

From: Environment ed. Raven, Berg  
(1993) + Johnson

Focus On



### The Gaia Hypothesis

One of the most unusual and controversial hypotheses to be advanced in recent years is the Gaia hypothesis, which states that the entire Earth can be viewed as a single living organism. According to this model, the planet Earth is alive in the sense that it is capable of self-maintenance. Living organisms on Earth interact with the nonliving environment to produce and maintain Earth's chemical composition, temperature, and other characteristics. Thus, the environment and living organisms of Earth depend on one another and work together as a homeostatic mechanism. (Biological systems have homeostatic mechanisms to help maintain a steady state or constant environment.)

As an example of the Gaia mechanism, consider the Earth's temperature. It is generally accepted that the temperature of the Earth has remained relatively constant at a temperature suitable for life over the past 3.5 to 4 billion years in which life has existed. Yet there is evidence that the sun has been heating up during that time. Why hasn't the Earth increased in temperature? Gaia proponents attribute the constant temperature to a drop in the level of atmosphere-warming  $\text{CO}_2$  in the atmosphere, which they say happened because the living Earth compensated for increased sunlight by "fixing"  $\text{CO}_2$  into calcium carbonate shells of countless billions of marine phytoplankton (photosynthetic plankton). As the phytoplankton died, their shells sank to the ocean floor, thus removing  $\text{CO}_2$  from the system. This Gaia planetary temperature mechanism is an example of a feedback loop between the abiotic environment and the living organisms on Earth, which mutually interact to regulate Earth's temperature.

Another example of interactions between the nonliving and living components of the Earth, according to the Gaia hypothesis, involves the salinity of the oceans. As terres-



The largest organism? According to the Gaia hypothesis, the Earth is a huge "organism" capable of self-maintenance. (NASA)

trial rocks are weathered, oceans tend to get saltier and saltier, in time becoming too saline to support life. However, geological evidence indicates that the salinity of the oceans has remained constant for millions of years. Gaia proponents suggest that there is a feedback loop in which bacteria remove excess salt from the ocean in salt flats, which are shallow bays along tropical and subtropical oceans where bacteria grow in such numbers that they form great mats.

Many scientists are reluctant to accept the Gaia hypothesis. Almost everyone agrees that the environment modifies living organisms and that living organisms modify the environment to some extent, especially on a local scale. However, the idea that Earth's living things *adjust* the physical environment to meet their needs has few backers, in part because it is difficult to test.

# Biology I

## The Mystery of Life

### *Living Things Are Composed of Cells*

Living things are made up of small self-contained units called cells. Each cell is a collection of living matter enclosed by a barrier that separates the cell from its surroundings. Most cells can perform all the functions we associate with life.

Cells are never formed by nonliving things. They are present in nonliving matter only if that matter was once alive. Wood, for example, is made up largely of the walls that separated individual cells in the living tree.

### *Living Things Reproduce*

Living things can reproduce - produce new organisms of the same type. Because all individual organisms eventually die, reproduction is necessary if a group of similar organisms (what we will later call a species) is to survive.

There are two basic kinds of reproduction: sexual and asexual. Sexual reproduction requires that two cells from different individuals unite to produce the first cell of a new organism. This increases genetic diversity in a species.

In asexual reproduction, a single organism can reproduce without the aid of another organism (the prefix *a-* means without, so asexual means without sex). Asexual reproduction can be very simple: some single-celled organisms merely divide in two to form two organisms. This does not increase diversity, but it is exceptionally quick (as fast as every 20 minutes!)

### *Living Things Grow and Develop*

All living things, at one stage or another in their lives, are capable of growth. During growth, most living things go through a cycle of change called development. The single cell that starts an organism's life divides and changes again and again to form the many (100 trillion in humans) and varied (over 200 different types) cells of an adult organism.

### *Living Things Obtain and Use Energy*

Living things obtain energy from their environment, or their surroundings, and use that energy to grow, develop, and reproduce. All organisms require energy to build the substances that make up their cells. In plants, photosynthesis uses energy from the sun in order to assemble more complex substances that are rich in energy. Organisms without photosynthesis, however, must obtain their energy in other ways (chemosynthesis, or better yet, outright theft!)

### *Living Things Respond to Their Environment*

Living things respond to their environment. Such responses can be rapid, usually through changes in behavior, or slow, usually through changes in metabolic processes or through growth. Anything in the environment that causes an organism to react is called a stimulus.

In general, living things respond to stimuli in ways that improve their chances for survival. The processes by which organisms respond to stimuli in ways that keep conditions in their body suitable for life is called homeostasis.

You might point out that nonliving things also respond to the environment. However, the responses of nonliving things are purely mechanical (like a spring that jumps when compressed and released) and are not related to survival.