A Recipe for Traits

Abstract

Students create and decode a "DNA recipe" for man's best friend to observe how variations in DNA lead to the inheritance of different traits. Strips of paper (representing DNA) are randomly selected and used to assemble a DNA molecule. Students read the DNA recipe to create a drawing of their pet, and compare it with others in the class to note similarities and differences.

Logistics

Time Required

- **Class Time:** 40 minutes
- **Prep Time:** 30 minutes to review activity, make copies of student pages, and prepare DNA strips

Materials

Copies of student pages, drawing paper, crayons or colored pencils, tape, envelopes, and colored paper for preparing DNA strips (4 colors needed)

Prior Knowledge Needed

Traits are heritable characteristics.

Appropriate For:

Ages: 10 - 16
USA grades: 5 - 10

Learning Objectives

- Every organism inherits a unique combination of traits.
- DNA is a set of instructions that specifies the traits of an organism.
- Information in the DNA molecule is divided into segments (called genes).
- Variations in the DNA lead to the inheritance of different traits.

Special Features You'll Find Inside

- Copy masters for preparing colored DNA strips having fun symbols to represent information about traits.
- A dog traits key that allows students to decode their DNA recipe and visualize how traits are specified.

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Classroom Implementation

Quantities

Per Student or Pair

- One copy of student pages S-1 to S-3
- One envelope containing "Dog DNA" (see instructions at left)
- Crayons or colored pencils, drawing paper, tape

Prepare "Dog DNA" envelopes:

For 28 envelopes:

1. Make eight copies each of DNA Strips A, B, C, and D (pages 4-7) on colored paper choosing one color for each type of DNA Strip. For example:

   DNA Strips A (page 5) 8 copies on Blue
   DNA Strips B (page 6) 8 copies on Green
   DNA Strips C (page 7) 8 copies on Yellow
   DNA Strips D (page 8) 8 copies on Red

2. Cut out the DNA strips on each page (a paper-cutter works well)
3. Place two DNA strips of each color in an envelope. The envelope should contain eight DNA strips total (four different colors).
4. Repeat step three until you have assembled 28 "Dog DNA" envelopes.

Note: This is the minimum number of DNA strips per envelope that you need to carry out the activity. Adding more DNA strips of each color increases the variety of possibilities for each trait.

Activity instructions:

- Display different types of instructions (e.g. a recipe book, a blueprint, a DNA molecule) and ask students for what they might use these instructions. Explain that just as a recipe is used to cook a meal or a blueprint is used to build a home, DNA contains instructions that specify an organism's traits.
- Read the beginning paragraph of *A Recipe for Traits* (student page S-1) as a class. You may want to show them a completed DNA "recipe" and point out the different segments (representing genes) as well as the 4 symbols (representing the 4 chemical bases A, C, G and T) that make up the DNA alphabet in this activity.
- Review the instructions on page S-1. You may want to demonstrate how to use the *Dog Traits Key* (see page S-2 to S-3) to read the DNA recipe and identify the first trait.
- Remind students to leave the DNA strips they choose out of the envelope and tape them together *in order*. The resulting long strand will be their DNA recipe.
- Have students work individually or in pairs to complete the activity. When students have finished, have them post their dog drawings on the wall along with the DNA recipe for their dog.

Discussion Points:

- Are any two dogs alike? Point out that every dog shares some traits in common with others, but each has an

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overall combination of traits that is unique.

- Variations in each DNA strand (the sequence of symbols) led to the inheritance of different traits.

Advanced Discussion Points:

- Information in a DNA strand (or molecule) is grouped into small segments called genes (represented here by colored DNA strips).
- A single DNA strand is often referred to as a chromosome. In this example, the dog had one chromosome containing 8 genes. (Humans have 23 pairs of chromosomes containing over 22,000 genes!)
- The DNA molecule contains a sequence of four chemical bases (represented here by four symbols). Each base is referred to by the first letter of its name: Adenine (A), Cytosine (C), Guanine (G) and Thymine (T). The sequence of these chemical bases encodes a detailed set of instructions for building an organism's traits. (The human genome contains approximately 3 billion pairs or bases!)
- Students were asked to assemble their DNA strips in the order they were drawn. This is because all individuals of a species have the same genes in the same order along their chromosomes. (This is what allows researchers to "map" the location of a gene to a specific place on a chromosome.) It is the small sequence variations within each gene that lead to differences in traits.
- There is usually a limited number of sequence variations for a gene. That is, a gene usually comes in a few different forms or flavors (called "alleles"). There was a possibility of four different flavors or alleles for each of the dog genes in this activity.
- In this activity, a single gene determined each dog trait. Typically, a trait is influenced by more than one gene as well as environmental factors.

Extension:

- As a class, make a "map" of your dog genome. Compare the different DNA recipes hanging up in the classroom. Point out that the gene for body shape is always at the top of the DNA molecule (or chromosome), the gene for head shape is always second, and so on. Draw a representation of a chromosome having 8 segments. Have students come up with a name for each gene. Label the segments with the gene names, and specify the trait they encode. Point out that although each dog looks differently (has a different combination of traits), it is still possible to make a general map of the dog genome.
- Show students a completed map of the human genome (e.g., the Human Genome Landmarks Poster or its web companion) and discuss how researchers have mapped the 22,000 plus genes to particular locations on the 23 pairs of human chromosomes. To order a free copy of this poster or view it online, check out the web site developed by the U.S. Department of Energy's Human Genome Management Information System

Learn More

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Module
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Standards

(HGMIS).

