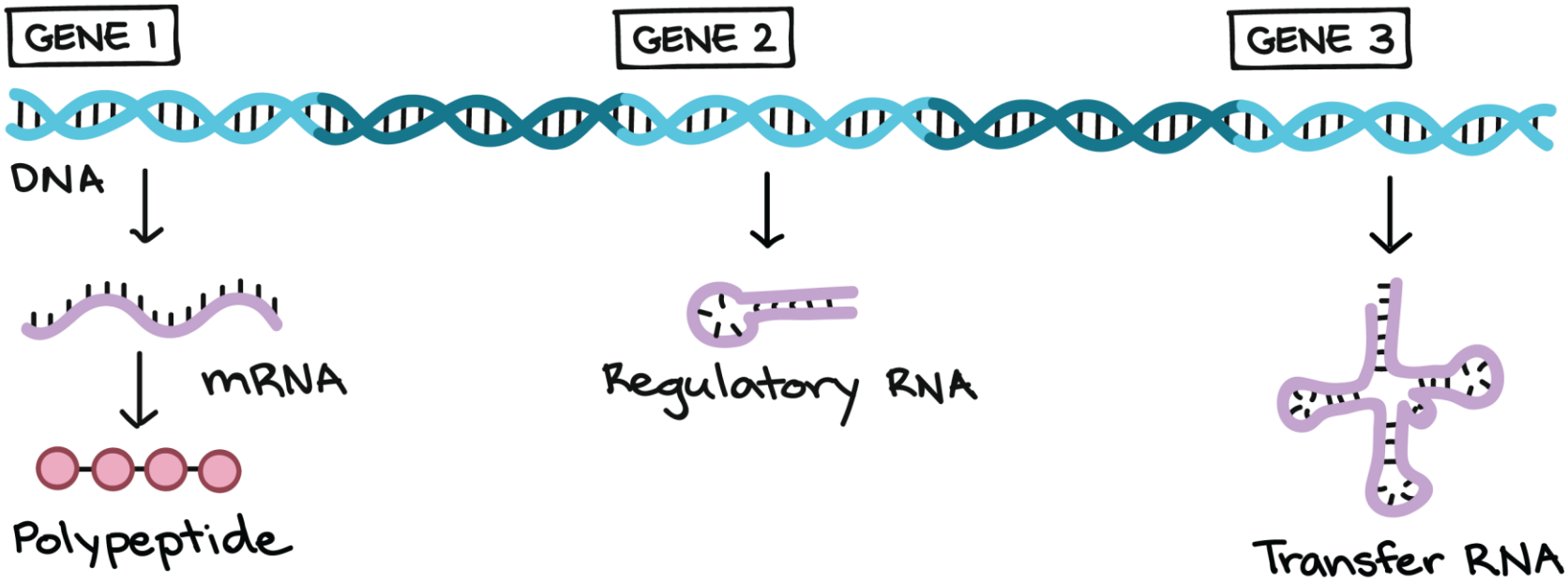
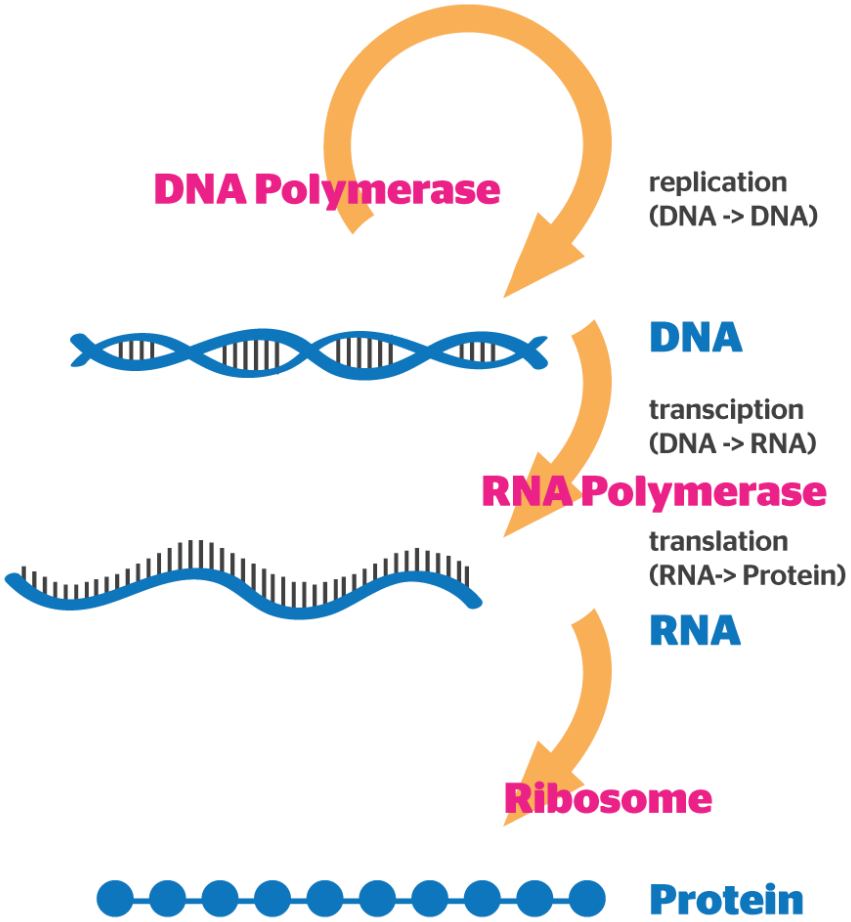
Gene Expression

