

## L2 . Genetics 2.

### Regulation of bacterial gene expression

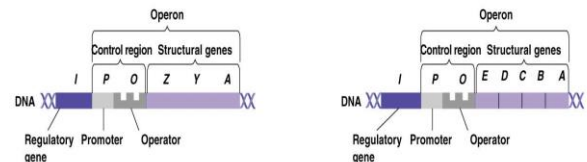
Mutations

Genetic Exchange in Prokaryotes

### 3) Regulation of bacterial gene expression

Repression and Induction

The operon model

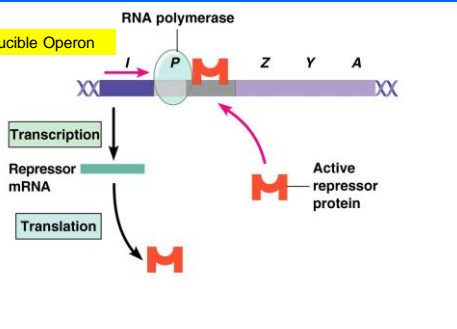


**1 Structure of the operon.** The operon consists of the promoter (P) and operator (O) sites and structural genes that code for the protein. The operon is regulated by the product of the regulatory gene (I).

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Figure 8.12, step 1

#### An inducible Operon

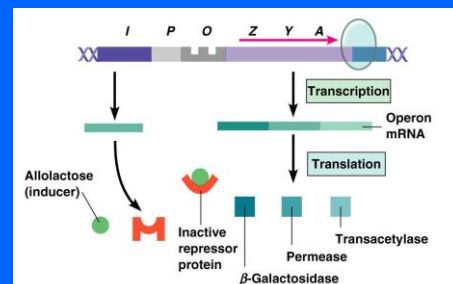


**2 Repressor active, operon off.** The repressor protein binds with the operator, preventing transcription from the operon.

(a) An inducible operon

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Figure 6.12a, step 2



**3 Repressor inactive, operon on.** When the inducer allolactose binds to the repressor protein, the inactivated repressor can no longer block transcription. The structural genes are transcribed, ultimately resulting in the production of the enzymes needed for lactose catabolism.

(a) An inducible operon

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Figure 6.12a, step 3

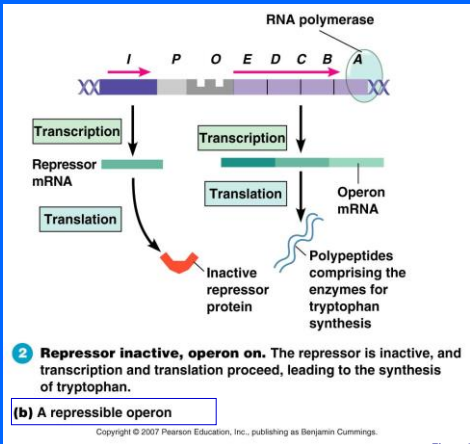


Figure 8.12b, step 2

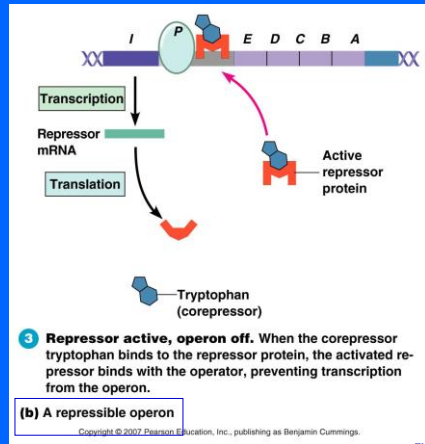
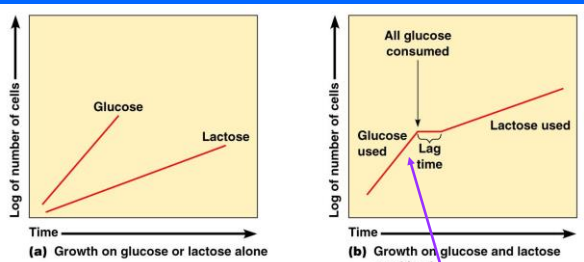


