

Central Dogma

Teacher Instructions: Creating the DNA Sequence

This lesson will begin the first panel of the 3-panel (total) art project. Please note that this lesson's panel is not completed until Lesson 3. The art instruction and the science instruction are integrated and intended to “flow” together.

Visual Inquiry:

DNA and cell images are shown, with the teacher asking leading questions to elicit students' prior knowledge about the DNA structure.

Ask:

What is the spiral, twisted structure?

What is DNA?

What is the base unit of DNA?

What do the letters represent? (The intent here is to move students toward the answer: “a code”. The teacher then helps students understand a code as an artificial representation which is formed through a sign system/language and may be translated to another sign system/language.)

How else could this code be represented? (Teacher guides students to the answer: “through color”.)

A color wheel is shown, with the teacher asking leading questions to help students connect art with science and to elicit prior art knowledge.

Ask:

What are the **primary colors**?

Answer: The three colors all other colors are derived from (i.e., red, yellow, blue).

Where are they located on the color wheel?

What are the **secondary colors**?

Answer: Colors located between (and composed of) the primary colors on the color wheel (i.e., orange, green, purple).

Where are they located on the color wheel?

What are **tertiary colors** (also called “intermediate” colors)?

Answer: Colors located between (and composed of) the primary and secondary colors on the color wheel (e.g., red-violet, blue-green, etc.).

Where do **tertiary colors** get their names?

Answer: By compounding the two colors that form them, with the primary color named first. For example, yellow-green is the tertiary color formed by combining yellow and green. Yellow is the most predominant color in this equation, because, in essence, it exists twice: once as yellow itself and once as a component of green. Therefore, yellow named first. It would be incorrect to call the color “green-yellow”.

What are **complementary colors**?

Answer: A pair of colors that are located across from each other on the color wheel (180 degrees). When mixed together, they produce a neutral (grays/tans/browns). When placed next to each other in a composition, they create the strongest contrast available. (They visually “pop” and create a color combination that is pleasing to the eye.)

Note: Emphasize the use of the word “complementary” in both the art world and the science world.

Emphasize to students that the goal of the overall project is to create an artistic model/representation of the process in which DNA code is transcribed and translated into amino acids. This process is known as protein synthesis and is how the cell “reads” the DNA code and turns it into tissue, enzymes, hormones or other proteins.

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Undertaking the Project

1. Students choose a palette.

Teacher leads students in a discussion resulting in the assignment of colors to nitrogen base letters. Note: Emphasize that each of the nitrogen bases, A, T, G, C and U, must have their own color. To communicate the close association between T and U, it is suggested that the teacher encourage students to consider choosing colors that are next to each other on the color wheel for T and U. (In art language, these colors are called “analogous”.) For example, if T = blue-green, then U = blue or green. Teacher also leads students to make A-T a complementary set of colors and G-C a different set of complementary colors. For example a 5-color palette could be:

- G = violet
- C = yellow
- A = red-orange
- T = blue-green
- U = blue

The teacher is encouraged to stimulate student logical reasoning by asking them leading questions that help them to create the associations outlined above.

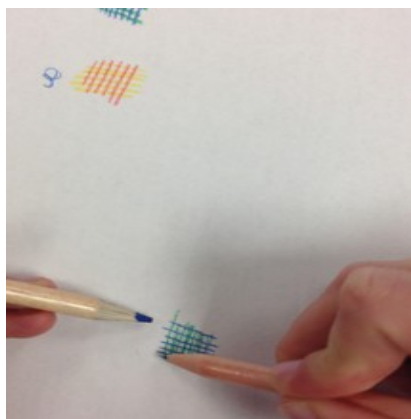
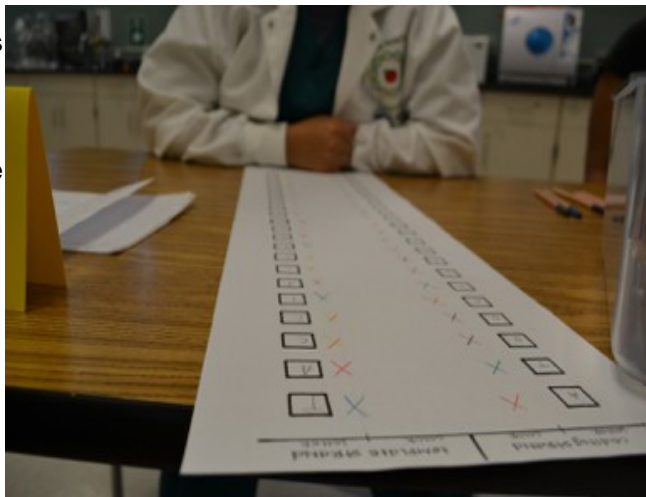
2. Students create their color-coded nitrogen base key.

