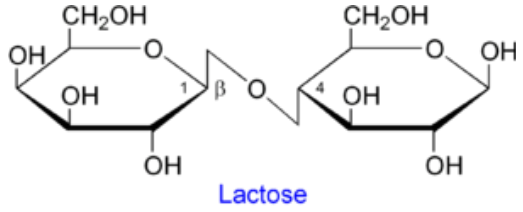
# Regulation of Transcription in prokaryotes

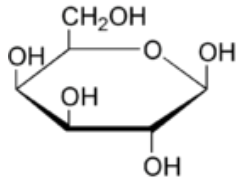
- -35 and -10 sequences determine the rate of a bacterial gene transcription – “strength of the promoter”
- Cell might need some proteins all the time. These proteins are synthesized continuously at the same rate. This is called *constitutive* gene expression.
- Other proteins could be synthesized in response to an external stimulus, e.g. certain nutrient present in the growth medium.

# Lactose operon

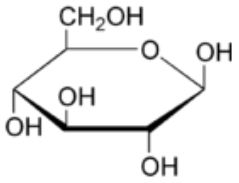
- A cluster of genes under the control of a single promoter is called *operon*.
- The *lac* operon (lactose operon) is an operon required for the transport and metabolism of lactose in Escherichia coli




Lactose




D-galactose



