trogen bases, each attached to a 3 cm piece of tape. After separating the two DNA strands by unhooking the base pairs, complementary new bases are attached to each strand, ultimately forming two identical DNA molecules (Figure 3, p. 58). I encourage my students to make at least one error in this process to demonstrate mutation, either by base-substitution or by skipping a base. The actual effects of the mutation can then be determined (see protein synthesis).

Protein synthesis

The DNA models also illustrate the steps of protein synthesis. As in DNA replication, the first step is to unzip the DNA strand. From the pool of available bases, students create a two-codon messenger RNA (mRNA) molecule corresponding to one of the DNA strands. The mRNA will be identical to the other DNA strand, except that uracil (white) is used instead of thymine (green). The mRNA is then detached from the DNA and moved to a ribosome, modeled as a big purple blob (construction paper). Here, two corresponding transfer RNA (tRNA) molecules are attached to the mRNA. My students look up the amino acids coded for by the RNA using a conversion table available in many textbooks or on the Internet (ThinkQuest 1999). Students can also determine whether a mutation in their models actually affects the coded amino acid.

Display

Several colorful and informative displays can be constructed to conclude this project. All of the DNA strands can by linked together to create an impressively long strand. My students create a poster featuring their DNA, mRNA, and tRNA molecules to describe the processes of replication, mutation, and protein synthesis.

DNA is the fundamental substance of all living things, encoding the unique traits of every organism on Earth. By modeling the essential functions of replication, mutation, and protein synthesis, students can gain a deep appreciation and understanding of this amazing molecule!

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The Area of an Irregular Object

Science teachers are often looking for ways to integrate more mathematics applications into laboratory situations. Quantifiable data can provide students with a greater understanding of scientific concepts. Most high school students have a working knowledge of introductory concepts in geometry and algebra. Direct application of these skills provides an interdisciplinary science-math approach to solving problems.

One such application is for students to determine the area of an irregular object. Most students are familiar with using formulas to determine areas of regular shapes such as rectangles, circles, and triangles. However, no simple formula exists for calculating areas of unusual shapes. Knowing how to measure an unusual shape is valuable. For example, students may need to calculate the area of a leaf to determine transpiration or may want to establish the area of a specific region on a topographic map. The following method to determine the area of irregular objects and curves requires only copy paper and a balance, preferably one with 0.001 g accuracy or greater. This technique produces consistent results.

Students begin by tracing the object onto copy paper. Copy paper is extremely uniform with consistent mass over a given area (Paper Task Force 1995). Students cut out the traced shape with scissors and also cut out a piece of copy paper that is precisely 1 cm × 1 cm.

The two items are massed independently on a balance. Students then set up a proportion and solve a simple algebraic equation:

$$\frac{\text{mass of traced object}}{\text{mass of cm}^2\text{ box}} = \frac{\chi\text{ cm}^2\text{ area}}{1\text{ cm}^2\text{ area}}$$

The result is the area of the object. The method is extremely accurate, reliable, and reproducible.

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