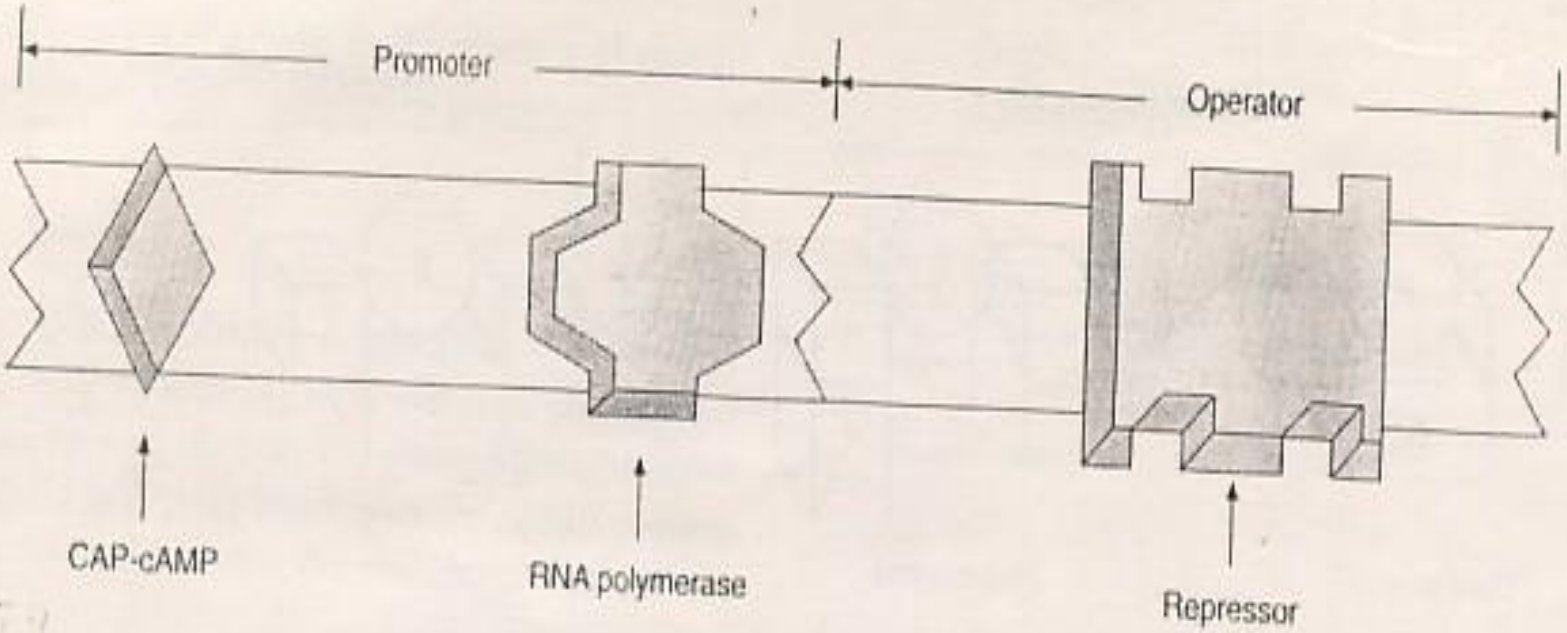
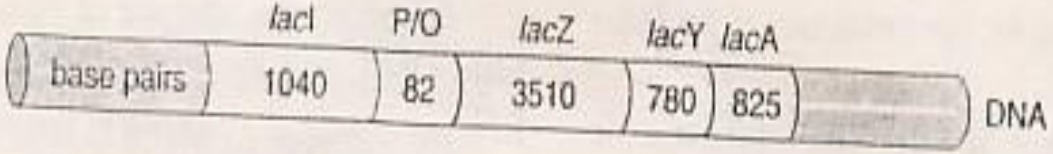
Pathway	Type	Regulatory mechanism	Repressor	Operon	Signal for gene expression
Anabolic (biosynthesis)	Uses energy	Enzyme repression (*trp* operon)	Inactive → activated and binds DNA	On → off	Absence of end product
Catabolic (biodegradation)	Releases energy	Enzyme induction (*lac* operon)	Active → inactivated and releases DNA	Off → on	Presence of nutrient

Comparison of inducible and repressible operons.



Promoter and operator binding sites of the *lac* operon.



The *lac* operon genes.

The *lac* Operon

Gene	Number of amino acids	Molecular weight of polypeptide (daltons)	Type and molecular weight (daltons) of protein	Gene codes for
I	360	38,000	Tetramer (152,000)	Repressor
Z	1021	125,000	Tetramer (500,000)	β-galactosidase
Y	260	30,000	Membrane (30,000) protein	Galactoside permease
A	275	30,000	Dimer (60,000)	Transacetylase

Note: A dalton is equal to the mass of a hydrogen atoms, or 1.67×10^{-24} g.