Figure 8.12b, step 3

### Positive Regulation



cAMP accumulation (alarmone), binding to allosteric site CAP (catabolic activator protein), followed by binding to *lac* promoter

Figure 8.13 - Overview

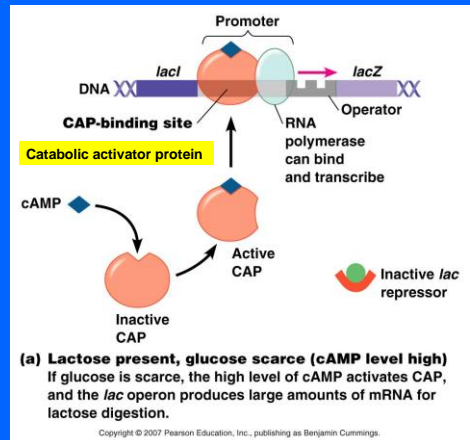


Figure 8.14a

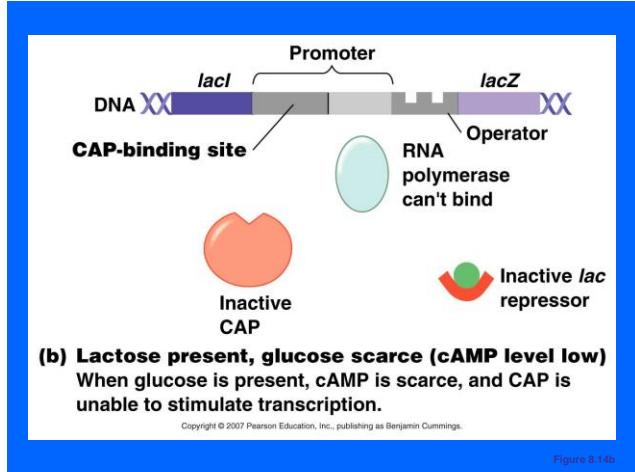
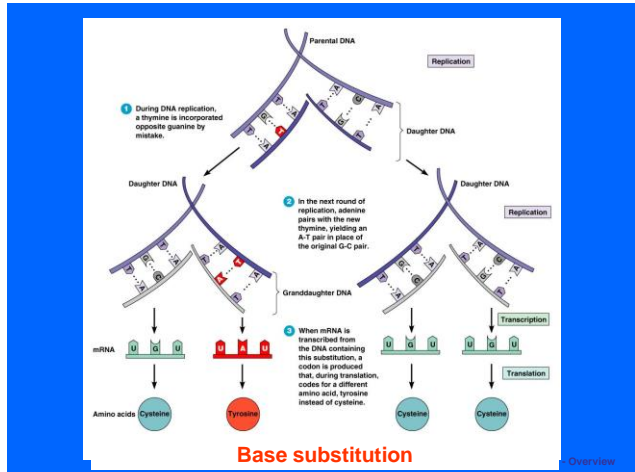


Figure 8.14b

# Mutations



Overview

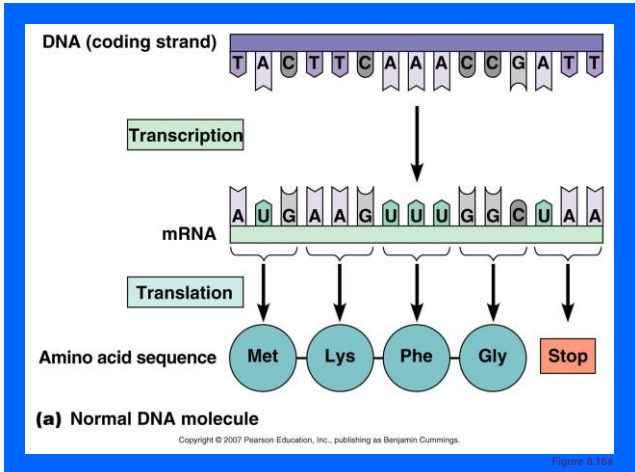
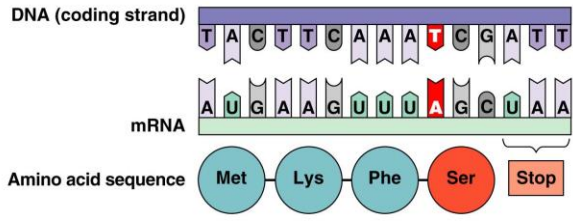