Students receive the Nitrogen Base Color Coding Key, which they will complete according to the color palette the class has collectively chosen. (This key will serve as their color coding guide throughout the art project.)

3. Students write the complementary nitrogen base letters on the “template” strand of the placemat. (The DNA code is provided on the “coding” strand.)

Using watercolor pencils, have students make “tick marks” on the placemat to indicate the appropriate colors that match the various nitrogen bases. This will serve as a guide once the students begin applying color to the printmaking paper, which will be part of the final project.

Teacher notes: The DNA sequence provided was made specifically for this project and likely does not occur in nature. It contains three viable “reading frames” that may or may not be used as part of instruction. In reality, there is usually only one reading frame that is functional and will result in a peptide chain. Reading frames are addressed in Lesson 4.



4. Using watercolor pencils, students crosshatch color-coded squares on the printmaking paper, matching the appropriate nitrogen base to the color specified by the key. Students will need to be instructed how to “cross-hatch” with the watercolor pencils.

Note: in tertiary color combinations (e.g., red-violet) the darker color is applied with a softer touch as the first hatched layer, and the lighter color is applied with more pressure as the second hatched layer. Emphasize that individual “style” can come into play here.

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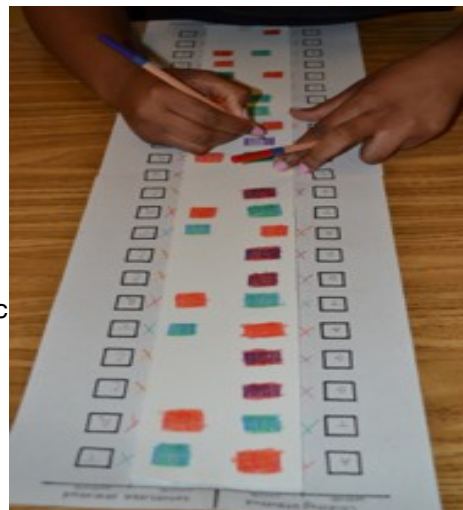
5. Prior to beginning Step 5, provide science instruction. There are many excellent science diagrams and videos that explain the processes of transcription and translation. Many science teachers already have these strategies as part of their established protein synthesis lesson plans. Insert these science lessons as needed to help students understand the process they are representing artistically.

Next, using small paintbrushes or cotton swabs dipped in a very small amount of water, moisten the cross-hatched, colored squares until the hatch marks are blended and disappear. This step is critical for the artistic component, because adding water causes the pencil marks to behave as if it were watercolor paint. If you skip this step, you simply have the appearance of colored pencils and you lose the aesthetic value of the watercolor medium.

6. Students “unzip” the two strands of DNA.

Show a video clip of the entire process of protein synthesis. Be sure to point out that “unzipping” of the double stranded DNA is one of the first steps in this process.

Instruct students in the differences between purines and pyrimidines. Emphasize that the nitrogen bases are held together by hydrogen bonds, which are weak attractions between molecules; these are not strong bonds. This fact will be artistically represented by tearing and not cutting between the two strands students have created on the printmaking paper. Prior to “unzipping” (tearing), students should “map” a tear line with pencil on their placemat.



Encourage students to compare their “map” to their neighbors’ before beginning the actual tearing process. Students might like a small scrap of printmaking paper to practice their tearing skills and build confidence before they begin to tear the good paper, which is part of the artwork itself. This is one section where it is difficult to make corrections if mistakes are made.

The teacher can elevate students aesthetic discernment skills by discussing the importance of “artistic tension” and “visual texture.” In other words, the visual interplay of the artwork’s geometric regularly with the more organic qualities of the cotton paper is highlighted through deckled/torn edges instead of the hard, straight edges that would be created by scissors. The careful tearing, thus embodies the actually scientific process and also elevates the visual balance of the composition.

Note: This is an excellent place to point out one of the inaccuracies in many DNA illustrations. Many show A-T and G-C as being equal sized molecules. DNA is portrayed as unzipping right down the center. In reality, purines (A and G) are larger molecules that bond with pyrimidines (T and C). Since the pyrimidines are smaller molecules, the DNA double strand does NOT unzip right down the middle. Students should “unzip” (tear) the printmaking paper closer to the pyrimidines nitrogen bases (C,T) and further away from the purine nitrogen bases (A,G).

If the teacher chooses to use Lesson 2 as a stand-alone project, please note that the instructions for “annealing” the DNA strand and mounting it to the poster board are described in Lesson 3, step 2.