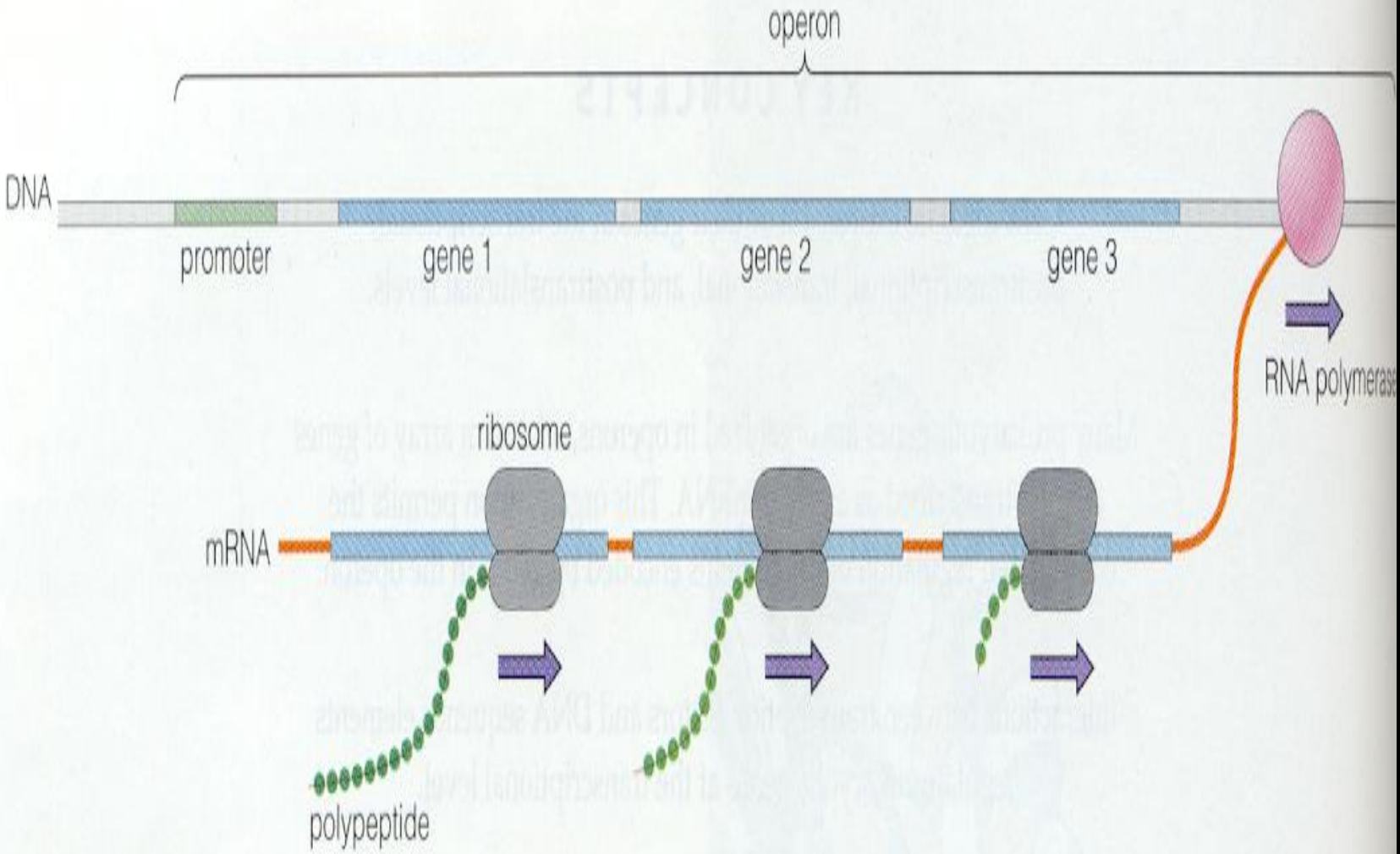
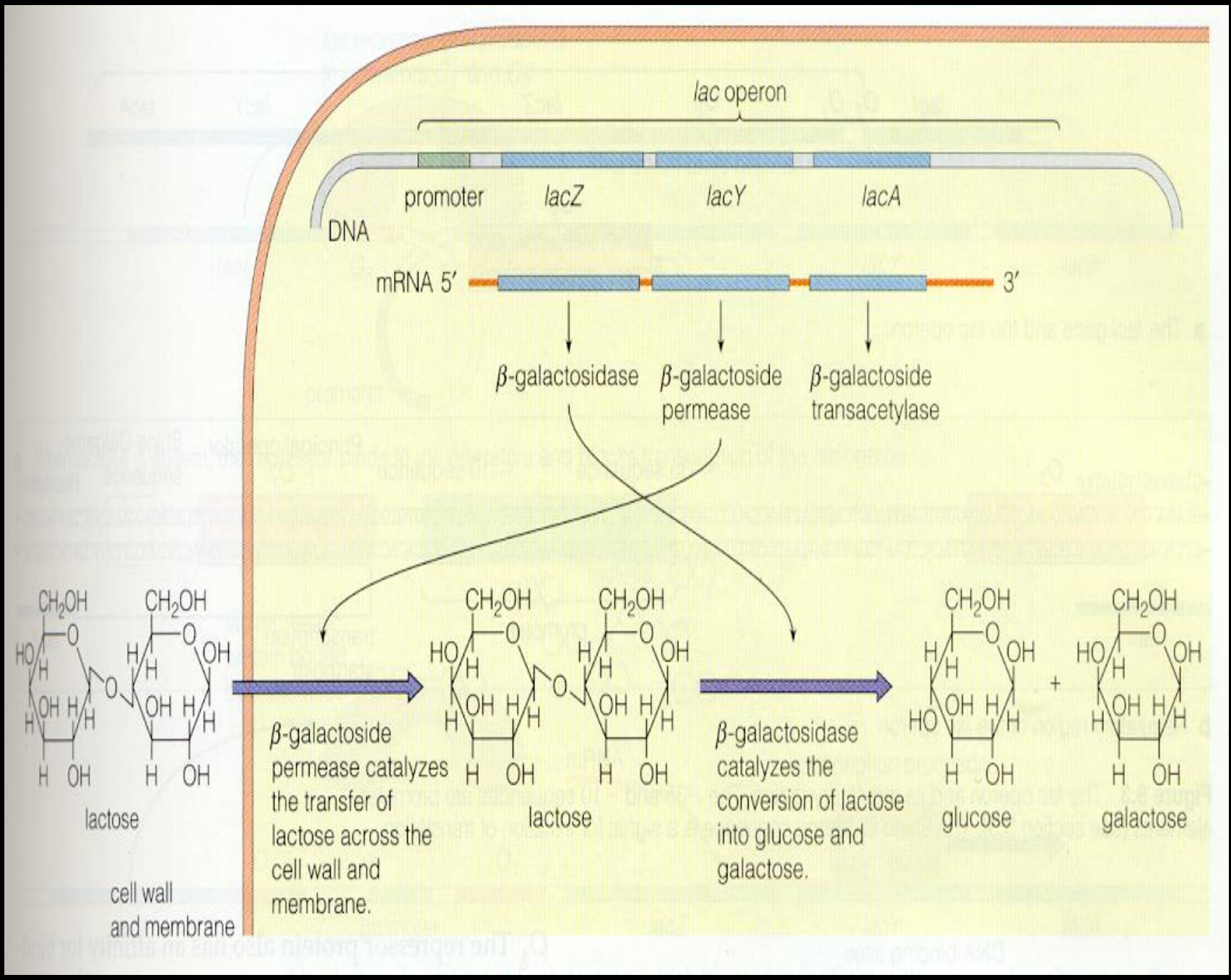
