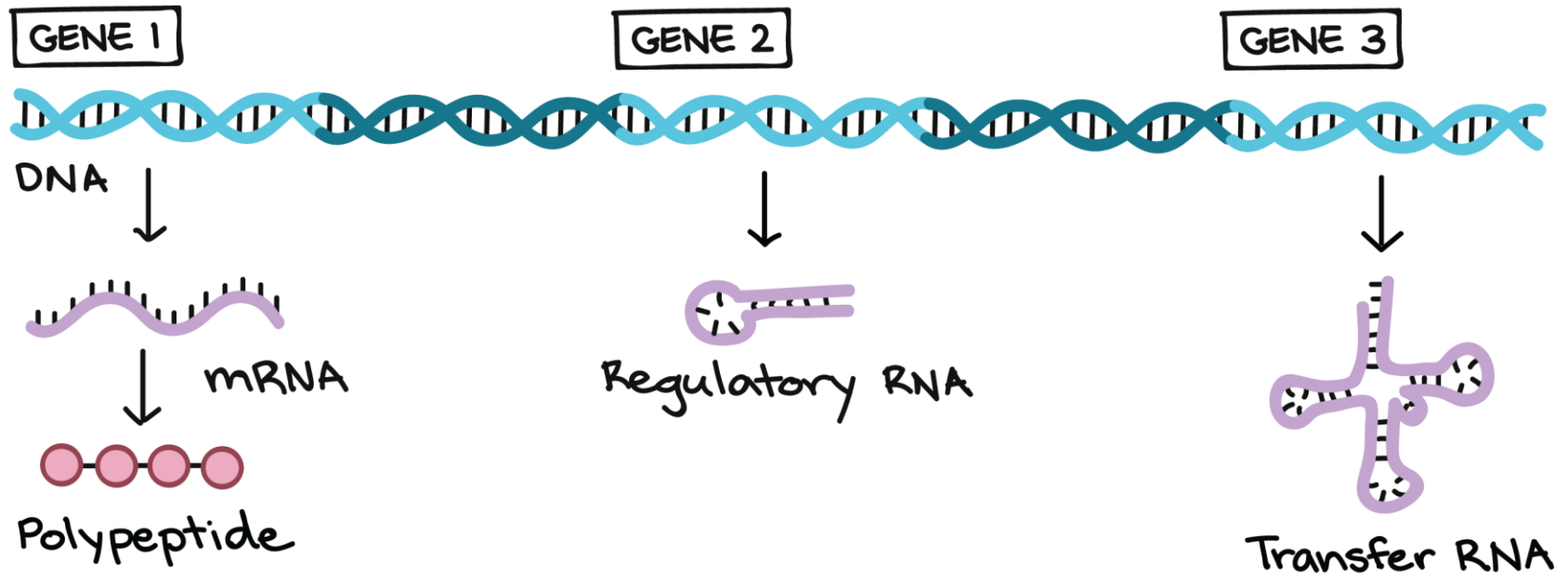


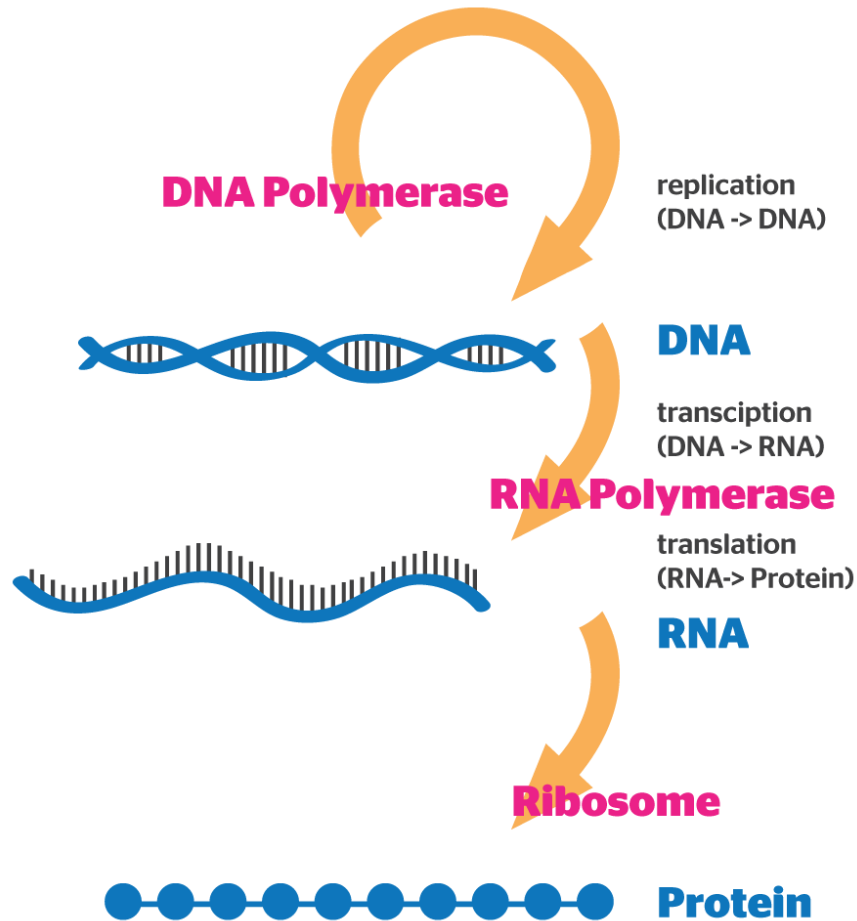
Gene Expression

Gene expression is the process by which information from a gene is used in the synthesis of a functional gene product.

