TITLE OF LESSON

Biology Unit 1 Lesson 25 – DNA Structure and Replication

How do cells store and transfer information?

TIME ESTIMATE FOR THIS LESSON

One class period

ALIGNMENT WITH STANDARDS

California – Biol CB 1d; G4 & G5a

MATERIALS

Three Theories of Replication – Teacher Page (one overhead copy)
Messelsohn Stahl Experiment – Teacher Page (one overhead copy)
Messelsohn Stahl Densities – Student Page

LESSON OBJECTIVES

- To learn about the structure of DNA
- To learn about complementary base pairing
- To analyze how Messelsohn and Stahl discovered semi-conservative replication
- To learn about DNA replication

EXPLANATION OF LESSON

The objective of the lesson is for the student to learn about the structure of DNA and complimentary base pairing. They will be required to analyze the experimental results found by Messelsohn and Stahl in order to learn how scientists actually create and analyze experiments. They will also learn about DNA replication.

FOCUS AND MOTIVATE STUDENTS – WARM-UP ACTIVITY

1) Homework Check – Collect all homework. Pass back all graded assignments. Make sure you initial the second draft of their Lab Report #2, if it is complete. Remind students that they will be required to have one adult edit their second draft tonight, as they will be typing it up tomorrow. Tell them to go directly to the computer lab tomorrow.
2) Agenda – Have students copy the agenda you posted.
3) Note Taking Outlines – Have the students take out their outlines from yesterday. Go over the main points with them and if possible, have a sample outline of the material that you made. In this way, they can compare what you've done with what they've done. They can use this information to write a better outline next time. Collect their outlines.
4) Brainstorm – Have the class Brainstorm as a group how a scientist creates a hypothesis and how he/she determines if it is correct. Give them five minutes to come up with some ideas. Write all of the ideas they come up with on the board. Then tell them they are going to analyze how Messelsohn and Stahl determined which of their hypotheses was correct using a computer-generated example of their data.

ACTIVITIES – INDIVIDUAL AND GROUP

1. Note Taking – Remind students they should be taking notes as you speak today and they should underline all new vocabulary. Show images of the nucleotides: adenine, guanine, thymine, cytosine and uracil. Tell them to write the names of these nucleotides in their notes, along with a rough sketch. They can be found in your textbook or the Biology web site:
   http://gened.emc.maricopa.edu/Bio/BIO181/BIOBK/BioBookDNAMOLGEN.html

Each nucleotide is formed from a base plus a sugar plus a phosphate group. Explain that Chargaff in 1949 discovered that the quantity of A was equal to T, and the quantity of C was equal to G. Ask why this was an important discovery. It indicated that A associated with T and C with G in a cell. It didn't tell how they were bound. During this time, scientists didn't know if there were two or three strands making up DNA. They didn't know if the strands were held together by the phosphates or by the nucleotides. Today, we know it is made of two strands and that they are bound to each other by hydrogen bonds.

2. Lecture – How did we learn that DNA replication occurred in a semi-conservative fashion? An experiment by Messelsohn and Stahl showed that it was semi-conservative. First, explain that they had to come up with a hypothesis based on the existing facts about DNA that could explain how DNA was replicated. Talk about how scientists normally create a hypothesis to explain what they expect to happen. Then they must design an experiment to prove that their hypothesis or one of their hypotheses is correct. This is an essential part of being a scientist. A lot of hours of thinking and reading occur before experiments are done. Realize that even though the scientist comes up with a hypothesis of what he/she thinks is happening, Many times their experiments don't prove what they think or, they may show something completely different. In some cases, it just means the scientist didn't come up with an experiment that definitively proved or disproved the hypothesis. In other cases, the results show that they hypothesis was completely wrong and that something entirely different is happening. Now, scientists don't get discouraged by this, in fact, most are excited by it because it shows how incredibly complicated life is. It creates another challenge for them to rethink about the system they are studying and create new hypotheses and experiments to prove and disprove. It is a continuous challenge. Then explain that Messelsohn and Stahl decided there were three possible ways DNA could be replicated, conservatively, semiconservatively and in a dispersive fashion. Show the students the three theories and explain how replication would occur in each case. Only explain what would happen in the first round of replication since they will be expected to complete the second and third replication in activity 4. Show an overhead of the three theories of DNA replication: conservative (a whole new DNA strand would form), semi-conservative (two DNA molecules would be formed which contain one old strand and one new strand) and dispersive (each strand would be a mixture of old and new DNA). Images of three theories of replication can be found at http://gened.emc.maricopa.edu/Bio/BIO181/BIOBK/BioBookDNAMOLGEN.html or the file **Three Theories of Replication** (found in teacher pages).