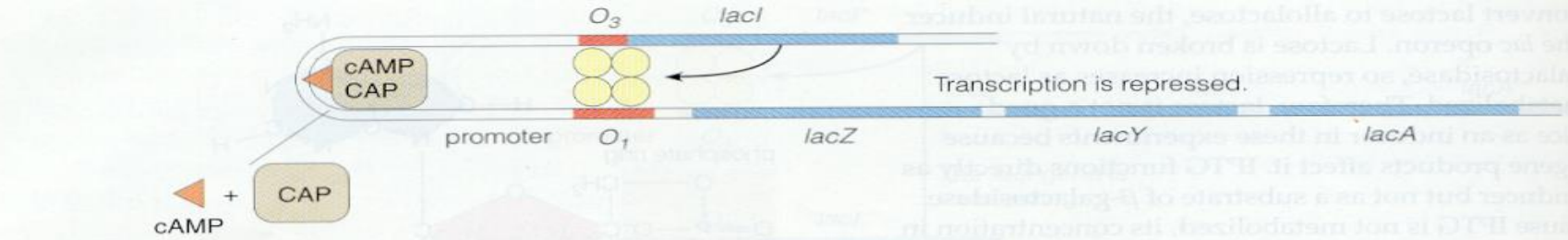
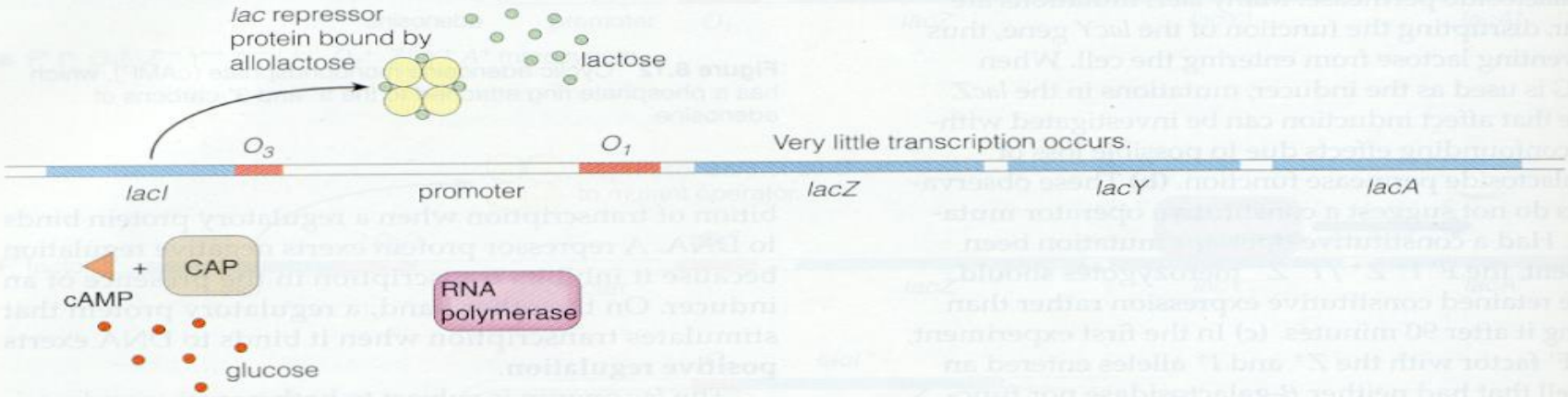