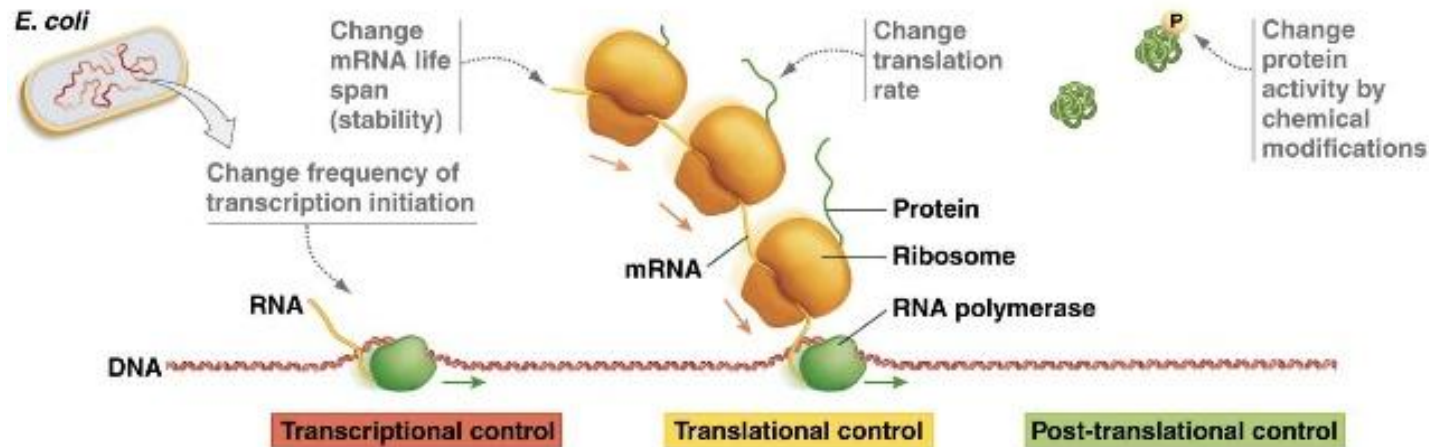
Functional gene products



Central dogma of molecular biology



Regulation of Gene Expression

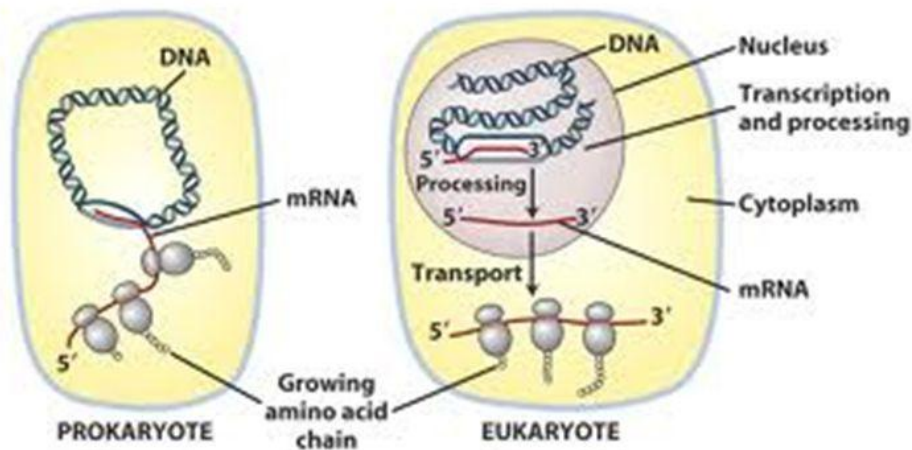


- Gene expression can be regulated:
 - During transcription (transcriptional control).
 - During translation (translational control).
 - After translation (post-translational control).

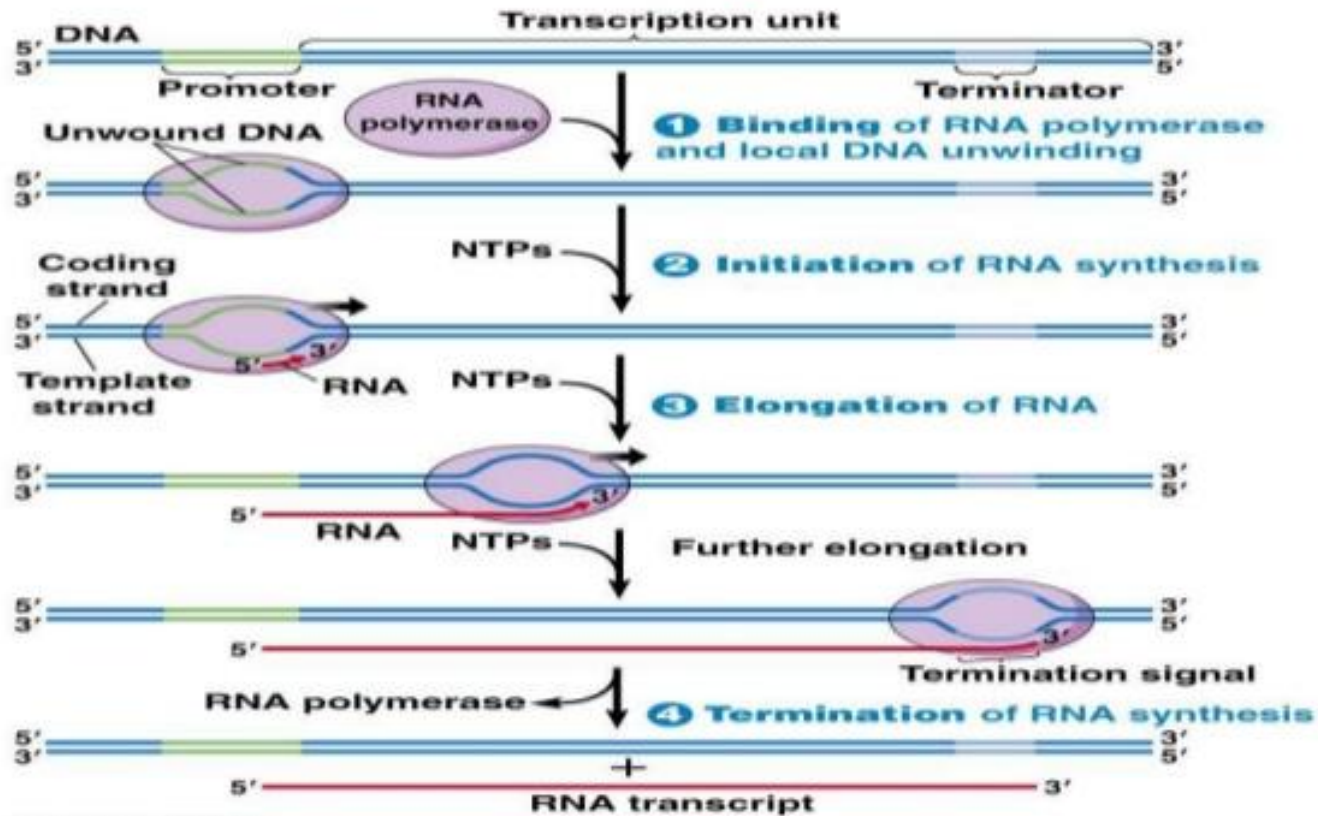
DNA Transcription in prokaryotes

Bacteria vs. Eukaryotes

- Both alter their patterns of gene expression in response to changes in environmental conditions
 - This regulation often happens during transcription



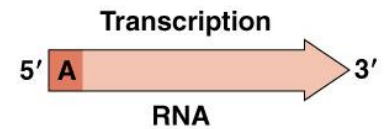
Overview of Prokaryotic DNA Transcription