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

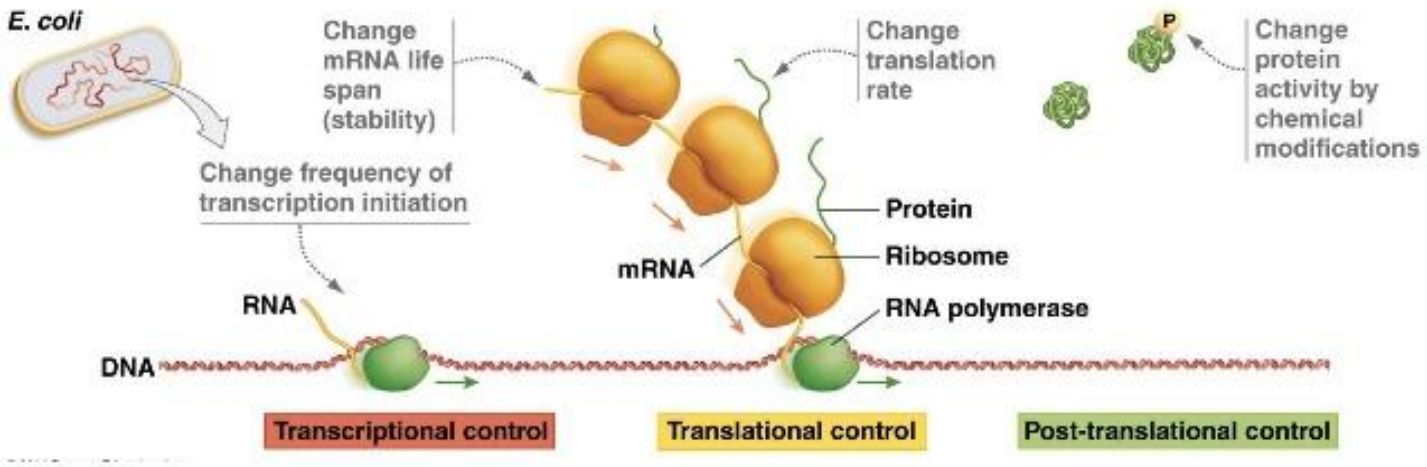
Functional gene products



Central dogma of molecular biology



Regulation of Gene Expression

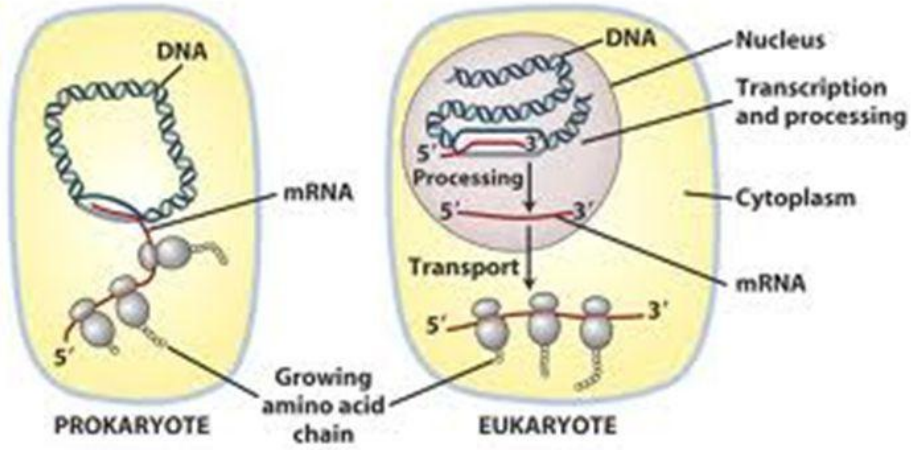


- Gene expression can be regulated:
  - During transcription (transcriptional control).
  - During translation (translational control).
  - After translation (post-translational control).