3. Lecture 2 – Tell students that Messelsohn and Stahl used a very simple principle to help them determine how replication occurred. They used radioisotopes of nitrogen, either ^{14}N (light or normal) or ^{15}N (heavy) since nitrogen is found in all the DNA bases (A, T, C, G). They grew *E. coli* bacteria on a growth medium that only contained heavy nitrogen ^{15}N. Therefore, all the DNA strands are heavy. The bacteria were then transferred to a medium that had light nitrogen ^{14}N. Watson and Crick proposed in their DNA model that replication was semiconservative. If true, then the DNA strands produced by the bacteria grown on light medium would be half heavy and half light. The DNA was isolated and put into a tube with cesium chloride, which allows separation by density when placed in a centrifuge. The molecule that is heavier is found closer to the bottom and a molecule of medium density is found in the center and the lightest is the closest to the top of the tube. Thus, DNA that consisted of two strands of heavy DNA would weigh the most and be located in a band the closest to the bottom of the tube. If one strand is light and one is heavy, then it would be of medium density and located in the middle of the tube, but if both strands were light, then it would be located closest to the top. Give students the **Messelsohn Stahl Densities** handout, which includes a computer-generated example of the potential results and the actual results Messelsohn and Stahl got. It shows where the bands would be located if the DNA strands were both light (light/light), both heavy (heavy/heavy) or a mixture of light and heavy (light/heavy). In the lower half of the handout is the distribution of bands in the parental, first, second and third generation that Messelsohn and Stahl found. Students should be writing all of this information in their notes.

4. Group Replictations – Have the students work on this project in their assigned groups. Then explain that the students must draw three rounds of replication that represent each theory that Messelsohn and Stahl proposed, conservative, semiconservative and dispersive, by drawing the distribution of heavy and light strands they would expect to find for each hypothesis. It will be easiest to do so if they use two different colored pens. For example, black to represent ^{15}N and red to represent ^{14}N. Then they will look at the data Messelsohn and Stahl found in their experiment (in the **Messelsohn Stahl Density** handout) and analyze the data in order to "prove" which hypothesis is correct. In this way they will be required to think out and draw a representation of the

hypotheses and analyze the data gotten after the experiment in order to determine which hypothesis is correct. Walk around the room and help students who are confused about what to do.

5. Debrief – Finally, you should check to see which hypothesis each group determined was correct and ask them why. Then use an overhead of the **Messelsohn Stahl Experiment** handout to go through the results to make sure that they all understood how to draw out the hypotheses and come to the Messelsohn Stahl conclusion. Remind students it is important to understand as much as you can about the topic you're studying before you design an experiment. Once designed, you have to carry it out, and then the difficult part of analyzing the data follows. All of these steps are important for scientific research.

6. Homework Review – At the end of the period, remind students of their homework. Have them go directly to the computer lab tomorrow.

HOMEWORK

1) Read Starr's textbook *Biology concepts and applications* chapter 12, pp. 194-198. Make sure the students read something about DNA structure, complimentary base pairing, DNA replication and repair. Ask them to take notes on the key points. Then have them list 5 questions they had about the ideas they read.
2) Have one adult edit your Lab Report #2.

GROUP ROLES

Recorder – The Recorder will record all responses for the Messelsohn and Stahl analysis. All students are recorders and should be taking notes.

Facilitator – The Facilitator will keep group members focused on the activity.

Illustrator – The Illustrator can draw a scheme or illustration of the data discussed.

Manager – The Manager is responsible for getting the handouts for the group.

DOCUMENTATION FOR PORTFOLIO

Lab Report #1
Method – Photoshop Image