U.S. National Science Education Standards

Grades 5-8:
Content Standard C: Reproduction and Heredity

- Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.
- Hereditary information is contained in genes, located in the chromosomes of each cell. Each gene carries a single unit of information. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes.
- The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment.

Grades 9-12
Content Standard C: Reproduction and Heredity

- In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA... genetic information that underlies heredity is encoded in genes (as a string of molecular "letters"). Each DNA molecule in a cell forms a single chromosome.

AAAS Benchmarks for Science Literacy

Grades 3-5:
The Living Environment: Heredity - Some likenesses between children and parents, such as eye color in human beings, or fruit or flower color in plants, are inherited. For offspring to resemble their parents, there must be a reliable way to transfer information from one generation to the next.

Grades 9-12:
The Living Environment: Heredity - The information passed from parents to offspring is coded in DNA molecules. Genes are segments of DNA molecules.

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The Basics and Beyond: An Introduction to Heredity

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Credits

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Steven Kiger (illustrations)
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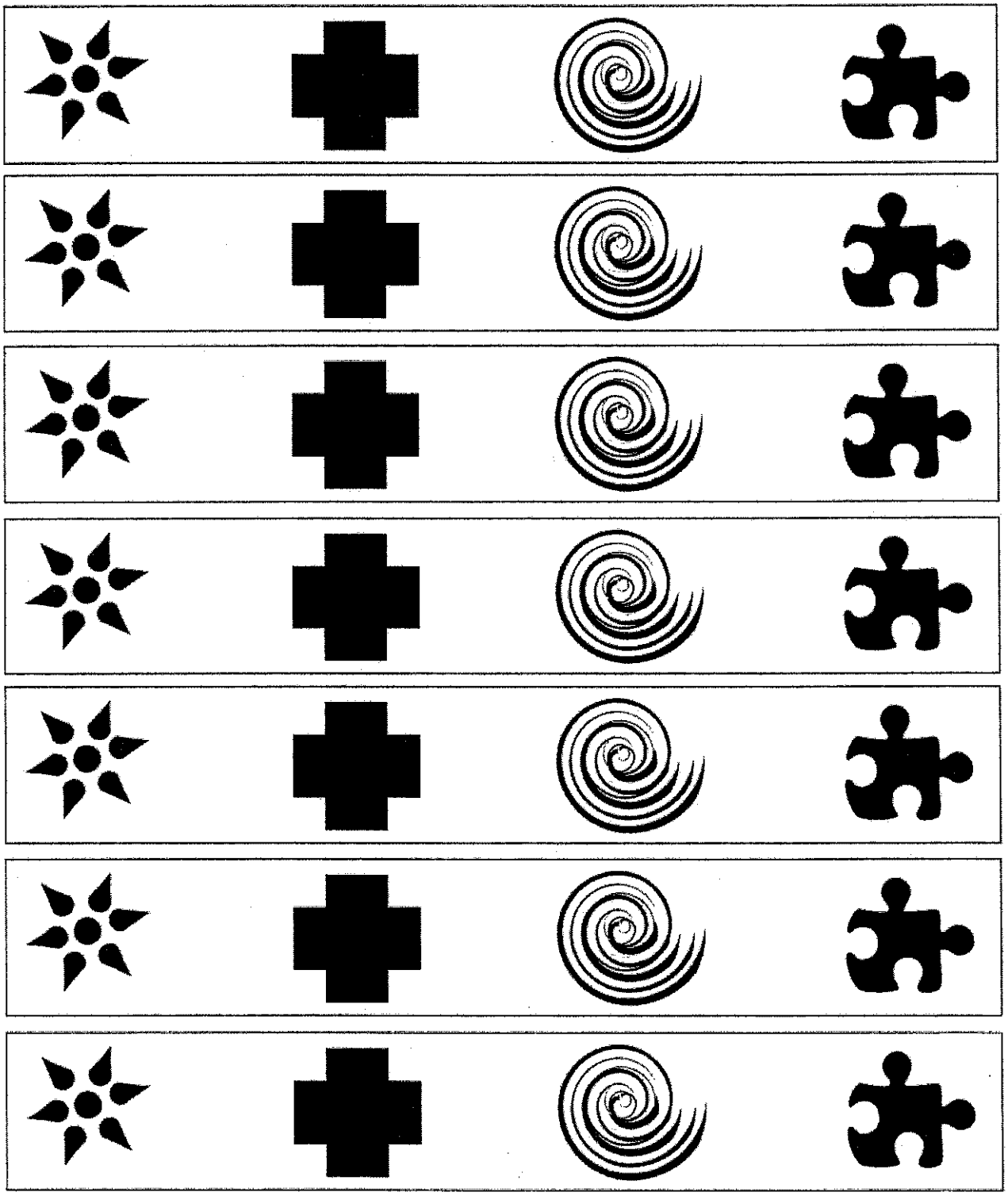
DNA Strips D



