Week 14

BIO-1305 - Biology 1 – Campbell Textbook

Hello and welcome to the weekly resources for BIO-1305 - Biology 1 – Campbell Textbook!

This week is Week 14 of class, and typically in this week of the semester, your professors are covering the topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

We also invite you to **look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester**.

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel, or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours (M-Th 9am-8pm on class days at 254-710-4135).

Keywords: Operons, Gene Regulation, Differential Gene Expression, Cancer

Topic of the Week: Operons

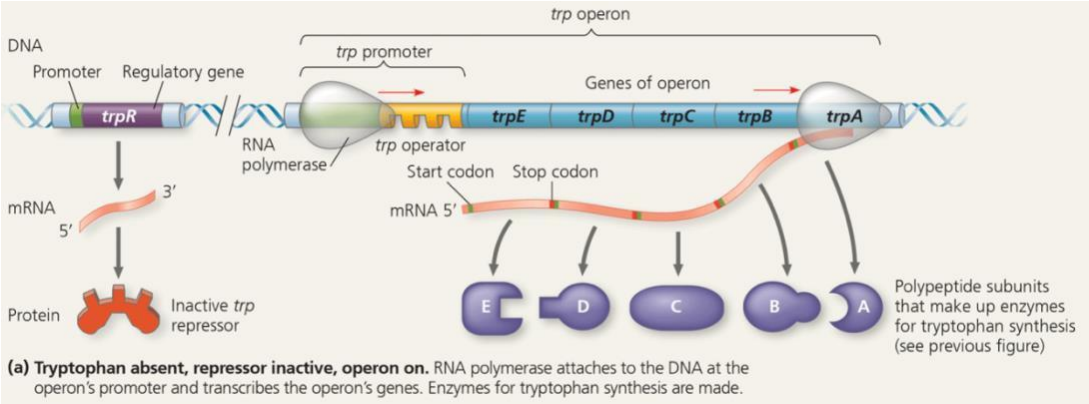
Operon: A *unit of genetic function* found in **bacteria and phages**, consisting of a promoter, an operator, and a regulated section of genes

Operons are found mainly in *prokaryotes*! The genes grouped together are grouped based on their **functions**! This is convenient because a single switch can turn the genes on or off depending on what is needed for the cell at the time.

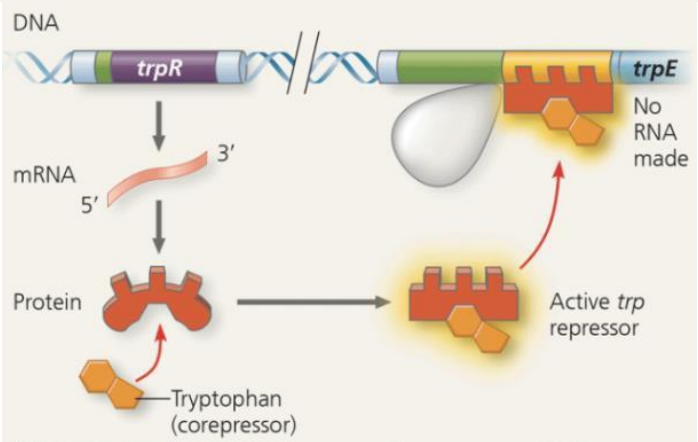
Terms related to operons

- **Operator:** sequence of nucleotides at the beginning of the operon where the repressor can attach. The repressor prevents the binding of RNA polymerase from attaching to the promoter and continuing transcription
- **Repressor:** protein that inhibits gene transcription. They bind to DNA near the promoter
- **Regulatory gene:** encodes for the repressor protein
- **Corepressor:** small molecule that binds to a repressor and changes its shape allowing it to bind to the operator

Below are photos of **the trp (tryptophan) operon**, a commonly studied operon in bacteria that shows the basic functions of many components of operons



(a) Tryptophan absent, repressor inactive, operon on. RNA polymerase attaches to the DNA at the operon's promoter and transcribes the operon's genes. Enzymes for tryptophan synthesis are made.



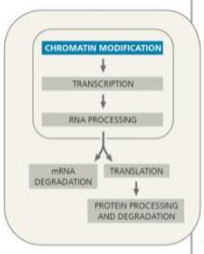
(b) Tryptophan present, repressor active, operon off. As tryptophan accumulates, it inhibits its own production by activating the repressor protein, which binds to the operator, blocking transcription. Enzymes for tryptophan synthesis are not made.