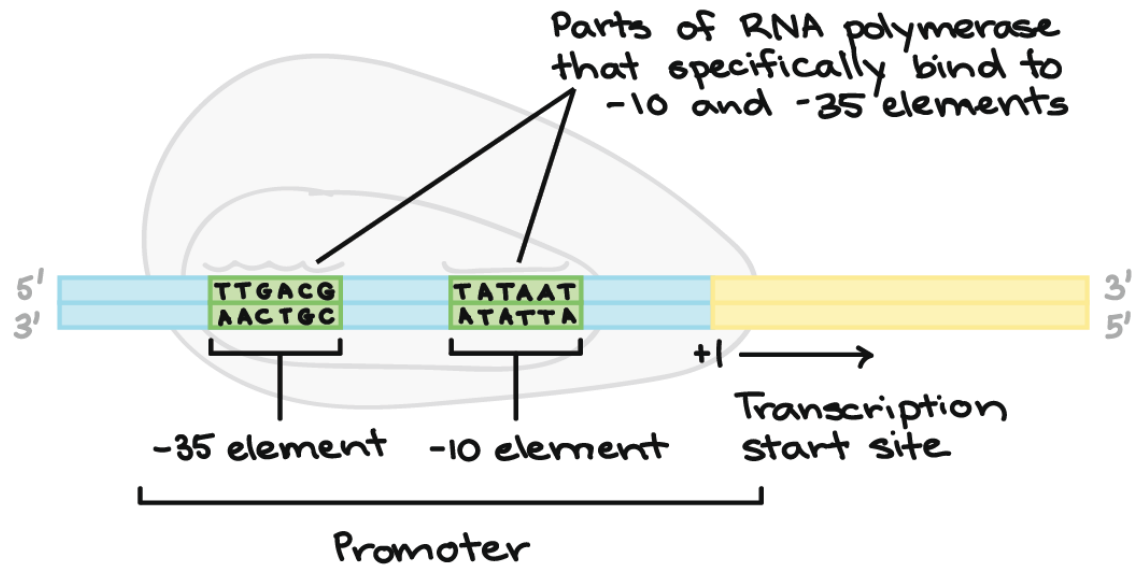


Bacterial promoter

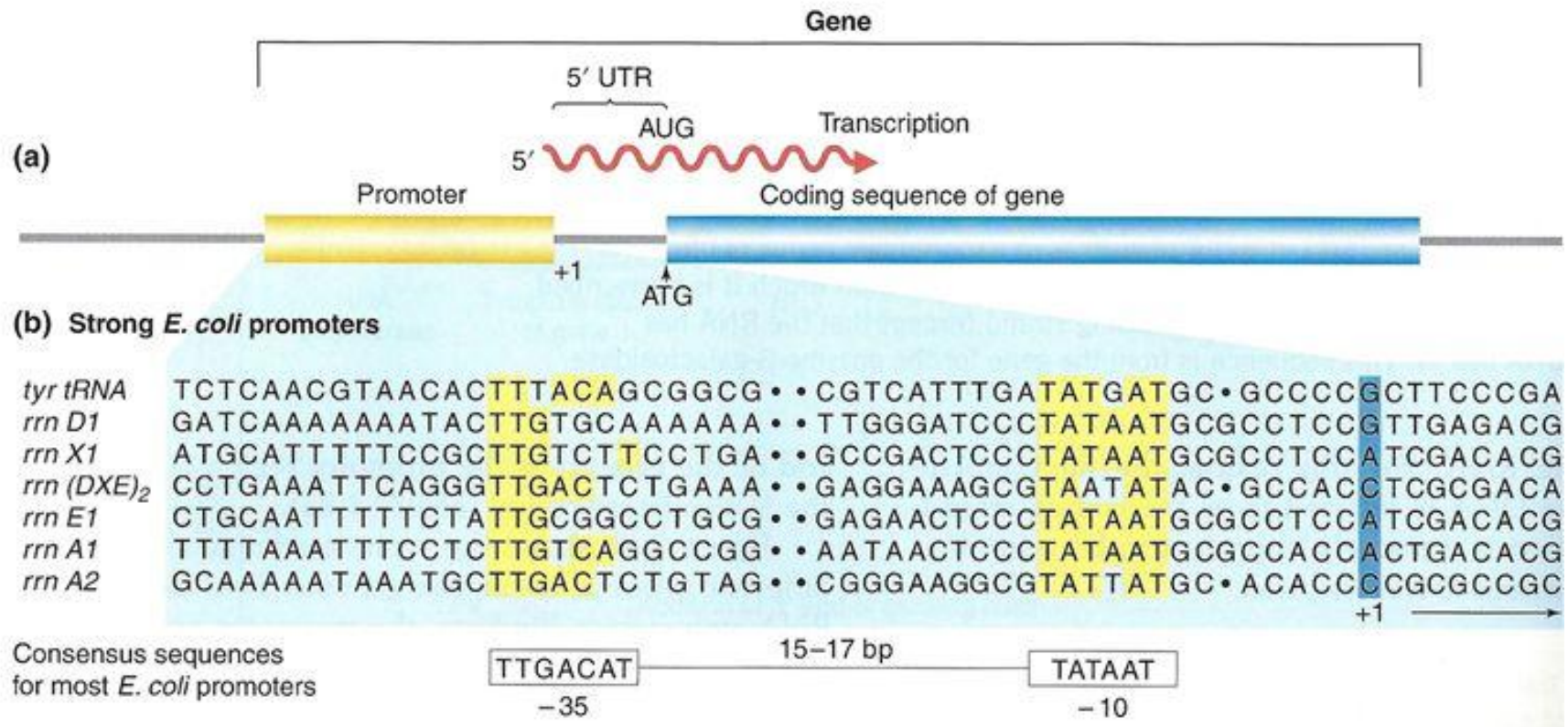
- In genetics, a promoter is a region of DNA that initiates transcription of a particular gene.
- In bacteria, the promoter contains two short sequence elements approximately 10 (Pribnow Box) and 35 nucleotides upstream from the transcription start site.