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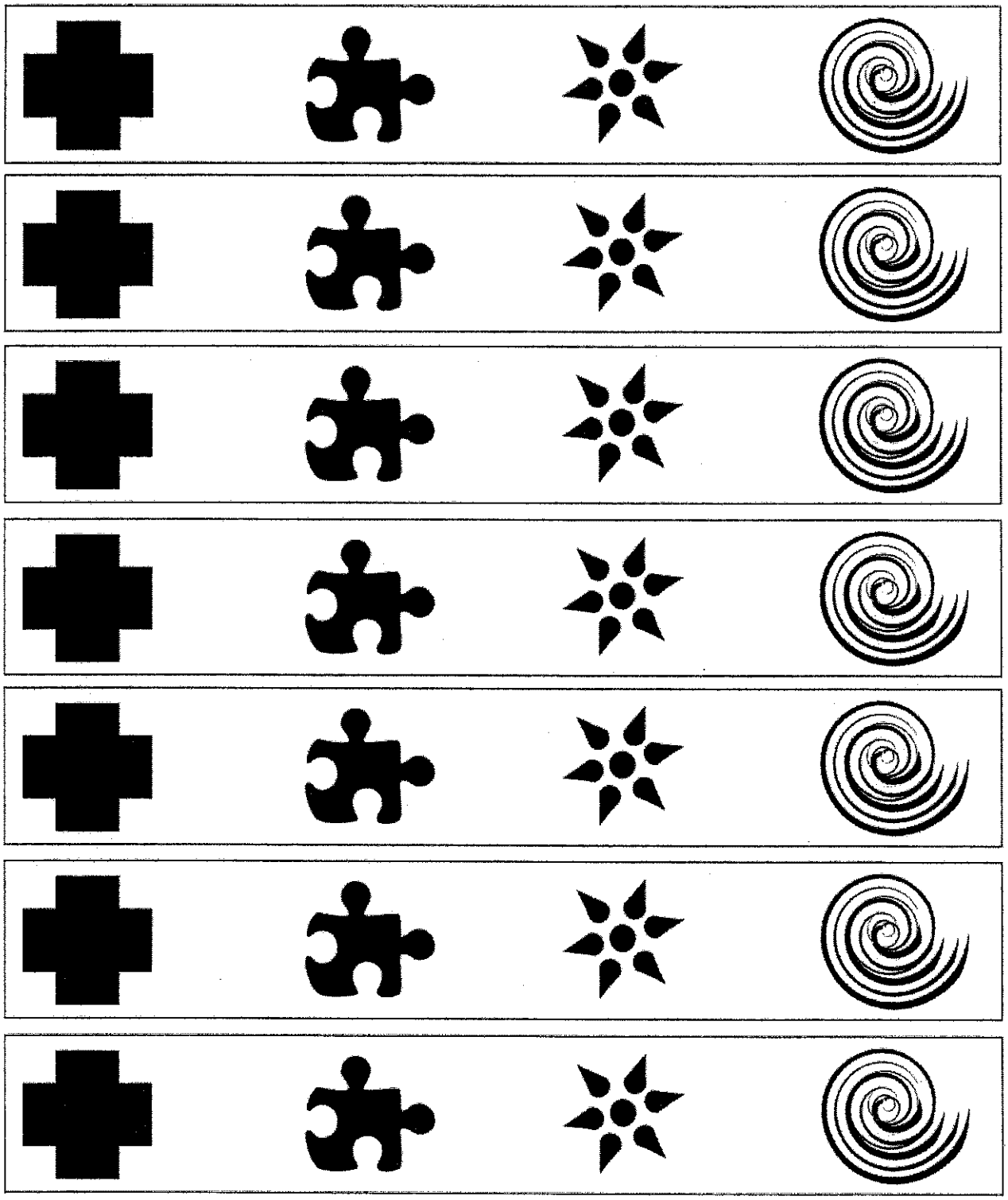
DNA Strips B



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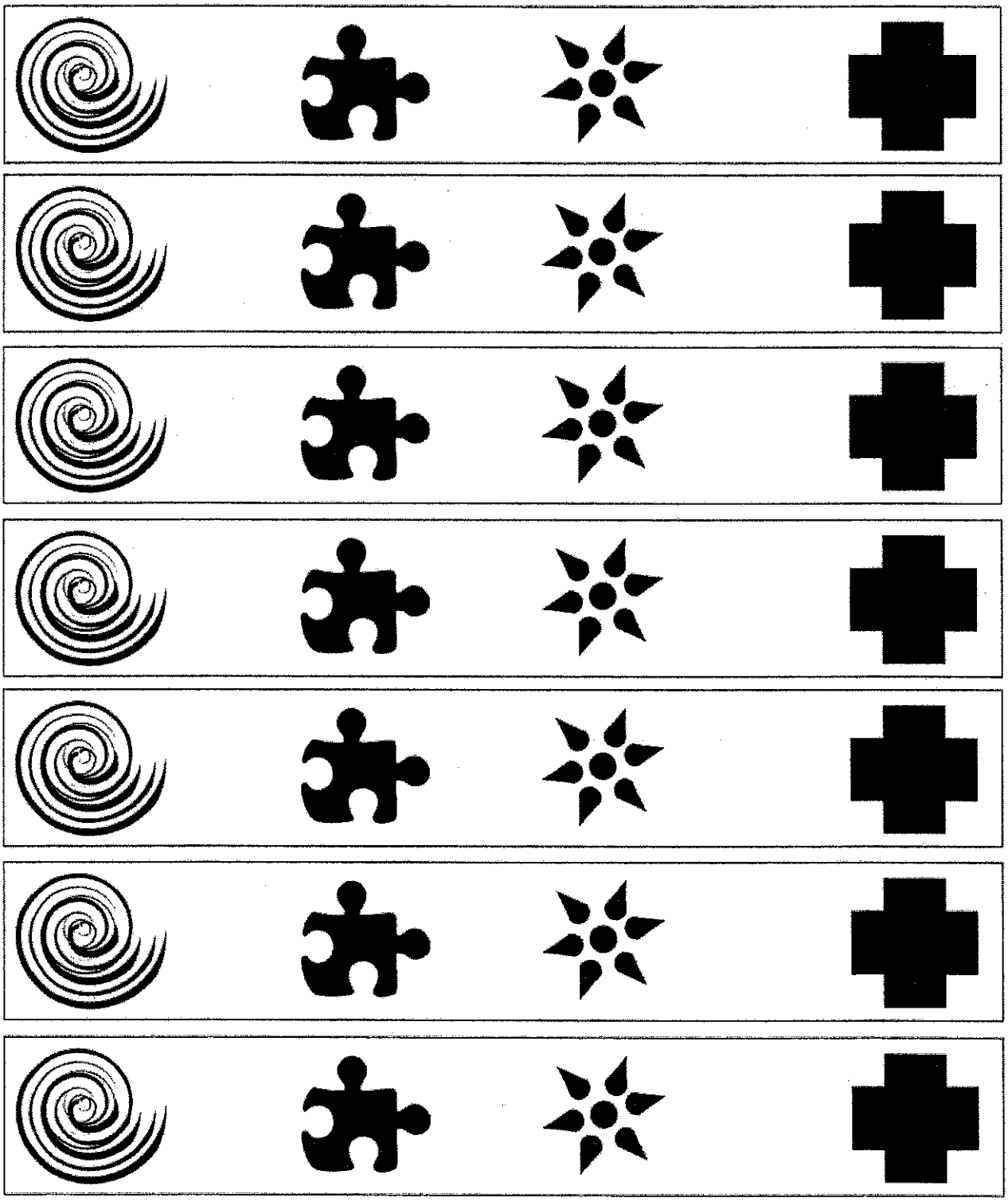
DNA Strips C