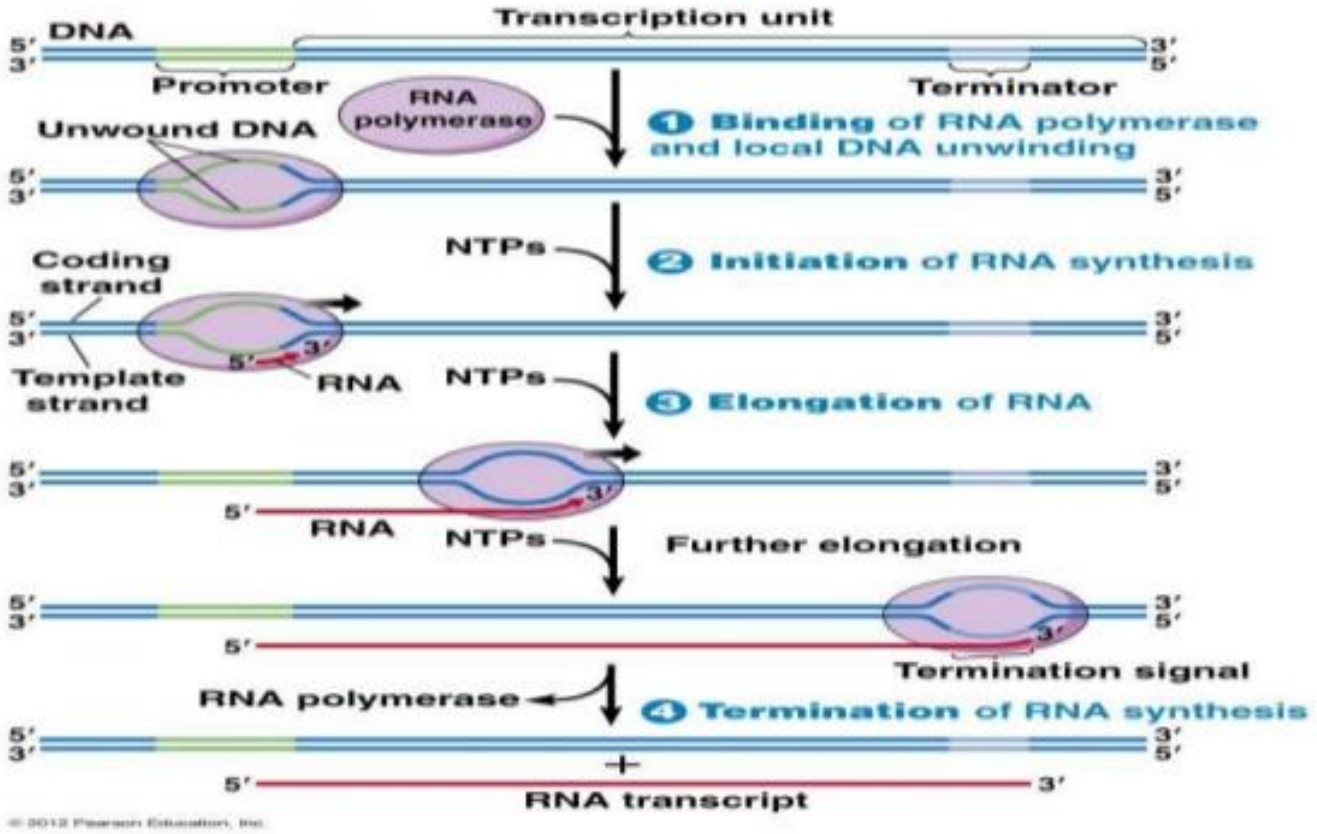
DNA Transcription in prokaryotes

Bacteria vs. Eukaryotes

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