Promoter DNA





Promoters may differ from the consensus sequence



Typical Bacterial Promoter

82 84 78 65 54 48

TTGACA

-35

← 17 bp →

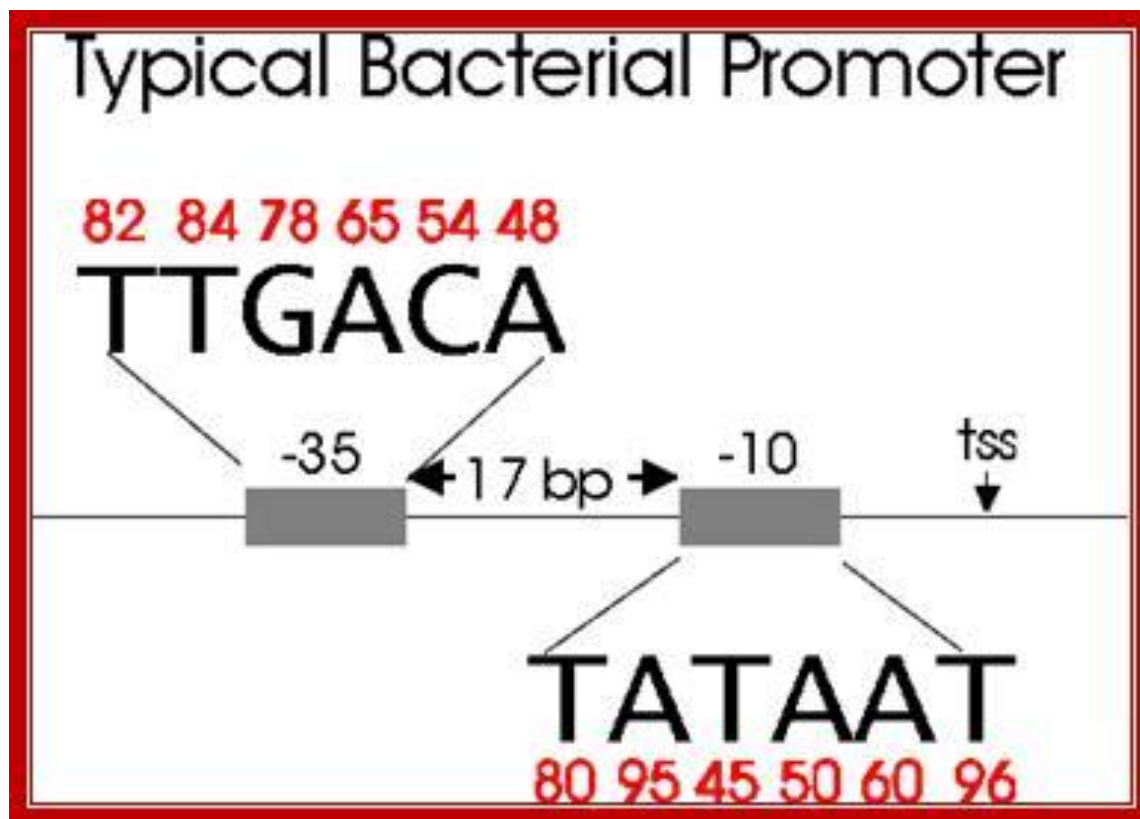
-10

tss



TATAAT

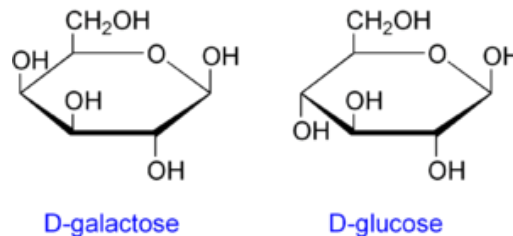
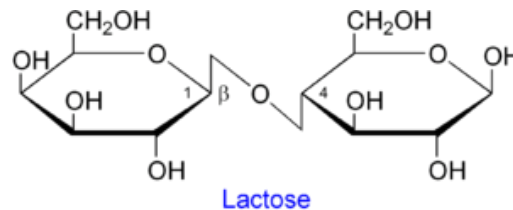
80 95 45 50 60 96



- -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

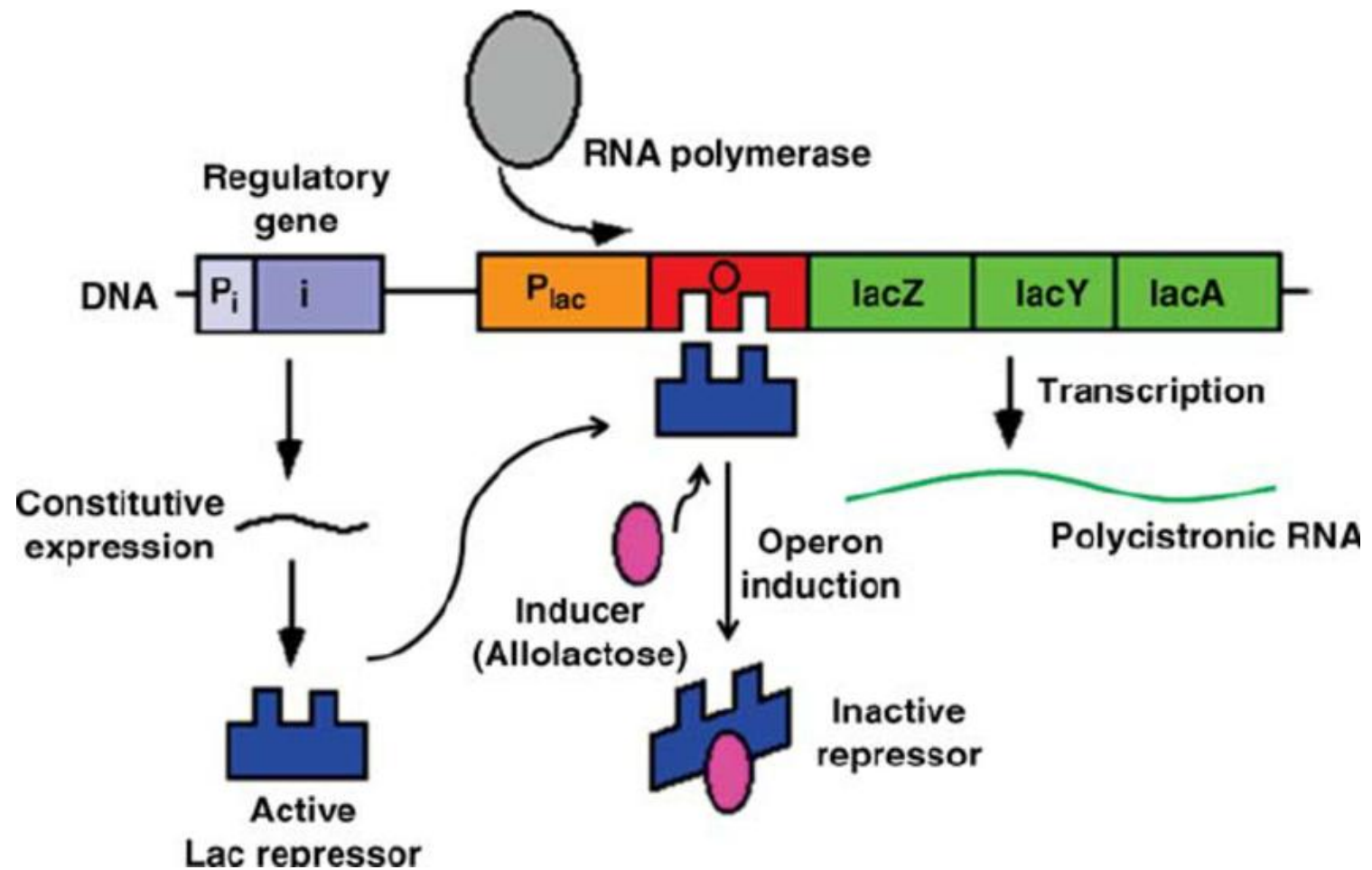
- A cluster of genes under the control of a single promoter is called operon.
- The lac operon (lactose operon) is an operon required for the transport and metabolism of lactose in *Escherichia coli*