Module
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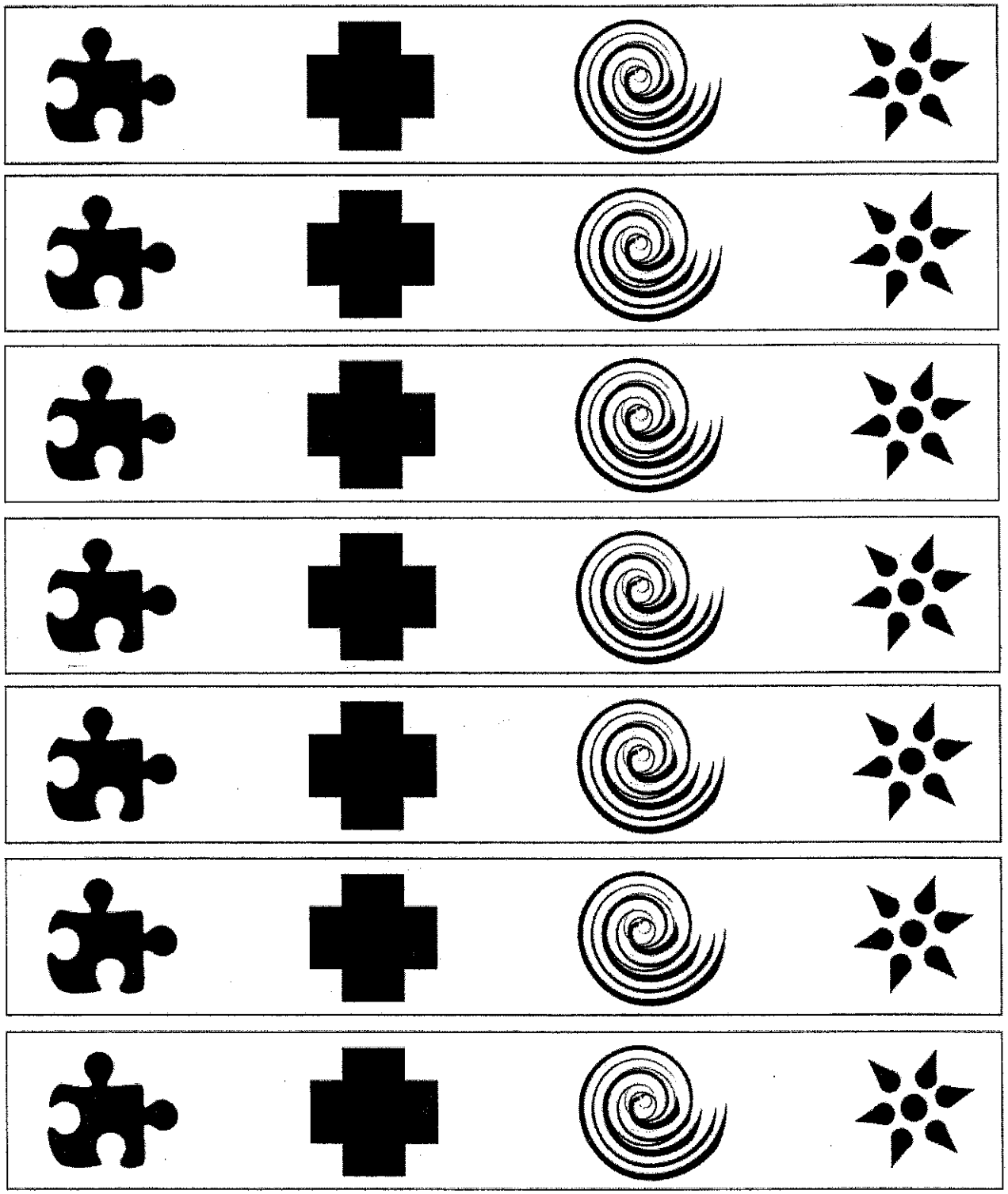
DNA Strips A

