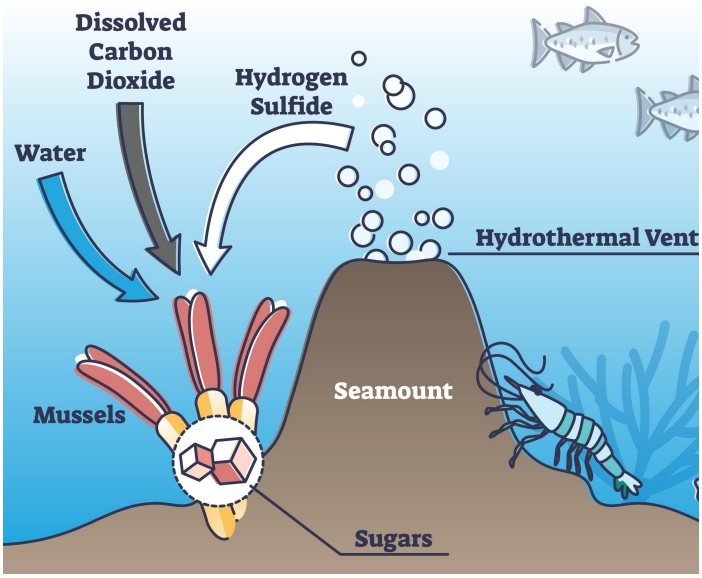
Science V12/S6 - Hydrothermal Vents

The inside of our planet is comprised of hot, molten rock that is churning under Earth's crust. The pressure and gases created by that process can form geological features where various minerals and chemicals spew from the Earth in superheated water. On land, these may look like fumaroles (hot springs), volcanic lakes, or geysers. In the ocean, one result of this phenomenon is hydrothermal vents.

Very deep on the ocean floor, where no sunlight can reach, scientists discovered large rocky tube-like chimneys belching out plumes of black smoke. It was discovered that this "smoke" was actually a mixture of minerals from deep within the Earth that shoot out of the chimneys at extreme temperatures. The minerals exiting the vents, like sulfur, were long thought to be poisonous to most living things on Earth. With so much sulfur coming out of the ground, scientists were confident that nothing could live in that extreme environment. Considering the temperature of these vents can reach an astounding 350 degrees Celsius or 660 Fahrenheit, it does seem hard to believe that anything could survive. It is also known that sunlight is the basis for most life on Earth via the photosynthesis of plants, converting solar energy to a usable form of sugar energy. With no sunlight reaching the depths where these vents were found, poisonous chemicals, and extreme temperatures, it was hard for scientists to imagine that there would be life around hydrothermal vents.

Although it is true that most organisms would not be able to survive such intense conditions, further discoveries caused scientists to re-evaluate what they thought was possible for the conditions needed not just for life to survive, but flourish. In 1977, researchers discovered a diverse community of organisms inhabiting the deep-sea hydrothermal vents of the Pacific Ocean, including giant tube worms. Some of these hydrothermal vent worms were found to be over two meters (8 feet) in height. Classified as extremophiles, the giant hydrothermal vent tube worms earn that title by being able to live in one of the most extreme environments on the planet. This perplexed scientists on how it was possible, a question that is still part of ongoing research.



The first mystery was how the tube worms got their energy. There was no sunlight for photosynthesis, and tube worms do not have a mouth or digestive tract, so they do not 'eat' in the traditional sense. It was found the source of energy for these ecosystems was the hydrogen sulfide and other inorganic chemicals that are abundant in the water that rises from the vents. Some species of bacteria can use these inorganic compounds in chemical reactions to produce sugar and other organic molecules in a process called chemosynthesis.

Tube worms developed a symbiotic relationship with these microbes in order to utilize the energy produced by chemosynthesis. The microbes make their home in special cells inside the worm, and the tube worms absorb chemicals through their red, feathery tips. The microbes living inside their bodies convert the chemicals to nutrients. Both organisms benefit because the bacteria have a safe place to live inside the tube worms, and the tube worms receive sugars produced as a by-product of the chemical reaction.

Tube worms are not the only lifeform that can take advantage of the chemosynthesis process. Other animals, like shrimp, consume the bacteria. Whole ecosystems exist in these seemingly impossible places. Some scientists have even proposed that early life could have started in the extreme environment that surrounds hydrothermal vents, where the immense heat and mixture of chemicals may have been exactly the conditions needed for various single celled organisms to combine and form complex life.