Figure 8.1 A prokaryotic operon containing three genes. RNA polymerase transcribes an operon as a single mRNA. Ribosomes translate each gene in the mRNA separately.

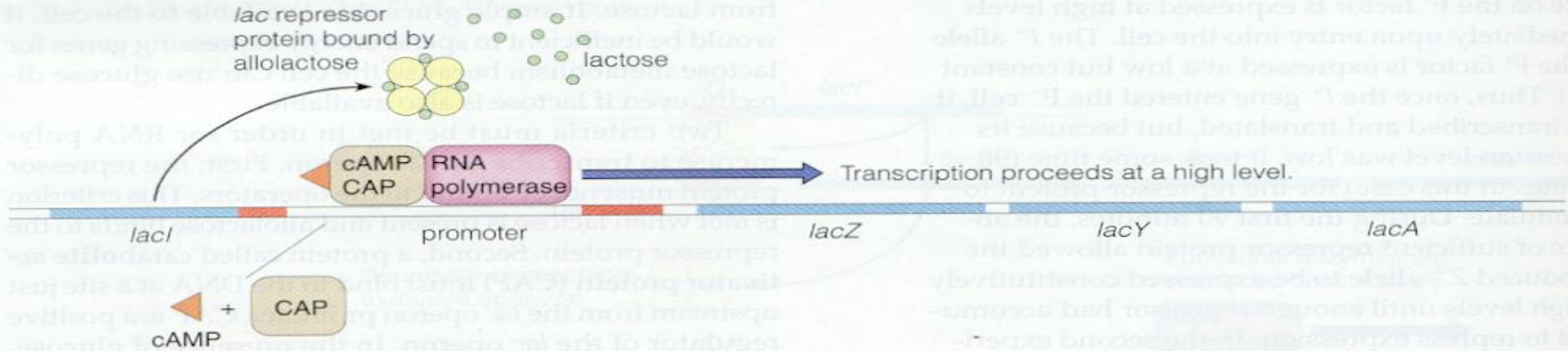

lac operon
promoter
lacZ
lacY
lacA
DNA
mRNA 5′
3′
β-galactosidase
β-galactoside permease
β-galactoside transacetylase
lactose
cell wall and membrane
β-galactoside permease catalyzes the transfer of lactose across the cell wall and membrane.
lactose
β-galactosidase catalyzes the conversion of lactose into glucose and galactose.
glucose
+
galactose



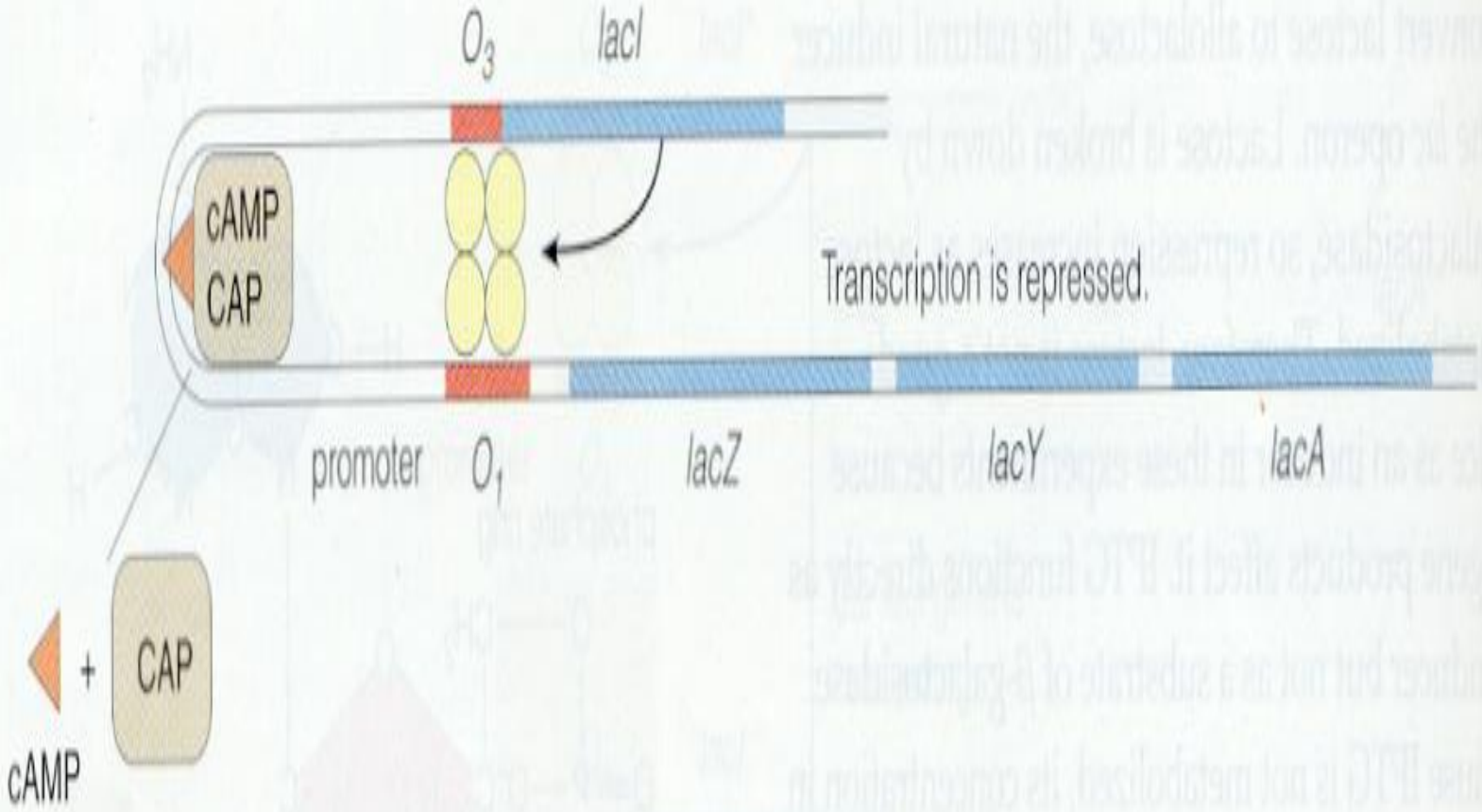
a When lactose is absent, the repressor protein binds to the operators and blocks transcription of the *lac* operon.