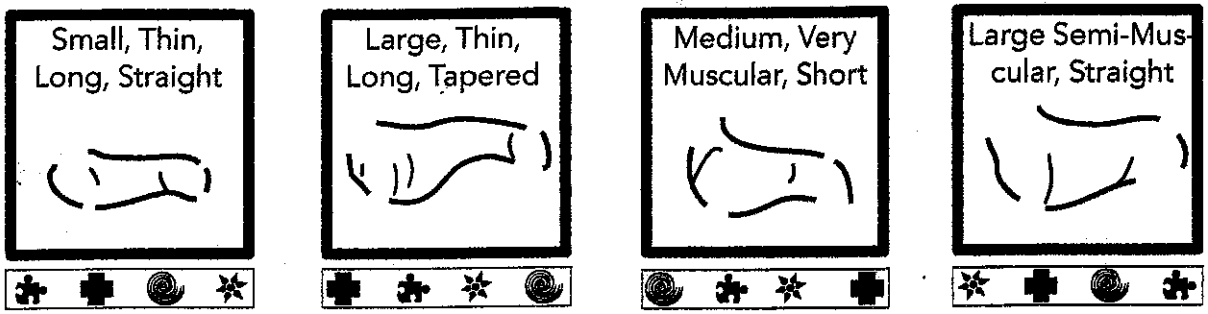


NAME _____ DATE _____

Dog Traits Key

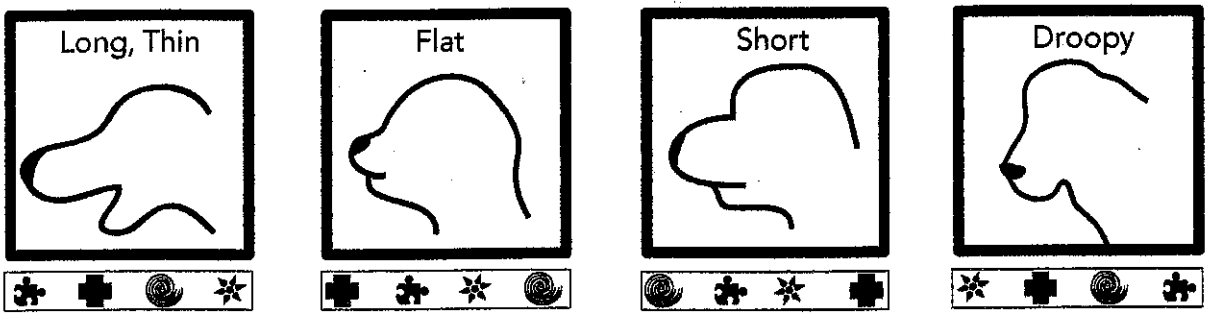
Body Shape

1.



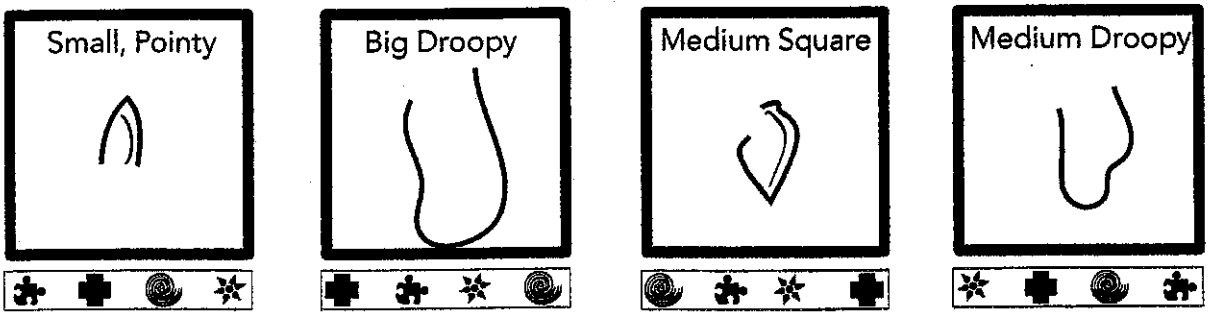
Head Shape

2.



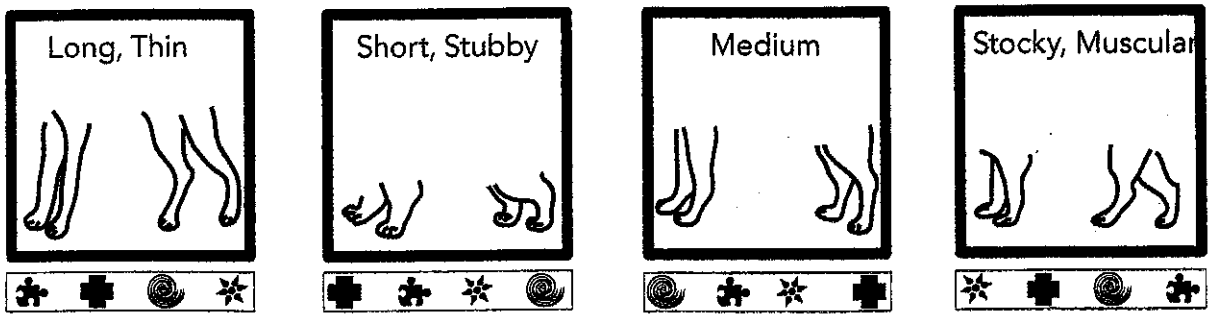
Ears

3.



Legs

4.

