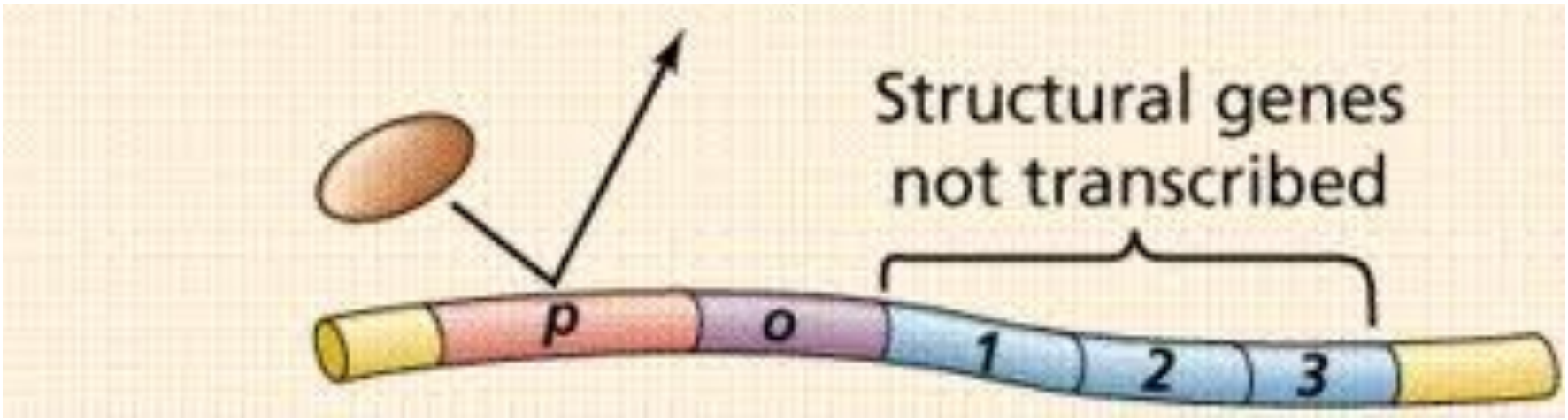
Controlling Gene Expression
Part A: In **Prokaryotes**

Control Mechanisms in Prokaryotes

- not all proteins are needed by all cells at all times, so **gene regulation** is important to an organism's survival

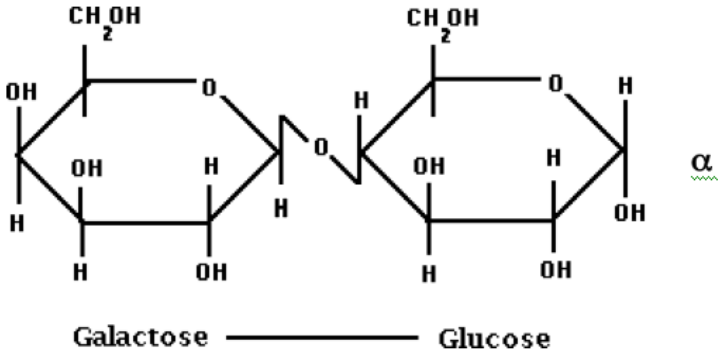
Prokaryotic Cells

- use **operons** to control gene expression
- an operon is:
  - one promoter region
  - an **operator**
  - a cluster of genes that follows



