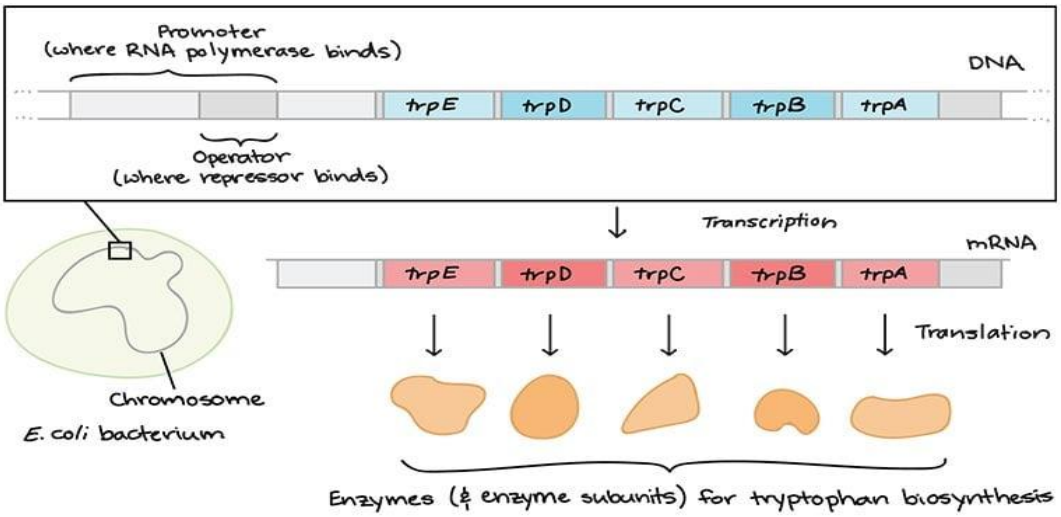
# Tryptophan (Trp) Operon

Many protein-coding genes in bacteria are clustered together in operons which serve as transcriptional units that are coordinately regulated.

1. It was Jacob and Monod in 1961 who proposed the operon model for the regulation of transcription.
2. The operon model proposes three elements:
   A set of structural genes (i.e. genes encoding the proteins to be regulated)
   An operator site, which is a DNA sequence that regulates transcription of the structural genes.
   A regulator gene which encodes a protein that recognizes the operator sequence.
3. Operons are thus clusters of structural genes under the control of a single operator site and regulator gene which ensures that expression of the structural genes is coordinately controlled.




4. The tryptophan operon is the regulation of transcription of the gene responsible for biosynthesis of tryptophan.
5. The tryptophan (trp) operon contains five structural genes encoding enzymes for tryptophan biosynthesis with an upstream trp promoter (Ptrp) and trp operator sequence (Otrp).

<u>Structural genes are TrpE, TrpD, TrpC, TrpB and TrpA</u>

trpE: It enodes the enzyme Anthranilate synthase I

trpD: It encodes the enzyme Anthranilate synthase II

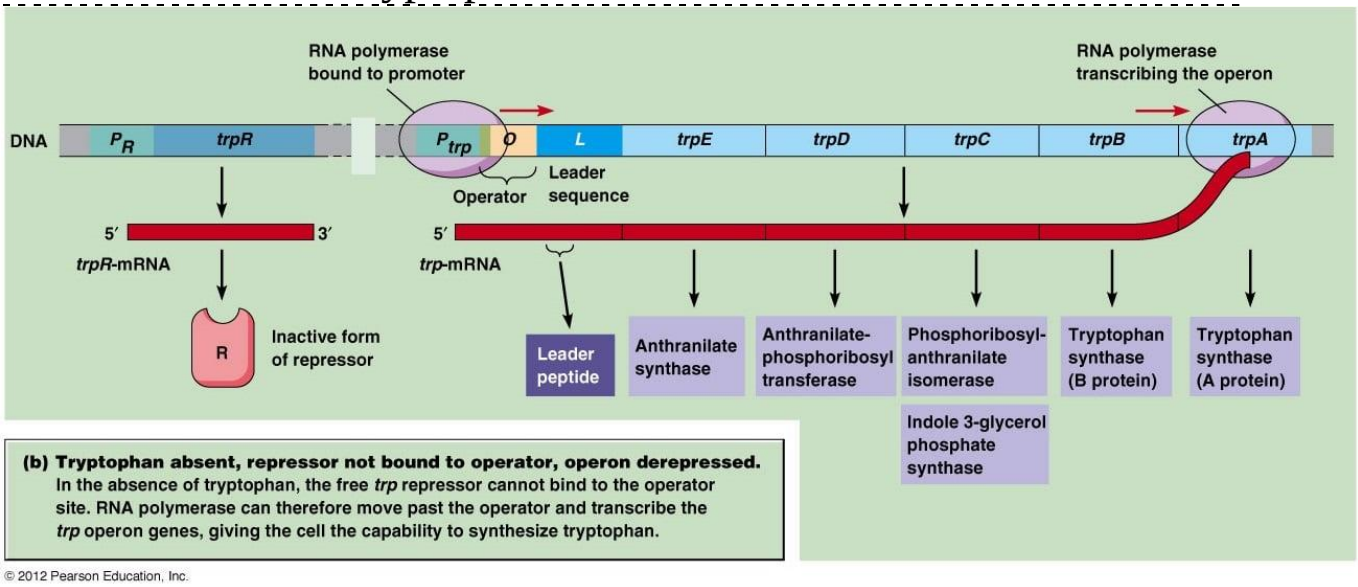
trpC: It encodes the enzyme N-5'-Phosphoribosyl anthranilate isomerase and Indole-3-glycerolphosphate synthase