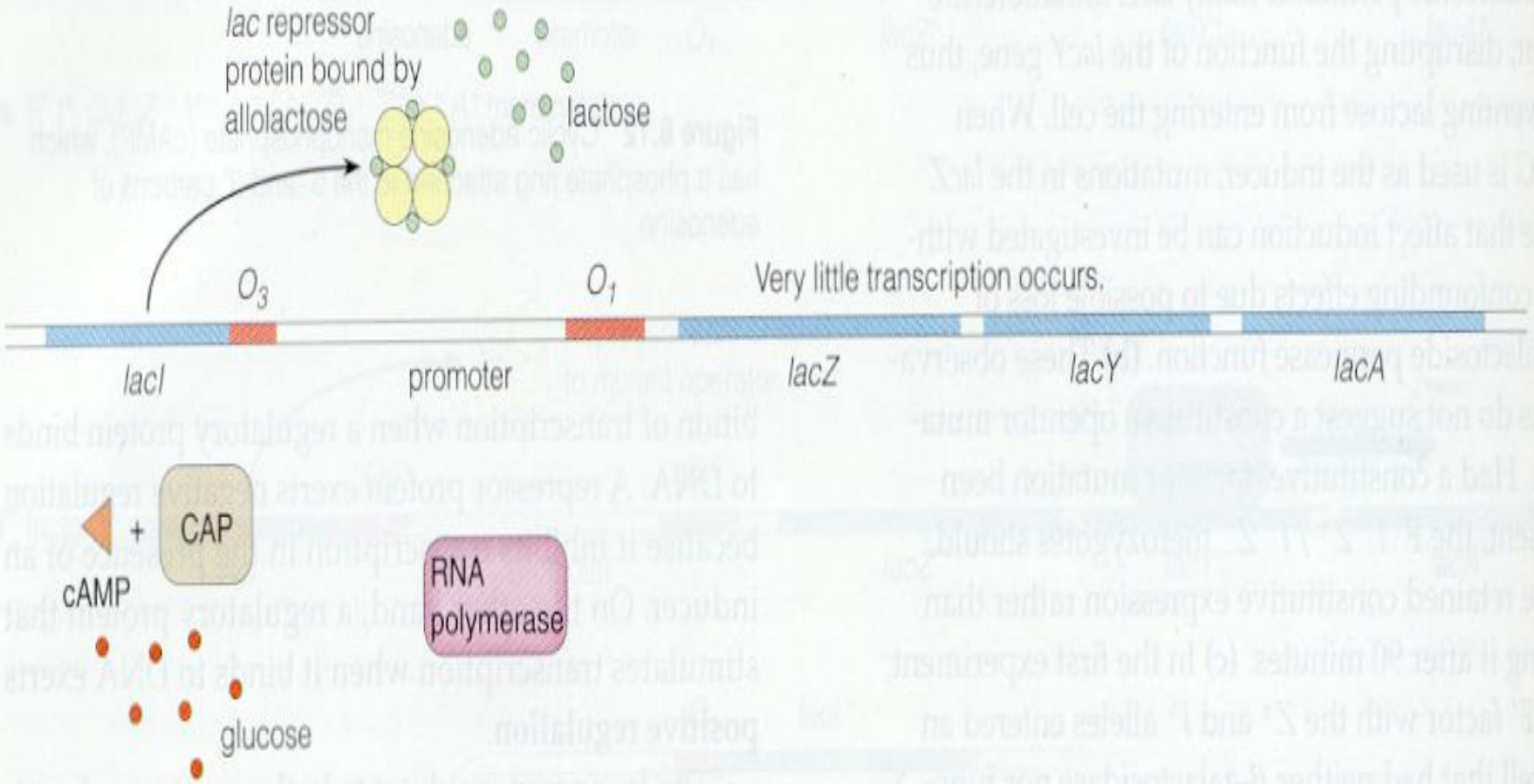
b When lactose and glucose are both present, neither the repressor protein nor CAP binds to the DNA. The level of transcription is very low because RNA polymerase does not bind readily to the promoter when CAP is not bound to the DNA.