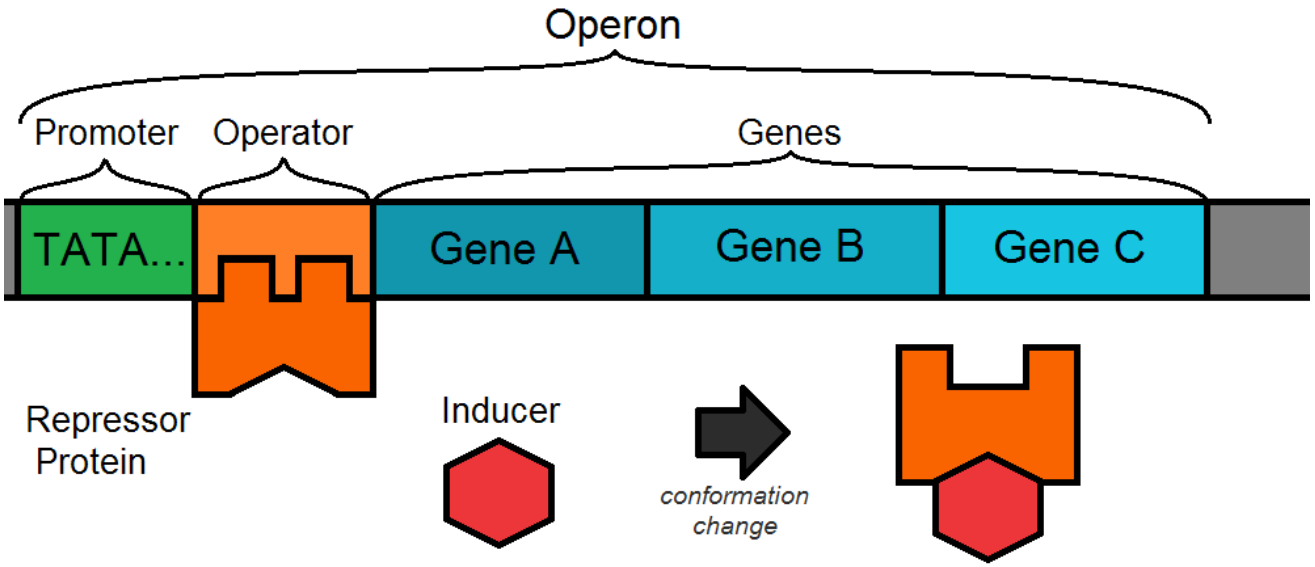
EXAMPLE 1 LAC Operon

- **lactose** is a disaccharide found in milk or milk sugars
- bacteria cells metabolize lactose (into glucose and galactose) to generate energy
- The genes that regulate the metabolism of lactose are only switched on when lactose is present.

