Protein Synthesis

Topic: Protein Synthesis in Cells

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Teacher Grade: 10-12

Teacher School: Worth County R-III, MISSOURI

Teacher District: Worth County R-III, MISSOURI

Standards:

NETS-S STANDARD

1.c. Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students use models and simulations to explore complex systems.

MISSOURI KNOWLEDGE STANDARD

Science 3. *In Science, students in Missouri public schools will acquire a solid foundation which includes knowledge of* characteristics and interactions of living organisms.

MISSOURI PROCESS STANDARDS

Goal 3.2. Students will demonstrate the ability to develop and apply strategies based on ways others have prevented or solved problems.

MISSOURI SCIENCE COURSE LEVEL EXPECTATIONS

SC.3.2.E.a Explain how the DNA code determines the sequence of amino acids necessary for protein synthesis.

SC.3.3.B.c Recognize that DNA codes for proteins, which are expressed as the heritable characteristics of an organism.

SC.3.3.B.d Explain how an error in the DNA molecule (mutation) can be transferred during replication.

SC.3.3.B.e Identify possible external causes (e.g., heat, radiation, certain chemicals) and effects of DNA mutations (e.g., altered proteins which may affect chemical reactions and structural development).

What concepts do you want students to understand after completing this lesson?

After completing this lesson, students will understand how proteins are synthesized and how mutations can affect how an organism functions. They will also know that the basic structure and function of DNA are fundamental to all biological processes. Students will link genetic diseases to mutations in DNA.

Essential Question:

How can mutations in your DNA structure affect your everyday functioning?

Criteria for Success (How will you know students have gained the understanding of the concepts?):

Students will design a "coded" DNA molecule and decode the DNA molecules of other students. They will relate this to how DNA works when it makes proteins inside the human body. They will also be able to determine the implications of mutations in the DNA structure based on messages coded from mutated DNA or their mistake in coding the DNA message.

Resources (What resources will you and your students use?):

TEACHER RESOURCES:
1) *Do It Yourself DNA Kit: An Introduction to DNA Structure, Replication and Protein Synthesis can be found out http://www.indiana.edu/%7Eensiweb/connections/genetics/diy.dna.html
2) *Say It With DNA: Protein Synthesis Tutorial can be found at http://www.indiana.edu/%7Eensiweb/connections/genetics/dna.les.html
3) *www.teachersdomain.org: Several short videos can be found here. You must register, but registration is free.
4) http://www.accessexcellence.org/AE/ATG/data/released/0247-LynnWartski/index.php (protein synthesis with words)
STUDENT RESOURCES:
1) Biology textbook
2) http://www.geneticheath.com/g101_changes_in_dna.shtml (describes the different types of DNA mutations)
3) http://learn.genetics.utah.edu/archive/sloozeworm/mutationbg.html (describes the causes of mutations in DNA)
4) http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/M/Mutations.html (gives examples of specific mutations as well as the frequency of the mutations)
5) http://www-personal.ksu.edu/~bethmont/mutdes.html (gives more detail about the causes of genetic mutations)

Management (How will students share technology resources? How will you break up the lesson into segments-the number of hours or days?)

Students will work independently, in pairs and in groups of four during this lesson.
Day One—Engage (one 45 minute class period): Students will generate lists of functions the body performs daily and "decode" a picture drawn by a lab partner.
Day Two—Explore and Explain (one 45 minute class period): Students will look at the double-helix structure of DNA and determine how nucleotide bases pair. They will also look at mutations websites and learn what happens when bases do not pair correctly.
Days Three thru Five—Elaborate (three 45 minute class periods): Students will code a DNA sequence through the steps of transcription and translation into a sentence. Students will also look at websites to determine the types of mutations and what causes them.
Days Six thru Eight—Evaluation* (three 45 minute class periods): Students will work backwards from a word (protein) to the DNA sequence that codes for that word. They will then construct the double-helix DNA molecule.
*Students may need more time in order to fully construct their projects but this can be done outside of class.
*For most of the lesson, students will work in pairs. One computer per pair.
*For group work, students will be designated as A and B partners.

Learner Diversity (What diverse learner needs do you need to consider when selecting resources, grouping students or planning the culminating project? Are there any special considerations such as assistive technologies or second-language learning to take into account?)

If there are children with special needs in the classroom, be sure to pair them up with students who can assist them.

Engage:
Capture the students' attention, stimulate their thinking and help them access prior knowledge.

