A prokaryote can respond to changes in its environment by turning genes on and off. In bacteria, genes are regrouped, with control sequences called operators and promoters, into clusters called operons. The lac and trp operons are two such gene clusters in the bacterium E. coli. Study the diagrams in Module 13.1, and then match each of the components of the lac and trp operon systems with its function.

**lac operon:**

1. Regulatory gene
2. Repressor protein + lactose
3. Repressor protein without lactose
4. RNA polymerase
5. Promoter
6. Operator
7. Operon genes
8. Enzymes

**trp operon:**

1. Regulatory gene
2. Repressor protein + tryptophan
3. Repressor protein without tryptophan
4. RNA polymerase
5. Promoter
6. Operator
7. Operon genes
8. Enzymes
Exercise 2 - Eukaryotic Regulation 13.2
Fill in the missing word to review the roles of DNA packing and protein activator in gene expression.

1. The color pattern of a T_____________ cat reflects the influence of chromosome inactivation.
2. Scientists think most eukaryotic regulatory proteins act as A_______________.
3. One X chromosome in each of a woman’s cells is I_______________.
4. Nucleosomes may control gene E_______________ by limiting access to DNA.
5. The DNA supercoil is further wrapped and folded into a C_______________.
6. In eukaryotes, many R___________ proteins interact with DNA and one another to turn genes on and off.
7. DNA is wound around small proteins called H______________.
8. The first step in initiating gene transcription in binding of activators to sites called E______________.
9. A transcription F_______________ may be involved in turning on a eukaryotic gene.
10. A N_______________ is a complex of DNA wrapped around eight histone molecules.
11. DNA packing seems to control gene expression at the T______________ stage.
12. Activators trigger RNA P________________ to begin transcription.
13. An activator may help position RNA polymerase on a gene’s P_______________.
14. In most eukaryotic cells, most G____________ are not expressed.

Exercise 3 -- RNA Processing 13.2
In eukaryotes, gene expression is also regulated after transcription of genes into mRNA and during and after translation of mRNA into protein. Review these processes by matching each of the processes on the left (listed in order of occurrence) with a description on the right.

___ 1. First step in RNA splicing
___ 2. Second step in RNA splicing
___ 3. Alternative RNA splicing
___ 4. Selective breakdown of mRNA
___ 5. Inhibition of translation
___ 6. Activation of finished protein
___ 7. Selective breakdown of proteins

A. Altering a protein to form an active final product
B. Retaining or breaking down mRNA molecules, controlling how much they are translated
C. Action of inhibitors that may block synthesis of protein from mRNA message
D. Joining exons in different ways to produce more than one polypeptide from a single gene
E. Removal of noncoding introns from RNA
F. Joining of exons to produce mRNA
G. Retaining or breaking down proteins, depending on cell’s need
**Exercise 4 - Mutations 13.3**

Use the genetic code chart (Figure 12.10 on page 224) to translate the following mRNAs into amino acid sequences and answer the questions.

**mRNA nucleotide sequence:**

(mRNA 1) A U G C C A G A C A A U A U A U A A G U G A

1. What is the amino acid sequence coded for by mRNA 1?

(mRNA 2) A U G C C A G A C C A U A U U A A G U G A

2. What is the amino acid sequence coded for by mRNA 2?

3. How many nucleotide bases have changed? _______

4. How many amino acids have changed? _______

5. What is the type of mutation? __________________________

6. Number of amino acids changed:
   (mRNA3; compared to mRNA 1)
   A U G C C A G A C G A A U A U U A A G U G A

2. What is the amino acid sequence coded for by mRNA 3?

7. How many nucleotide bases have changed? _______

8. How many amino acids have changed? _______

9. What is the type of mutation? __________________________

10. Which mutation had the greatest effect on the final polypeptide and why?
Exercise 5 - DNA Cloning 14.1
“Clone,” “sticky ends,” “vector” - Gene engineers have their own lingo. Start building your genetic engineering vocabulary by matching each of the terms on the right with a description on the left. Each answer is used only once.

___ 1. Used to cut DNA at a specific location for splicing  A.  E. coli
 ___ 2. Using organisms or their components to make useful products  B.  Genetic engineering
 B  3. Direct manipulation of genes for practical purposes  C.  Reverse transcriptase
 ___ 4. Making multiple copies of gene-sized pieces of DNA  D.  Recombinant DNA technology
 ___ 5. A small piece of bacterial DNA used for gene transfer  E.  Vector
 ___ 6. DNA transcribed from RNA  F.  Restriction Enzyme
 ___ 7. Used to “splice” pieces of DNA  G.  Complementary DNA (cDNA)
 D  8. A set of techniques for combining genes from different sources  H.  Biotechnology
 ___ 9. A virus that attacks bacteria; used to clone genes  I.  Plasmid
 ___ 10. An organism used to clone genes  J.  DNA ligase
 O  11. A collection of DNA fragments  K.  Recombinant DNA (rDNA)
 ___ 12. Specific location where an enzyme cuts DNA  L.  Gene cloning
 C  13. An enzyme used to make DNA from an RNA master  M.  Bacteriophage
 ___ 14. DNA in which genes from different sources are combined  N.  Restriction site
 ___ 15. A gene carrier  O.  Genomic library

Exercise 6 – Cloning 14.2
Cloning experiments show that differentiated cells retain all of their genetic potential. Stem cells of embryos and adults are able to differentiate into many kinds of cells – useful for reproduction and therapy. Review cloning and stem cells by matching each phrase with a term from the list on the right.

___ 1. Partially differentiated cells present in mature animals  A.  Reproductive cloning
 ___ 2. Producing genetically identical organisms for agriculture, research, or saving endangered species  B.  Nuclear transplantation
 ___ 3. Cells that give rise to all specialized cells in the body  C.  Differentiation
 ___ 4. The process of cell specialization  D.  Embryonic stem cells
 ___ 5. Growing cells for replacement or repair of damaged or diseased organs  E.  Therapeutic cloning
 ___ 6. Genetically identical organisms  F.  Adult stem cells
 ___ 7. Replacing the nucleus of an egg or zygote with a nucleus from a differentiated cell  G.  Clones