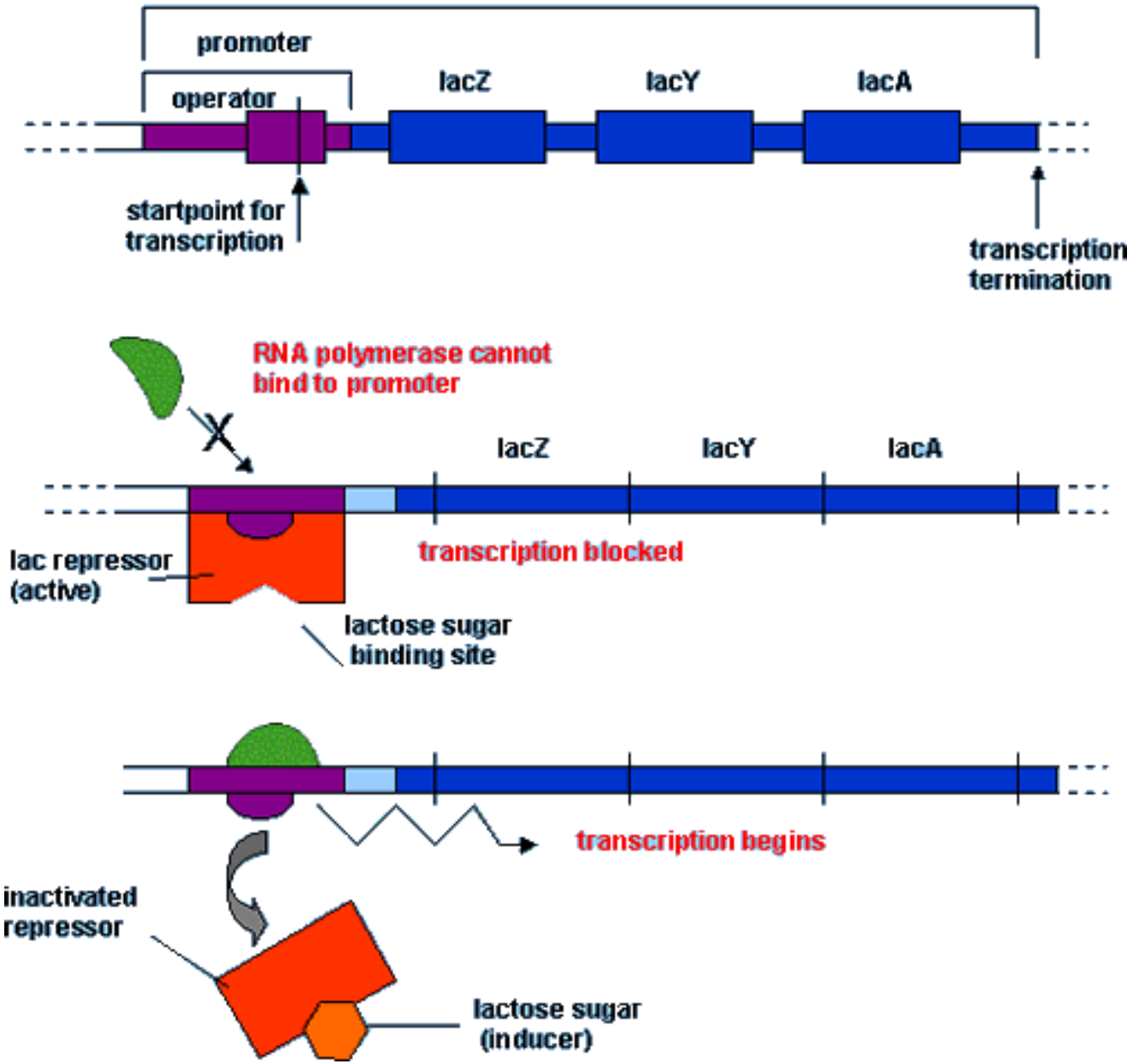


lac operon

- the ***lac* operon** contains:
  - a promoter
  - an operator
  - 3 genes
  - a **repressor protein**
- lactose is the signal molecule, in this case it is an **inducer**



lac operon


promoter
operator
lacZ
lacY
lacA
startpoint for transcription
transcription termination
RNA polymerase cannot bind to promoter
lacZ
lacY
lacA
lac repressor (active)
transcription blocked
lactose sugar binding site
transcription begins
inactivated repressor
lactose sugar (inducer)

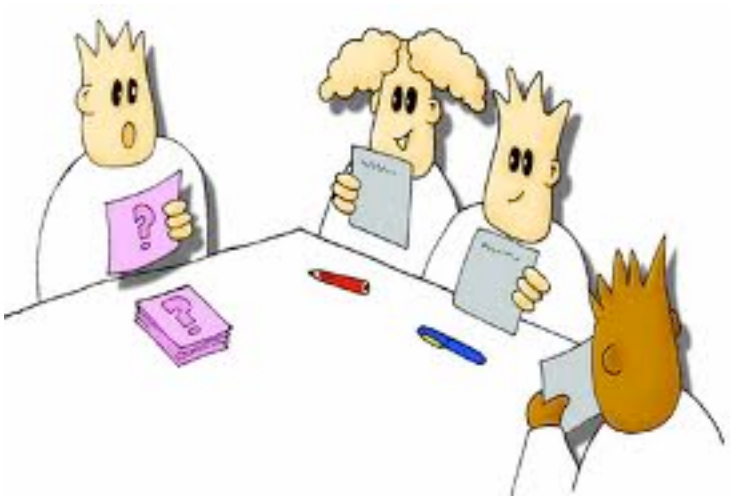
lac operon animation

Produced by Sumanas, Inc. for

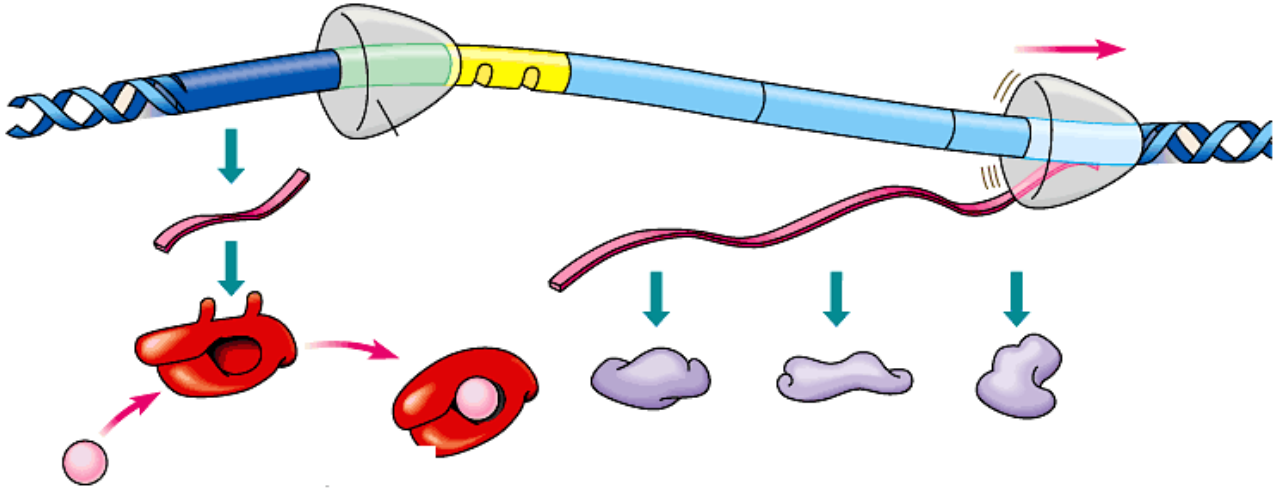
Life: The Science of Biology, Tenth Edition

