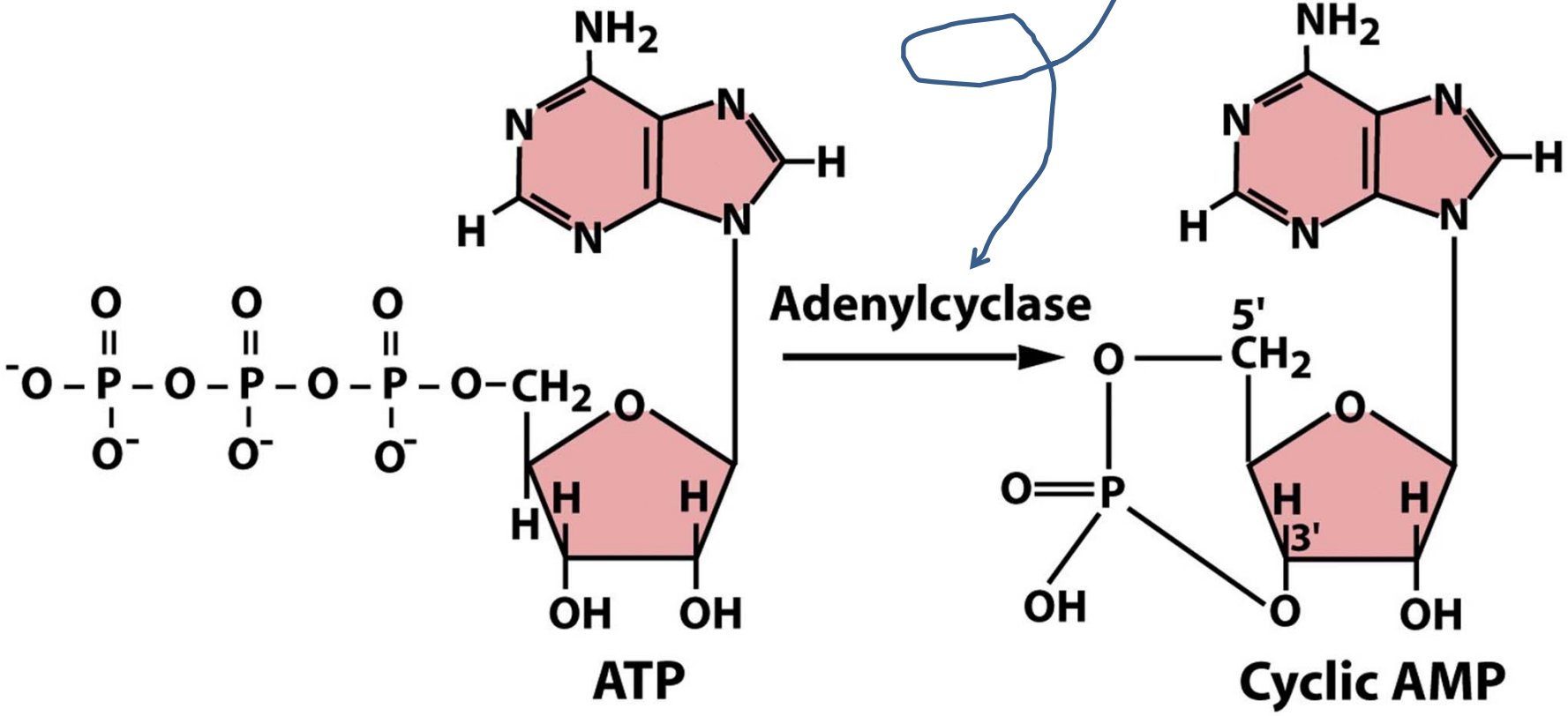
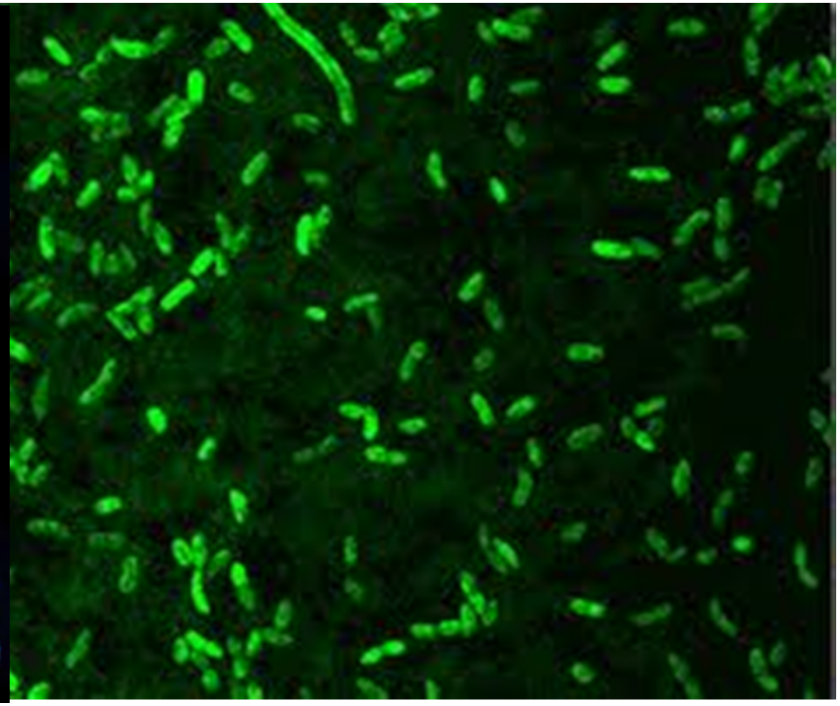


Figure 20-9 Principles of Genetics, 4/e

lux gene regulation by Quorum sensing

Light organ of squid



The luminescent marine bacterium
Vibrio fischeri