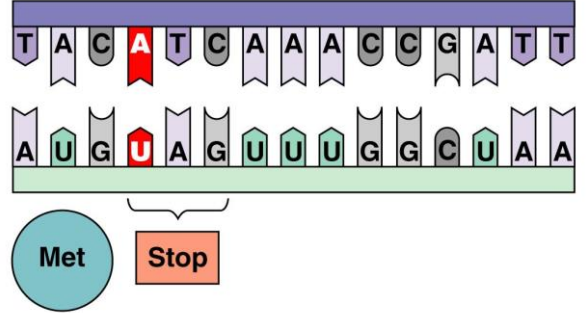
Figure 8.15a



**(b) Missense mutation**

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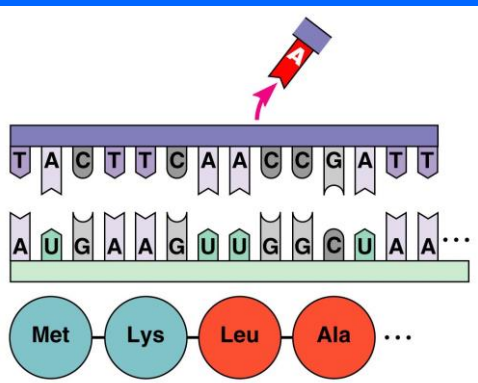
Figure 8.16b



**(c) Nonsense mutation**

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Figure 8.16c



**(d) Frameshift mutation**

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Figure 8.16d

Mutagens are chemical, physical, or biological agents that increase the mutation rate.

Mutagens can alter DNA in many different ways. However, alterations in DNA are not mutations unless they can be inherited.

Some DNA damage can lead to cell death if not repaired, and both error-prone as well as high-fidelity DNA repair systems exist.

**Table 10.3** Types of mutant strains

Designation	Phenotype
Auxotroph	Requires an exogenous growth factor, e.g., an amino acid or vitamin
Carbon source	Unable to use a particular compound as a source of carbon
Nitrogen source	Unable to use a particular compound as a source of nitrogen
Phosphorus source	Unable to use a particular compound as a source of phosphorus
Sulfur source	Unable to use a particular compound as a source of sulfur
Temperature sensitive	Loses a particular function at a high or low temperature
Heat sensitive	Loses a particular function at a high temperature
Cold sensitive	Loses a particular function at a low temperature
Osmotic sensitive	Loses a particular function at high or low osmolarity
Conditional lethal	Unable to grow in a particular environment (e.g., high temperature) in any medium

**Table 10.7** Some physical and chemical mutagens

Agent	Mutagenic action
<b>Physical agents</b>	
X rays	Cause double-strand breaks in DNA, the repair of which leads to macrolesions
UV light	Cause adjacent pyrimidines in DNA to join at positions 4 and 5, forming dimers, which in the process of their repair result mostly in transversions, but also in frameshifts and transitions
<b>Chemical agents</b>	
Base analogs	Become incorporated in DNA and then, owing to their ambiguous pairing on subsequent replication, cause transitions
2-Aminopurine	Can pair with either thymine or cytosine
5-Bromouracil	Can pair with either adenine or guanine
DNA modifiers	
Nitrous acid	Deaminates bases; deamination of cytosine produces uracil and then a CG-to-TA transition
Hydroxylamine	Hydroxylates 6 amino group of cytosine, causing CG-to-TA transition
Alkylating agents (e.g., nitrosoguanidine and ethyl methane sulfonate)	Alkylate DNA bases, distorting DNA structure and resulting in a variety of types of mutations
Intercalating agents (e.g., acridine orange and ethidium bromide)	Intercalate between stacked bases in DNA; replication results in frameshift mutations