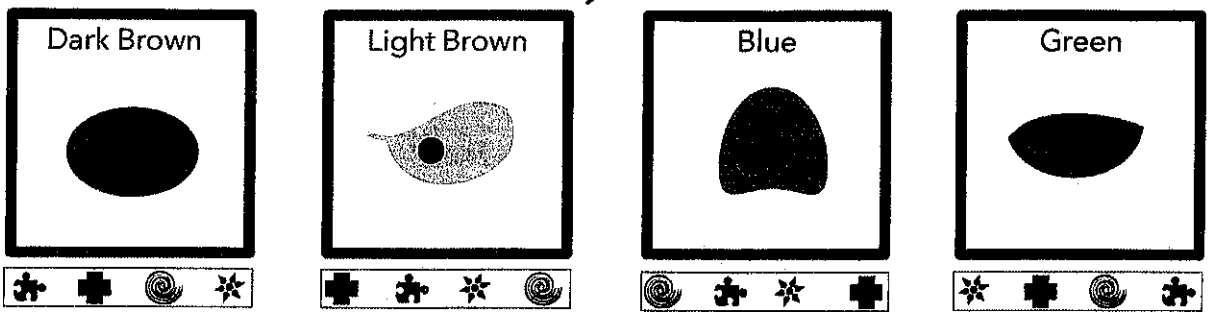


NAME _____ DATE _____

Dog Traits Key

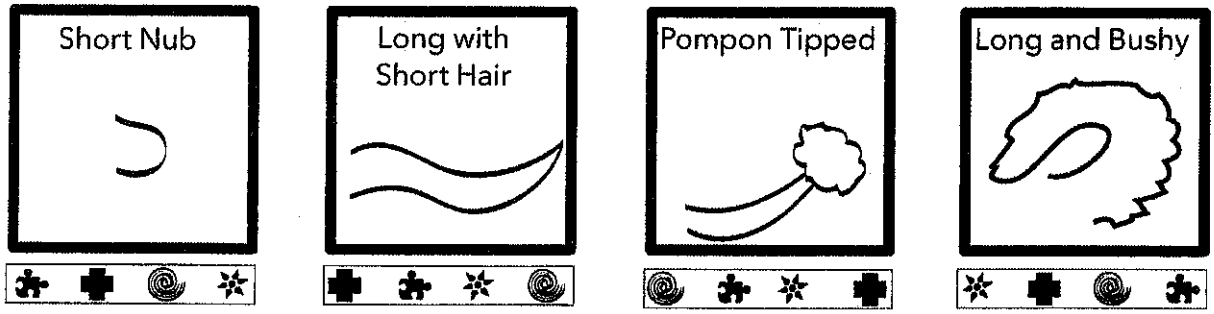
Eyes

5.



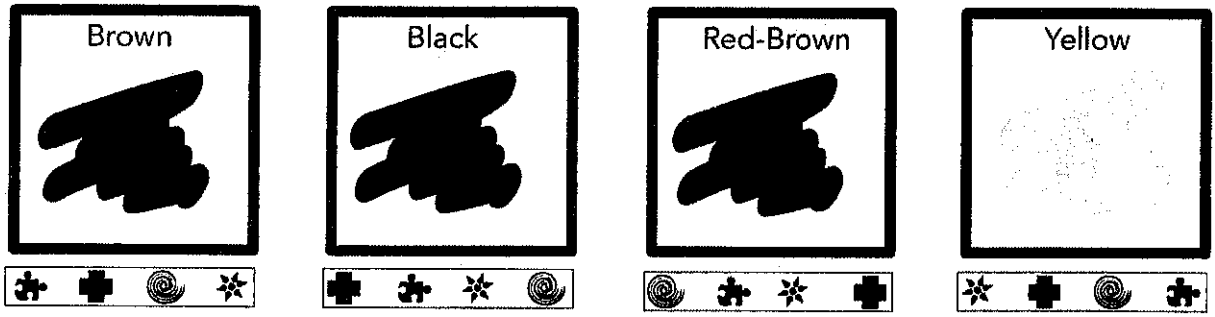
Tail

6.



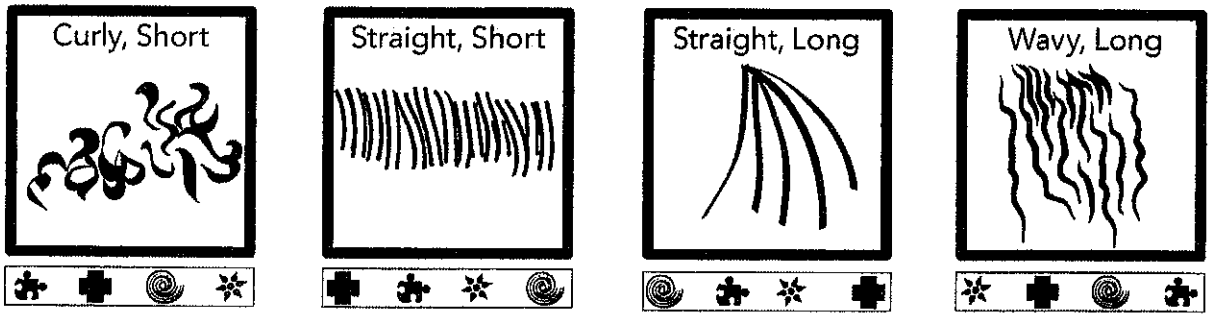
Coat Color

7.



