Modeling Modeling

Focus on Inquiry

The student will

- Give examples of models used in science
- Identify several different types (groups) of models
- Identify similar and different characteristics among model types
- Select appropriate models for different scenarios (based on standards).

Next Generation Science Standards – Inquiry

NGSS Practice 2:Developing and Using Models

Florida Science Standards – Inquiry

SC.7.N.3.2 Identify the benefits and limitations of the use of scientific models
SC.8.N.3.1 Select models useful in the investigations

Materials and Advance Preparation

Materials List

Class set:

Projector and Whiteboard
Models PowerPoint

Student materials:

One set for each small group:

Pictures of various types of models (**Blackline Master #4 Model Cut-outs)**
Worksheet 1 (**Blackline Master #1: Model Sorting)**
Worksheet 2a **OR** 2b (**Blackline Master # 2: Select Appropriate Models)**

Blackline Masters

1. **Blackline Master #1: Worksheet 1 - Model Sorting**
2. **Blackline Master # 2: Worksheet 2 - Select Appropriate Models**
    a. **Blackline Master 2a: Science Standards**
    b. **Blackline Master 2b: Science Cases**
3. **Blackline Master #3 Model Cut-outs**
4. **Blackline Master #4 Example for Comparing Model Categories**

Advance Preparation

1. Create a copy of the **Blackline Master #1 Model Cut-outs for each group**
2. Cut out Model pictures.
3. Present 1 set to each group

Lesson Information

Learning Objectives

1. The student will be able to identify the multiple uses of models in science and their advantages and limitations.
2. The student will be able to identify that different models can be appropriate in the same context based on the different groupings formed in class and the subsequent discussion on the criteria (and limitations) for each group.
3. The student will be able to select appropriate models to use to address different scientific questions.

Prior Knowledge Needed by the Students

- Students will need a basic definition of the term "model". A PowerPoint File with additional information on models and modeling is provided to accompany this activity

Background Information

A model is a simplified representation of a system. Modeling is the process of building, using and evaluating external representations of systems. Modeling is an important practice that scientists use to understand complex systems, from atoms to cells to nutrient cycles to the solar system.

Scientists use models to represent important components of systems, so that they can focus their attention and efforts on understanding these parts and how they work together. Models are also useful for communicating ideas. A scientist can create a model to represent her ideas about how a system works. She can then share that model with other scientists who can use it to help understand their own research, or modify it to show their ideas about how the system works.

Models can be categorized based on several criteria including their level of abstractness or whether they are static or dynamic (e.g. simulations and computer models). Here is a categorization of models from most concrete to most abstract

- Physical models
- Drawings and figures
- Graphical representations
- Symbolic models
- Simulations
- Mathematical

A PowerPoint File with information on models and modeling is provided to accompany this activity. At the end of the presentation, you will find a list of challenges that students experience when using models and some guiding questions to help students create and evaluate models.

Activity Procedure

1. Sorting activity followed by class discussion

1. Students will form small groups of 2-4 students per group. Each group will receive one copy of each of the model pictures.
2. Instruct the students that they can sort models pictures into 2 or more categories. Emphasize that there is **no correct number** of categories of models. There can be several ways to arrange the pictures but each group must decide on how to arrange them and why. Give students about 5-10 minutes to divide their pictures into model types.
3. Introduce the worksheet (Blackline Master #1) and have each group fill in the number of categories, a name or number for each category, and description of the category. For each category, the description should emphasize what is common about this set of models and how this group is different from other categories. (5-10 minutes). Let students know that they will share their categories with the rest of the class.
4. Return to a whole class discussion. Have each group report the total number of model categories. How many categories did you create? Point out that there are a range of categories.

5. Ask for volunteers to describe their model categories. How many categories did you create? How did you go about creating these categories? Could you describe your categories to the class? Make a note of each group's categories on the board (see Blackline Master #4). As more groups volunteer their category descriptions, make note of models that were placed into similar or different categories.
6. Select 1 -2 models that fall into different categories. As the members of these groups to discuss these differences.

