

SAY IT WITH DNA: Protein Synthesis Tutorial

by Larry Flammer

SYNOPSIS

This activity uses the metaphor of decoding a secret message for the Protein Synthesis process. Students teach themselves the sequence of DNA-Translation (DNA-mRNA-tRNA-protein), and practice with DNA codes which translate into amino acid sequences spelling out meaningful sentences in English! This activity provides practice in base-pair matching and following the sequence as performed by cells. Further practice is provided by requesting students to create new DNA messages which can be "decoded biologically" by others.

CONCEPTS

DNA is the central repository of information (in molecular code form) which controls life via protein synthesis. DNA makes RNA makes Protein ("The Central Dogma"), or, more precisely

DNA makes mRNA, which is read by ribosomes to position tRNA carrying amino acids into a particular sequence forming a particular protein, which in turn (at least as an enzyme) enables (or inhibits) a particular biochemical reaction.

DNA bases match (pair) in specific ways: A with T, C with G, (A with U in RNA)

ASSESSABLE OBJECTIVES

1. recognize DNA as a central repository of information (in code form) which controls life via protein synthesis.
2. know the "Central Dogma": DNA makes RNA makes Protein
3. know that certain DNA bases match: A & T, C & G, (and A & U in RNA)

MATERIALS

Handouts

TIME: one 45 minute period

STUDENT HANDOUTS

Protein Synthesis Worksheet (directions, tutorial, sample message, tRNA dictionary)

DNA-Decoding Practice Sheet

DNA Messages (2 pages, back-to-back on one sheet: 30 to choose from; placed in plastic sleeves)

DNA Message-Maker

TEACHING STRATEGY

1. This activity provides a logical activity to use following your Protein Synthesis reading assignment.
2. Be sure that students understand the **significance** of controlling protein production, namely the "One Gene - One Enzyme" concept: each step of a biochemical series of reactions requires a unique enzyme which in turn is the product of one gene. If the gene is there, the enzyme can be produced, and that step of the series can proceed; if the gene is not there (or has mutated), the enzyme may not be produced, and that step may not proceed. This is to some extent a simplification of reality, but should be recognized as a fairly good generalization for understanding how DNA (genes) can control life processes.
3. The one-letter symbols for the amino acids are the standard symbols assigned in molecular biology.

PROCEDURE

1. Hand out the Protein Synthesis Worksheet to every student.
2. Have students read the Worksheet and finish the partially solved message.
3. Meanwhile, hand out the Practice Sheet, and the sheet of 30 DNA Messages.
4. Assign each student one of the practice messages. They can do more, if interested and have the time.
To check for accuracy of decoded messages, use the **Messages Key**.
5. Optional: Students can do additional messages for homework.

6. Hand out the DNA Message Maker sheet.
7. Encourage (require?) students to create at least one good message. This could be done for homework.
8. Collect messages and re-distribute for them to be decoded
9. Ask students to do the **Quick Check** measure of their understanding of the functional roles for the real "players" involved in protein synthesis in the cell. (Alternatively, have them do just one of the analogies here, and use the other for assessment, OR, use the Quick Check for assessment only. You could also enlarge the table, place it on an overhead transparency, and do the Quick Check with the entire class in dialogue/recitation mode. Be sure to cut off the KEY table before using the Quick Check as a master for making handouts.

ASSESSMENT

1. Along with your unit test on the DNA unit, include the "practical" test supplement, requiring students to decipher a short DNA message during a test. Provide the **Test Supplement** (including tRNA Dictionary), the special answer sheet, and a unique word for each student (on little slips of paper, which you can prepare from the sample sentences provided, or use the 33 3-letter **test words** provided (along with a **test key** for you to use in grading the test).. Insist that each step be shown and the molecules involved be labeled (DNA, mRNA, tRNA, "protein" (as the "meaningful amino acid sequence")). Include completeness and accuracy in showing these steps and labels in your grading.
2. In addition, you may want to use the "**Quick Check**" here as a measure of understanding of the actual roles for the real "players" in protein synthesis in the cell.

EXTENSIONS AND VARIATIONS

1. Students can use the DNA Message Maker to create the DNA sequence which would code for their initials or 3-letter name or nickname, then use that code to build DNA jewelry (earrings, etc.) in the **Genetic Jewels** activity. They would have to be sure that the base letters (beads) for the code runs end to end along one strand, and the complementary base letters (beads) run along the connected strand. Such items would have even greater meaning and be uniquely personal, contributing to their retention of understanding.
2. As a special project, a student (or team) could build a large DNA demo model in which the base sequence codes for the name or initials of the school, or the school mascot. Flat rectangular sheets of styrofoam could serve as the base-pair steps; flat pentagonal pieces as deoxyribose sugars, and flat round pieces as the phosphate groups. If interested in trying this, contact the webmaster on this site for templates and other details.

ATTRIBUTIONS

Larry Flammer, idea developed in 1963 and used in Biology classes ever since, as the finale to a series of Do-It-Yourself DNA Kits (1. DNA Structure & Sub Structure, 2. DNA Replication, and 3. Protein Synthesis, all involving manipulation of cutouts, and resulting in the spelling out of a little 3-letter word (meaningful amino acid sequence).