Molecular Genetics

Before You Read

Before you read the chapter, respond to these statements.

1. Write an A if you agree with the statement.
2. Write a D if you disagree with the statement.

<table>
<thead>
<tr>
<th>Before You Read</th>
<th>Molecular Genetics</th>
<th>After You Read</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>James Watson and Francis Crick discovered that DNA was the genetic material.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DNA replication is the same in prokaryotes and eukaryotes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information in a cell flows from DNA to RNA to protein.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A mutation is a permanent change in a cell’s DNA.</td>
<td></td>
</tr>
</tbody>
</table>

Science Journal

Ponies on the Shetland Islands in Scotland have short stature, thick hair, strength, and hardiness so they can thrive in their harsh environment. How do you think the DNA of their population has changed over time?
Molecular Genetics
Section 12.1 DNA: The Genetic Material

Main Idea

Scan Section 1 of the chapter. Identify the results of three DNA experiments.

1. 
2. 
3. 

Details

Use your book or dictionary to define nucleic acid.

Review Vocabulary
nucleic acid

New Vocabulary
double helix

Use your book or dictionary to define each term. In the box to the right, make a sketch to help you remember each term.

Academic Vocabulary
transform

Define transform to show its scientific meaning.
Complete the table below about geneticists and their discoveries.

<table>
<thead>
<tr>
<th>Scientist</th>
<th>Discovery</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fredrick Griffith</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oswald Avery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfred Hershey and Martha Chase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>James Watson and Francis Crick</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Organize the characteristics of nucleotides by filling in the graphic organizer below.

**Characteristics of Nucleotides**

- All nucleotides have a five-carbon and in DNA it is and in RNA it is
- a negative
- one of four

In DNA they are and in RNA they are
Create a memory device to help you remember how the nitrogenous bases are always paired.

Analyze the DNA molecule by explaining how each word applies to the molecule. Use a sketch to back up your explanation in each case.

<table>
<thead>
<tr>
<th>Word and What It Means</th>
<th>Sketch of Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>complementary:</td>
<td></td>
</tr>
<tr>
<td>helix:</td>
<td></td>
</tr>
<tr>
<td>double (as in “double helix”):</td>
<td></td>
</tr>
</tbody>
</table>

Synthesize and rephrase how a DNA strand that is 200 million bases long can fit inside a cell.

State how Watson and Crick’s DNA structure supported Chargaff’s rules.
Scan Section 2 of the chapter. Write three questions that come to mind from reading the headings and the illustration captions.

1. 
2. 
3. 

Use your book or dictionary to define template.

Use your book or dictionary to define the following terms. Then look through the section to find a sentence with each term. Write the sentence.

DNA polymerase

Okazaki fragment

semiconservative replication
**Main Idea**

Semiconservative Replication

*I found this information on page ________.*

**Details**

Describe semiconservative DNA replication.

<table>
<thead>
<tr>
<th>Model</th>
<th>During replication, the parental strands</th>
<th>The new DNA molecule is composed of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semiconservative replication</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sequence and model** each step in the replication of a DNA molecule. Write about what happens, and draw a DNA molecule going through each step. In the last box, describe and draw the products of replication.

A.  

B.  

C.  

D.  

**Analyze** how a DNA molecule acts like a template.
Section 12.2 Replication of DNA (continued)

Complete the table below on the role of each protein in DNA replication. The first one has been done for you.

<table>
<thead>
<tr>
<th>Protein</th>
<th>Stage of DNA Replication</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA helicase</td>
<td>unwinding</td>
<td>unwinds and unzips the DNA</td>
</tr>
<tr>
<td>DNA ligase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNA polymerase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNA primase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-stranded binding protein</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comparing DNA Replication in Eukaryotes and Prokaryotes

I found this information on page __________.

Contrast the differences between prokaryotic and eukaryotic DNA replication.

<table>
<thead>
<tr>
<th></th>
<th>Eukaryotes</th>
<th>Prokaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of origins for DNA replication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where replication takes place in the cell</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SUMMARIZE

Analyze how the activity of DNA polymerase is consistent with Watson and Crick’s model of semiconservative replication.

________________________________________

________________________________________

________________________________________

________________________________________
Section 12.3 DNA, RNA, and Protein

Molecular Genetics

Scan the headings and boldfaced words for the section. Predict two things that you think might be discussed.

