

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

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

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

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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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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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A Recipe for Traits

Credits

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Steven Kiger (illustrations)

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Funding

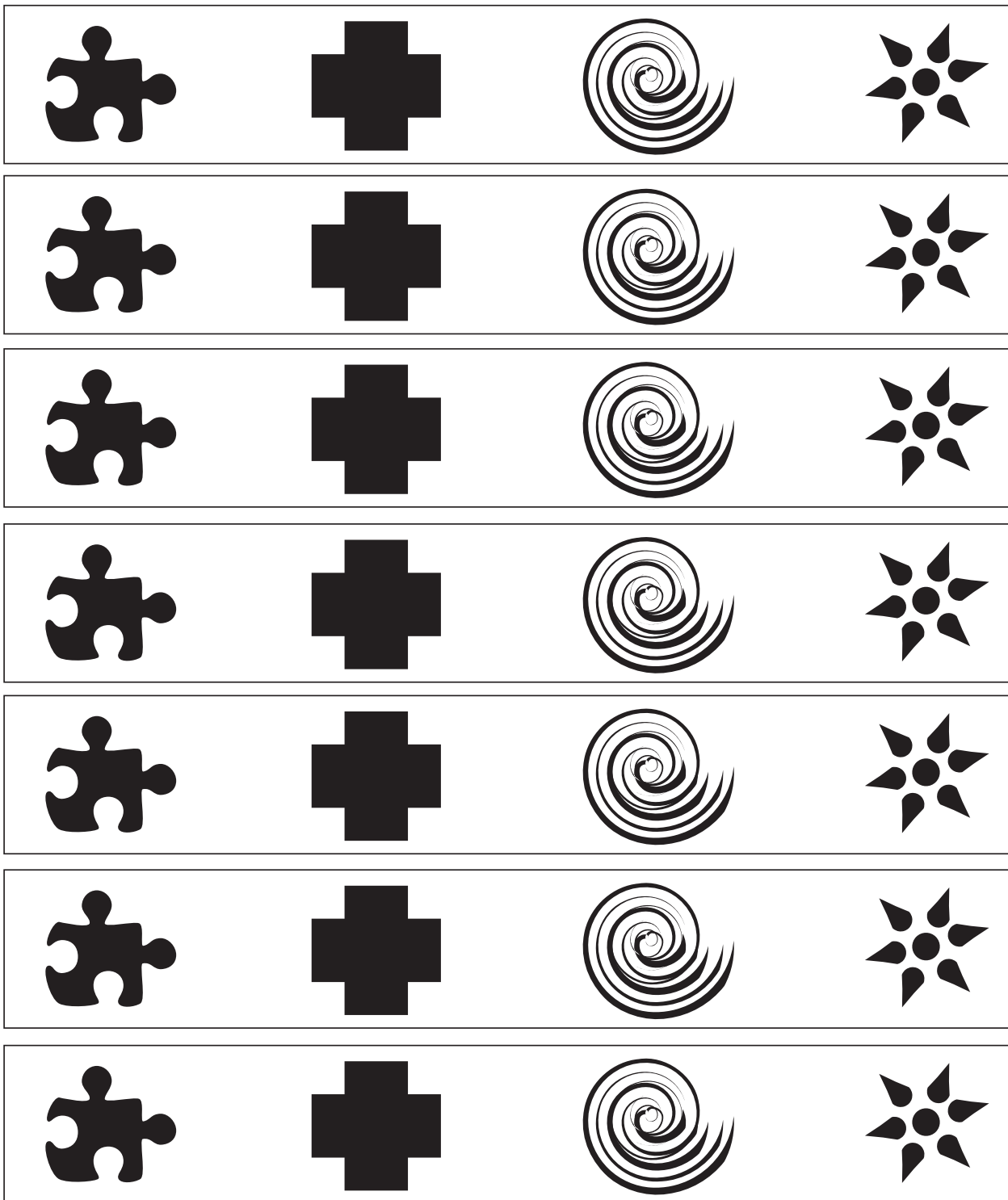
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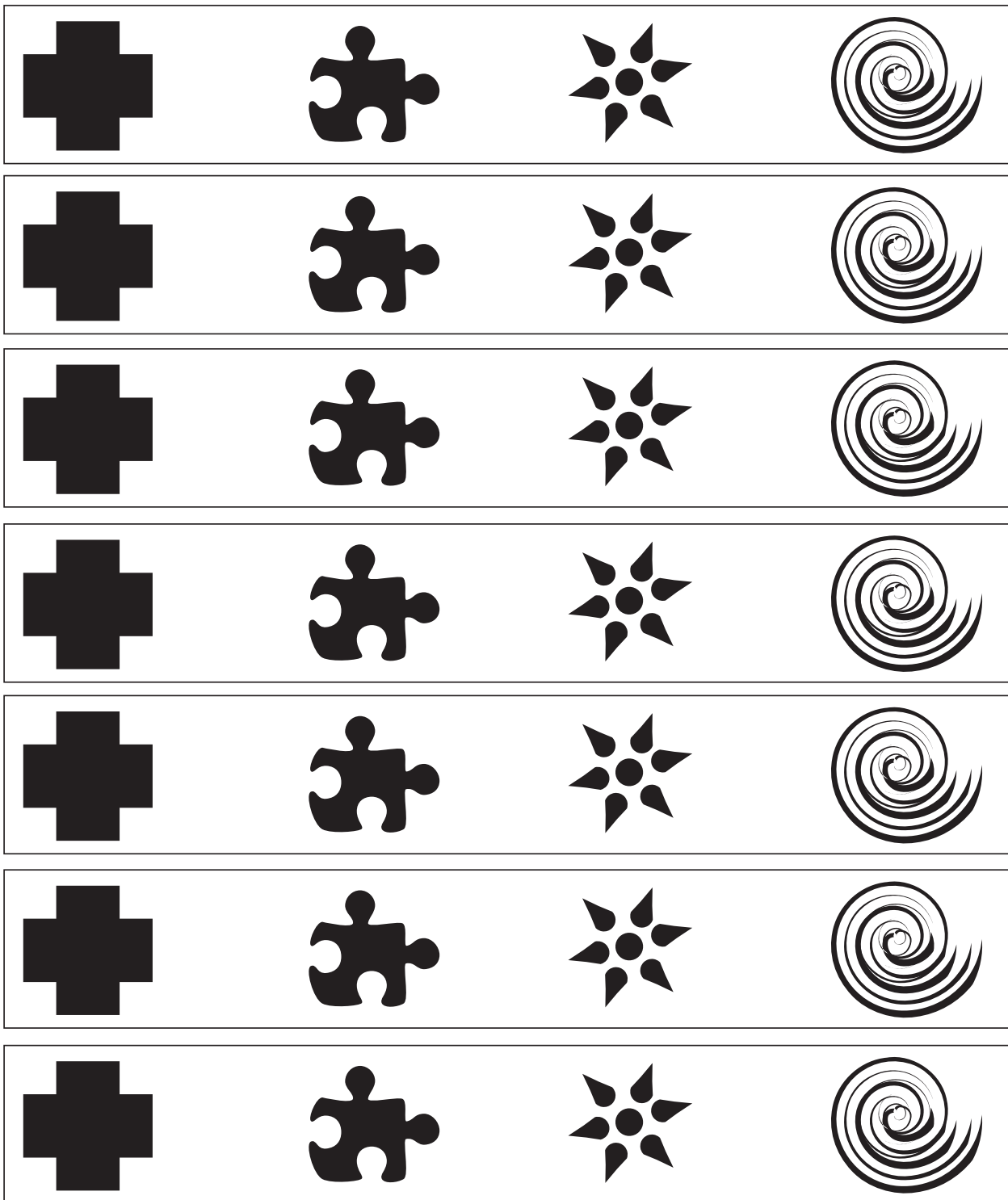
A Recipe for Traits