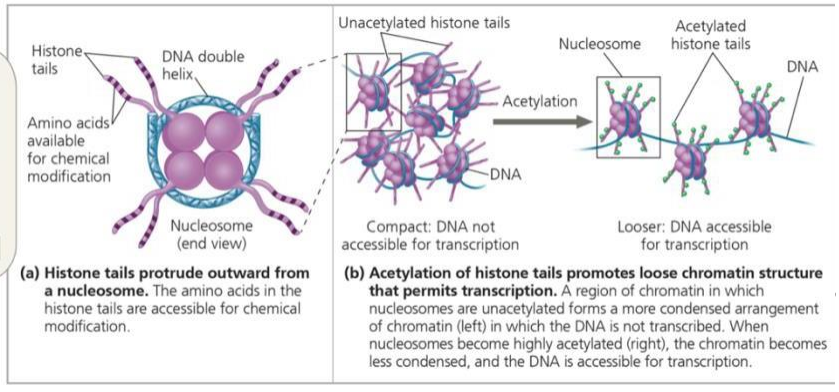
HIGHLIGHT #1: Regulation of Chromatin Structure

Remember that DNA is packed with proteins into **chromatin**! The structure of chromatin helps to *regulate gene expression*.

Chemical modifications of histones play a role in gene regulation

- **Histone acetylation**: addition of an acetyl group to amino acids of histone tails
  This *promotes* transcription by opening the chromatin up
- **DNA methylation:** addition of methyl groups on the DNA bases (usually cytosine)
  Can *promote* or *inhibit* transcription





(a) Histone tails protrude outward from a nucleosome. The amino acids in the histone tails are accessible for chemical modification.

(b) Acetylation of histone tails promotes loose chromatin structure that permits transcription. A region of chromatin in which nucleosomes are unacetylated forms a more condensed arrangement of chromatin (left) in which the DNA is not transcribed. When nucleosomes become highly acetylated (right), the chromatin becomes less condensed, and the DNA is accessible for transcription.

HIGHLIGHT #2: Differential Gene Expression

There are many different things that contribute to the different cell types that we have in our bodies. Here are a few terms to be familiar with:

Differentiation: process by which a cell or group of cells becomes specialized in structure and function

Cytoplasmic determinants: maternal substance like protein or RNA that influences early development by regulating gene expression that affect development of cells

Induction: the process through which a group of cells influences the development of another group of cells

Determination: the point at which an embryonic cell is committed to becoming a specific cell type

Pattern formation: development of an organism's spatial arrangement of organs and tissues

Overall, the story here is that cells in embryos are *committed* to becoming certain types of cells in the future that are specialized for specific functions. The cells all have the same genome, but have different functions based on the differences between what genes are expressed. **Cytoplasmic determinants** in an egg are evenly distributed daughter cells in order to regulate expression of these genes to make sure the cells stay on the path towards their fate. The cells **differentiate** into different tissues.

HIGHLIGHT #3: Cancer

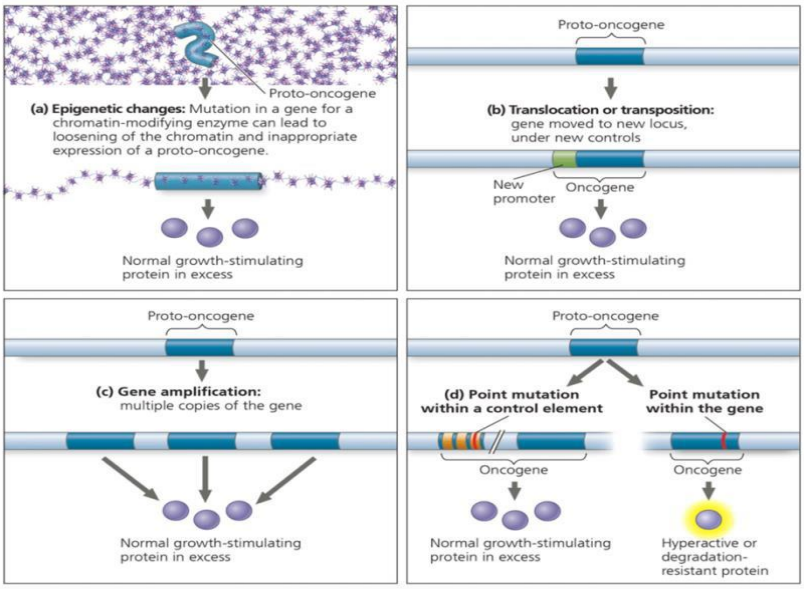
We have discussed how cells divide and we have touched on what happens when mistakes mare made when DNA is replicated. Let's look at a few more terms that are important to know regarding genes that are associated with cancer.