1. Put students into groups of four. In their groups, label the members A-D. Each group of four needs one piece of paper. Each member of the group needs a pen with a different color of ink (for example, A would have red, B would have blue, C would have black and D would use a pencil). Pose the questions to the students: Name some things your body has to do during the day in order for it to function normally. (You may need to remind them that the "things" need to be school appropriate.) The students are to circle the paper around and each write by "saying, writing and passing." (For those unfamiliar with "say, write, pass", the students says what they are going to write down, they write it down and then they pass the paper to their right.) The paper needs to go around the group at least twice. A time limit may also be useful. (The paper can be collected for a grade. The instructor can easily tell what students have contributed based on how much they have written based on their "ink" color.)
2. When students have completed their lists, have them choose 3-4 things they would like to share with the class. Ask student A to share with the class. Write the shared things on the board. When the list has been compiled, ask "How do you think the body manages to do all of these tasks during the day? Does it require you to think about each task? Do you have to tell your body what to do?"
3. Pair students up with the shoulder partners and label each student in the pair (A & B). Each pair will need two blank sheets of paper. Using only four shapes (triangle, square, rectangle, circle), Student A will draw the four shapes out on a piece of paper without allowing Student B to see the design. Student B will try to draw the pattern that Student A made, using only the verbal instructions given by Student A. When finished, compare drawings.
4. After this is finished, regroup as a class and say "You had a simple task. Were the instructions given so that you could recreate the design?" Go on to relate the "things your body does" to the instructions that the body needs to do those things. Be sure to emphasize that the body speaks to itself through the use proteins. Give the example of lactose intolerance. When the body senses that lactose is present, the cells will start manufacturing the code to make lactase (the enzyme that breaks down lactose). What happens if the body does not do this? The body is miserable.

YOU CAN COLLECT A "TIME ON TASK" GRADE AT THIS POINT.

Explore:

Give students time to think, plan, investigate and organize collected information.

Using pages 2.1, 2.2 and 2.3 (Do It Yourself DNA Kit), students will demonstrate the double helix and DNA replication. Do not give the students page 2.1 initially (this page contains the instructions for how to cut out the DNA strand on page 2.2). On page 2.2, students are cut out the DNA strand. Have student B (hereafter referred to as the cutter) cut out the DNA strand. Instruct them to also cut out the shaded section. Students A , C and D will cut out the nucleotides on page 2.3. When directed, the cutter will twist the DNA to show what the double helix structure looks like. Then the cutter will "unzip" the DNA and the group will insert nucleotides in to demonstrate DNA replication.

THE INSTRUCTOR CAN CIRCULATE AND HAVE THE STUDENTS DEMONSTRATE THE UNZIPPING AND BASE-PAIRING FOR A GRADE AT THIS POINT.

If students struggle with the unzip concept, have the students form two lines and face each other. Each student will link hands with the student directly across from them. Start at one end and have the students unzip. You can also show how nucleotides come in by assigning a base pair sequence to the DNA using note cards taped to the students. Be sure and give the correct note cards to the nucleotides that will come in once the strand has been unzipped. Having extra nucleotides would emphasize the fact that the nucleus always has nucleotides "floating" around in it.

Give the students page 2.1 and go over the questions:

1) Did you notice a pattern during DNA replication?
2) What always matches with thymine?
3) What always matches with cytosine?
4) What always matches with adenine?
5) What always matches with guanine?
6) How many DNA molecules did you start with?
7) How many DNA molecules did you end up with?
8) Compare the two strands. How would you describe them?

(HANDOUTS CAN BE COLLECTED FOR A GRADE)

Explain:

Involve students in an analysis of their explorations. Use reflective activities to clarify and modify their understanding.

Start the session with a short video from Teacher's Domain called "One Wrong Letter". http://www.teachersdomain.org/resource/tdc02.sci.life.gen.onewrong/ (This video is about a small Jewish boy who was born with Tay-Sachs, a genetic defect caused by one wrong nucleotide in the DNA sequence. It is a genetic disorder found mainly in the Jewish culture.) Discuss thoughts on the video and then redirect students to yesterday's activities, asking the following:

1) What process did we demonstrate yesterday? (replication)
2) In replication, what nucleotide always matches with thymine? (adenine)
3) In replication, what nucleotide always matches with cytosine? (guanine)
4) In replication, what nucleotide always matches with adenine? (thymine)
5) In replication, what nucleotide always matches with guanine? (cytosine)
6) How many DNA molecules do you start with? (one)
7) How many DNA molecules do you end up with? (two)
8) Compare the two strands. How would you describe them? (identical)

Now we know how DNA is replicated, how do we get the instructions from inside the nucleus to where they need to go in the cell?