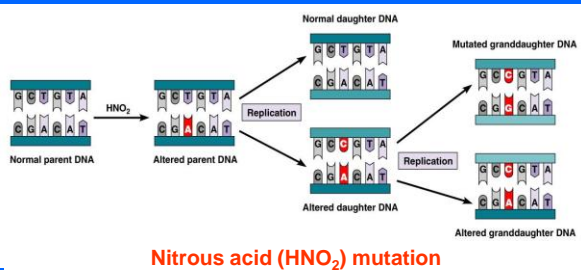
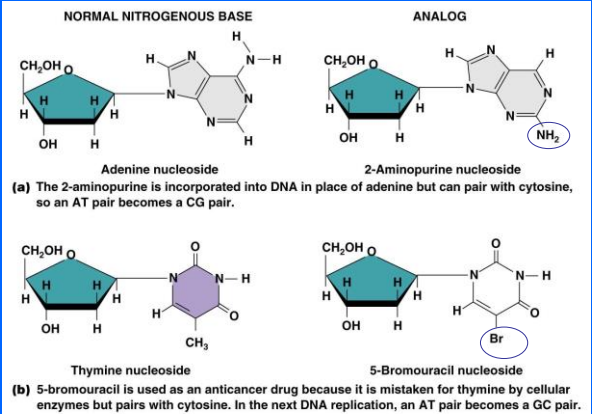


Figure 8.17 - Overview (1 of 3)

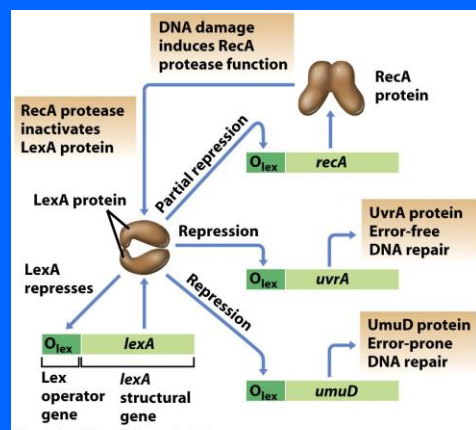
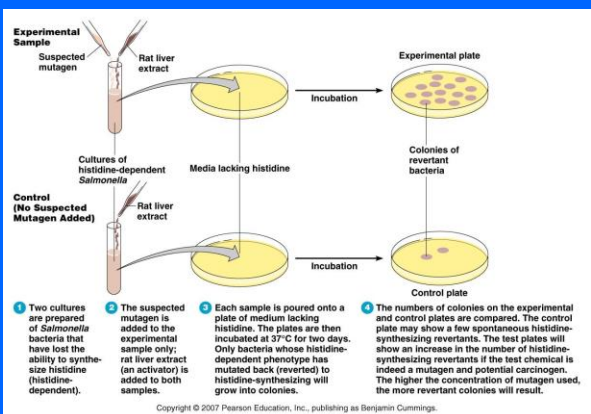
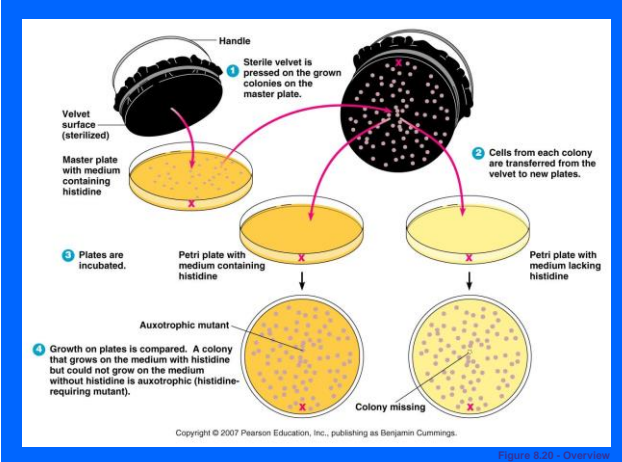
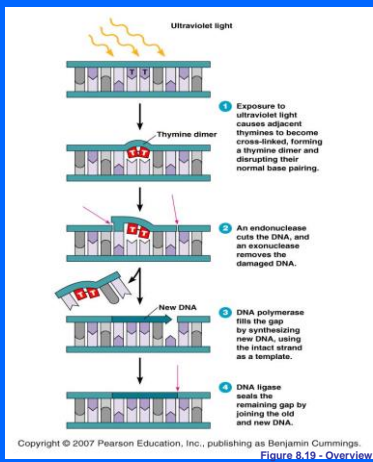
**Nucleoside analogs**