DNA Strips A



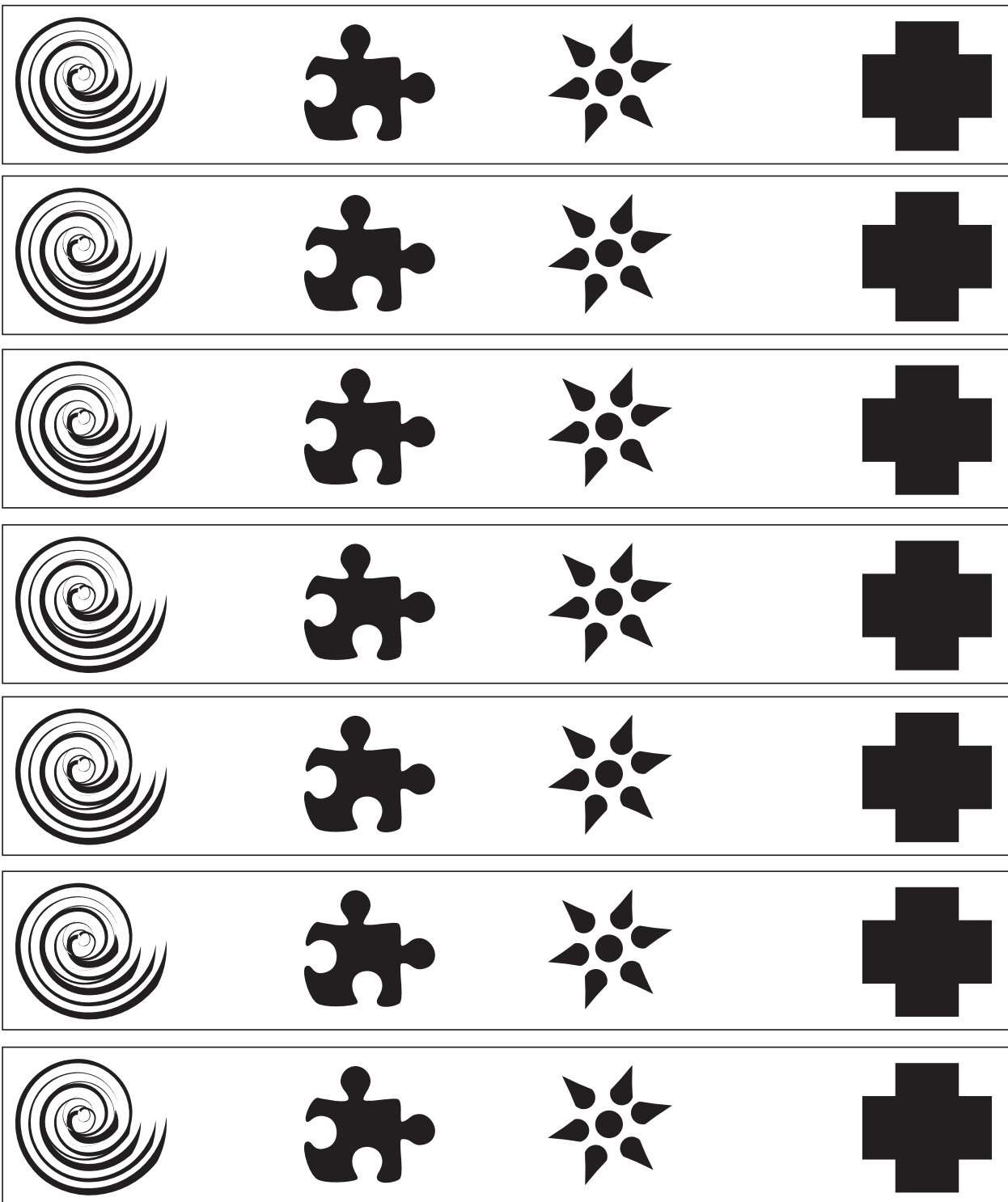
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DNA Strips B