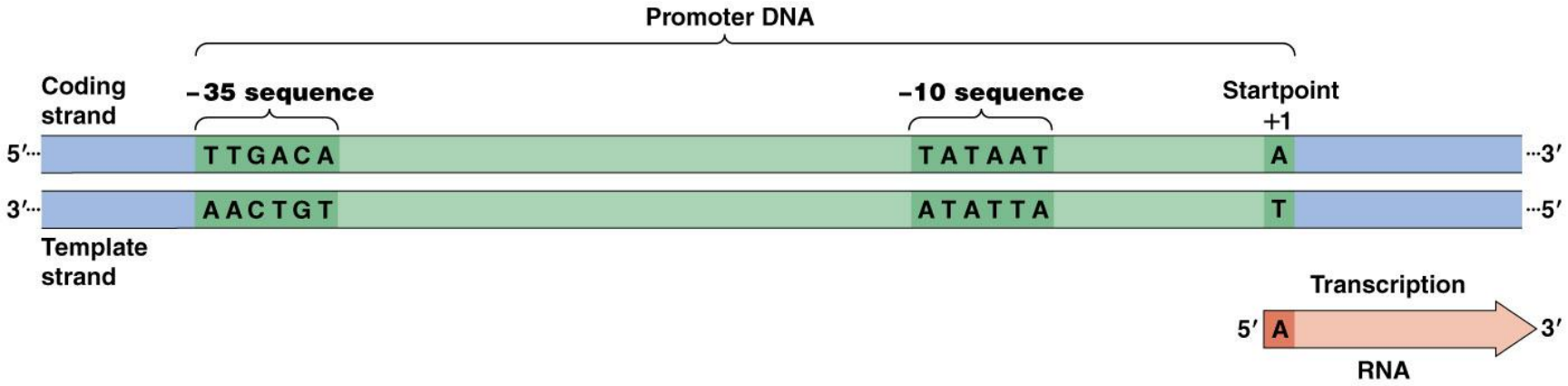


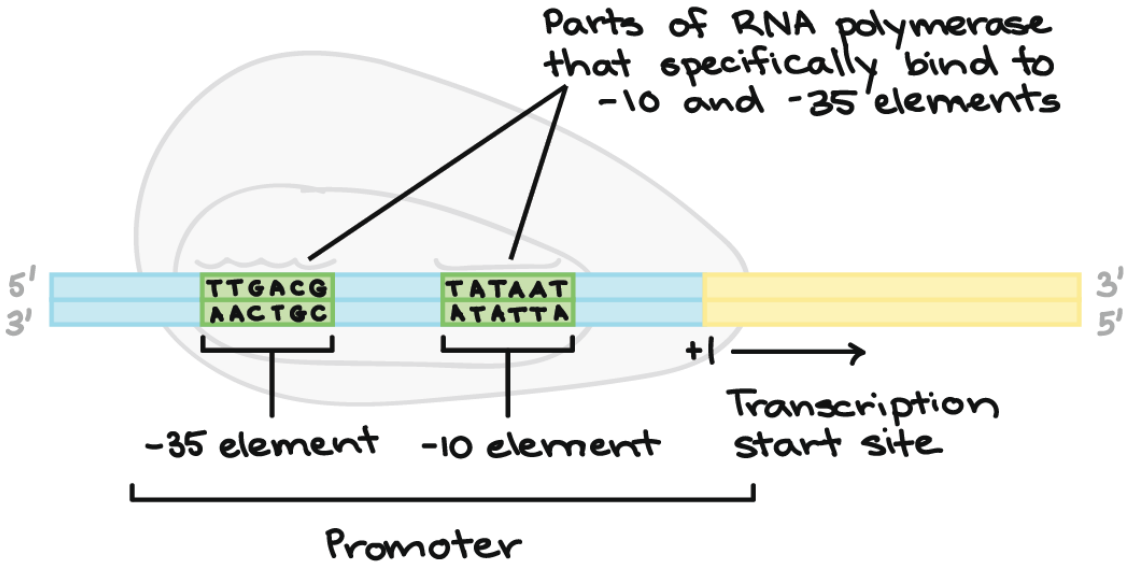
Overview of Prokaryotic DNA Transcription



