1. Biochemistry and the Language of Chemistry

1.1 The Science of Biochemistry

The roots of biochemistry can be traced thousands of years into human history, long before we understood the scientific mechanisms. Before the work of Friedrich Wohler, it was believed that substances were either of biological or nonliving origins, and that the two were fundamentally different. Wohler's 1828 breakthrough was to synthesize urea from ammonium cynate, proving that the difference between types of substances may be less than previously thought.

A second important development in the field of biochemistry was that of Louis Pasteur, who devised methods for excluding bacteria in fermentation mixtures. Though still believing in "vitalism", the view that biological reactions require a supernatural force, Pasteur recognized that certain organisms provide different products in fementation, such as yeast's ability to convert sugar into alcohol in winemaking.

Through the early work in genetics by Gregor Mendel, and later the advances in our knowledge of DNA by James Watson and Francis Crick, it was recognized that DNA provided a storage mechanism for an enormous amount of genetic information.

Biochemistry is largely a science that depends on results of experiments, unlike more theoretical sciences such as physics. Biochemistry has benefited greatly from technological advances that allow more information to be elucidated in experiments. For example, X-ray diffraction was key to the discovery of DNA's double helix structure.

1.2 The Elements and Molecules of Living Systems

An astounding fact of biochemistry is that it is only possible through the death of stars. The early universe was abundant in only the lightest elements, which condensed into stars and formed into heavier elements through thermonuclear reactions in stars. These elements are released when the star dies and recondenses into planets and smaller stars.

Life depends heavily on elements that are only created in these stellar forges, such as Carbon, Oxygen, Nitrogen, and Phosphorous. These elements existed in a "primodial soup" for billions of years on Earth, before some event was able to assemble these simple molecules into a self-replicating structure. It is believed RNA may be based on these early stuctures.

Simple molecules are usually combined into macromolecules in lifeforms, either in biopolymers or lipids. Biopolymers are carbohydrates, proteins, and nucleic acids that have assembled into larger chain-like structures. Lipids, or fats, are hydrogen-carbon chains that are important in cellular functioning.

1.3 Distinguishing Characteristics of Living Systems

What is life? The answer is debated between biochemists even today, but one biochemist, Daniel Koshland, suggests there are seven "pillars" of life. The pillars, such as "improvisation" and "regeneration", provide a framework for determining life. However, these pillars are not agreed on by all biochemists, and viruses pose an interesting example where not all scientists agree are alive.

1.4 The Unit of Biological Organization: The Cell

In 1665, Robert Hooke indentified a cellular structure in plants that we know today as cell walls. When Theodor Schwann discovered evidence that animals are also made up of cells, it was theorized that all organisms are either cells or groups of cells, which we know is true today.

The main types of cells are prokaryotes and eukaryotes. Prokaryotic cells lack internal subdivisions, or organelles, that eukaryotes posesses. Organisms can be single cells, or multicellular, consisting of many different types of cells.

1.5 Biochemistry and the Information Explosion

Technology and information have been very beneficial for biochemistry. Through knowledge of chemical reactions and biological processes, biochemists have been able to identify important pathways of metabolism.

Other related fields have also benefited, such as bioinformatics, genomics, and proteomics. The future for biochemistry is bright, with cutting-edge technology such as synthetic biology on the horizon.