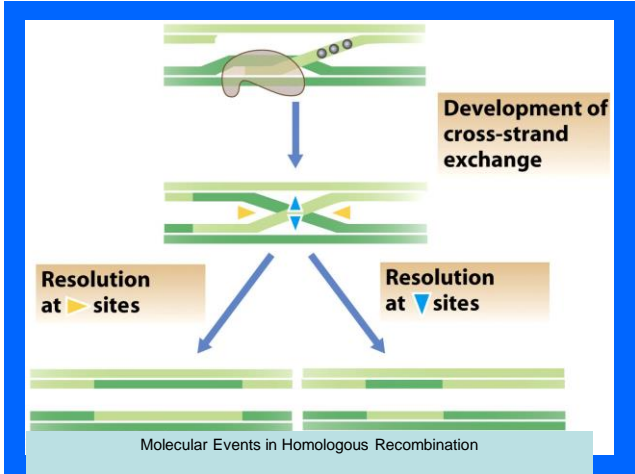
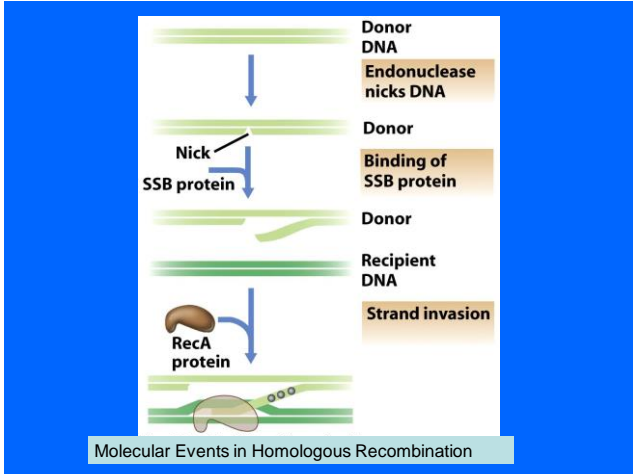


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Figure 8.18 - Overview

## Thymine dimers





**Genetic Exchange in Prokaryotes**  
**Griffith's experiment**

- 1 Living encapsulated bacteria injected into mouse.
- 2 Mouse died.
- 3 Colonies of encapsulated bacteria were isolated from dead mouse.

(a)

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Figure 8.23a

- 1 Living nonencapsulated bacteria injected into mouse.
- 2 Mouse remained healthy.
- 3 A few colonies of nonencapsulated bacteria were isolated from mouse; phagocytes destroyed nonencapsulated bacteria.

(b)

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Figure 8.23b

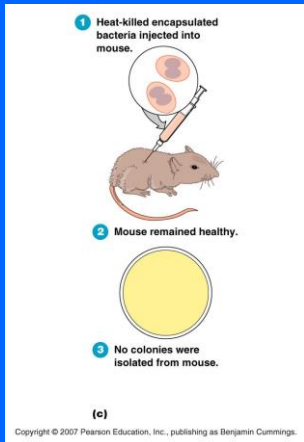


Figure 8.23c

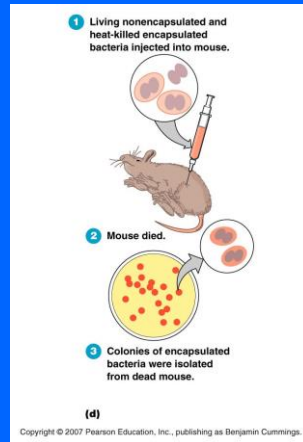


Figure 8.23d