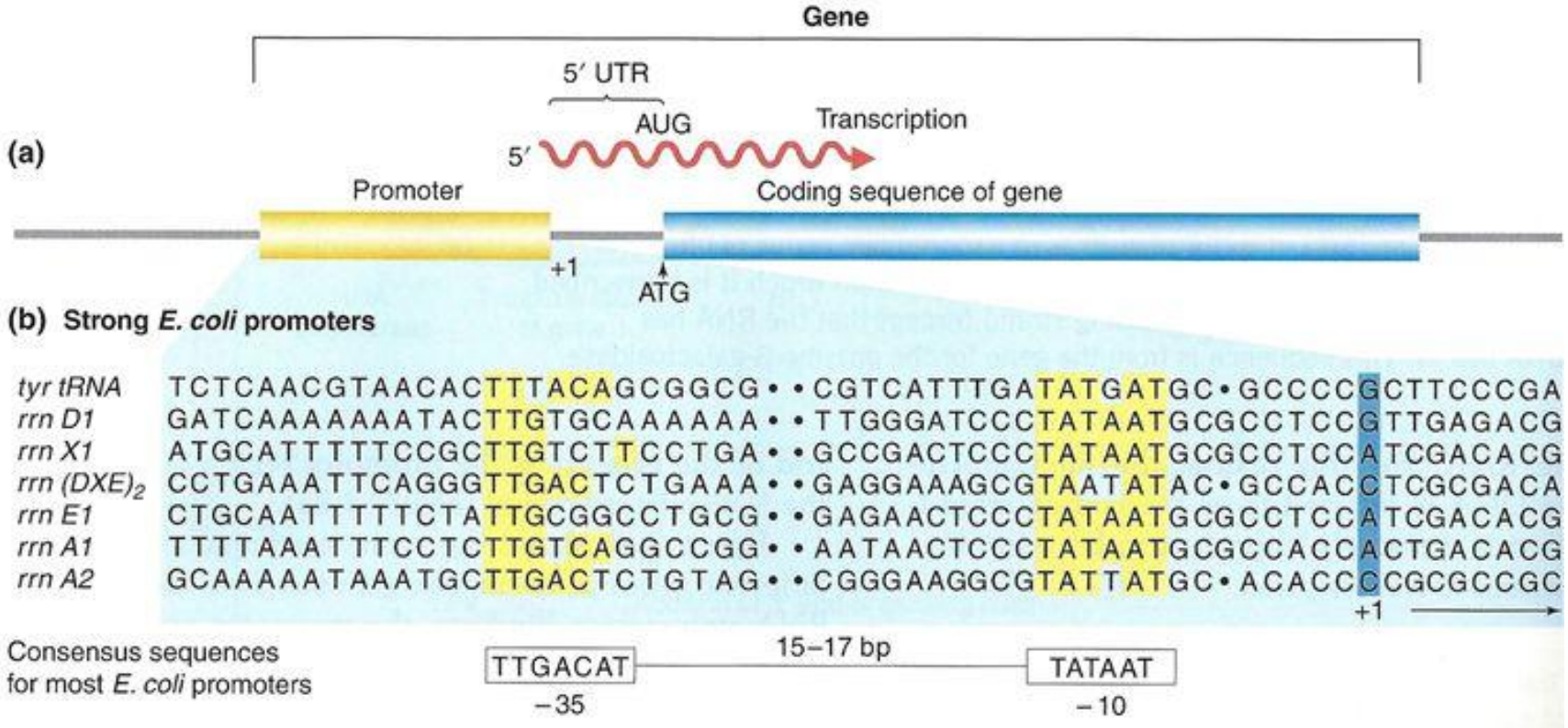
Bacterial promoter

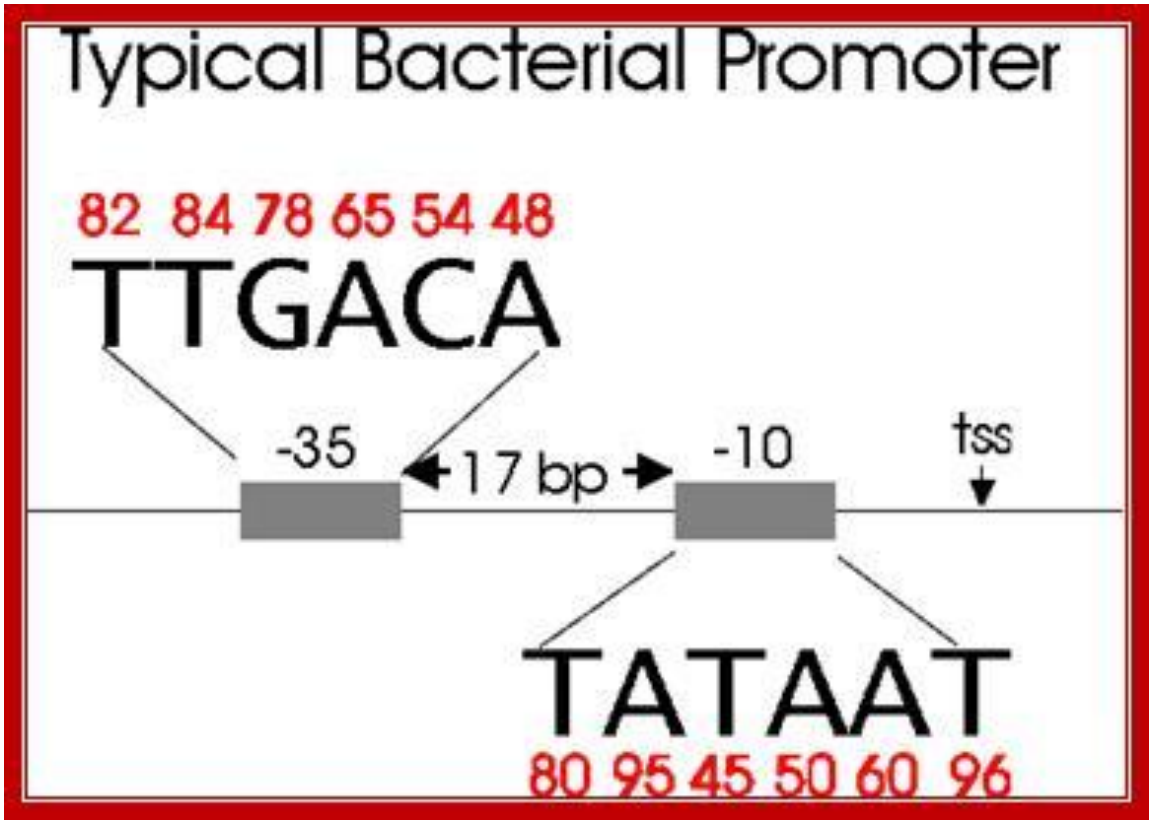
- In genetics, a promoter is a region of DNA that initiates transcription of a particular gene.
- In bacteria, the promoter contains two short sequence elements approximately 10 (Pribnow Box) and 35 nucleotides upstream from the transcription start site.




Parts of RNA polymerase that specifically bind to -10 and -35 elements
5'
3'
TTGACG
AACTGC
TATAAT
ATATTA
3'
5'
+1
Transcription start site
-35 element
-10 element
Promoter

Promoters may differ from the consensus sequence

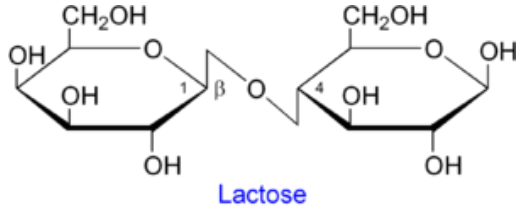



Typical Bacterial Promoter
82 84 78 65 54 48
TTGACA
-35
17 bp
-10
tss
TATAAT
80 95 45 50 60 96

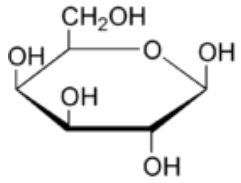
- -35 and -10 sequences determine the rate of a bacterial gene transcription – “strength of the promoter”
- Cell might need some proteins all the time. These proteins are synthesized continuously at the same rate. This is called constitutive gene expression.
- Other proteins could be synthesized in response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

Lactose operon

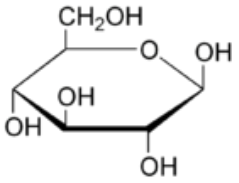
- A cluster of genes under the control of a single promoter is called operon.
- The lac operon (lactose operon) is an operon required for the transport and metabolism of lactose in Escherichia coli