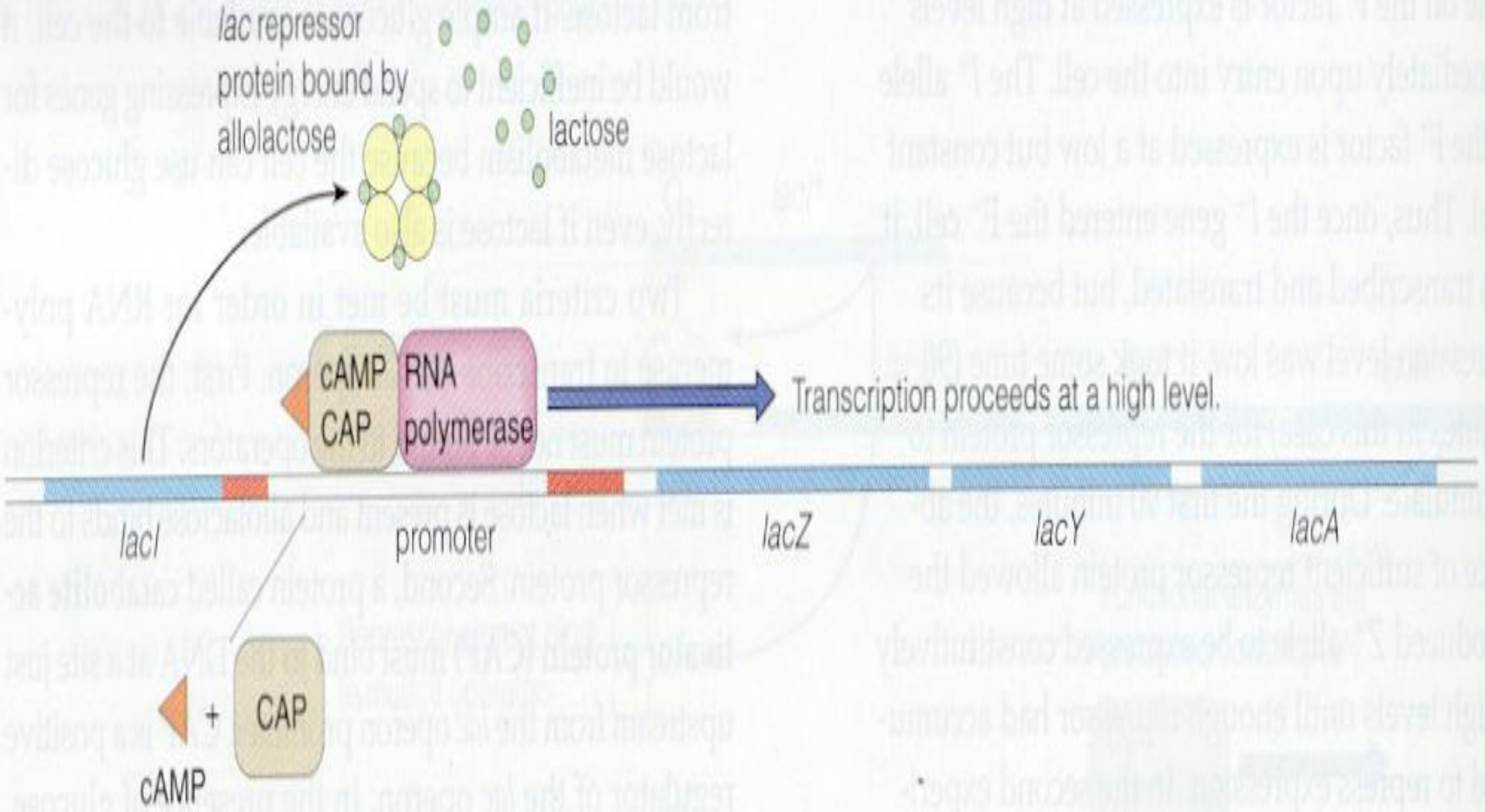
c When lactose is present and the concentration of glucose is low, CAP binds to the DNA and the repressor protein does not bind to it. RNA polymerase transcribes the *lac* operon at a high level.



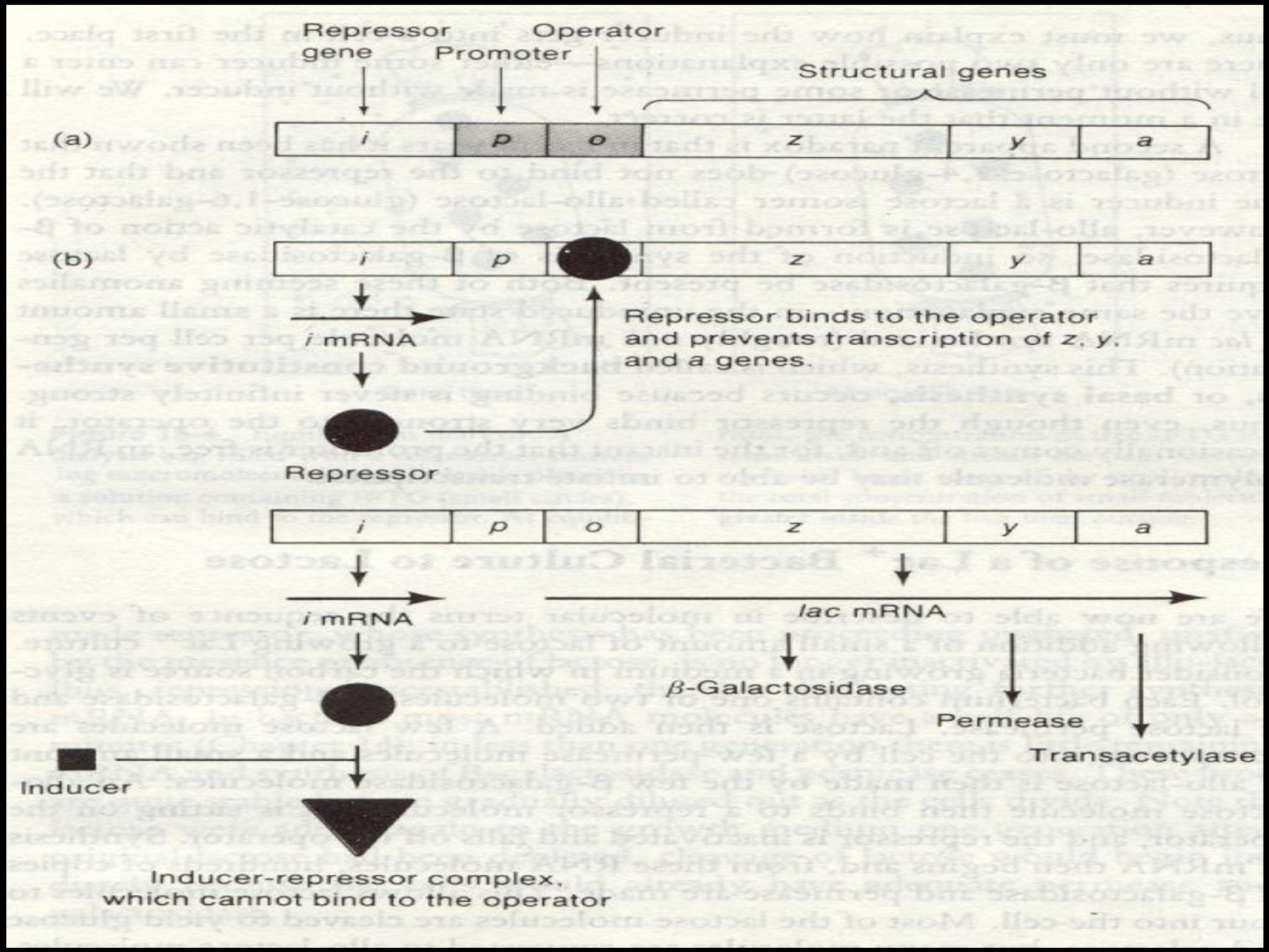
a When lactose is absent, the repressor protein binds to the operators and blocks transcription of the *lac* operon.