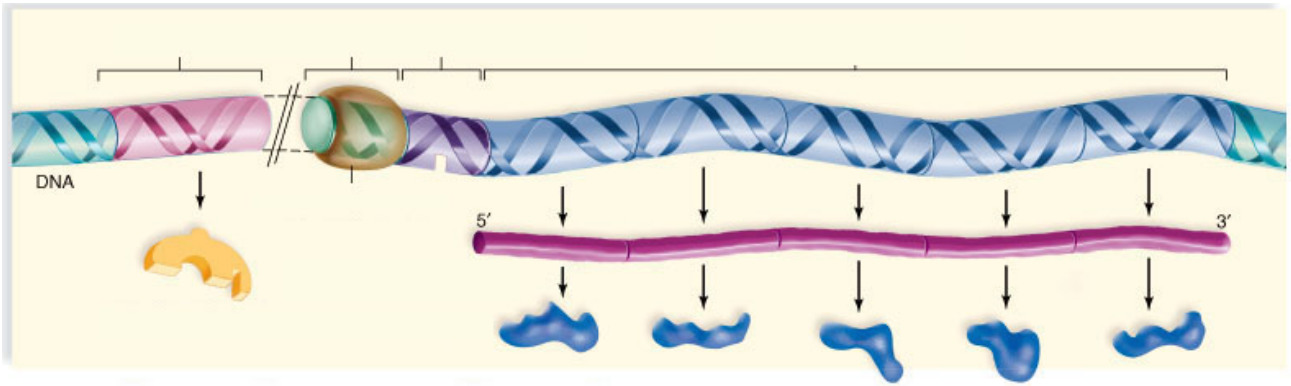
trp operon animation

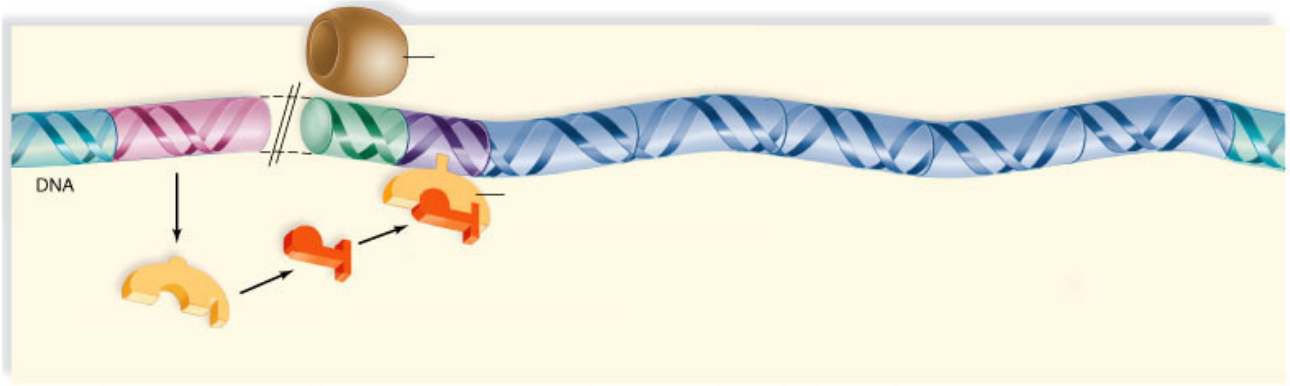
- Narrated animation:
- https://highered.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120080/bio26.swf::The%20Tryptophan%20Repressor



