ABIOGENESIS

Biology, like other forms of science, progresses by observation. Unfortunately, observations of nature are often flawed by interpretations that attempt to explain what was observed. This is due, in part, to the fact that the observer is actually part of nature. Therefore, the observer is subject to many of the same factors as the objects being observed. In an attempt to interpret natural events, scientists often propose explanations. An explanation is also called a hypothesis. Hypothesis proposed by early scientists were almost never tested by experiment. Often 1 unsubstantiated hypothesis became the basis for another, and scientists moved further and further from the truth.

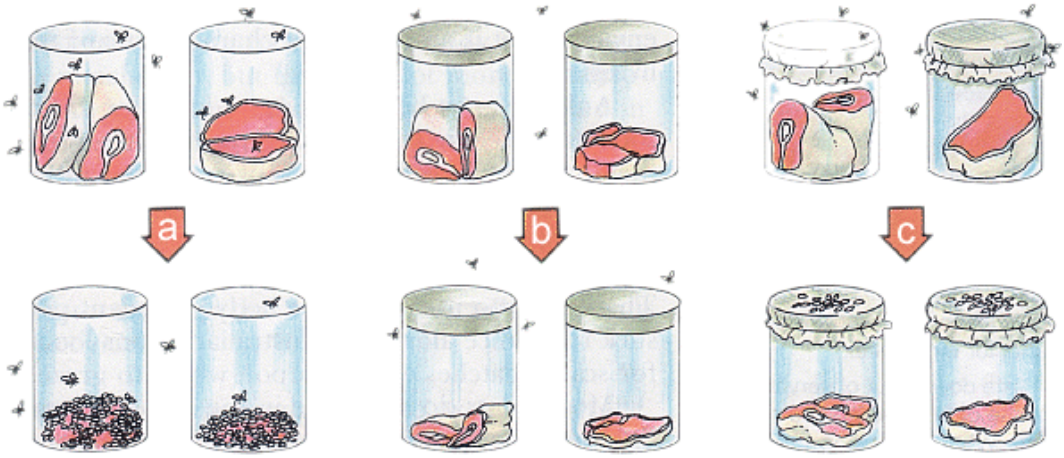
Early scientists noticed that ponds dried up during a long period of drought and that no living fish were found in the mud. When rain began to fall in the spring and the pond filled with water, observers noticed that the pond was teeming with frogs and fish. Some concluded that the frogs and fish must have fallen to Earth during a rainstorm. Incredible as of this explanation may seem now, it seemed a logical to many people in earlier times. The fact that nobody had ever been hit by a frog or a fish during a rainstorm did not seem to have occurred to anyone!

Aristotle, the great Greek philosopher, did not accept the hypothesis of fish and frogs falling from the sky. He proposed that fish and frogs came from the mud. He also believed that flies came from rotting meat, because he had always observed flies on decayed meat. Aristotle was so persuasive in his arguments that scientists accepted his theory of abiogenisis for nearly 2000 years. Abiogenesis is the theory that proposes that nonliving things can be transformed into living things spontaneously. The theory is sometimes referred to as " spontaneous generation. " A mere 300 years ago, a Belgian doctor, Jean van Helmont, concluded that mice could be created from grains wheat and a dirty shirt. Van Helmont had placed grains of wheat and a dirty shirt in a container, and within 21 days mice appeared. According to Van Helmont, the sweat in the shirt caused the wheat to ferment. The fermenting wheat bubbled and was eventually transformed into mice.

In 1668, Francesco Redi, and Italian physician, conducted an experiment to test the hypothesis rotting meat can be transformed the into flies. Prior to Redi's work, science was based on logical analysis rather than on experimentation. Redi placed bits of snake, eel, fish and veal in four different jars. He repeated the same steps in 4 other jars, but sealed the 2nd set of the jars. The open set of jars was designated the experimental group, while the closed set was designated the the control group. What do you think happened next? After a period of time, Redi noticed that

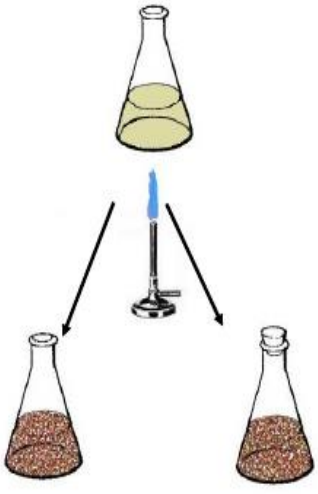
maggots were crawling all over the meat in the open jars. Apparently, flies had been attracted to the meat and began laying eggs on the food supply. The eggs hatched in to maggots, which began to feed on the meat. The maggots then became flies and the cycle continued. Redi concluded that flies come from other flies, not from rotting meat. However, Redi's critics replied that the sealed jars were different from the control set, because no fresh air circulated around the meat. Air, claimed the critics, is the " active ingredient " that causes spontaneous generation. Fresh air must circulate around the meat in order for flies to appear.