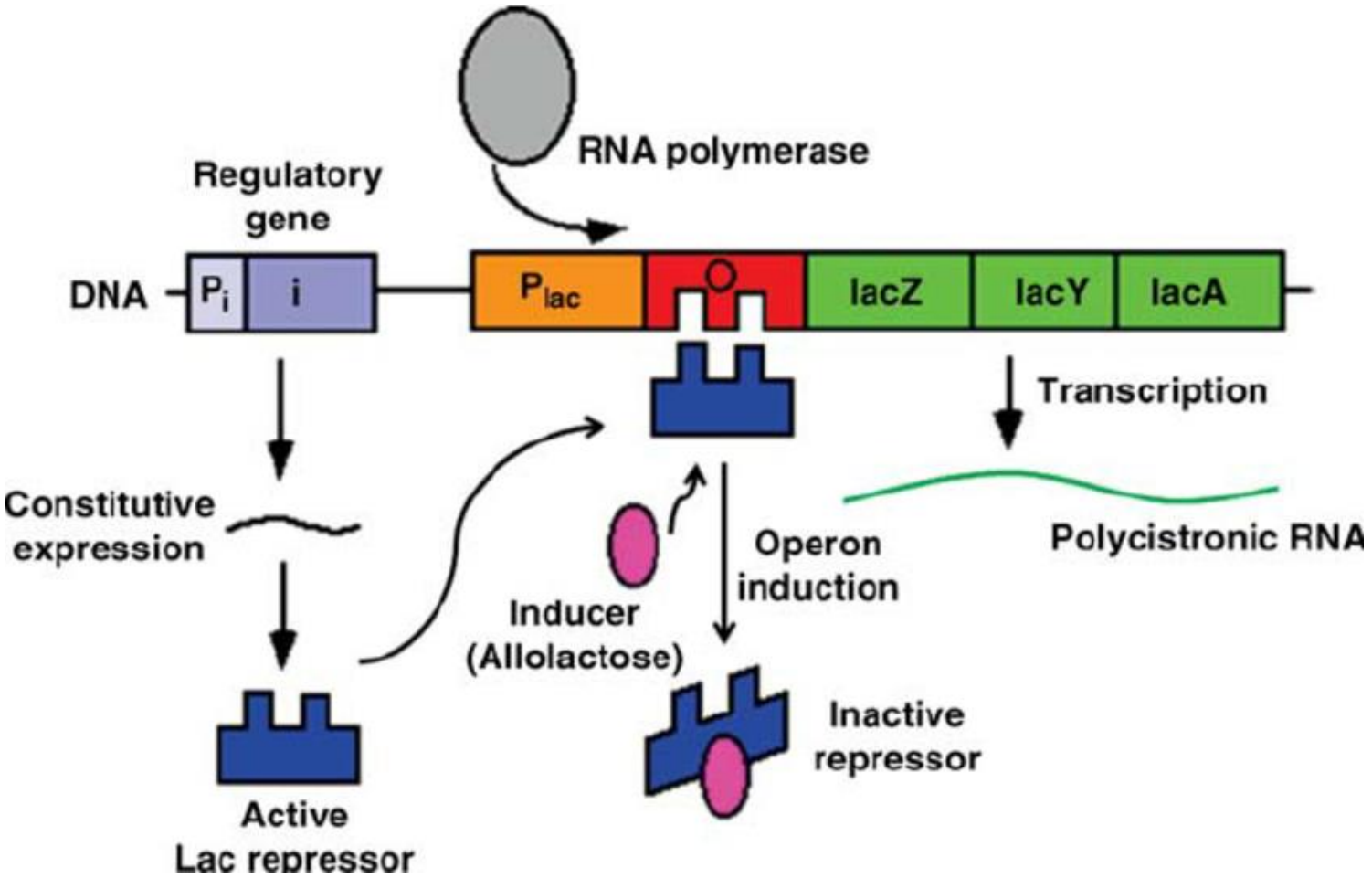

D-glucose

The *lac* operon consists of three structural genes, and a promoter, a terminator, regulator, and an operator. The three structural genes are: *lacZ*, *lacY*, and *lacA*.

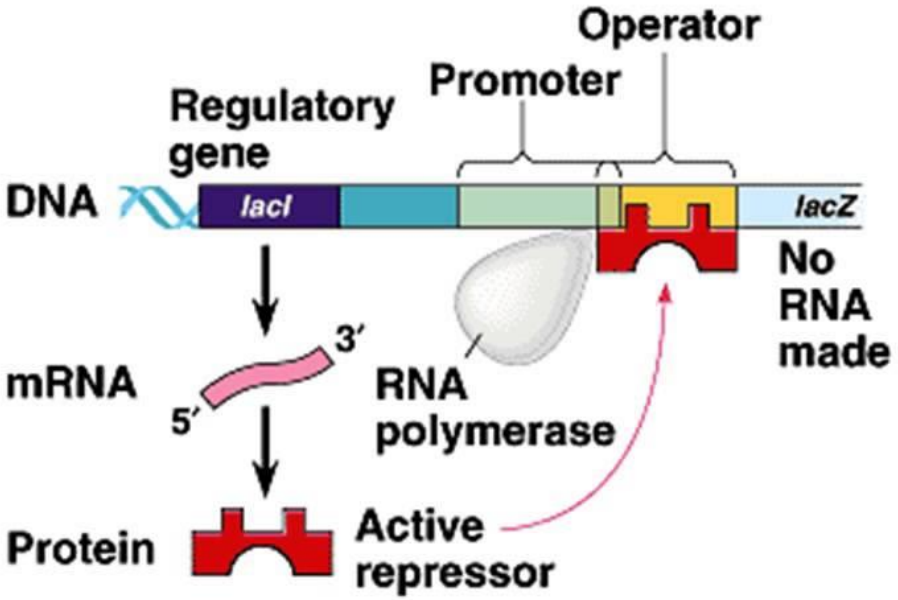
- *lacZ* encodes β-galactosidase (LacZ protein), an intracellular enzyme that cleaves the disaccharide lactose into glucose and galactose.
- *lacY* encodes Beta-galactoside permease (LacY protein), a transmembrane symporter that pumps β-galactosides including lactose into the cell using a proton gradient in the same direction.
- *lacA* encodes β-galactoside transacetylase (LacA protein), an enzyme that transfers an acetyl group from acetyl-CoA to β-galactosides.

Only lacZ and lacY proteins appear to be necessary for lactose catabolism.