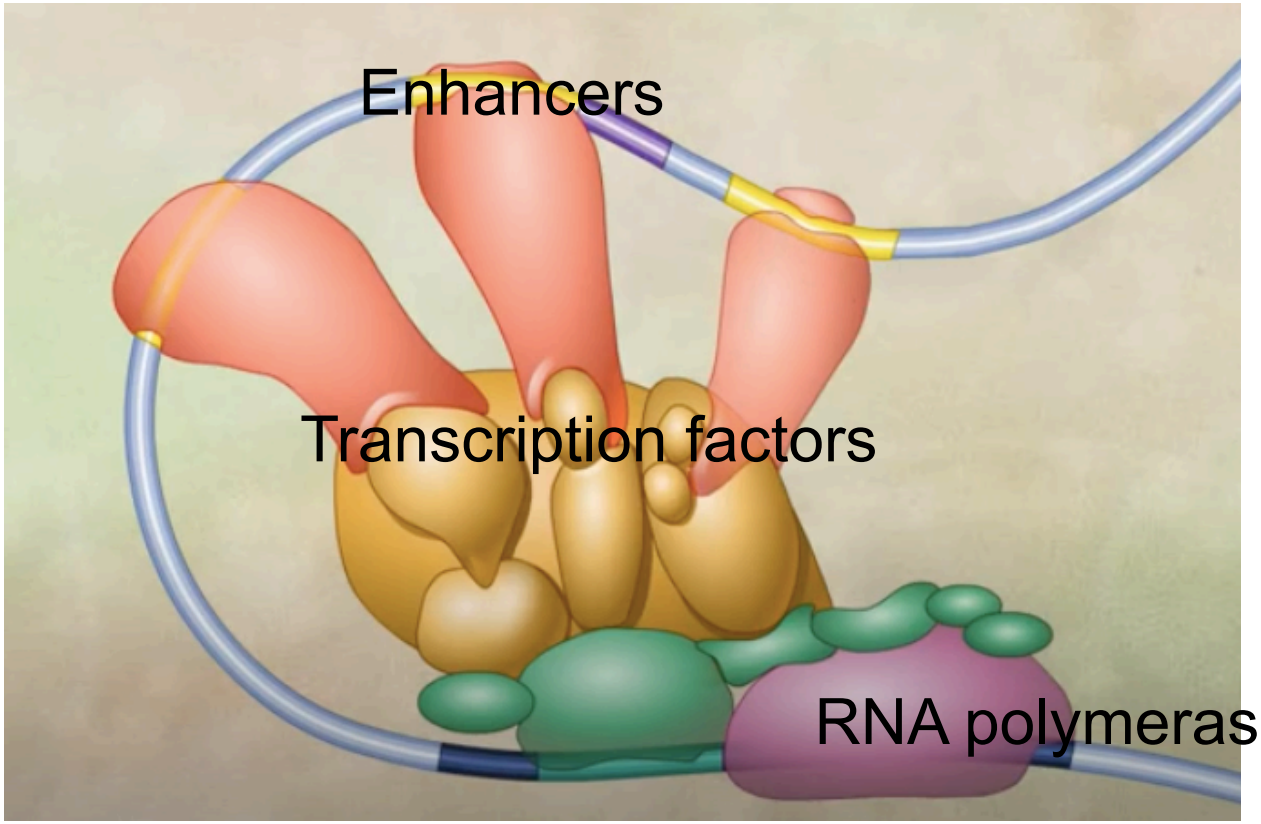
Create a VENN diagram comparing the *lac* and *trp* operon.