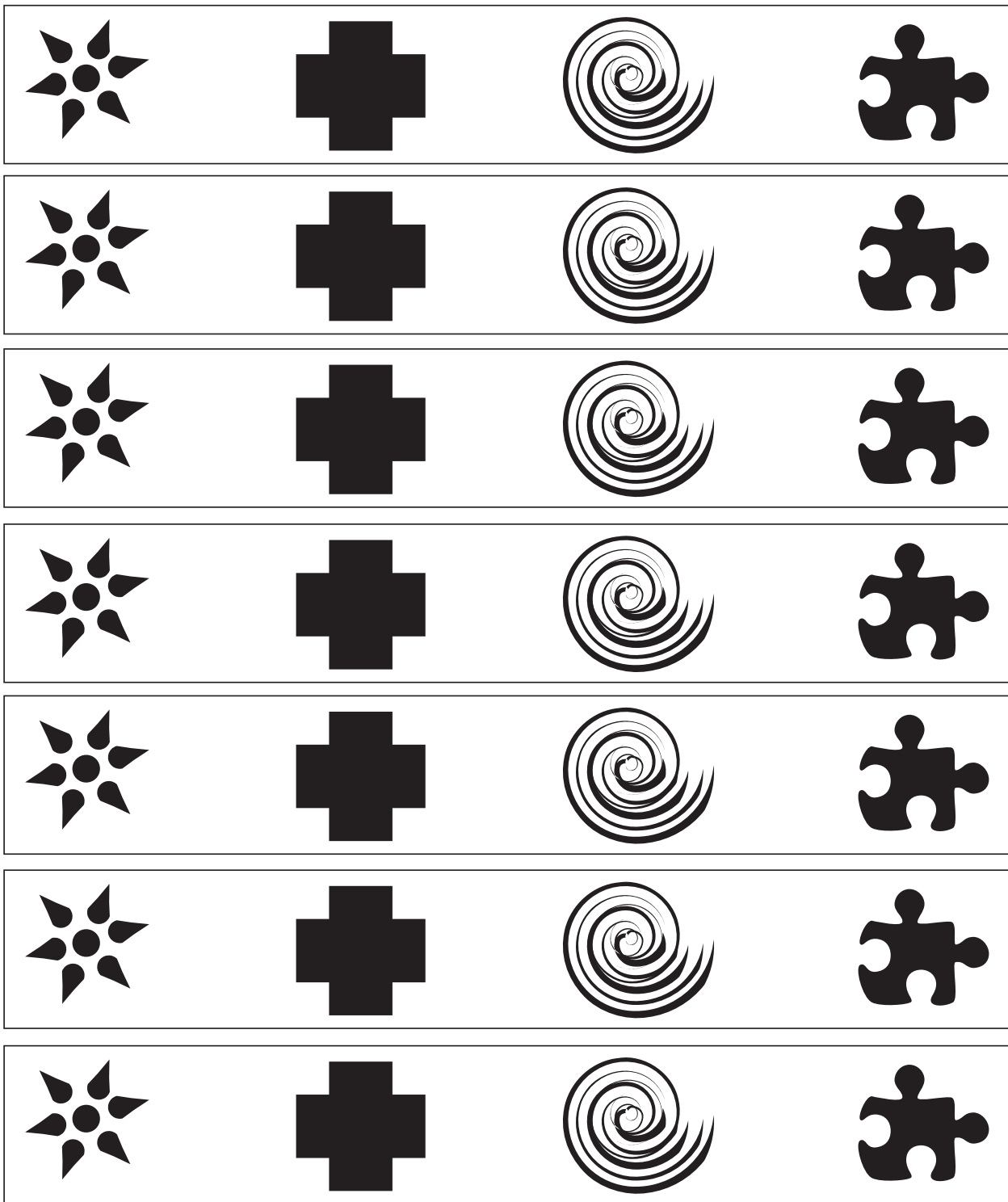
A Recipe for Traits

DNA Strips C



A Recipe for Traits

DNA Strips D



Name _____

Date _____

A Recipe for Traits

A set of instructions called DNA makes a “recipe” for traits in all organisms. Information in a DNA strand is grouped into small segments. Each segment is made of even smaller units (like recipes are made of words, and words are made of letters). Differences in the DNA “alphabet” are what make differences in traits (just like a different sequence of letters makes different words, and a different recipe).

Follow the directions below to create a DNA recipe for a dog. Using the Dog Traits Key, read your DNA recipe and make a drawing of your dog showing all of its traits.

