Preface

Chemical evolution describes chemical changes on the primitive Earth that gave rise to the first forms of life. The first living things on Earth were prokaryotes with a type of cell similar to present-day bacteria. Prokaryote fossils have been found in 3.4-million-year-old rock in the southern part of Africa, and in even older rocks in Australia, including some that appear to be photosynthetic. All forms of life are theorized to have evolved from the original prokaryotes, probably 3.5-4.0 billion years ago. The chemical and physical conditions of the primitive Earth are invoked to explain the origin of life, which was preceded by chemical evolution of organic chemicals. Astronomers believe that 20-30 billion years ago, all matter was concentrated in a single mass, and that it blew apart with a "big bang." In time, a disk-shaped cloud of dust condensed and formed the Sun, and the peripheral matter formed its planets. Heat produced by compaction, radiation, and impacting meteorites melted Earth. Then, as the planet cooled, Earth's layers formed.

The first atmosphere was made up of hot hydrogen gas, too light to be held by Earth's gravity. Water vapour, carbon monoxide, carbon dioxide, nitrogen, and methane replaced the hydrogen atmosphere. As Earth cooled, water vapour condensed and torrential rains filled up its basins, thereby forming the seas. Also present were lightning, volcanic activity, and ultraviolet radiation. It was in this setting that life began.

According to one theory, chemical evolution occurred in four stages. In the first stage of chemical evolution, molecules in the primitive environment formed simple organic substances, such as amino acids. This concept was first proposed in 1936 in a book entitled, "The Origin of Life on Earth," written by the Russian scientist, Aleksandr Ivanovich Oparin. He considered hydrogen, ammonia, water vapour, and methane to be components in the early atmosphere. Oxygen was lacking in this chemically-reducing environment. He

stated that ultraviolet radiation from the Sun provided the energy for the transformation of these substances into organic molecules. Scientists today state that such spontaneous synthesis occurred only in the primitive environment. Abiogenesis became impossible when photosynthetic cells added oxygen to the atmosphere.

The oxygen in the atmosphere gave rise to the ozone layer which then shielded Earth from ultraviolet radiation. Newer versions of this hypothesis contend that the primitive atmosphere also contained carbon monoxide, carbon dioxide, nitrogen, hydrogen sulfide, and hydrogen. Present-day volcanoes emit these substances. In 1957, Stanley Miller and Harold Urey provided laboratory evidence that chemical evolution as described by Oparin could have occurred. Miller and Urey created an apparatus that simulated the primitive environment. They used a warmed flask of water for the ocean, and an atmosphere of water, hydrogen, ammonia and methane.

This book can serve as a basic book for students of molecular biology, genetics, biochemistry, agriculture and biotechnology, or as a reference book for those interested in learning the fundamentals of cell biology.

—Editor