1. 

2. 

Use your book or dictionary to define synthesis.

Write the correct term in the left column for each definition below.

process in which RNA is synthesized from DNA

a group of three nitrogenous bases in DNA or mRNA that code for one amino acid

nucleic acid made of ribose, phosphate, and one of four nitrogenous bases—adenine, cytosine, guanine, or uracil

intervening DNA sequences that are transcribed and then removed from the final mRNA

process by which mRNA directs the synthesis of a protein

long strands of RNA that are complementary to one strand of DNA

protein coding sequences in DNA that are transcribed into mRNA and translated into protein

small RNA molecules that transport amino acids to the ribosome

an enzyme that catalyzes the synthesis of mRNA using DNA as a template

RNA molecules that make up part of the ribosome
Compare and contrast RNA and DNA by writing at least five characteristics of their structure and composition in the Venn diagram.

State the central dogma of biology.

Compare the function of each type of RNA molecule by completing the table.

<table>
<thead>
<tr>
<th>Type of RNA</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>mRNA</td>
<td>codes for</td>
</tr>
<tr>
<td>rRNA</td>
<td>directs the synthesis of</td>
</tr>
<tr>
<td>tRNA</td>
<td></td>
</tr>
</tbody>
</table>

Sequence the steps in transcription of RNA.
Section 12.3 DNA, RNA, and Protein (continued)

Main Idea

The Code, One Gene—One Enzyme

I found this information on page ________

Details

Identify four examples of codons and state the instructions they encode.

1. __________________________  
2. __________________________  
3. __________________________  
4. __________________________  

Model the movement of tRNA molecules showing the translation process.

State the updated version of Beadle and Tatum’s hypothesis.

_________________________ codes for ________________________

Create a flow chart to describe the formation of a protein.

Describe the activities of DNA and the three types of RNA.
**Main Idea**

Scan the illustrations and tables in Section 3. Predict the effect of mutations on organisms.

**Details**

**Review Vocabulary**

Use your book or dictionary to define prokaryote.

- prokaryote

**New Vocabulary**

Use your book or dictionary to define the following terms.

- gene regulation
- mutagen
- mutation
- operon

**Academic Vocabulary**

Define substitution and write a sentence to show its scientific meaning.

- substitution
**Main Idea**

Prokaryote Gene Regulation

I found this information on page ____________

Eukaryote Gene Regulation

I found this information on page ____________

**Details**

Describe gene regulation in prokaryotes by using the terms below to complete the paragraph.

- **E. coli**
- environment
- genes
- metabolic pathway
- operator
- promoter
- proteins
- repressor
- RNA polymerase

An operon is a cluster of genes in ______________. These genes make ______________ that work together in one ______________. An operon is able to respond to changes in the ______________. The ______________ is a segment of DNA that acts as a switch for transcription, turning the operon on or off. When the operon is on, [RNA polymerase] binds to the ______________ and transcribes the DNA. When the operon is off, a ______________ blocks transcription.

**Compare and contrast the trp operon and the lac operon.**

<table>
<thead>
<tr>
<th></th>
<th>Trp Operon</th>
<th>Lac Operon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responds to the presence of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transcription is turned on when</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The repressor is active when</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When the operon is turned on, the cell can</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analyze the ways eukaryotes control gene expression.**

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Effect on Gene Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hox genes</td>
<td></td>
</tr>
<tr>
<td>Nucleosomes</td>
<td></td>
</tr>
<tr>
<td>Small interfering RNA</td>
<td></td>
</tr>
<tr>
<td>Transcription factors</td>
<td></td>
</tr>
</tbody>
</table>
Main Idea

Mutations
I found this information on page _________.

Details

Compare and contrast a point mutation and a frameshift mutation by defining each mutation and stating its consequence.

<table>
<thead>
<tr>
<th>Mutation</th>
<th>Result</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missense mutation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonsense mutation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromosome rearrangement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromosome deletion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyze each type of DNA mutation and its result. Sketch what each change might look like.

Discuss why a mutagen can have longer-lasting effects in a sex cell than in a body cell.
Create a concept web to tie together what you learned in this chapter about molecular genetics. Hint: You might find it easier to first list the facts or topics you want to include, then decide how to connect them in the web.