DNA
5′
3′

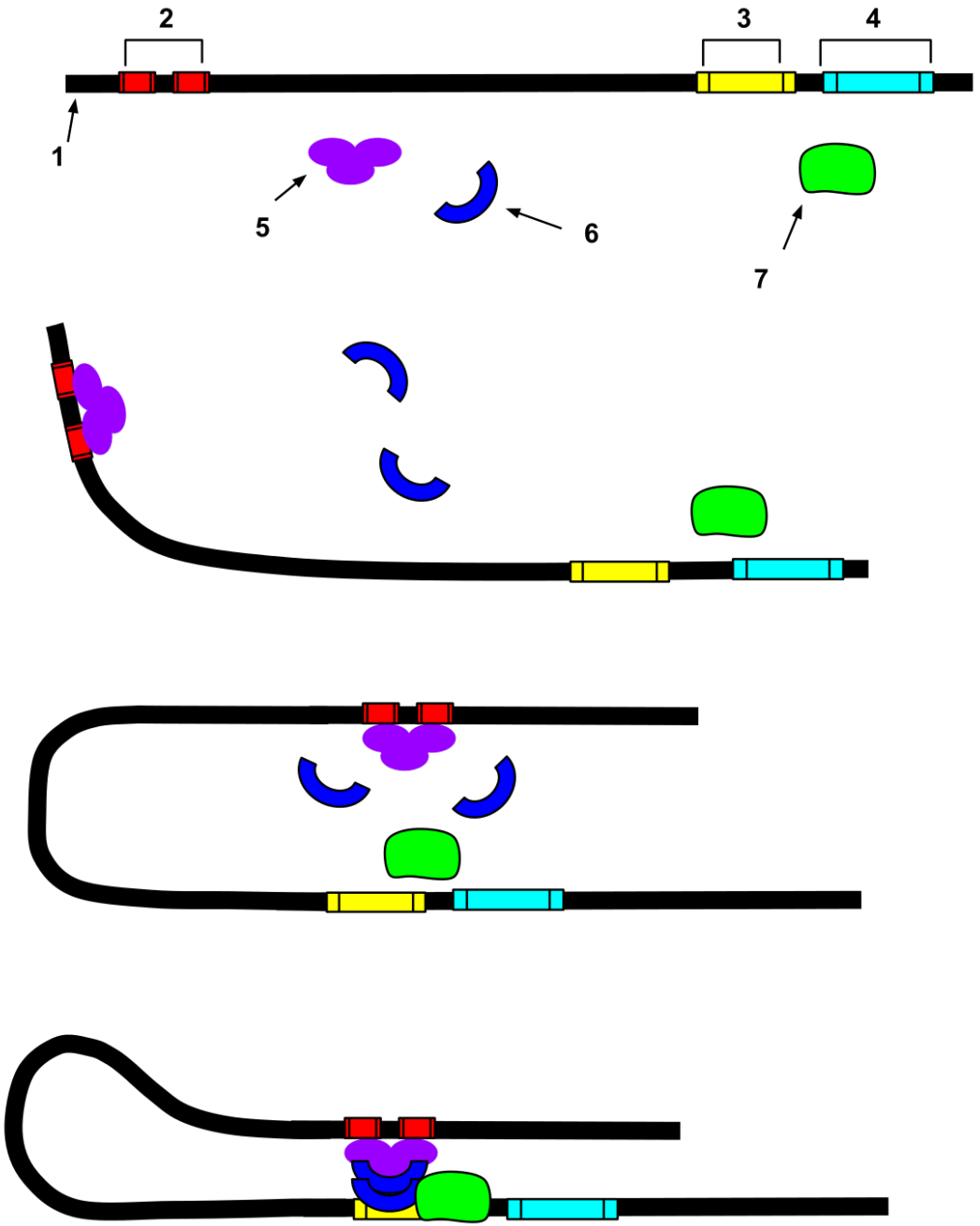

DNA

Controlling Gene Expression Part B: in Eukaryotes



1. DNA
2. Enhancer
3. Promoter
4. Gene
5. Transcription factors
6. Transcription factors
7. RNA Polymerase

Enhancers - regions upstream of of the operator the increase gene expression

