THE 60-SECOND GENERAL CHEMISTRY COURSE

Nature has provided 92 simple building materials, called **"elements,"** of which all matter is composed. Elements are made of tiny particles called **atoms**. Atoms, in turn, consist of a very dense nucleus containing **protons** and **neutrons,** and an almost massless cloud of **electrons** surrounding the nucleus. The elements are organized into a **Periodic Table,** which took its present form in the mid-twentieth century. Elements having similar chemical properties are found in the table's columns, while the buildup of electrons from one atom to the next repeats periodically throughout the table. It is the electrons that determine the chemical properties of atoms and their chemical combinations.

"Diversity results from the tendency of atoms of the same or different elements to combine to form molecules."[1] **Chemical reactions** occur when one combination of atoms changes into a different combination. It is the electrons surrounding the nucleus of each atom that rivet the atoms together into molecules; it is the electrons of molecules that are the sticky parts which allow molecules to come together as solids or liquids. Large molecules, such as long chains of carbon atoms, have many sticky parts. When molecules are not very sticky, the resulting compounds are gasses. **Nuclear reactions** – the conversion of one element into another – occur when the number of protons and/or neutrons changes or the energy content of the nucleus changes. This is the basis of **nuclear medicine** – a non-invasive means to diagnose and treat disease.

We live in a **Chemical Age**[2] characterized by an abundance of materials manufactured with deliberate intent rather than simply isolated from Nature. We have plastics, synthetic fibers, pharmaceuticals, superconducting materials, genetically engineered materials, materials which self-assemble, molecular machinery, and more. The Chemical Age began around the time of World War II.

Chemistry has been called the **Central Science,** not because it is more important than other human activities, but because many fields of science and engineering depend in at least some way on the vocabulary, concepts, insights, and problem solving techniques of chemistry. Traditionally, **five subheadings** constitute the field of chemistry, although the division between each is becoming more difficult to discern. **General chemistry** tries to touch upon each of these subheadings.

Organic chemistry is the study of long chains and rings of carbon atoms. Twenty-nine of the top 50 chemicals manufactured by the chemical industry are organic molecules.[3] Almost all of the molecules associated with life are organic molecules. Most organic molecules possess the property of chirality – the nonsuperposability of their mirror images. This left hand-right hand property imparts a three dimensional complexity and subtlety to organic chemistry. The large number of non-bonding interactions between organic molecules allows chemists, not to mention Nature, to design molecules with memory.

Inorganic chemistry centers on the remaining elements. Twenty-one of the top 50 chemicals manufactured by the chemical industry are inorganic molecules.[3] In both organic and inorganic chemistry the relationship between structure – how the atoms and the types of atoms are linked together in three dimensions – and function – the chemical and physical properties of material substances – is the primary question of interest and the basis for the development of new materials.

Physical chemistry deals with the mathematical nature of the electron clouds holding molecules together, the most probable arrangements of atoms as they undergo changes in combinations, the conversion of one state of matter to another, and the energy changes of these processes. Much of general chemistry is inorganic and physical chemistry. General chemistry provides a basis for understanding our environment (atmospheric chemistry, water chemistry, soil chemistry, and pollution) and human interaction with it.

Analytical chemistry develops methods of determining what compounds are present in the air we breathe, the water we drink, and the food we eat. These methods, many using sophisticated computer controlled instrumentation, are becoming so sensitive as to measure contaminants previously undetectable. Analytical chemistry and the chemistry of pollution are very much interrelated.

Biochemistry studies how simple inanimate molecules interact with one another to form supramolecular assemblies.[4] It is the ability of these assemblies to chemically recognize each other or simple molecules (molecular memory) that causes the formation of a living entity. Studying biochemistry makes use of many concepts basic to the four previously mentioned divisions.

While not everyone may be cut out to be a chemist, we all enjoy the benefits of chemical research. The chemical industry makes up 25% of our GNP. Chemistry is a significant part of our lives in the materials we use, the forms of energy we use, and the political decisions we must make. While everyone need not be an expert chemist, personal and civic responsibility demand that we be **chemically literate**.

1. McGree, L.A. *J. Chem. Educ.* **1993**, *70*, 543-544.
2. Crone, H.D., *Chemicals & Society: A Guide to the New Chemical Age*, Cambridge University Press.: New York, 1986.
3. Chemical & Engineering News **1994** (April 11), *72*, 13.
4. Lehninger, A.L., *Biochemistry,* Worth Publishers, Inc.: New York, 1970, p 19.

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