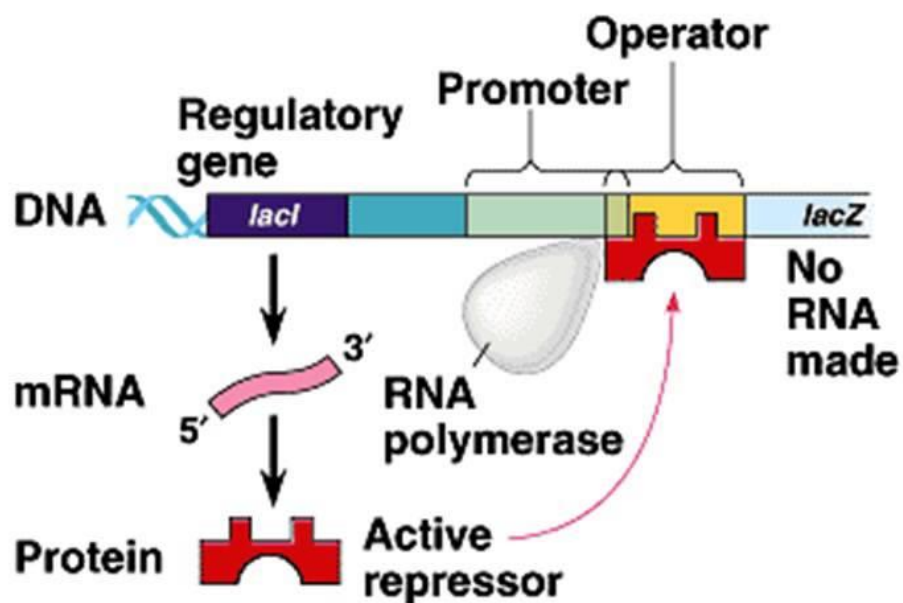


The lac operon consists of three structural genes, and a promoter, a terminator, regulator, and an operator. The three structural genes are: lacZ, lacY, and lacA.

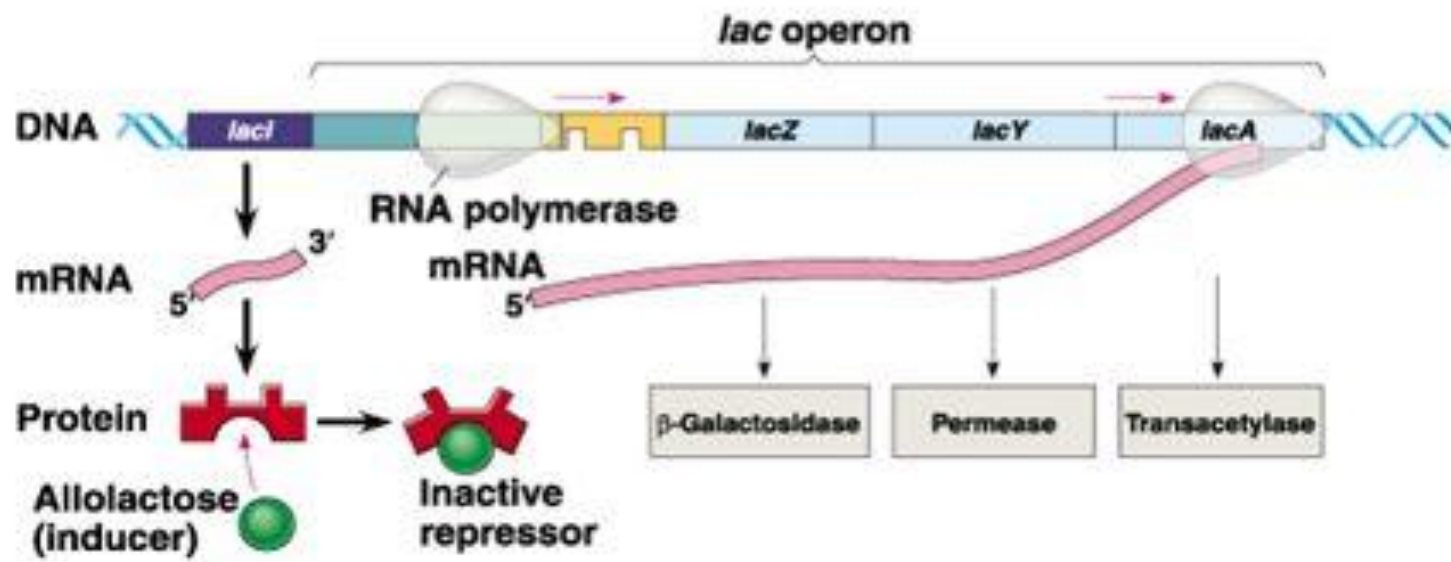
- lacZ encodes β -galactosidase (LacZ), an intracellular enzyme that cleaves the disaccharide lactose into glucose and galactose.
- lacY encodes Beta-galactoside permease (LacY), a transmembrane symporter that pumps β -galactosides including lactose into the cell using a proton gradient in the same direction.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

