What is ahead?

- Gene expression
  how do cells use DNA to synthesize proteins

- DNA technology
  how DNA is manipulated for new technologies

- Cell division: Mitosis and Meiosis
  how DNA is distributed in new cells

- Genetics
  how DNA determines physical traits
Gene expression: process of how the information in gene (DNA) is employed to make a protein.
How genes work

**Inside nucleus**

**TRANSCRIPTION**
The sequence for a gene is copied from DNA to a middle-mane molecule called mRNA.

**Cytoplasm**

**TRANSLATION**
The sequence for a gene, now encoded in mRNA, is used to direct the production of a protein.

**Protein molecule**
Study Guide

- Define transcription and translation.
- Explain how the language of DNA directs the production of proteins.
- Explain how codons are used to construct proteins.
- Describe the function of RNA polymerase in transcription.
- Compare the structures and functions of mRNA, tRNA, and rRNA.
- Describe the function of ribosomes, mRNA and amino acids in translation.
- Explain the effect of a mutation on gene expression. Explain how mutations can be harmful or beneficial to organisms.
- Describe the mechanism used to regulate gene expression after eukaryotic mRNA is transported to the cytoplasm.
Review of Protein

1. Long chain of …..

2. In a protein, the sequence of amino acid determines its __________

3. which determines the protein’s ________

4. A protein with an enzymatic function and another one with a contractile function. Why do they have different functions?
Review of Nucleic Acid (DNA and RNA)

- They are long chain of ______________________

- A nucleotide is different from another by the type of ________

- Information in a nucleic acid is used for making __________
In the two strands of DNA, the bases are complementary to each other.
5. If one strand of DNA has the sequence CGATT, the sequence of the other strand of the same molecule will be _________
ORGANIZATION OF DNA
GENOME
CHROMOSOME
GENE

Find the analogy to a cookbook:

6. Which is the book?

7. Which is the chapter of desserts?

8. Which is the recipe for making cookies?
Gene expression involves two steps

From DNA to RNA:
Only one strand of DNA is used

This conversion is complementary
Base (DNA) to base (RNA)

From RNA to PROTEIN:
This conversion uses
3 bases (RNA) to 1 amino acid (Protein)
1 codon for 1 amino acid

The sequence of bases (A,T,C,G) of the nucleotides in a strand of DNA codes for the sequence of amino acids in a protein
9. In the process of gene expression, transcription creates a _______ using _______ as a template, and translation creates a ____________ using the information stored in ________.

A. DNA, DNA, protein, DNA

B. mRNA, DNA, protein, mRNA

C. Protein, mRNA, mRNA, DNA
Transcription: from DNA to RNA

The molecules involved:

DNA

Single nucleotides

RNA polymerase

Product:

RNA strand

Location in cell:
10. Which of the following statements about transcription is FALSE?

A. In RNA, U, rather than T, pairs with A
B. The RNA molecule is built one nucleotide at a time
C. Both DNA strands serve as the template for one RNA
D. Transcription begins when RNA polymerase attaches to the promoter
E. As the RNA molecule is produced, it peels away from its DNA template
Three types of RNA

**figure 10.2** Relationship among three of the different RNAs—messenger, transfer, and ribosomal—during protein synthesis. These three types of RNAs are found together at the ribosome during translation, with the ribosomal RNA being a component of the ribosome.
Translation: from RNA to protein

The molecules involved:
mRNA
Ribosomes (made of rRNA)
amino acids
tRNA

End product:
Protein

Location in the cell:
11. During the process of translation, _____ matches an mRNA codon with the proper amino acid.

A. a ribosome
B. DNA polymerase
C. ATP
D. messenger RNA
E. transfer RNA
12. Match the player of protein synthesis in the cooking analogy

A. Index card  ____  Nucleus
B. Bookshelf  ____  DNA (gene)
C. Spoons and whisks  ____  Cytoplasm
D. cookies  ____  Ribosome
E. Butter and flour  ____  mRNA
F. recipe  ____  Amino acids
G. Mixing bowl  ____  Protein
The universal dictionary of the genetic code

