Name:_____Period:_____Date:_____
Ms. Randall
Marine Science

HYDROTHERMAL VENTS AND CHEMOSYNTHESIS: A HABITAT IN THE DARK

Many of us are familiar with "Old Faithful" in Yellowstone National Park. This famous geyser erupts several times a day. It spouts a column of water heated by volcanic rock deep within the Earth's crust.

A hydrothermal vent

A **hydrothermal vent** is a geyser on the seafloor, where it is very deep and very dark. They are usually found in areas of volcanic activity. They continuously gush super-hot, mineral-rich water that supports a diverse community of organisms. Even though we might consider this to be a harsh environment, hydrothermal vents are abundant with life. In fact, more than 300 species live around the vents and are unique to this type of environment. These creatures include tubeworms taller than you, fish, crabs, shrimp, clams, and **chemosynthetic bacteria. These organisms** have evolved to survive in the complete darkness, the extremely hot vent water and the tremendous water pressure.

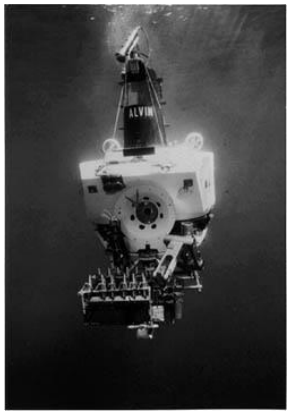
Hydrothermal vents were discovered in 1977 in the Pacific Ocean. Since then, they have been found in the Atlantic, Indian, and most recently, the Arctic Ocean. Most occur at an average depth of about 2,100 meters (7,000 ft) in areas of seafloor spreading along the Mid-Ocean Ridge system — the underwater mountain chain that winds around the globe.

How do hydrothermal vents form? In some areas along the Mid-Ocean Ridge, the huge plates that form the Earth's crust are moving apart, causing deep cracks in the ocean floor. Seawater seeps into these openings and is heated by the molten rock, or magma, beneath the crust. As the water heats up, it rises (hot water is less dense than cold water!).

When this "hot spring" gushes out into the ocean, its temperature may be as high as 360°C (680°F)! Yet this water does not boil because it is under so much pressure from the tremendous weight of the ocean above.

Hydrothermal vents are so deep that light is unable to penetrate. Without light, plants, algae (seaweed) and phytoplankton are unable to perform the process of **photosynthesis**. Therefore, *photoautotrophs* are unable to form the basis of the food chain as they do where light is available. Organisms in hydrothermal vents must acquire energy in another way.

Before scientists had the technology to study hydrothermal vents, they believed that only small animals lived at the ocean bottom. They thought that these animals received their food from above, from organisms that depended on sunlight and photosynthesis, just as a food chain on land does. Scientists knew that when plants and animals that live near the ocean's surface die, they sink to the bottom of the ocean. They assumed that this dead organic material would then feed bottom-dwelling animals.



The Alvin, a deep-sea submersible

But this turned out not to be entirely true. With the use of deep-sea submersibles, scientists have now discovered vast communities of fairly large animals in the dark depths! Instead of using light to create organic material to live and grow (**photosynthesis**), microorganisms at the bottom of the food chain near vents used chemicals such as hydrogen sulfide (**chemosynthesis**).

At the seafloor, thriving ecosystems receive energy from a source that had never been thought of before - heat and chemicals from the planet itself. The energy to sustain life was not coming down from the sun. It was coming up from the interior of the Earth.