Hair

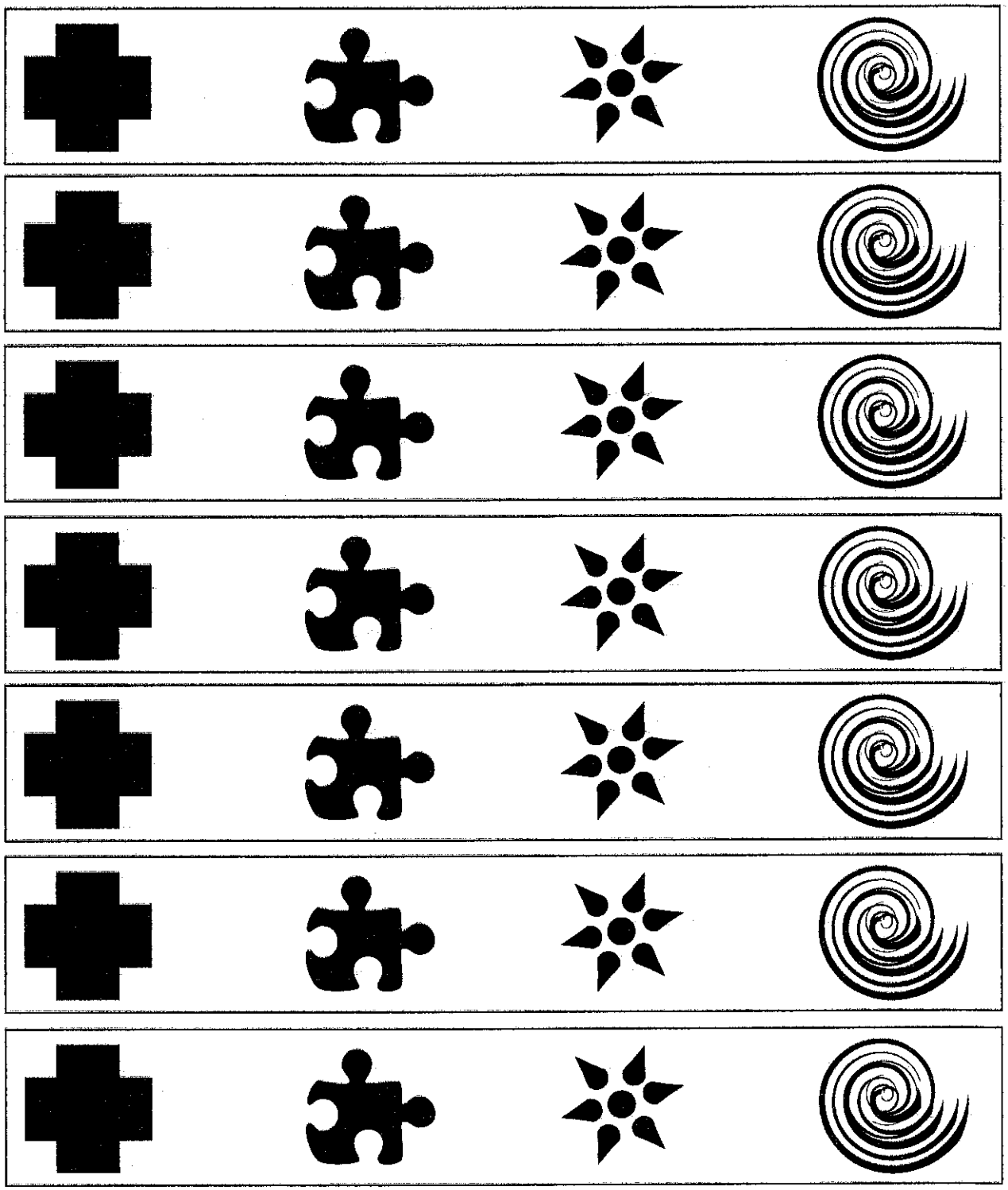
8.