2. Application of models to science standards

7. When might it might be appropriate to use each type of model? Distribute worksheet 2 to each small group. Have the students fill in categories of models that they would to address each standard (Blackline Master #2a) **OR** scenario (Blackline Master #2b). (10 minutes)
8. Return to a whole class discussion. Ask each small group to share their choices for each standard/case. Why did you choose this category of model here? Did any other group select the same model? Did anyone select a different model? If you, can you explain why your choice would also be appropriate? Why didn't you select this other model? Have students share their reasoning for why a model may not be suitable in scenario 2 but not 3 or vice versa? Explain to students that every model has **limitations**. Can you give another example of a limitation of a model?

CITATION OF SOURCES.

Dauer, J. T., Momsen, J. L., Speth, E. B., Makohon-Moore, S. C., & Long, T. M. (2013). Analyzing change in students' gene-to-evolution models in college-level introductory biology. Journal of Research in Science Teaching, 50(6), 639–659.

Harrison, A. G., & Treagust, D. F. (1996). Secondary students' mental models of atoms and molecules: Implications for teaching chemistry. Science Education, 80(5), 509–534. http://doi.org/10.1002/(SICI)1098-237X(199609)80:5<509::AID-SCE2>3.0.CO;2-F

Harrison, A. G., & Treagust, D. F. (2000). A typology of school science models. International Journal of Science Education, 22(9), 1011–1026. http://doi.org/10.1080/095006900416884

Leenaars, F. A., van Joolingen, W. R., & Bollen, L. (2013). Using self-made drawings to support modelling in science education. British Journal of Educational Technology, 44(1), 82–94.

Models obtained from the following websites:

1. Florida Population Density Map: https://commons.wikimedia.org/wiki/File:Florida_population_map.png
2. Water Cycle: http://pmm.nasa.gov/education/water-cycle
3. Gene to Amino acid model: modified from Dauer, J. T., Momsen, J. L., Speth, E. B., Makohon-Moore, S. C., & Long, T. M. (2013). Analyzing change in students' gene-to-evolution models in college-level introductory biology. Journal of Research in Science Teaching, 50(6), 639–659.
4. World Population Growth: https://www.flickr.com/photos/mplemmon/3203403780
5. Fashion Model : Photo Credit: kris krüg staticphotography.com https://www.flickr.com/photos/kk/3279476466;
6. Fashion Model 2: Photo Credit: Associated Press; http://www.nbcnewyork.com/entertainment/entertainment-news/Brazilian-Supermodel-Gisele-Bundchen-Retires-Catwalk-Colcci-300054031.html
7. Cladogram of primates: https://commons.wikimedia.org/wiki/File:Primate_cladogram.jpg
8. Pedigree: https://commons.wikimedia.org/wiki/File:Autosomal_Dominant_Pedigree_Chart.svg
9. Water molecule: https://commons.wikimedia.org/wiki/File:H2O_Kalottenmodell_und_St%C3%A4bchenmodell_8127.JPG
10. Globe: https://en.wikipedia.org/wiki/Globe
11. Photosynthesis: https://commons.wikimedia.org/wiki/File:Photosynthesis_equation.svg?uselang=ru

Name _____ Date _____ Student No. _____

Working with your group members, organize these model pictures into categories. You can create as many categories as you like. There is no one correct number of categories. However, for each category your group creates, you should be able to describe why put these models in same group.

Give each of your categories a name or number and describe that category in Table 1 below.

Table 1. Description of Model Categories

Group	Description

Name _____ Date _____ Student No. _____

Part 1. Which model category (categories) would be appropriate for each of these standards?

SC.7.E.6.1 Describe the layers of the solid Earth, including the lithosphere, the hot convecting mantle, and the dense metallic liquid and solid cores.

_____

_____

SC.8.L.18.2 Describe and investigate how cellular respiration breaks down food to provide energy and releases carbon dioxide.

_____

_____

SC.912.L.18.8Identify the reactants, products, and basic functions of aerobic and anaerobic cellular respiration.

_____

_____

Part 2. Is there a model that you chose for standard SC.8.L.18.2 but not standard SC.912.L.18.8 or vice versa? Give one reason why a model would work in one case but not the other? Note: you are describing a *LIMITATION* of the model

_____

_____

Which model category (categories) would be appropriate for each of these cases?