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



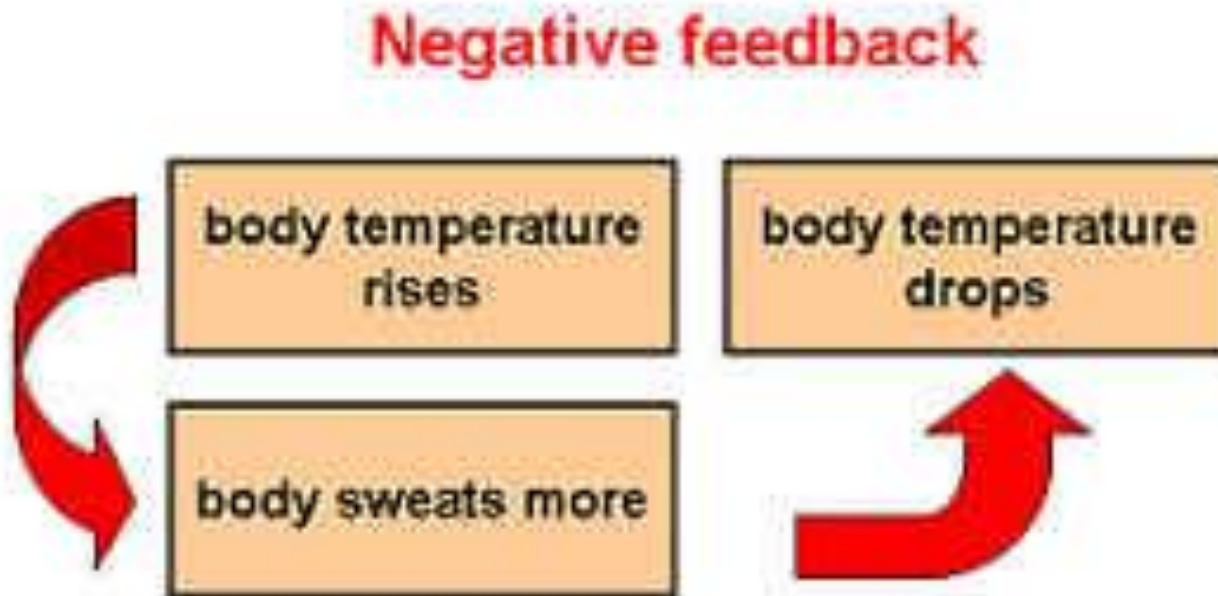


(a) Lactose absent, repressor active, operon off



(b) Lactose present, repressor inactive, operon on

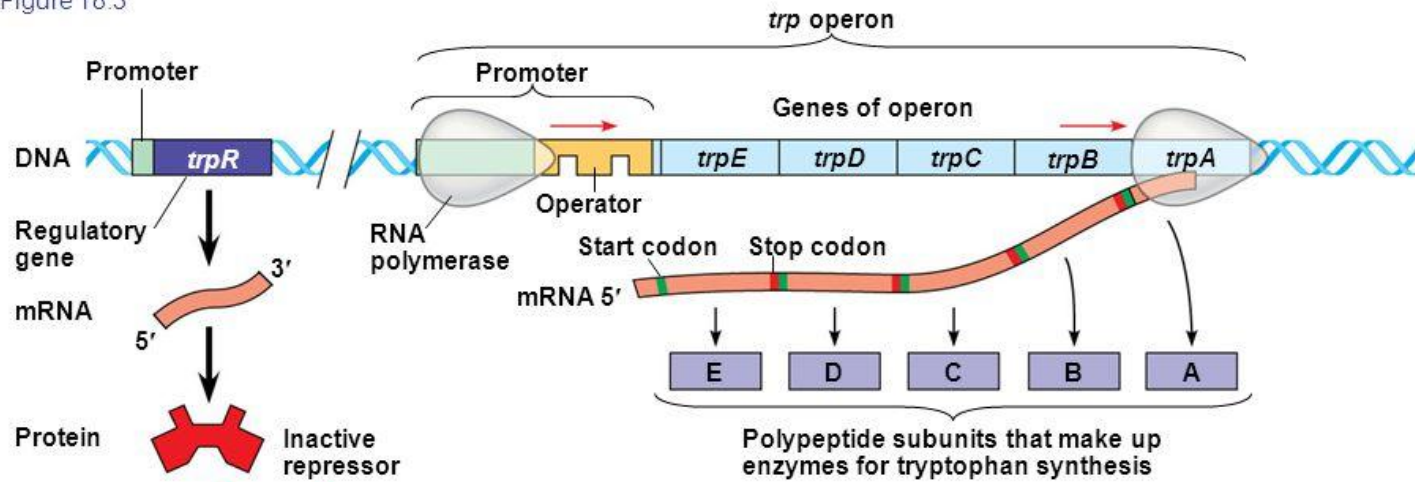
Negative feedback loop



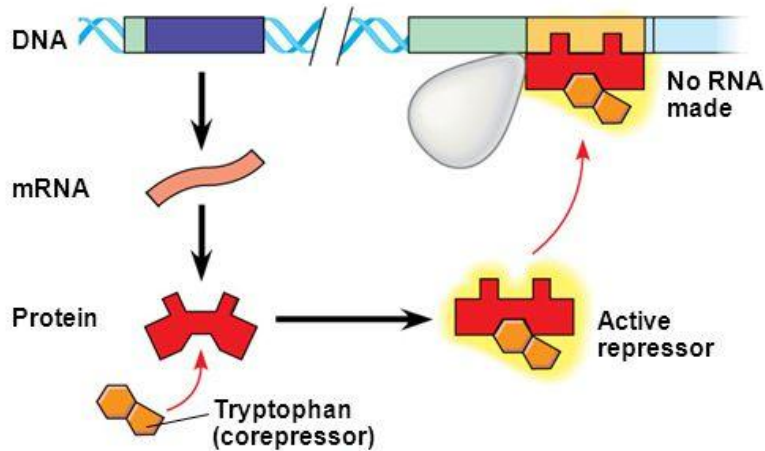
Tryptophan operon

- 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. Thus the operon is regulated through the negative feedback loop mechanism.