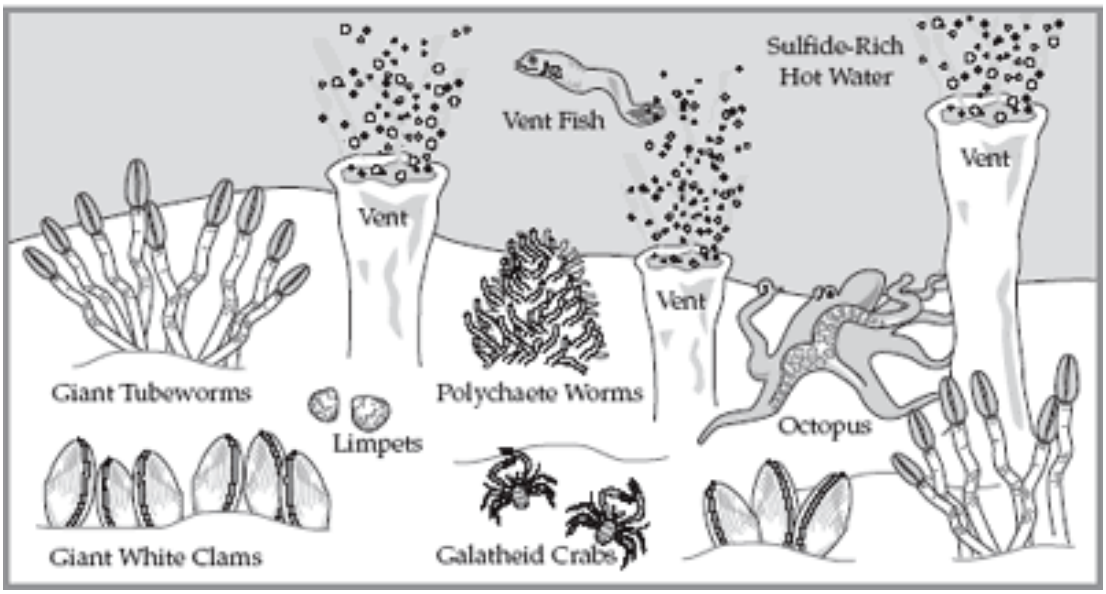
Animals at these depths depend on bacteria that are able to use sulfur and other compounds within vent discharge as energy sources to make glucose, a process called **chemosynthesis**. Larger animals then eat the **chemosynthetic bacteria,** or eat the animals that eat the bacteria. In some cases, the chemosynthetic bacteria live inside the bodies of vent creatures in a **symbiotic relationship**. Some organisms, such as tubeworms, that live around the vents do not have a mouth or even a digestive tract as we do. The bacteria actually live inside their bodies and provide nutrients directly to the organism's tissues.

Crabs, Worms and Mussels in a Hydrothermal Vent

Adapted From:

http://www.onr.navy.mil/focus/ocean/habitats/vents2.htm
http://www.divediscover.whoi.edu/vents/index.html
http://www.ceoe.udel.edu/extreme2004/geology/hydrothermalvents/index.html

HYDROTHERMAL VENT COMMUNITY



CHEMOSYNTHESIS vs. PHOTOSYNTHESIS

Below is the chemical reaction that occurs during ***chemosynthesis****. Remember that this reaction is happening in the deep, dark ocean near the intense heat of hydrothermal vents. Reactants are the compounds that go into a chemical reaction. Products are the new compounds made as a result of a chemical reaction.*

Chemosynthesis

$$6\ CO_2 + 6\ H_2O + 3\ H_2S \xrightarrow{\text{heat}} C_6H_{12}O_6 + 3\ H_2SO_4$$

carbon dioxide, water, hydrogen sulfide → glucose, sulfuric acid

1. What are the REACTANTS in chemosynthesis? _____

_____

_____

2. What are the PRODUCTS of chemosynthesis? _____

_____

3. What form of ENERGY is used for chemosynthesis? _____

Below is the chemical reaction that occurs during photosynthesis. Remember that this reaction requires sunlight.

Photosynthesis

$$6\ CO_2 + 6\ H2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6\ O2$$

carbon dioxide — water — glucose — oxygen

4. What are the REACTANTS in photosynthesis? _____

_____

5. What are the PRODUCTS of photosynthesis? _____

_____

6. What form of ENERGY is used for photosynthesis? _____

Using the reading and information you compiled in your worksheet answers, complete the Venn diagram below comparing ***chemosynthesis*** *to* ***photosynthesis.***