Oncogenes: gene involved in triggering molecular events that can lead to cancer

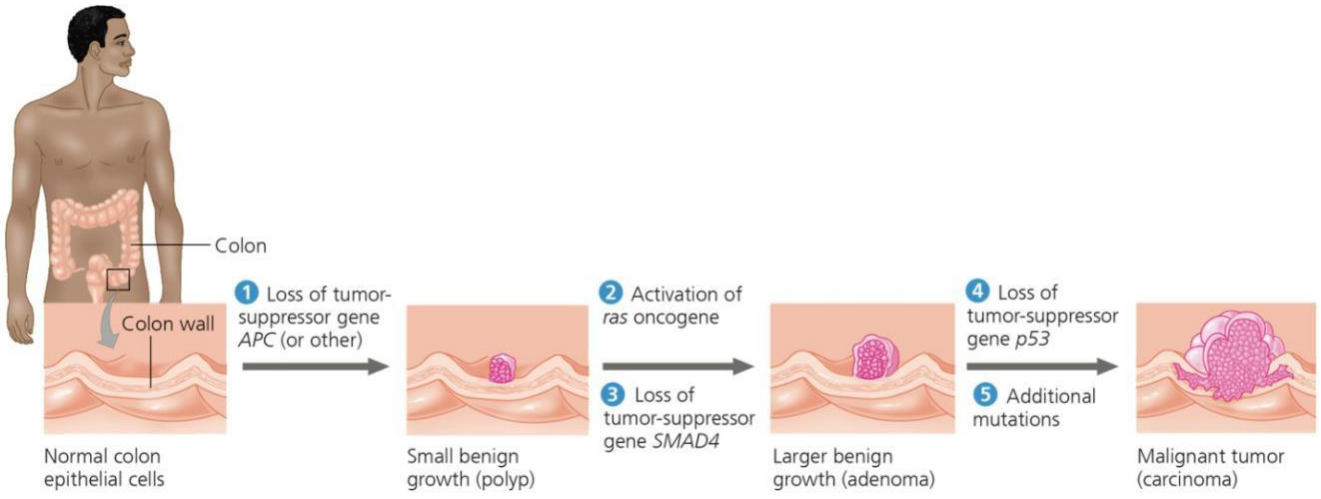
Proto-oncogenes: normal genes that may potentially become oncogenes

Tumor suppressor genes: gene whose protein product inhibits cell division which prevents uncontrolled cell growth that can lead to cancer

Here are some ways in which proto-oncogenes can be *turned into oncogenes*:



Cancer has a method of growing. There is a model of this multistep pathway that is shown through the development of *colorectal cancer*.



This emphasizes the fact that **many changes** have to occur in order for a cell to be considered fully cancerous.

CHECK YOUR LEARNING

1. True or false: An operator is a group of genes clustered together that can be regulated in prokaryotes.
2. How are histone acetylation and DNA methylation similar? How are they different?

THINGS YOU MAY STRUGGLE WITH

1. It is important to understand the different between differentiation and determination. Differentiation is the process by which cells separate into their respective tissues. Determination occurs early on in the embryo where the cells are assigned a specific developmental fate.
2. Many students struggle with the operon concept. Make sure you understand what the terms mean separately before you put them together and look at the overall concepts.

Thanks for checking out these weekly resources!
Don't forget to check out our website for group tutoring times, video tutorials and lots of other resources: www.baylor.edu/tutoring! Answers to *Check your Learning* questions are below!

Answers:

1. False- operons fit that definition, not operators
2. They both regulate DNA transcription. DNA methylation can either speed up or slow down the process while histone acetylation can generally speed it up