Directions:

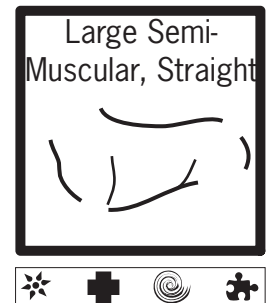
1. Make sure you have an envelope containing “Dog DNA”.
2. Determine the first trait of your dog (body shape) by randomly picking a piece of dog DNA out of the envelope.
3. Look at the symbols on the DNA strip you have chosen. Match the pattern to one you see on the Dog Traits Key for body shape.
4. Circle the picture for body shape that matches the DNA piece that you picked.
5. Set the piece of DNA aside and repeat steps 1-4 for the next trait on the key.
6. After circling the matching picture, tape the second piece of DNA to the first to make one long strand. This will become the DNA recipe for your entire dog.
7. Repeat these steps for each of the traits listed on the Dog Traits Key.
8. When you have finished, draw your dog with all of its traits (the traits you have circled on the Dog Traits Key) on a separate piece of paper.
9. As instructed by your teacher, hang up the picture of your dog along with its DNA recipe (the DNA pieces you chose attached in a long strand).

Is your dog different from or the same as others in the class?

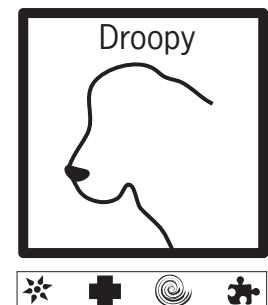
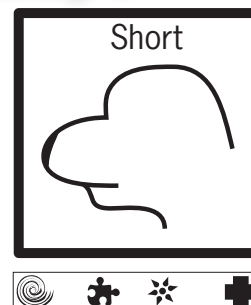
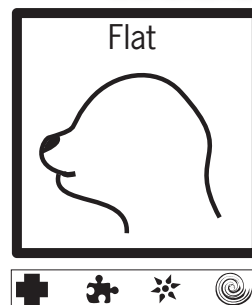
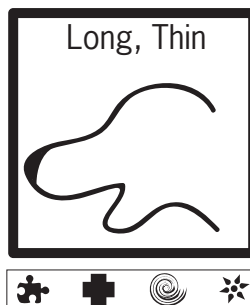
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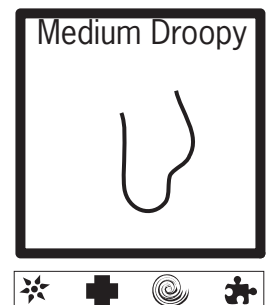
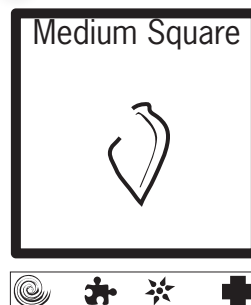
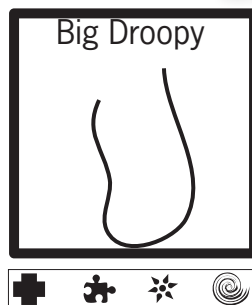
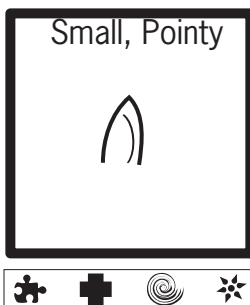
Body Shape



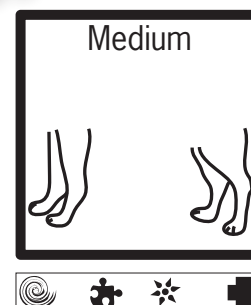
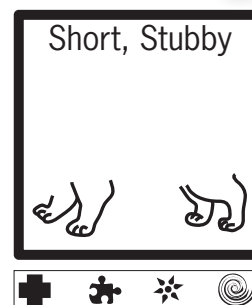
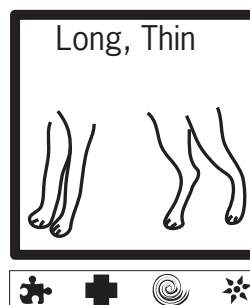
Head Shape