Once again, Redi turned to experimentation for his answer. He repeated the experiment, but this time placed fine mesh wire over the opening of the experimental set of jars. As Redi had predicted, flies were not found inside the experimental jars, despite the fact that air had circulated around the meat.



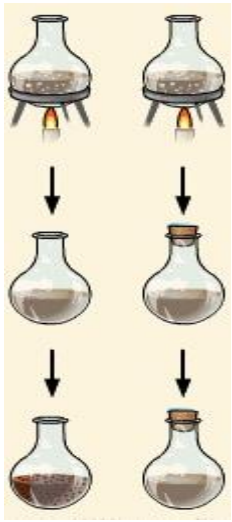
ABIOGENESIS AND MICROBES

Even as the invention and refinement of the light microscope revolutionized the study of biology, scientists continued to make mistakes as they sought to interpret their observations. Such was the case of the English biologist John Needham [1713-1781] when he set out to be examined the theory of abiogenesis. Needham observed that meat broth left unsealed soon changed color and gave off a putrid smell. Mold and bacteria were found growing in the rich nutrient, but it was unclear where these microbes came from. Unlike the early supporters of abiogenesis who used logical analysis, Needham tested his hypothesis through experimentation. Experimentation had become an essential component of science.



Needham boiled flasks containing nutrient meat broth in loosely sealed flasks for a few minutes in order to kill the microbes. The solutions appeared clear after boiling. The flasks were then left for a few days and the murky contents were examined under a microscope. the broths was teaming with microorganisms. Could this mean that the broth had spontaneously created microbes? Needham rushed to retest the experiment, using different nutrient solutions. Despite the boiling, the microbes reappeared a few days later. Needham concluded that the microbes had come from nonliving things in the nutrient broth.

Needham's conclusions sent many scientists down the wrong path. Let us re-examine his experiment to understand why. One of the difficulties arose from the fact that the flasks were not sealed properly -- the tiny microbes could have entered the flasks after boiling. Another difficulty resulted from the design of his experiment. The fact that the flasks appeared clear immediately after boiling did not mean that all the microorganisms were destroyed. If only a few of the tiny microbes had survived, they would be able to multiply to millions within a few days. Needham did not check the flasks for microbes immediately after boiling. Even if he had checked the flasks, it is unlikely that he would have found any of the remaining microbes. Each drop of the nutrient would have to be examined, and such an examination might even infect the flask.



Needham's conclusions were upheld for nearly 25 years. Lazzaro Spallanzani [1729-1799] repeated Needham's experiment, but boiled the flasks longer. Spallanzani also took care to seal the flasks completely. No microorganisms were found; abiogenesis did not occur. Needham's supporters were cautious about Spallanzani's experiments. They suggested that because Spallanzani had completely sealed the jars, the active principle had been destroyed. You will recall that that active principle objection had been used to oppose the work of Francesco Redi about 100 years earlier. Others claimed that the boiling had destroyed the nutrients. Although Spallanzani did not believe that an active principle existed, he was unable to overcome the objections that centered on the active-principle hypothesis.

The final blow to the theory of abiogenesis was a delivered by the great French scientist Louis Pasteur [1822-1895]. In 1864, Pasteur had a glass worker develop a special swan-necked flask. Broth was placed in the flask and subsequently boiled to destroy the microbes. Fresh air entered the flask as the flask cooled. However, the microbes were trapped in the curve of the flask and were not carried into the broth from the surrounding air. Because the broth remained clear, Pasteur predicted that microbes were not present. A microscopic examination of the nutrient broth confirmed his prediction. Microbes could not be created from nonliving broth. As a finale, Pasteur tipped the broth in 1 of the flasks, allowing it to run into the curve of the swan-necked flask. As Pasteur had predicted, the broth became contaminated by the microorganisms trapped there. In a few days, the flask became cloudy.