Name_____ Course/Section_____

Date_____ Professor/TA_____

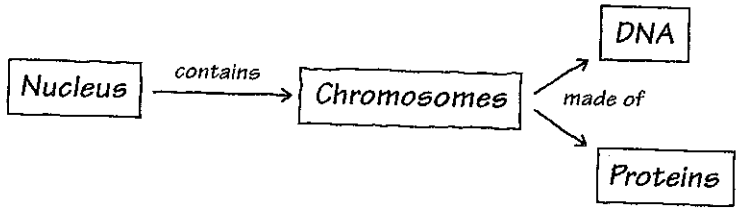
Activity 16.1 Is the hereditary material DNA or protein?

Accumulating and Analyzing the Evidence

Build a concept map to review the evidence used to determine that DNA was the genetic material, the structure of DNA, and its mode of replication. Keep in mind that there are many ways to construct a concept map.

- First, develop a separate concept map for each set of terms (A to D on the next page). Begin by writing each term on a separate sticky note or sheet of paper.
- Then organize each set of terms into a map that indicates how the terms are associated or related.
- Draw lines between the terms and add action phrases to the lines to indicate how the terms are related.

Here is an example:



- After you have completed each of the individual concept maps, merge or interrelate the maps to show the overall logic used to conclude that DNA (not protein) is the hereditary material.
- When you have completed the overall concept map, answer the questions.

Terms

Map A
Griffith
mice
S strain of *Streptococcus*
R strain of *Streptococcus*
live
heat-killed
transformation
Avery, McCarty, and MacLeod
DNA
protein

Map B
Hershey and Chase
bacteria
bacteriophage (phage) (only a protein and DNA)
^{35}S
^{32}P
Waring blender
high-velocity centrifugation

Map C
Watson and Crick
X-ray crystallography
Chargaff's rule
purine structure
pyrimidine structure
H bonds
phosphate sugar backbone

Map D
Meselson and Stahl
conservative
dispersive
semiconservative
nucleic acid bases
^{14}N
^{15}N
bacteria
density equilibrium centrifugation
replication

Name_____ Course/Section_____

1. In the early to mid-1900s, there was considerable debate about whether protein or DNA was the hereditary material.

   a. For what reasons did many researchers assume that protein was the genetic material?

b. What key sets of experiments led to the understanding that, in fact, DNA and not protein was the hereditary material?	c. What evidence did each experiment provide?

2. Watson and Crick were the first to correctly describe the structure of DNA. What evidence did they use to do this? How did they use this evidence to put together or propose the structure of DNA?

3. How did the results of Meselson and Stahl's experiments show that DNA replicates semiconservatively? To answer this, answer the following questions.

   a. Diagram the results that would be expected for each type of replication proposed.

   b. What evidence allowed Meselson and Stahl to eliminate the conservative model?

   c. What evidence allowed them to eliminate the dispersive model?

Name_____ Course/Section_____

16.1 Test Your Understanding

An *E. coli* cell that contains a single circular chromosome made of double-stranded DNA is allowed to replicate for many generations in ^{15}N medium until all of the *E. coli* cells' DNA is labeled with ^{15}N. One *E. coli* cell is removed from the ^{15}N medium and is placed into medium in which all of the available nucleotides are ^{14}N labeled. The *E. coli* cell is allowed to replicate until eight *E. coli* are formed.

1. Given this situation, which of the following is true?
   a. Some ^{15}N-labeled DNA will be found in all eight cells.
   b. Some ^{15}N-labeled DNA will be found in only four of the cells.
   c. Some ^{15}N-labeled DNA will be found in only two of the cells.
   d. Some ^{15}N-labeled DNA will be found in only one of the cells.

2. To explain your answer, draw the sequence of events that occurred.

Name_____ Course/Section_____

Date_____ Professor/TA_____

Activity 16.2 How does DNA replicate?

Working in groups of three or four, construct a dynamic (working or active) model of DNA replication. You may use the materials provided in class or devise your own.

Building the Model

- Develop a model of a short segment of double-stranded DNA.
- Include a key for your model that indicates what each component represents in the DNA molecule—for example, adenine, phosphate group, deoxyribose.
- Create a dynamic (claymation-type) model of replication. Actively move the required bases, enzymes, and other components as needed to model replication of your DNA segment.

Your model should describe the roles and relationships of all the following enzymes and structures in replication:

parental DNA
nucleotide excision repair
daughter DNA
mutation
antiparallel strands
single-stranded DNA-binding proteins
leading strand
telomeres
lagging strand
telomerase
5′ end
3′ end
$3' \rightarrow 5'$ versus $5' \rightarrow 3'$
nitrogenous bases A, T, G, C
replication fork
replication bubble
Okazaki fragment
DNA polymerase
helicase
DNA ligase
primase
RNA primers
origin of replication

Use your model to answer the questions.

1. Explain how Meselson and Stahl's experiments support the idea that DNA replication is semiconservative.

2. A new form of DNA is discovered that appears to be able to replicate itself both in the $3' \rightarrow 5'$ direction and in the $5' \rightarrow 3'$ direction. If this is true, how would this newly discovered DNA replication differ from DNA replication as we know it?

3. Amazingly, an alien species of cellular organism is found alive in the remains of a meteorite that landed in the Mojave Desert. As a scientist, you are trying to determine whether this alien life-form uses DNA, protein, or some other type of compound as its hereditary material.

   a. What kinds of experiments would you propose to determine what the hereditary material is?

   b. Assuming that the hereditary material turns out to be similar to our DNA, describe the simplest experiments you could run to try to determine if it is double-stranded like our DNA, triple-stranded, or something else.

4. Some researchers estimate that the mutation rate for any given gene (or its DNA) in certain strains of bacteria is about 10^{-8}. This means that one error or mutation in a given gene is introduced for every 100-million cell divisions.

   a. What can cause mistakes in replication?

   b. How are such mistakes normally corrected?