- It would be wasteful to produce enzymes when no lactose is available. Therefore, cell expends energy producing the enzymes encoded by the *lac* operon only when necessary.
- In order to achieve that cell utilizes yet another gene - *lacI* which is located in a different part of *E.coli* chromosome and expressed constitutively.
- LacI protein can bind to a specific site within the *lac* operon called *operator*.

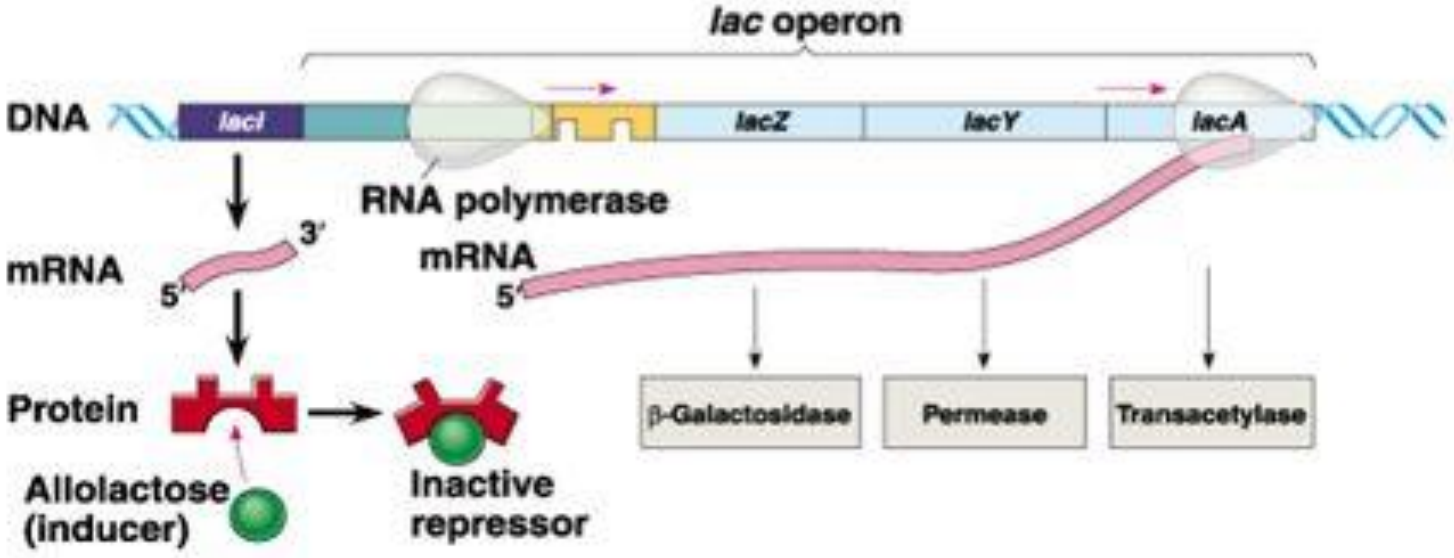

RNA polymerase
Regulatory gene
DNA
$P_i$
i
$P_{lac}$
lacZ
lacY
lacA
Transcription
Constitutive expression
Polycistronic RNA
Operon induction
Inducer (Allolactose)
Inactive repressor
Active Lac repressor

- In the absence of lactose, the *lac* repressor (LacI) binds to the *lac* operator and halts production of the enzymes encoded by the lac operon.




(a) Lactose absent, repressor active, operon off

- If lactose is present it can bind to the LacI protein. This binding changes the conformation of the LacI protein and renders it incapable of binding to DNA.
- Lactose-binding region of the LacI protein is different from its DNA-binding domain. Thus, binding of the LacI protein to the operator is regulated allosterically.