Ears



Legs



Dog Traits Key

Name _____

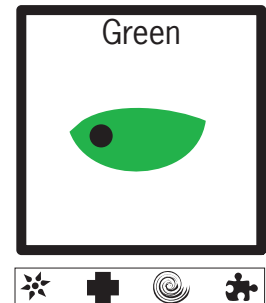
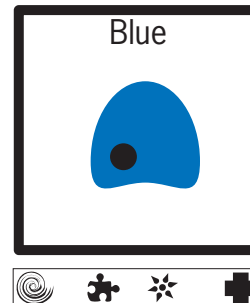
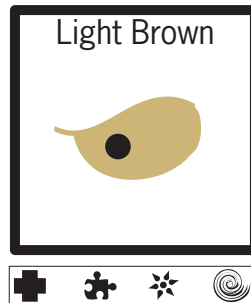
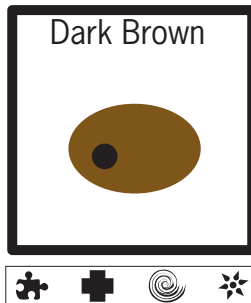
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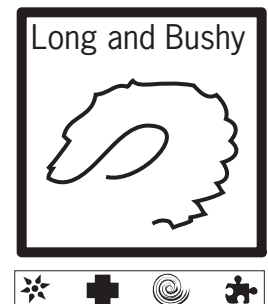
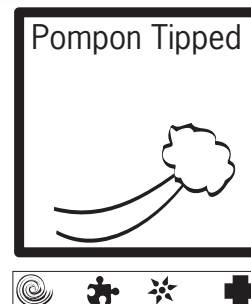
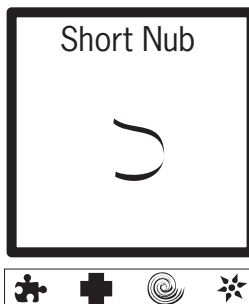
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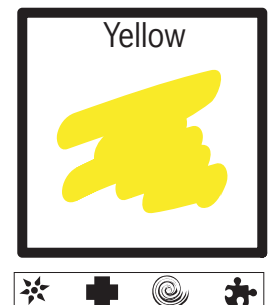
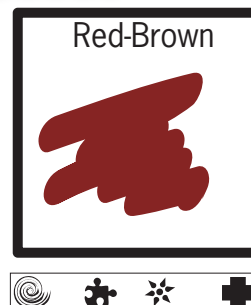
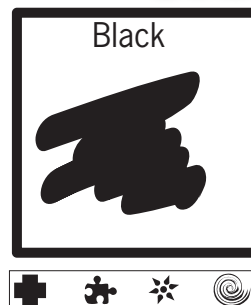
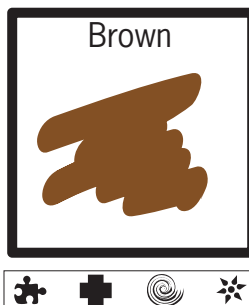
Eyes



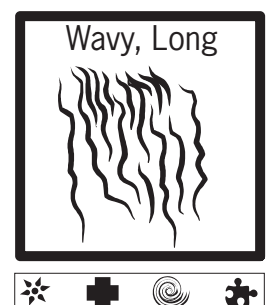
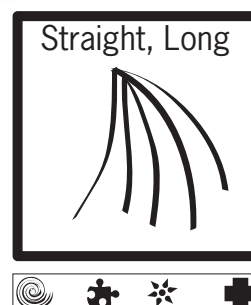
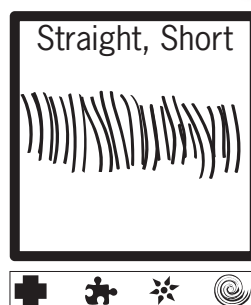
Tail



Coat Color



Hair



Dog Traits Key

Name _____

Date _____

Una Receta de Rasgos

Un sistema de instrucciones llamado ADN provee una “receta de rasgos” para todos los organismos. La información se agrupa en segmentos pequeños en el filamento del ADN. Cada segmento incluso está hecho de unidades más pequeñas (como las recetas que están hechas de palabras y las palabras de letras). Las diferencias en el “alfabeto” del ADN son lo qué hace diferente a los rasgos (justo como la diferente secuencia de las letras hace que las palabras sean diferentes y por ende, una diferente receta).

Siga las instrucciones de abajo para crear una receta de ADN para un perro. Con la clave de rasgos del perro lea su receta del ADN y haga un dibujo que demuestre todos los rasgos de su perro.

