# Regulation of prokaryotic gene expression

By

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❖***There are two types of gene according to their expression:***

**1-Constitutive genes:**

- These genes are not regulated ,
- They code their protein products which are required for the basic cellular functions and so, they are continuously expressed at a low rate;
- They are also known as "**housekeeping**" genes.

## 2-Inducible genes:

- They express their protein product only in the presence of an **inducer or derepressor**.
- They are negatively regulated by specific proteins termed **repressors**.
- **The inducer produces inactivation of the repressor.**

- **In bacteria**, the **structural genes** that code for the enzymes of a metabolic pathway are often found grouped together on the chromosome together with the **regulatory genes** that determine their transcription as a single long piece of mRNA.
- **This entire package is referred to as an operon.**
- So operon is a linear array of the genes that are involved in a metabolic pathway.
- One of the best understood examples is the **lactose operon of E. coli**.

# The lactose operon of E coli
# (as a model of prokaryotic gene regulation)

- Lac operon contains the genes **responsible for lactose metabolism by E coli bacteria** when lactose is available to the cell but glucose is not.
- [**Note:** Bacteria use glucose as a fuel in preference to any other sugar.]

# The Lac operon of E-coli is formed of:

**1-Structural genes:** They are three liked **inducible** genes as follows:

- ***-Lac Z gene***; encodes **β-galactosidase** that hydrolyses lactose to glucose and galactose.
- ***-Lac Y gene:*** encodes **permease** enzyme that allows lactose transport into the cells.
- ***-Lac A gene:*** encodes **thiogalactoside transacetylase** of unknown function.
- *The lacA gene encodes thiogalactoside transacetylase, which rids the cell of toxic thiogalactosides that also get transported in by lacY. (i.e. cellular detoxification)*

- **The three liked genes are transcribed into one large polycistronic mRNA molecule that contains multiple independent translation start and stop codons for each cistron.**
- **Thus, each protein is translated separately and they are not processed from a single large precursor protein.**

- **A gene** is a part of DNA that gets transcribed into an RNA( mRNA, tRNA, rRNA or any other form of rna).
- **Cistron** is a part of mRNA that begins with a start codon, ends with a stop codon and in between these codons lies the series of codon which code for a single polypeptide.
- You can say that cistron is the part of mRNA that gets translated into polypeptide.

**2-Regulatory gene or lac I gene:** It is **constitutive gene** and codes for the regulatory protein (**Lac repressor**).

**3-Operator region:** At which Lac repressor binds and inhibits gene expression.

**4-A single common Promoter:** It is the site where RNA polymerase binds to it and start transcription of the structural gene.