b When lactose and glucose are both present, neither the repressor protein nor CAP binds to the DNA. The level of transcription is very low because RNA polymerase does not bind readily to the promoter when CAP is not bound to the DNA.



c When lactose is present and the concentration of glucose is low, CAP binds to the DNA and the repressor protein does not bind to it. RNA polymerase transcribes the *lac* operon at a high level.


Repressor gene
Promoter
Operator
Structural genes
(a)
i
p
o
z
y
a
(b)
i mRNA
Repressor binds to the operator and prevents transcription of z, y, and a genes.
Repressor
lac mRNA
β-Galactosidase
Permease
Transacetylase
Inducer
Inducer-repressor complex, which cannot bind to the operator

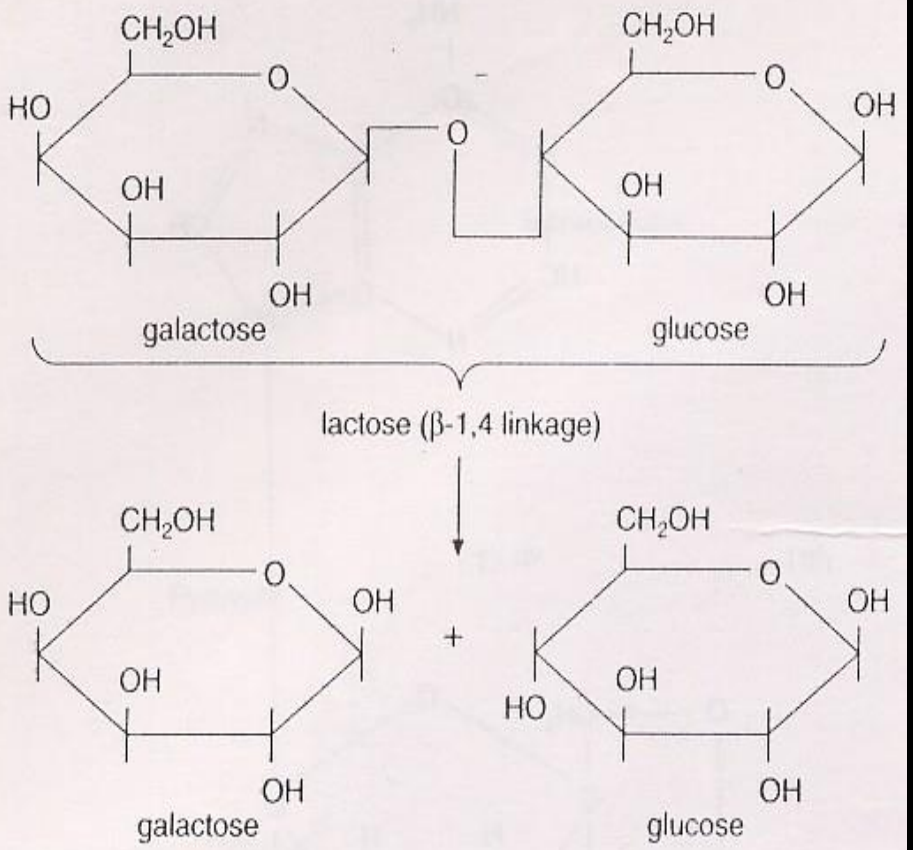
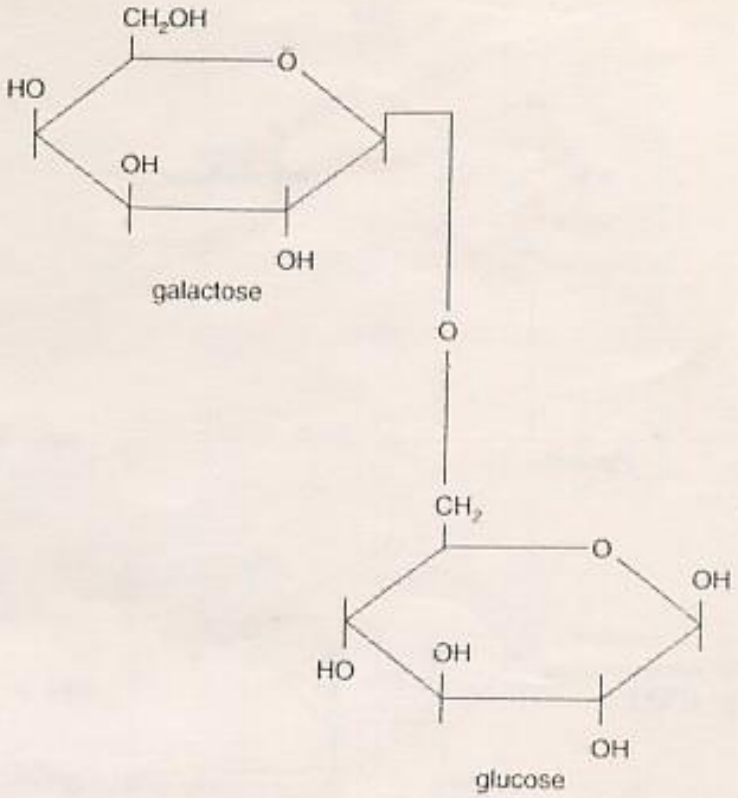