1. Describing the layers of the solid Earth

_____

_____

2. Investigating how cellular respiration breaks down food to provide energy and releases carbon dioxide.

_____

_____

3. Identifying the reactants, products aerobic cellular respiration.

_____

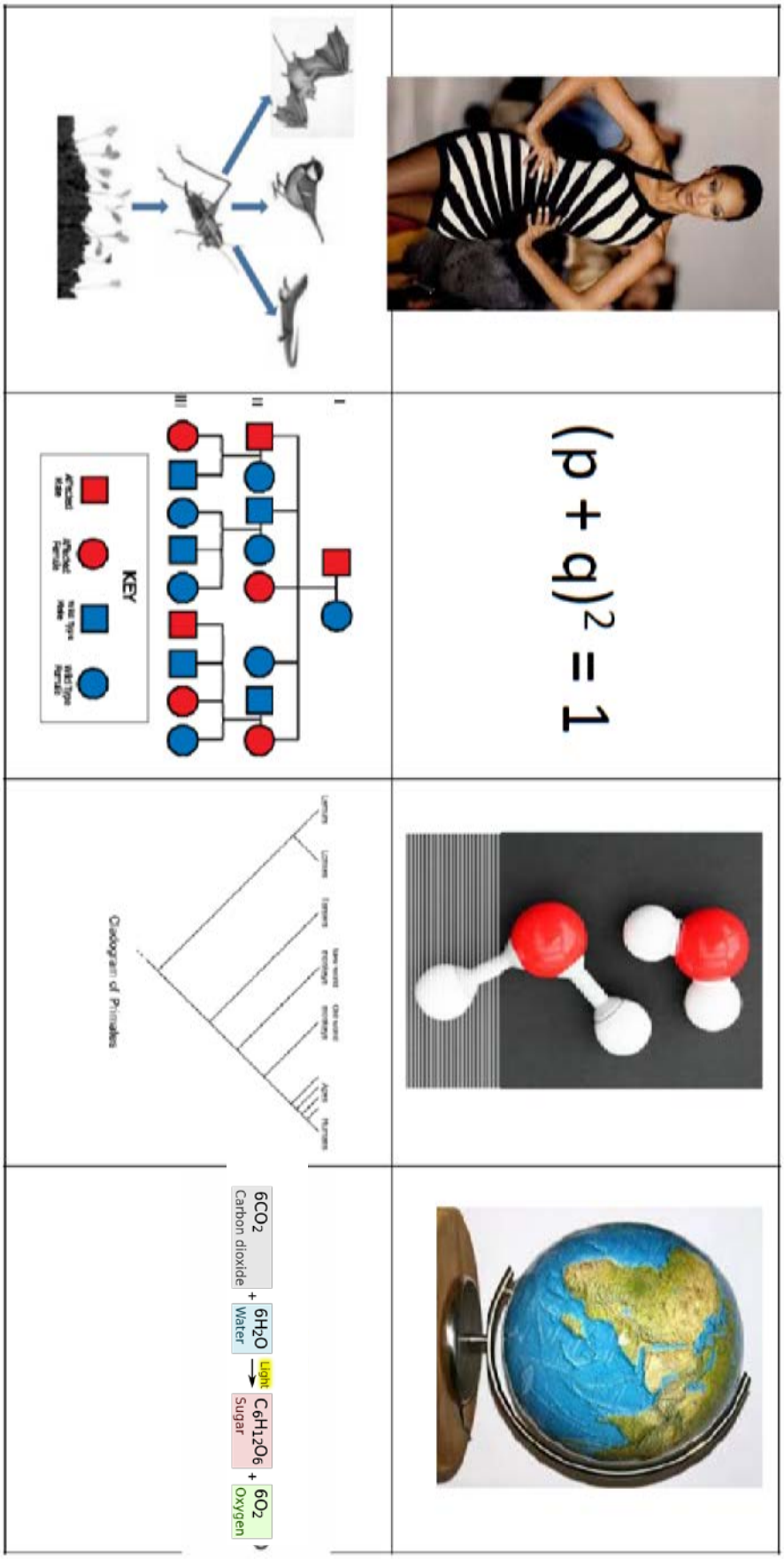
_____

Part 2. Is there a model that you chose for case 2 but not case 3, or vice versa? Give one reason why a model would work in one case but not the other? Note: you are describing a *LIMITATION* of the model