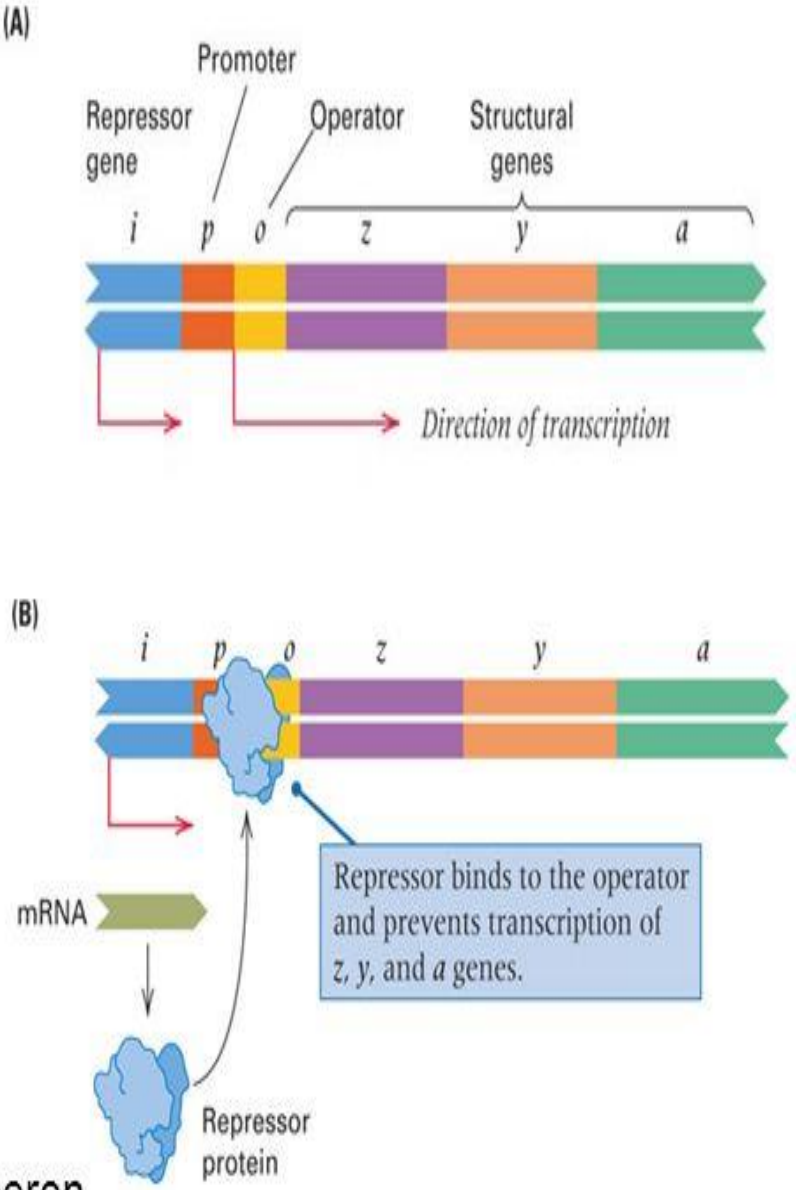
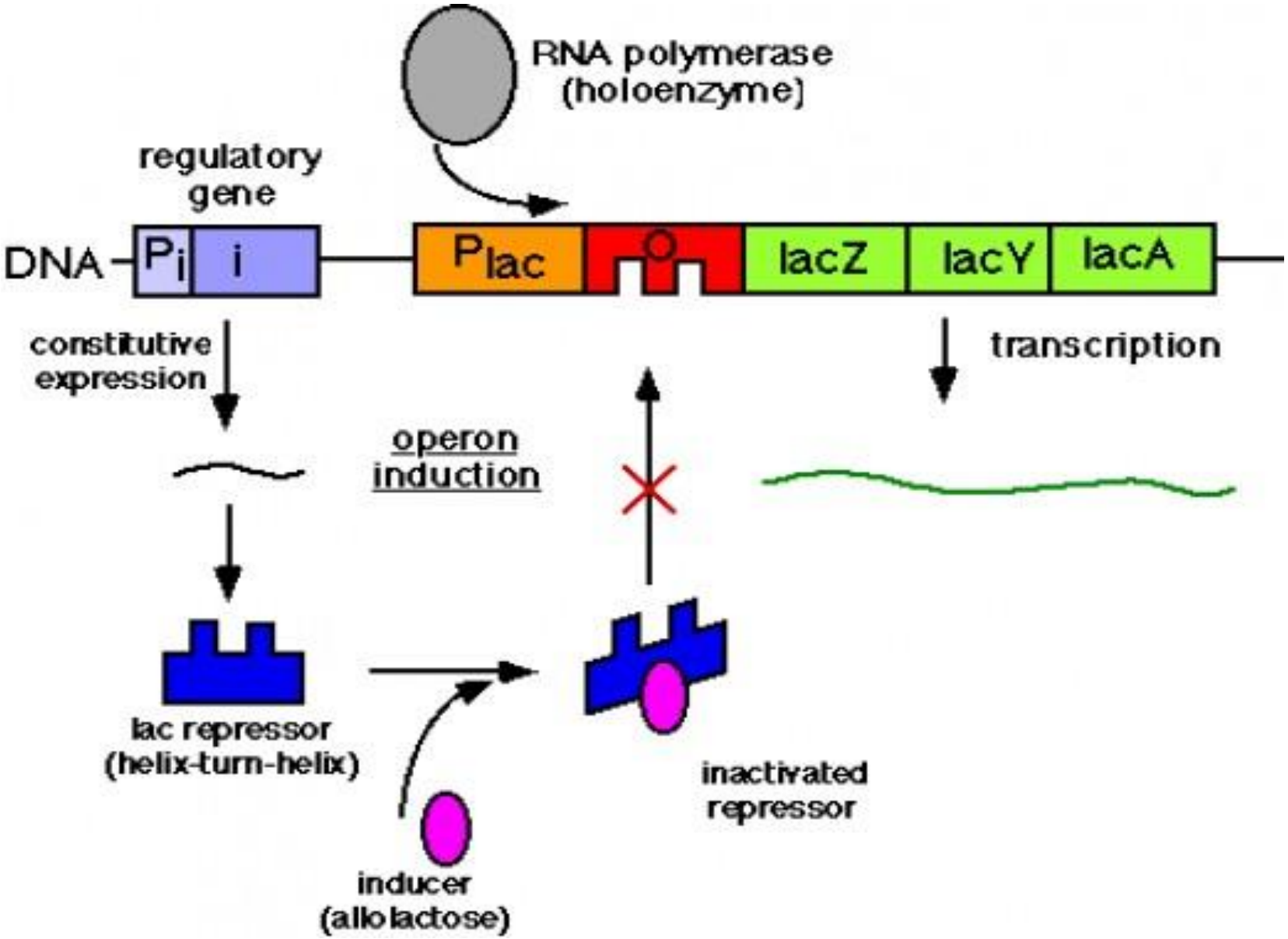



Figure 9.4a/b: *lac* operon


RNA polymerase
(holoenzyme)
regulatory
gene
DNA
Pi
i
Plac
O
lacZ
lacY
lacA
constitutive
expression
transcription
operon
induction
lac repressor
(helix-turn-helix)
inactivated
repressor
inducer
(allolactose)

## When glucose is the only sugar available (Gene repression):

- In this case, the lac operon is repressed (**turned off**).
- Repression is mediated by the repressor protein binding to the operator site, **which is downstream of the promoter region.**
- Binding of the repressor interferes with the progress of RNA polymerase, and blocks transcription of the structural genes.
- This is an example of **negative regulation**.

## When only lactose is available (Gene induction):

- In this case, the lac operon is induced (**maximally expressed or turned on**).
- A small amount of lactose is converted to an isomer, allolactose. This compound is an inducer that binds to the repressor protein, **changing its conformation** so that it can no longer bind to the operator.
- This allows RNA polymerase to enter at the promoter region and initiate transcription of the structural genes. **This is an example of positive regulation.**
- After the inducer or lactose is removed, expression of the lac operon stops quickly because **the lac mRNA is unstable and decays within minutes.**