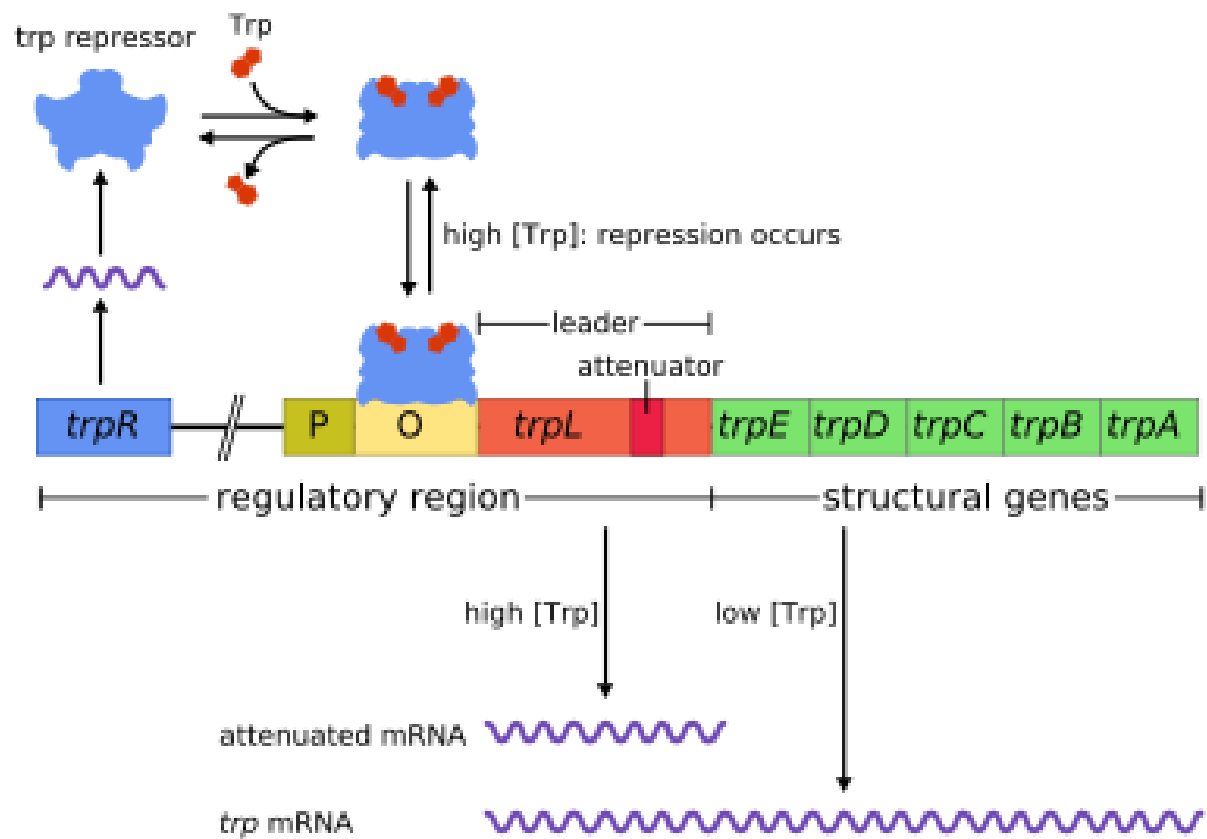
Figure 18.3



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



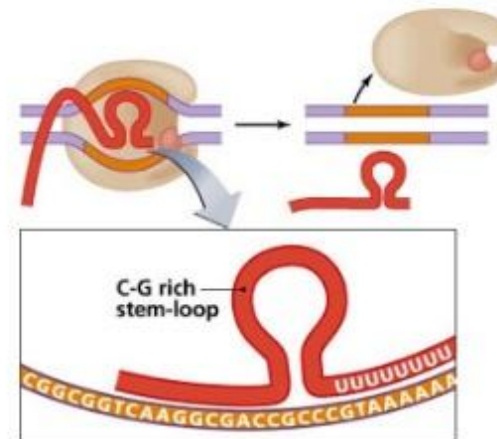
(b) Tryptophan **present**, repressor active, operon off



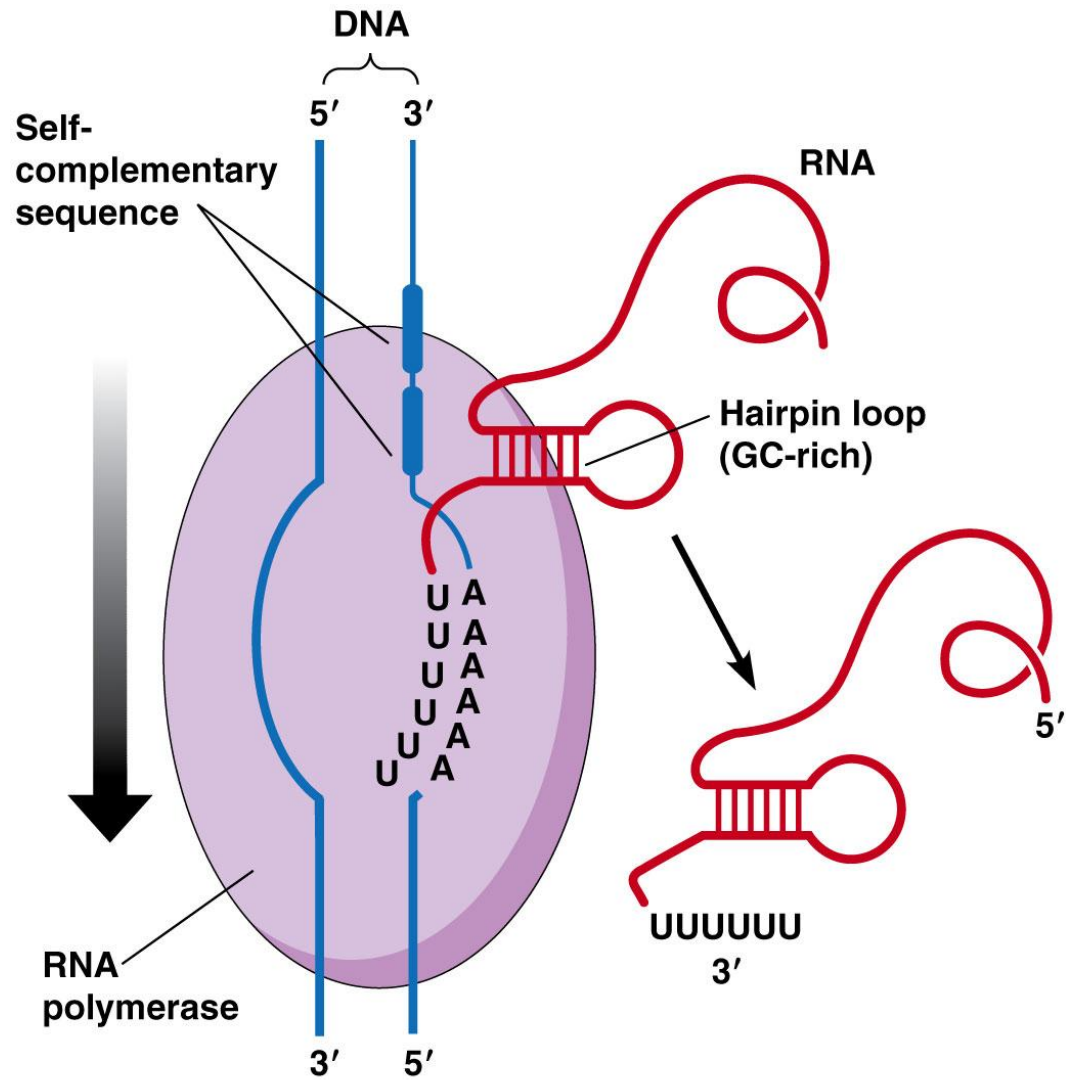
Bacterial transcription termination

Termination (Rho-independent terminator) - type 1 terminator

- RNA moves past the inverted repeats and transcribes the termination sequence.
- Because of the inverted repeat arrangement → RNA synthesized forms a hairpin loop structure.
- Hairpin loop makes the RNA polymerase slow down and eventually stops.