trpB: It encodes the enzyme tryptophan synthase-B sub unit

trpA: It encode the enzyme tryptophan synthase-A sub unit

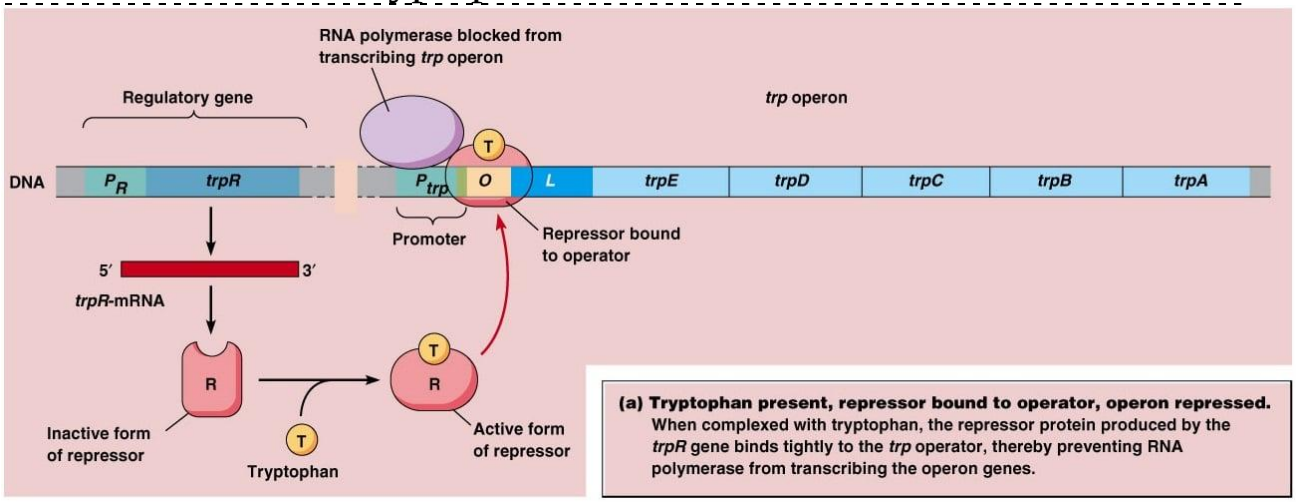
The trp operator region partly overlaps the trp promoter.
The operon is regulated such that transcription occurs when tryptophan in the cell is in short supply.

## In the Absence of Tryptophan




- In the absence of tryptophan, a trp repressor protein encoded by a separate operon, trpR, is synthesized and forms a dimer.
- However, this is inactive and so is unable to bind to the trp operator and the structural genes of the trp operon are transcribed.

## In the Presence of Tryptophan




- When tryptophan is present, the enzymes for tryptophan biosynthesis are not needed and so expression of these genes is turned off.

- This is achieved by tryptophan binding to the repressor to activate it so that it now binds to the operator and stops transcription of the structural genes.
- Binding of repressor protein to operator overlaps the promoter, so RNA polymerase cannot bind to the prometer. Hence transcription is halted.
- In this role, tryptophan is said to be a co-repressor. This is negative control, because the bound repressor prevents transcription.