ACTIVITY: "Protein Synthesis Satisfies"—Each pair of students is given pages 3.1, 3.2, 3.3 and 3.4. They are instructed to place the nuclear membrane down the center of the desk. The DNA molecule from earlier is placed on one side of the "membrane" along with mRNA nucleotides. On the other side of the membrane, students will place the ribosome surface with the tRNA pieces and amino acids. The former represents the inside of the nucleus, the latter represents outside of the nucleus. Now, inside of the nucleus, students will unzip the DNA, mRNA nucleotides will come in and pair up with the unzipped DNA and make a new strand. The new strand will leave the nucleus through a nuclear pore. On the outside of the nucleus, amino acids will correctly match to their tRNA molecules. Once this is done, the ribosome will grab the mRNA blueprint, the tRNA will bring their amino acids in and a protein will be formed. Students will whisper the three-letter word to the instructor that is spelled by the first letters of the amino acids. After completing the protein and putting away their materials (into an envelope provided by the teacher), students will work on the analogies at the end of section 3.1. The analogies compare protein synthesis to a construction project and to a tape player. COLLECT ANALOGIES FOR A GRADE.

Elaborate:

Give students the opportunity to expand and solidify their understanding of the concept and/or apply it to a real-world situation.

1. ACTIVITY: "Say It With DNA"—Distribute a copy of "Say It With DNA: Protein Synthesis Worksheet: Practice Pays" and "DNA Messages 1-30" to each pair of students. Give each student a copy of "Say it With DNA: Protein Synthesis Practice Sheet". Assign 1-2 DNA messages to each student. Give them time to work on their messages.
2. Once students have gotten the hang of decoding messages, do the Protein Synthesis with word activity (http://www.accessexcellence.org/AE/ATG/data/released/0247-LynnWartski/index.php). In this activity students will pretend their desk is the nucleus. DNA cannot leave the nucleus. They will transcribe their DNA, leave the nucleus as messenger RNA, translate their messenger RNA to transfer RNA and find the "amino acids" that make their sentence/protein.

Go over the messages as a class and pose the following question: What happens if there is a mutation in the DNA sequence? Discuss lactose intolerance and other examples of mutations. Pose another question: "What causes mutations in DNA?"

3. As a homework assignment, give them the following four websites
http://www.geneticheath.com/g101_changes_in_dna.shtml,
http://learn.genetics.utah.edu/archive/sloozeworm/mutationbg.html,
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/M/Mutations.html,
http://www-personal.ksu.edu/~bethmont/mutdes.html

AND have them answer the following questions: (this can be done in groups, pairs or individually depending upon class dynamics)

1) What are the types of mutations that can occur in DNA transcription?
2) What causes these types of mutations?
3) What kinds of disorders result from these mutations?
4) Can these mutations be fixed? Why or why not?
5) Choose one of the disorders from question 3 and describe how the life of a person with this disorder would be different from your life.

In groups, students will use the information from the questions to design a concept map.

A GRADE FOR TIME ON TASK MAY BE TAKEN OR DIFFERENT WORKS CAN BE COLLECTED IN THIS SECTION. SOME OF THESE INCLUDE THE 2 DECODED MESSAGES FROM PART 1, THE "END" SENTENCE FROM PART 2 OR THE CONCEPT MAP FROM PART 3.

Evaluate:

Evaluate throughout the lesson. Present students with a scoring guide at the beginning. Scoring tools developed by teachers (sometimes with student involvement) target what students must know and do. Consistent use of scoring tools can improve learning.

Students will construct a DNA model in which the base sequence codes for something school related (i.e. mascot, name, colors). They will use the DNA Message Maker as a code (found on the "Say It With DNA: Making New Messages" handout). This can be done in a variety of ways including, but not limited to, a paper model (or other material) or a multimedia presentation. Evaluation can be done individually or in groups. If group evaluation is done, time on task should be individually graded in the following scoring guide.

	4	3	2	1
Appearance (x2)	Model is visually appealing and constructed with quality workmanship	Model is visually appealing but lacks in workmanship	Model is constructed with quality workmanship but lacks visual appeal	Model looks thrown together
Scientific	Model is	Model has one	Model has 2-5	Model is grossly

process (x2)	scientifically correct	or two scientific errors	scientific errors	scientifically wrong
Time on task	Student was on task 95% or greater.	Student was on task 85-94% of the time.	Student was on task 75-84% of the time.	Student was on task <75% of the time.
Creativity	Model is different from anyone else in the class.	Model is similar to one other group/student.	Model is similar to 2-3 other groups/students.	Model is similar to 4 or more other groups/students.
Planning	Model was well-planned out.	Model could have used a little more planning.	Model had a small amount of planning.	Model was thrown together with no plan.

Before the instructor grades the models, students can trade models and decipher the DNA strand. Groups can provide feedback to one another before final projects are turned in.

The eMINTS staff has adapted this form from materials available at this website: http://www.mdk12.org/instruction/curriculum/science/5emodel.html.

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