<table>
<thead>
<tr>
<th>First base</th>
<th>Second base</th>
<th>Third base</th>
</tr>
</thead>
<tbody>
<tr>
<td>UUU</td>
<td>Phenylalanine (Phe)</td>
<td>UUC, UCU, UCC, UCA, UCG</td>
</tr>
<tr>
<td>UUC</td>
<td>Cys (Cys)</td>
<td>UCU, UCC, UCA, UCG</td>
</tr>
<tr>
<td>UUA</td>
<td>Leucine (Leu)</td>
<td>UCA, UCC, UCG</td>
</tr>
<tr>
<td>UUG</td>
<td>Glutamine (Gln)</td>
<td>UCA, UCG</td>
</tr>
<tr>
<td>CUU</td>
<td>Leucine (Leu)</td>
<td>CCU, CCA, CCG</td>
</tr>
<tr>
<td>CUC</td>
<td>Histidine (His)</td>
<td>CAU, CAC, CAA, CAG</td>
</tr>
<tr>
<td>CUA</td>
<td>Arginine (Arg)</td>
<td>CGU, CGC, CGA, CGG</td>
</tr>
<tr>
<td>CUG</td>
<td>Met or start</td>
<td>AUG</td>
</tr>
<tr>
<td>AUA</td>
<td>Isoleucine (Ile)</td>
<td>ACU, ACC, ACA, ACG</td>
</tr>
<tr>
<td>AUG</td>
<td>Threonine (Thr)</td>
<td>AAU, AAC, AAA, AAG</td>
</tr>
<tr>
<td>GUU</td>
<td>Asparagine (Asn)</td>
<td>AGU, AGC, AGA, AAG</td>
</tr>
<tr>
<td>GUC</td>
<td>Arginine (Arg)</td>
<td>AGA, AGG</td>
</tr>
<tr>
<td>GUA</td>
<td>Serine (Ser)</td>
<td>AGU, AGC</td>
</tr>
<tr>
<td>AUG</td>
<td>Valine (Val)</td>
<td>GUC, GCC, GCA, GCG</td>
</tr>
<tr>
<td>GUG</td>
<td>Glycine (Gly)</td>
<td>GCC, GCA, GCG</td>
</tr>
<tr>
<td>AUC</td>
<td>Aspartic acid (Asp)</td>
<td>GAU, GAC, GAA, GAG</td>
</tr>
<tr>
<td>ACA</td>
<td>Glutamic acid (Glu)</td>
<td>GGU, GGC, GGA, GGG</td>
</tr>
<tr>
<td>UAG</td>
<td>Stop</td>
<td></td>
</tr>
<tr>
<td>UGA</td>
<td>Stop</td>
<td></td>
</tr>
<tr>
<td>UGU</td>
<td>Cysteine (Cys)</td>
<td></td>
</tr>
<tr>
<td>UGG</td>
<td>Tryptophan (Trp)</td>
<td></td>
</tr>
</tbody>
</table>

13. mRNA: ______ ______ ______ ______ ______ ______ ______ ______ ______
14. AA: ______ ______ ______ ______ ______ ______ ______ ______ ______
Mutations are changes in a sequence of DNA. These can be inherited or acquired. These changes get transcribed and translated. Result?
Mutations can be bad, neutral or... Good....
Mutations are the source of life’s diversity.
Regulation of Gene Expression

Genes can be turned off or on

A typical human cell normally expresses about 3% to 5% of its genes at any given time

What is the benefit of regulation?
(think of an orchestra)
Gene regulation during transcription

Transcription factors turn genes on by attaching to DNA regions called enhancers, making it easier for RNA polymerase to bind to DNA and begin transcription.

Lactase film
Pair the following terms with the boxes where they belong:

**Amino acids** (_______)
**Nucleotides** (_______)
**Ribosomes** (_______)
**Transcription** (_______)
**Translation** (_______)
**RNA polymerase** (_______)
**mRNA** (_______)
**rRNA** (_______)
**tRNA** (_______)

**Concept map of Gene Expression**

- DNA
  - is a polymer made from monomers called (a)
  - is performed by enzyme called (c)
- RNA
  - comes in three kinds called (d)
  - (e)
  - (f)
- Protein
  - is performed by organelles called (h)
  - one or more polymers made from monomers called (i)
Exercise 8: Observing DNA

• Follow the protocol on page 56 and Show me your extracted DNA