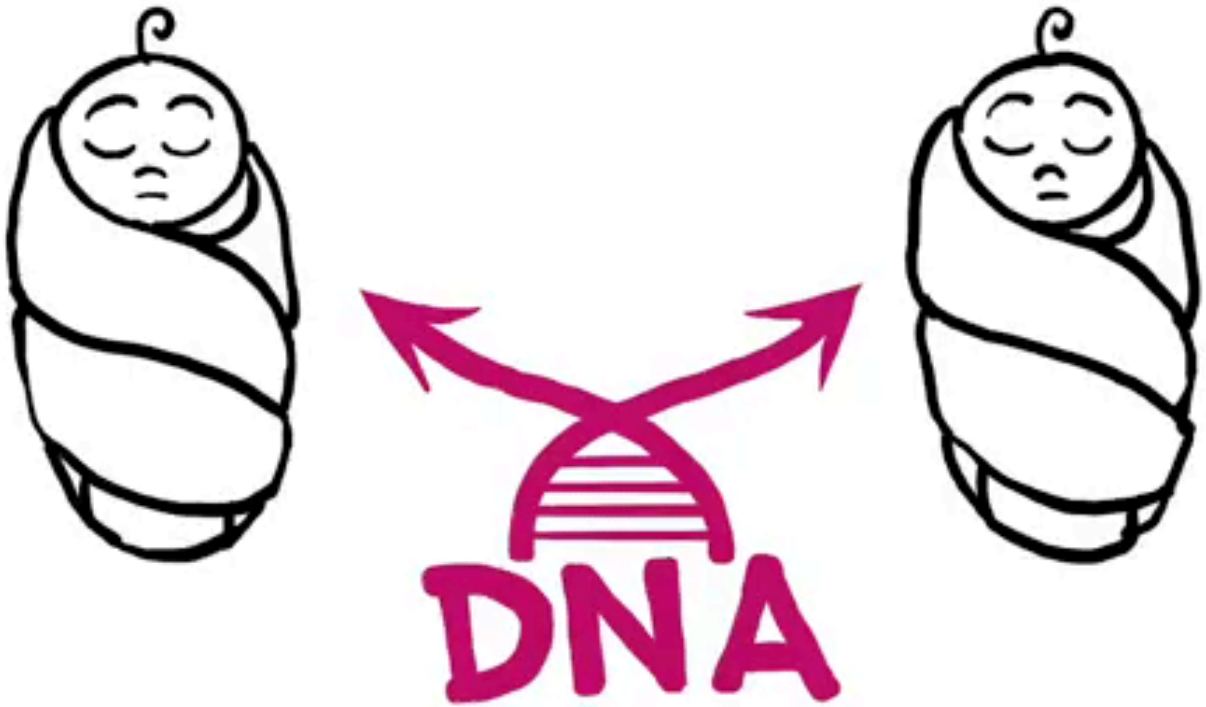


Transcription factors

» Start and stop the binding of RNA polymerase to start gene expression

» These factors are regulated by enhancers and enhancer regions which turn on and off transcription.

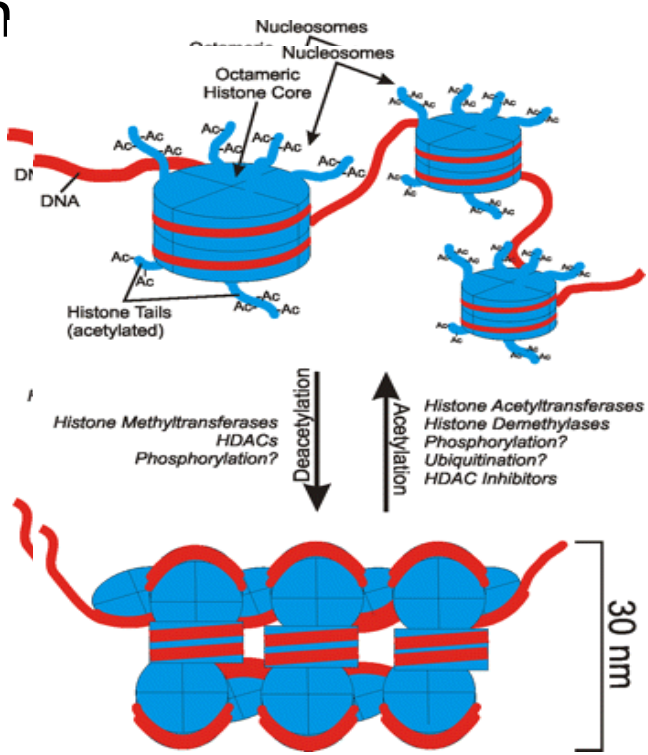
Controlling Gene Expression
Part B: in Eukaryotes