Lactose



D-galactose

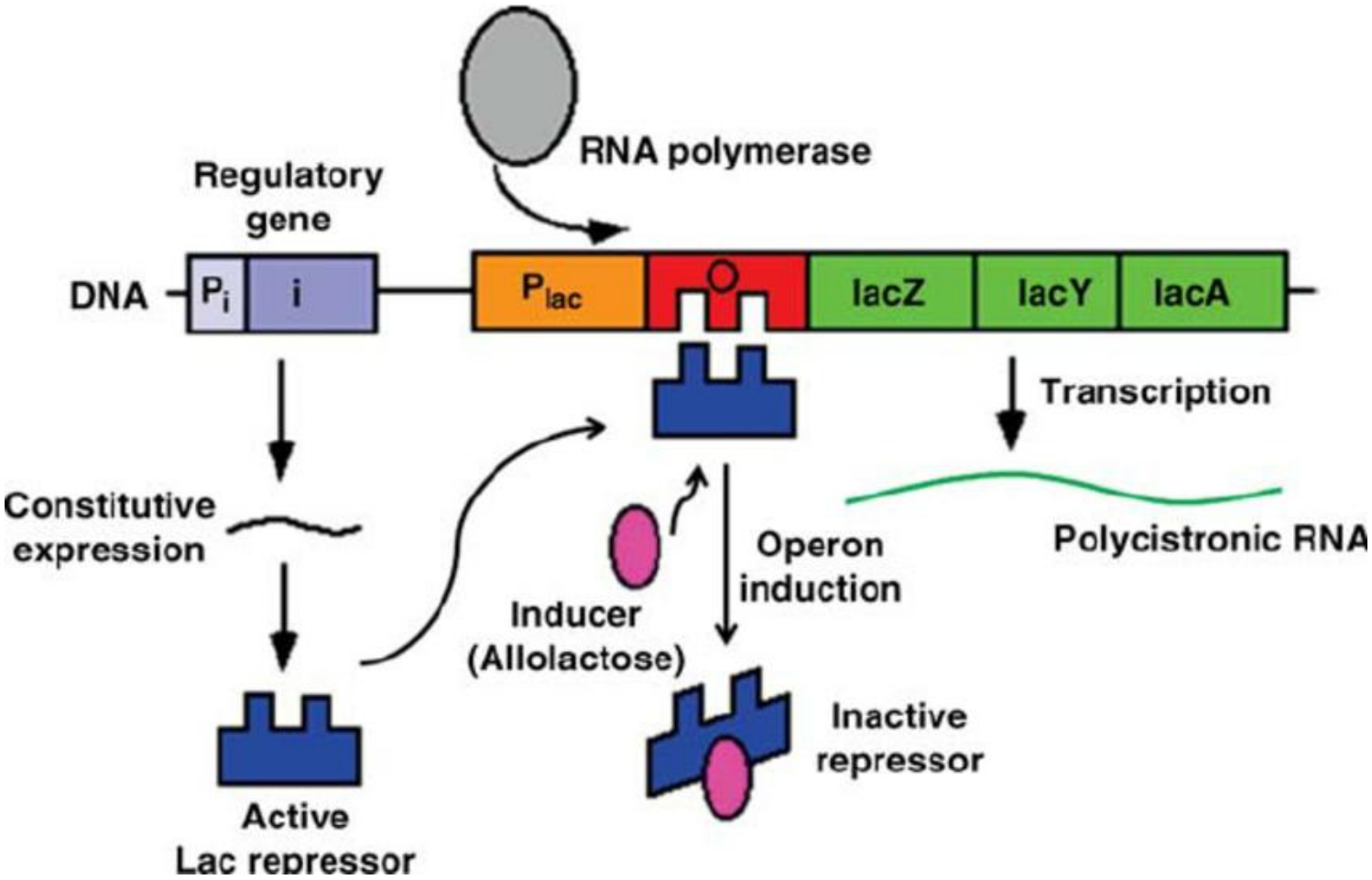


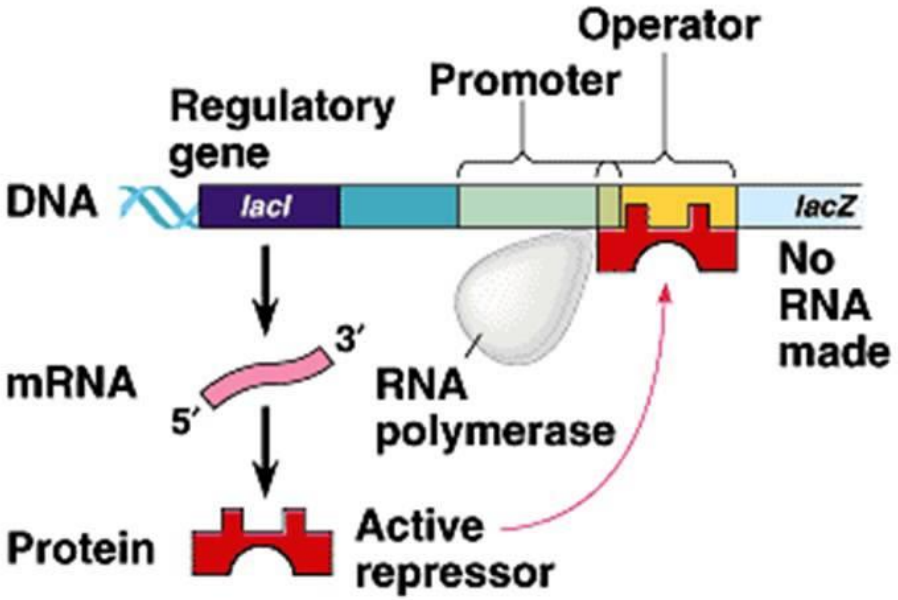
D-glucose

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.

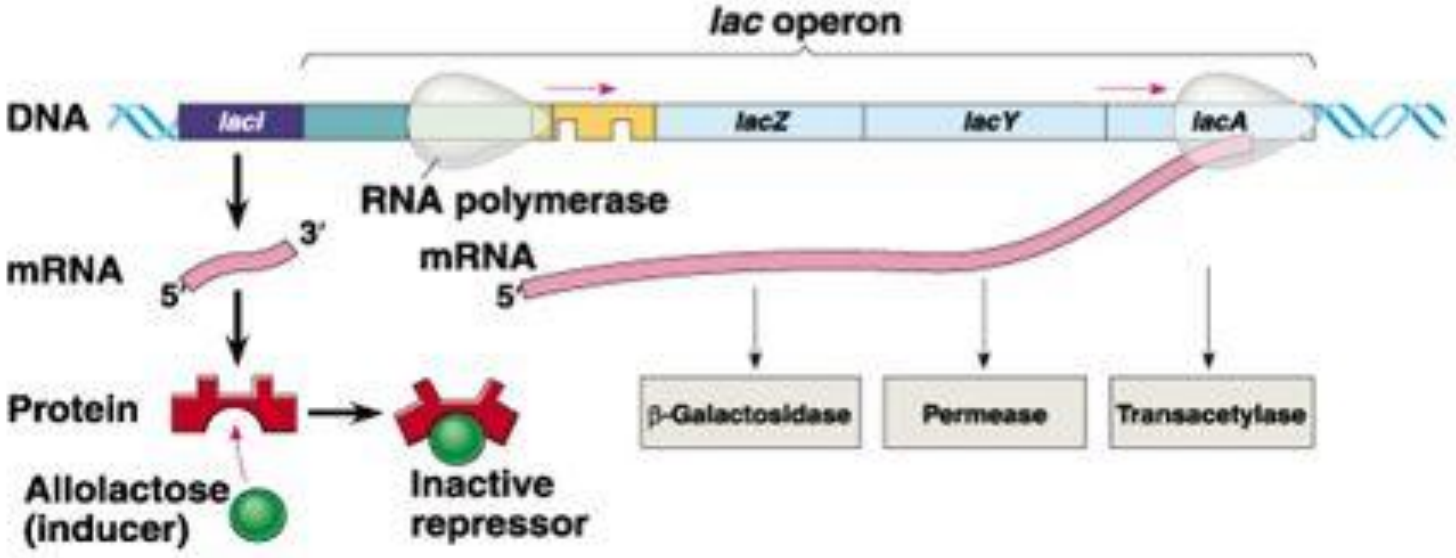
- lacZ encodes β-galactosidase (LacZ), an intracellular enzyme that cleaves the disaccharide lactose into glucose and galactose.
- lacY encodes Beta-galactoside permease (LacY), a transmembrane symporter that pumps β-galactosides including lactose into the cell using a proton gradient in the same direction.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


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



(a) Lactose absent, repressor active, operon off



(b) Lactose present, repressor inactive, operon on