Instrucciones:

1. Asegúrese de tener un sobre que contenga el “ADN del Perro”.
2. Determine el primer rasgo de su perro (forma del cuerpo) escogiendo al azar un pedazo del ADN del perro fuera del sobre.
3. Mire los símbolos en el filamento del ADN que escogió. Iguale el patrón con uno que vea en la clave de rasgos del perro para la forma del cuerpo.
4. Haga un círculo en la forma del cuerpo de la figura que igualó al pedazo de ADN que escogió.
5. Ponga el pedazo del ADN a un lado y repita los pasos del 1 al 4 para los rasgos que siguen.
6. Después de circular las figuras emparejadas, usando cinta engomada pegue el segundo pedazo de ADN al primero para hacer una tira larga. Esta se convertirá en la receta del ADN para su perro entero.
7. Repita los pasos para cada rasgo enumerado en la lista de la clave de rasgos del perro.
8. Cuando acabe, dibuje su perro en una nueva hoja de papel con todos los rasgos (los rasgos que ha circulado en la clave de rasgos del perro).
9. Siga las instrucciones del profesor. Cuelgue la figura de su perro junto con su receta del ADN (los pedazos de ADN que escogió unirlos en un largo filamento).

¿Es su perro igual o diferente a los demás en su clase?

Name _____

Date _____

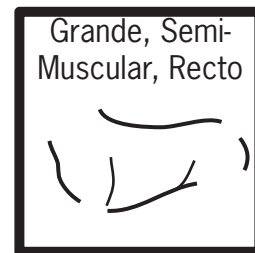
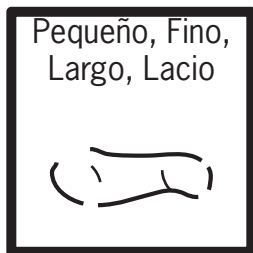
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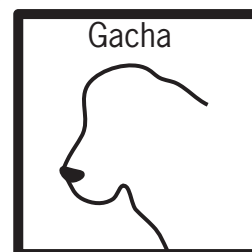
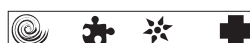
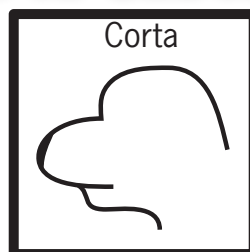
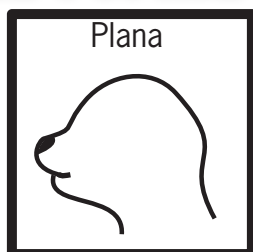


Clave de Rasgos en un Perro

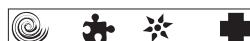
La Forma del Cuerpo



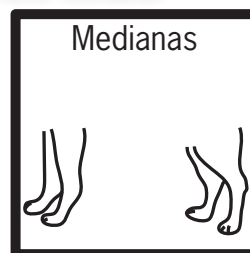
La Forma de la Cabeza



Las Orejas



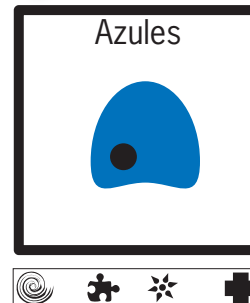
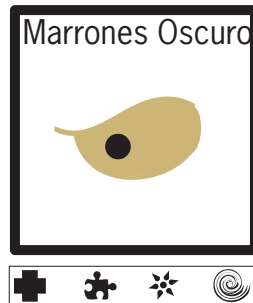
Las Piernas



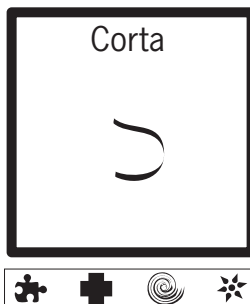
Name _____

Date _____

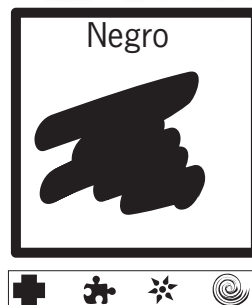
Los Ojos



La Cola



El Color del Pelaje



El Pelo



Clave de Rasgos en un Perro