DNA

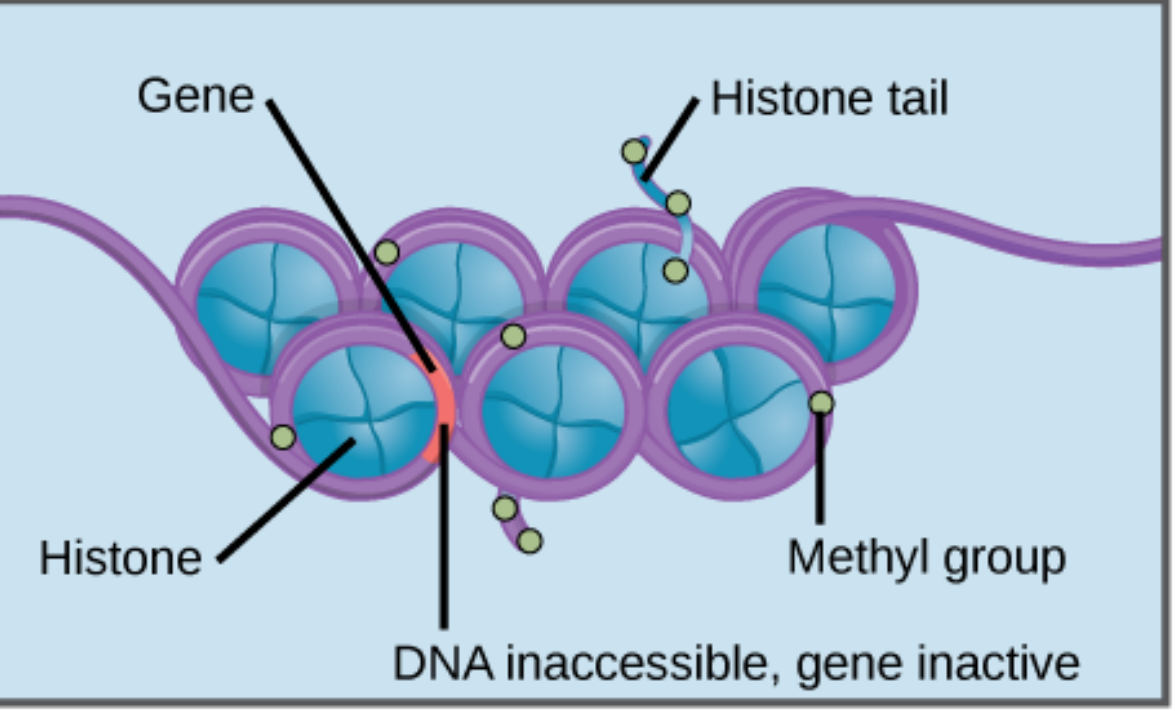

UF-1
REITER
FOSSUM
NOWAK
WILSON
SELLERS
WALZ
BURBANK
GILBERTSON

Transcriptional Regulation

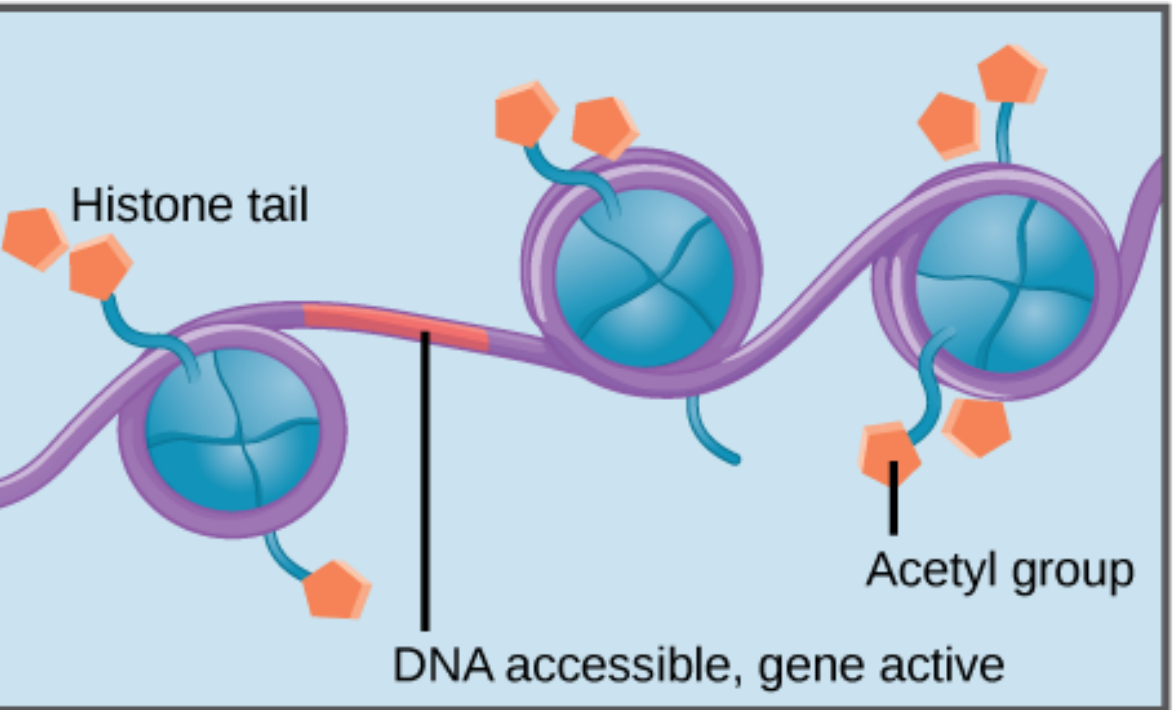
- dissociating DNA and histones to allow access to promoter by transcription factors
  - Activator molecules/regulatory region remodeling histones
  - addition of acetyl groups (exposes promoter sites)



- methylation - methyl groups binding to cytosine on DNA to reduce gene exposure



Methylation of DNA and histones causes nucleosomes to pack tightly together. Transcription factors cannot bind the DNA, and genes are not expressed.



Histone acetylation results in loose packing of nucleosomes. Transcription factors can bind the DNA and genes are expressed.

Agouti Mice

These Agouti Mice are twins that have different rates of methylation and acetylation acquired through diet which regulated the expression of their genes.

Homework

» Read on ‘Impact of Environment of gene expression’, ‘ Patterns of methylation’ , and read sections on nucleosomes and the regulation of transcription

» DBQ on page 356 and page 358