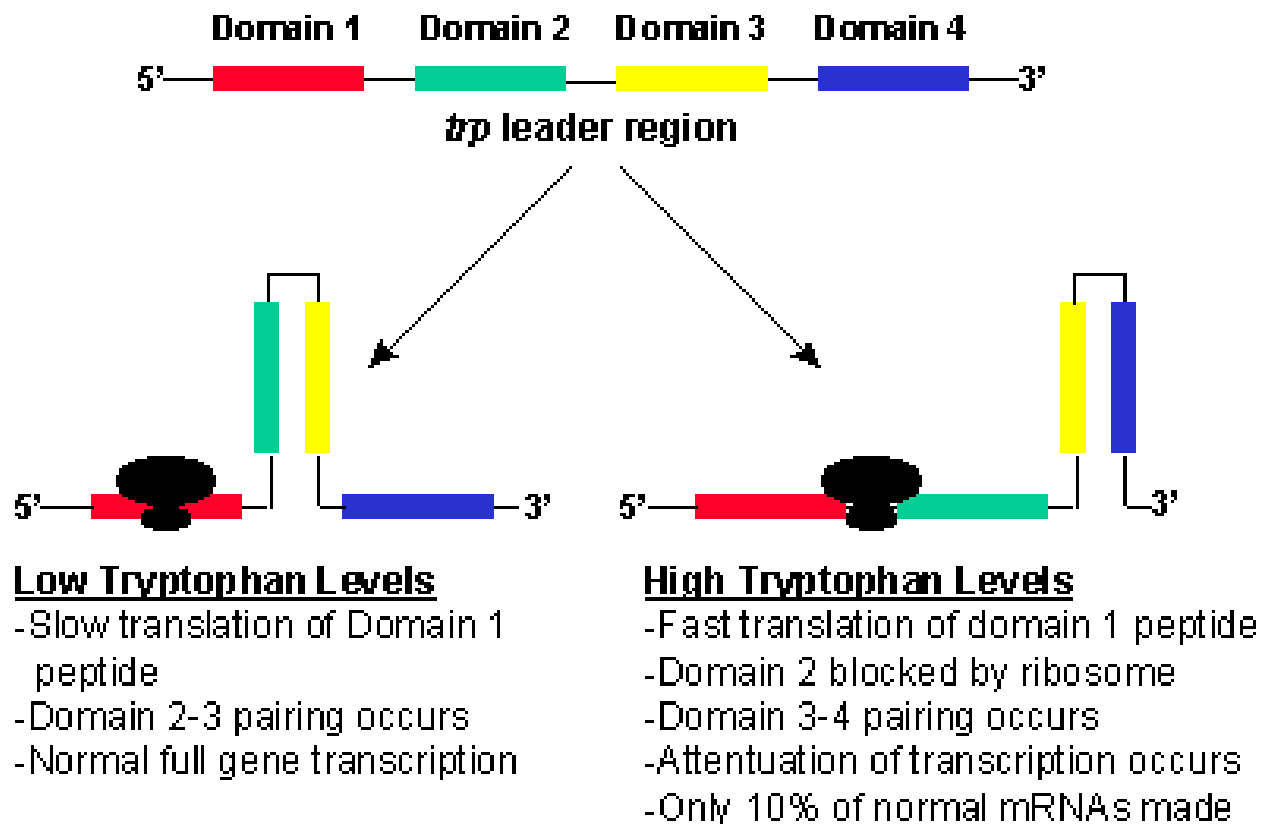
(c) Termination of transcription



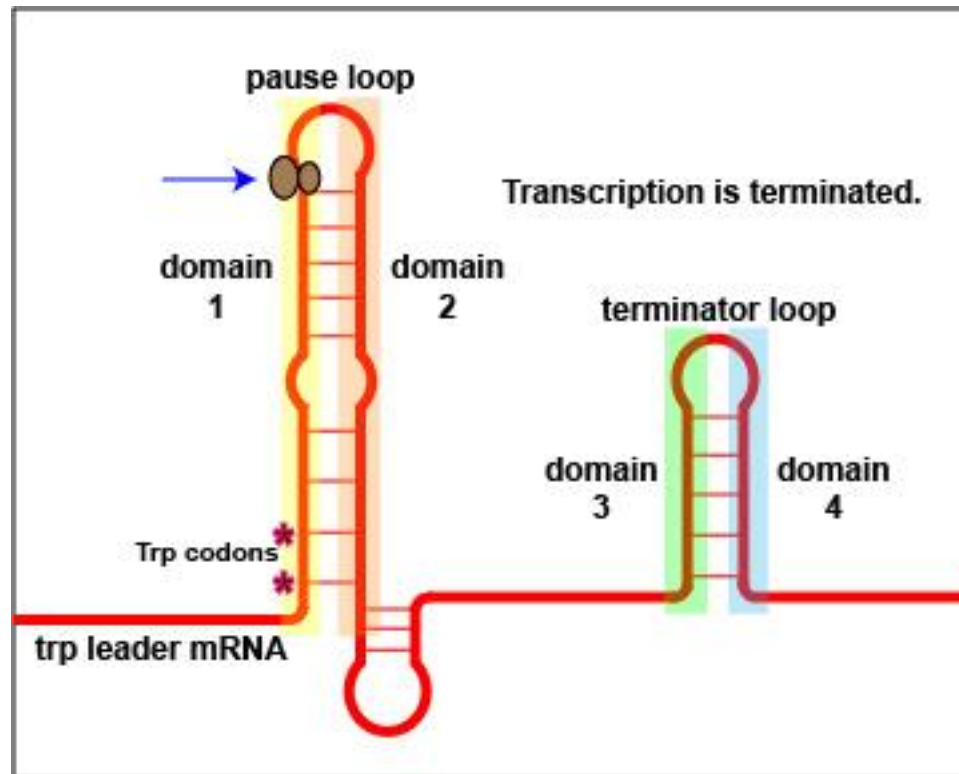
Attenuation of trp operon

- Attenuation is a second mechanism of negative feedback in the trp operon. The repression system targets the intracellular trp concentration whereas the attenuation responds to the concentration of charged tRNA^{trp}
- Attenuation is made possible by the fact that in prokaryotes (which have no nucleus), the ribosomes begin translating the mRNA while RNA polymerase is still transcribing the DNA sequence. This allows the process of translation to affect transcription of the operon directly.

Attenuation of the *trp* operon mRNA



Attenuation, tryptophan present



Attenuation, no tryptophan