FIGURE 7.3
Lactose structure.



Allolactose (β-1, 6 linkage).

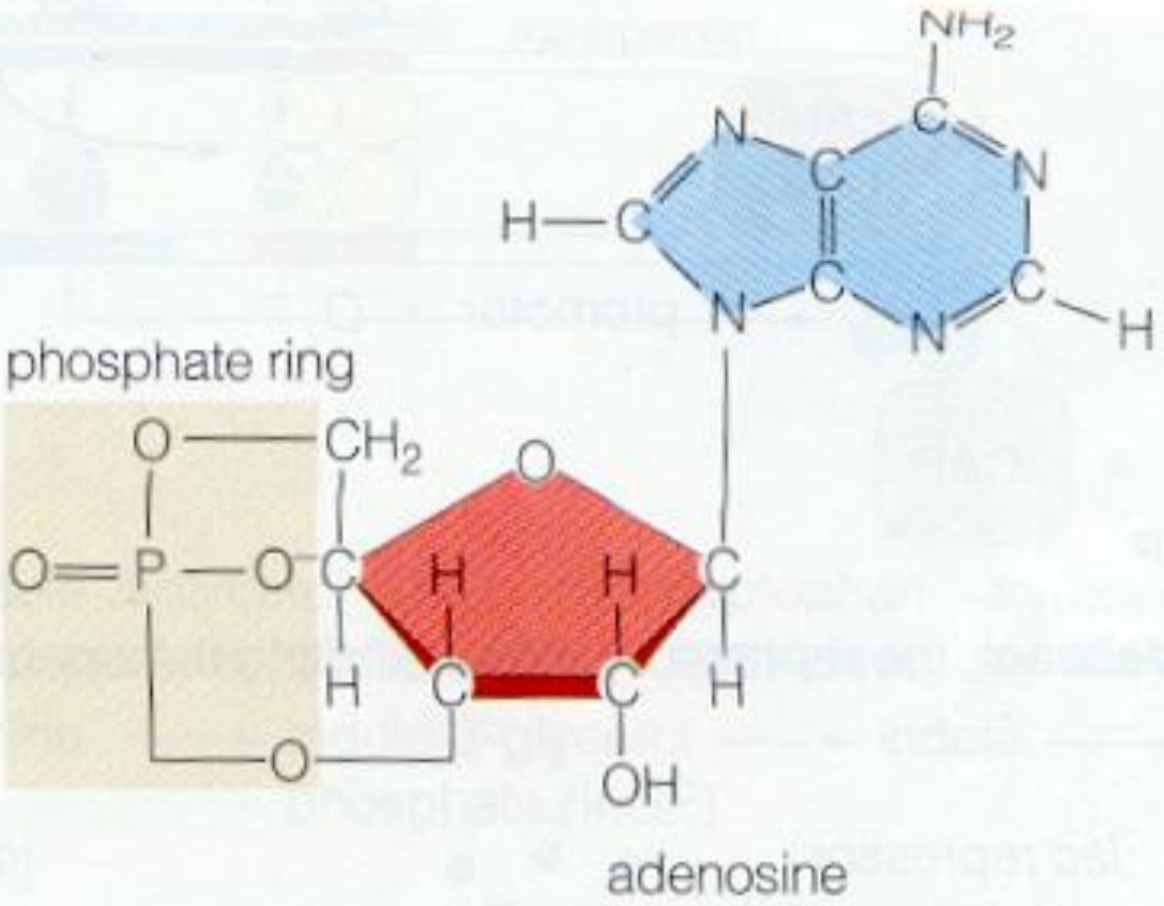


Figure 8.12 Cyclic adenosine monophosphate (cAMP), which has a phosphate ring attached to the 5′ and 3′ carbons of adenosine.