GREEN

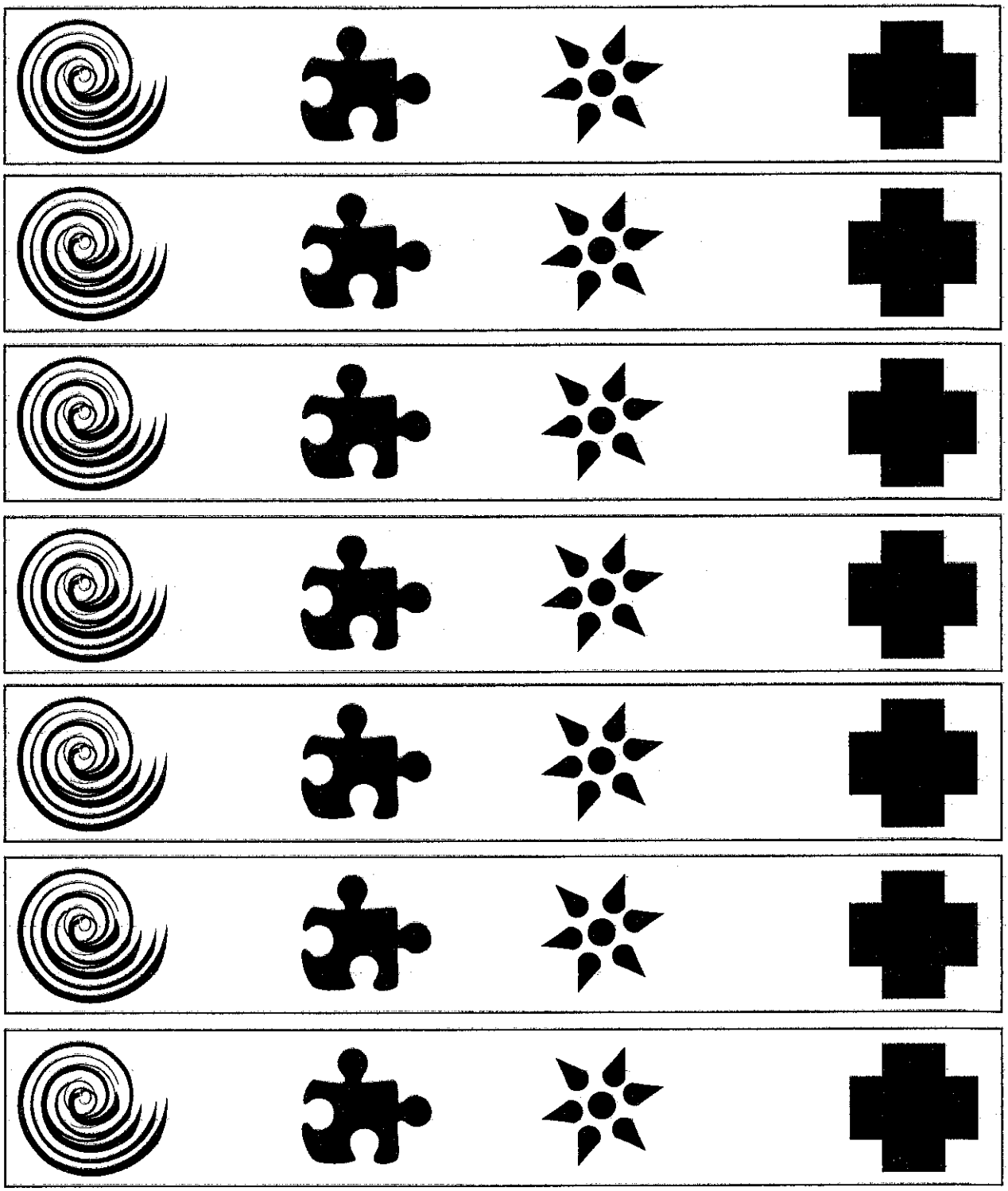
GREEN

DNA Strips B



Yellow Yellow

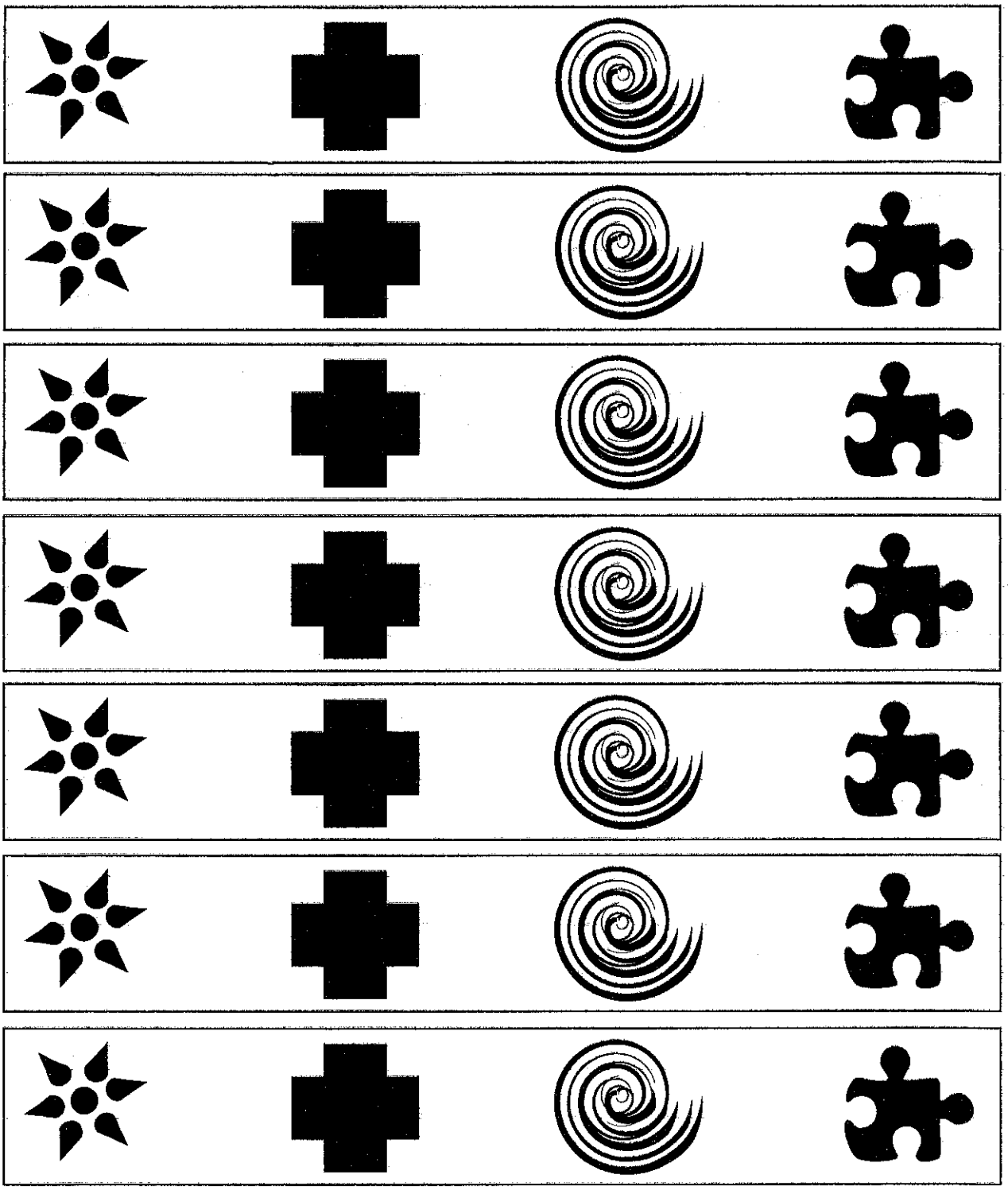
DNA Strips C



ORANGE

ORANGE

DNA Strips D



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Cut-outs

BLUE

BLUE

DNA Strips A