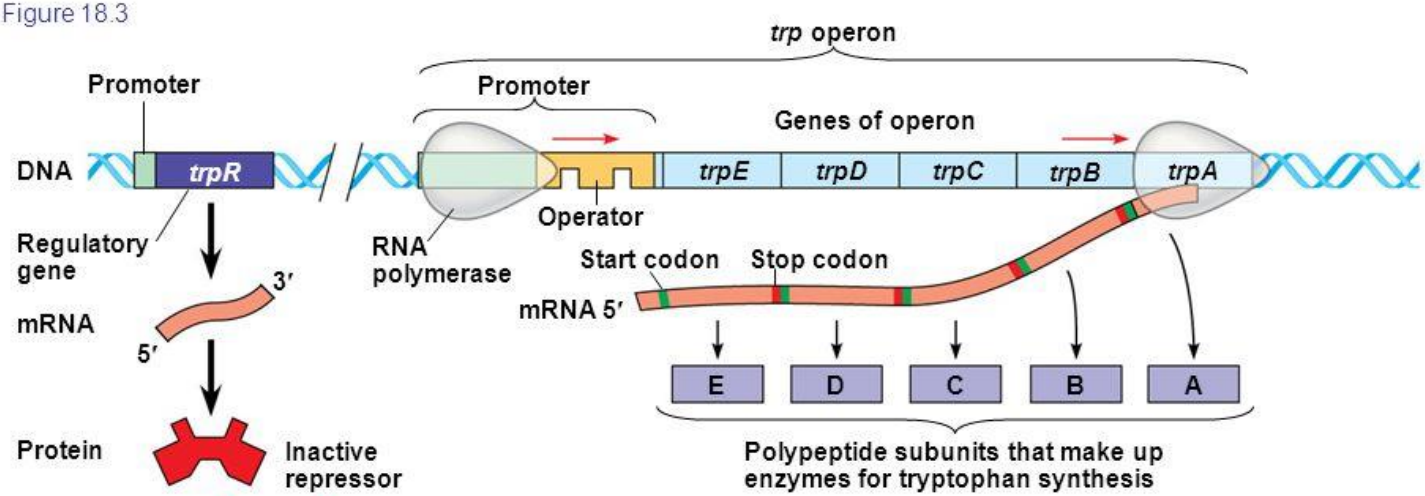

(b) Lactose present, repressor inactive, operon on

- Lactose metabolism system was used by François Jacob and Jacques Monod to determine how a biological cell knows which enzyme to synthesize. Their work on the *lac* operon won them the Nobel Prize in Physiology in 1965.
- Later research showed that the overall regulation mechanism of the *lac* operon is more complex and may involve additional genes and their products.

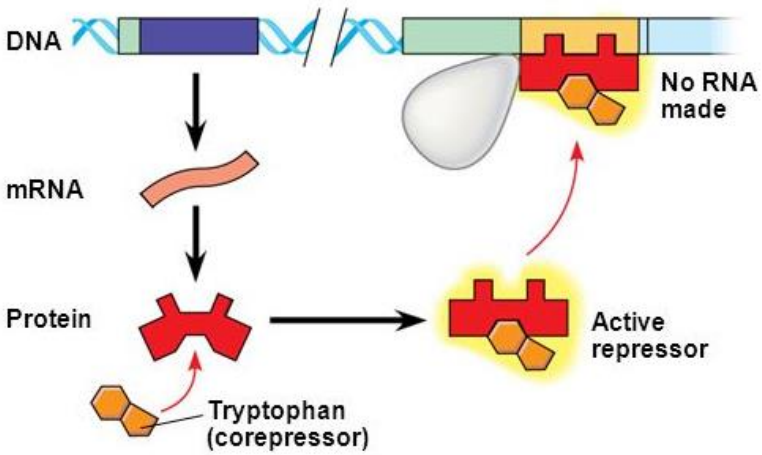
# Tryptophan operon

- The *trp* operon is an operon—a group of genes that is used, or transcribed, together—that codes for the components for production of tryptophan.
- When sufficient amount of tryptophan is present in the cell the expression of the *trp* operon is repressed.

Figure 18.3




(a) Tryptophan **absent**, repressor inactive, operon on




(b) Tryptophan **present,** repressor active, operon off