Teacher Sheet 1

# CRITICAL THINKING ACTIVITY:
# INTERPRETING THE GOLDILOCKS EFFECT (1)

**OBJECTIVES:** Students will:

- Identify those factors which appear to be the most important in determining the habitability of a planet
- Analyze a data table of the physical and chemical characteristics of Venus, Earth and Mars
- Present the information from their data table in a visual format (poster, drawing, cartoon, etc.)
- Synthesize the knowledge they acquired and creative imagination to visualize the evolution of life.

**MATERIALS:**

- Reference materials on the three planets/Computer access
- Copies of **Student Activity Sheets;**
- Paper/pencil/ drawing/ chart paper
- Colored pencils/markers;
- Old magazines, ruler/Scissors

**PROCEDURE:**

**PART 1: Interpreting the Goldilocks Effect**

1. Read the introductory reading section "Interpreting the Goldilocks Effect" with the class.
2. Discuss the conditions necessary to consider a planet suitable for life.
3. Create a list on chart paper to post around the room.
4. Project an image of **DATA TABLE 1.**
5. Direct student to complete the data tables on each of the planets.
6. Direct students to create a visual representation of each of the 3 planets including the information that supports the Goldilocks theory.
7. Explain to students that they will be responsible as a group to present their final work to the class.
8. Students should then complete the **ANALYSIS/COMPREHENSION QUESTIONS.**

**Teacher Sheet 2**

## PART 2: CREATURE FEATURES

Before beginning the activity, discuss the following information with the class or provide a written copy for them to review in small groups. Emphasize that scientists who study the possibility of life on other planets have no actual extraterrestrial creatures to study, since none have been discovered yet. However, they can do mockups based on what they know of Earth life and how it evolved. For example, when Pangaea separated into the modern continents, each continent became a "little world" on which evolution proceeded independently: marsupials evolved in Australia, while in North America, placental ("true") mammals evolved.

Biologists also know that any organism on any planet must have solved the same problems that all Earth organisms have, although there are many possible solutions to each problem. For example, any organism on any planet must have body openings so that solids and gasses can pass into and out of it in order to allow for life processes and growth. Also, an organism on any planet has to have a way to get nutrients into its body; the actual method depends on the organism's size. Also, each animal must fit into some sort of food web as both predator and prey. The number of offspring may have to do with how much the parent animal cares for its young.

In this activity, students will consider many of the important characteristics that distinguish different forms of animal life on the Earth, such as kind of skeleton, body size and shape, how it gets around, senses, method of reproduction, relationship to other forms of life, and so on, in an evolutionary context. All of these characteristics are the result of natural selection; they are all adaptations to their environments. The students also have an opportunity to be creative as they draw a picture and describe the creature they have invented. As they work through their task, the students learn that biological concepts are expected to apply to all life, no matter where in the universe it may have evolved.

1. Have the students invent a creature from Venus or Mars, using their imagination but basing their choices on fact. They should describe all of the characteristics of their creatures, and how their new invented animals or plants are adapted to the conditions found on the planet they choose. Using the attributes they have given their creature, they should:

- Draw what their organism and its food source look like.
- Give the species a name.
- Have a friend check their drawing to see that it has the attributes on the recording sheet.
- Write a page about their creature, telling about all of the characteristics not shown in the drawing, plus any other information they would like to add.

2. Help as needed, and check to see that all of the students are recording their results. Have reference materials, pictures or Internet access available for research.

3. Post all of the students' drawings on the wall. Allow time for each student to describe his or her creature. Ask students to tell how intelligent they think their creature might be, but do not emphasize intelligence as it is a complex topic.

4. Have student answer the questions in the section **"In Conclusion!"**

- Invite students to share their responses. In response to these questions, students might recognize, for example, the many different life forms could exist in different habitats on the same planet. They might also see that characteristics implying the amount of gravity or composition of the atmosphere might mean that the creatures must be from different planets. For example, on a planet with a thin atmosphere, land dwelling creatures might have huge lungs. On a massive planet with strong gravity, creatures might be flat and low to the ground.
- Encourage open discussion and alternative points of view.

Teacher Sheet 4

# DATA TABLE: CHARACTERISTICS of TERRESTRIAL PLANETS

| CHARACTERISTICS | VENUS | EARTH | MARS |
|---|---|---|---|
| Total mass | 5 | 6 | 0.6 |
| Radius (km) | 6049 | 6371 | 3390 |
| Atmospheric mass | 100 | 1 | 0.06 |
| Distance to Sun (m) | 108 | 150 | 228 |
| Solar constant | 2613 | 1380 | 589 |
| Albedo % | 75 | 30 | 15 |
| Cloud cover % | .100 | 50 | Variable |
| Surface Temp. (C) | 427 | 15 | -53 |
| Nitrogen % | <2 | 78 | <2.5 |
| Oxygen % | <1 | 21 | <0.25 |
| Carbon dioxide % | >98 | 0.035 | >96 |
| Water vapor % | <0.0001 | <1 | 0.001 |
| Sulfur dioxide % | 150 | <1 | 0 |
| Cloud Composition | Sulfuric acid | Water | Dust, water, CO |
| Greenhouse warming | 15 | 1 | 0.1 |