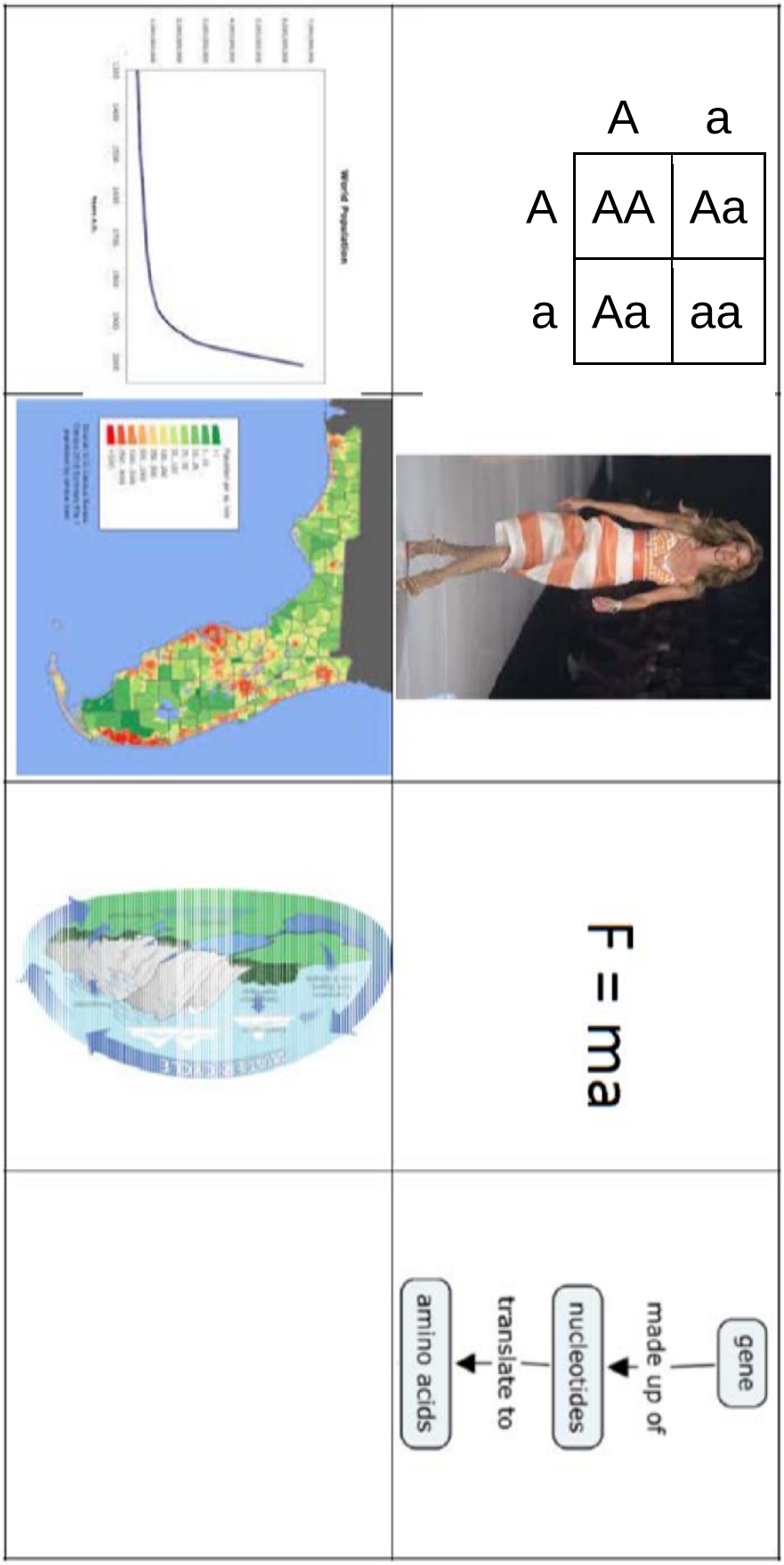
_____

_____

Blackline Master #3



Blackline Master #3



Blackline Master #4

Example for Comparing Model Categories

An example of how each small groups' categories may be displayed to show similarities and differences.

Small Group A creates 4 categories	Group B creates 4 categories	Group C creates 5 categories	Group D creates 3 categories
Pictures	Maps graphs	Maps	Maps
Formulas	Equations	Graphs Equations	Mathematical
people	Physical models	Physical models Fashion models	physical
physical models			