TIMELINE – CHAPTER 1

THE HUMAN ORGANISM AND THE ORGANIZATION OF MATTER

1986 Discovery of fullerenes, a family of molecules shaped like soccer balls

This type of molecule is a new form of carbon discovered by American chemists Richard Smalley and Robert Curl along with British chemist Harold Kroto. For their discovery, they received the Nobel Prize for Chemistry in 1996. The name *fullerene* was created in honour of Richard Buckminster Fuller, the American architect who in the 1960s designed the geodesic dome (such as that of the Biosphère on Île Sainte-Hélène in Montréal), the pentagonal- and hexagonal-shaped structure of which resembles this type of molecule. The most widely known and first observed fullerene molecule, called *fullerene* C_{60}, *Buckminsterfullerene* or *molecule* C_{60}, is made up of 60 carbon atoms combined in a structure shaped like a soccer ball.

1944 Development of paper chromatography

Paper chromatography is a technique for separating the ingredients of a homogeneous mixture to identify or measure certain constituents. For example, the technique is used to separate the different pigments of a leaf of spinach or an ink spot. British chemists Richard Synge and Archer Martin applied the technique to separate amino acids, the basic units of proteins. In 1949 Erwin Chargaff was able use the technique to demonstrate the proportions of the four nitrogen bases that make up DNA.

1898 Discovery of radium and polonium, the first radioactive elements

French physicists Marie and Pierre Curie discovered polonium, then radium, two unstable elements, in a sample of uranium ore present in great quantity in mines in central Europe. In 1903 they, along with Henri Becquerel, received the Nobel Prize for Physics for the discovery of these radioactive elements; in other words, elements that emit radiation outward from their core. Marie Curie was subsequently awarded the Nobel Prize for Chemistry in 1911 for her work with radium. The word "radium" comes from the Latin *radius*, meaning "ray."

1860 First distinction made between atoms and molecules

It was during the first international chemistry conference in Karlsruhe (Germany), which brought together 140 chemists from around the world, that the distinction between atoms and molecules was made clear and a system of atomic mass for each element was described. From that time on, the study of atomic theory allowed for the development of notions about elements, atoms, molecules, structure and chemical bonds. A few years later, in 1869, Russian chemist Dimitri Mendeleev established the first system of classification of the 63 known chemical elements according to atomic mass and invented the periodic table.

1827 Observation of Brownian motion of particles

Brownian motion, the irregular and constant movement of particles in a fluid (liquid or gas), was discovered by Scottish botanist Robert Brown as he was observing under a microscope granules of pollen suspended in water. The explanation for Brownian motion is well understood today: a particle of pollen or dust suspended in a fluid is constantly bombarded by the molecules that make up the fluid. The quantity of movement of an isolated molecule is never enough to make its effect visible through a microscope on a suspended particle. However, if enough molecules collide at the same time on one side of a particle, it can be noticeably displaced.

1807 Dalton's atomic theory

At the beginning of the 19th century, the theory of the four fundamental elements was set aside definitively in favour of the atomic theory. John Dalton, British chemist and physicist, published the atomic theory which states that matter is made up of atoms. He developed his theory following research on the physical properties of air and other gases. The atomic theory, the base of modern chemistry, states that all matter is made up of atoms of different elements. It put an end to beliefs such as the transformation of lead into gold. The dalton is a unit of atomic mass, named in honour of John Dalton.

1754 Discovery of the chemical composition of carbon dioxide

The chemical properties of carbon dioxide were studied by Scottish chemist and physicist Joseph Black, who named this gas *fixed air*. He discovered the presence of carbon dioxide in the atmosphere. This gas was then isolated by English clergyman Joseph Priestley in 1766. Ten years later French chemist Antoine Laurent de Lavoisier deduced that this gas is the product of the combustion of carbon.

1661 Introduction of the concept of chemical elements

The modern notion of "chemical element" is due to Robert Boyle, an Irish chemist and physicist. Through his experiments, Boyle learned that matter is composed of primary particles that make up accumulations called *molecules*. He published an important work entitled "The Sceptical Chymist," in which he rejected the old theories of four basic elements and alchemy. In doing so, he became a pioneer of experimentation in atomic theory. He also established the essential distinction between an element and a compound.

1619 Discovery of carbon dioxide

Carbon dioxide was discovered by Flemish physician and chemist Jan Baptist van Helmont. He first developed the concept of gas, of which there was then only one type recognized: air. Van Helmont then went on to discover different types of gases, introducing what he called *gas sylvestre* (wood gas): CO_2, which results from burning charcoal, or the reaction of vinegar (an acid) on limestone, or fermentation (grape juice, for example). Through his experiments, he established a link between alchemy and chemistry.

CIRCA –400 Introduction of the idea that matter is composed of atoms: at first rejected, only to reappear in the 19th century

Two Greek philosophers, Leucippus and Democritus, were at the origins of the first formulation of the atomic theory called *atomism*. According to this theory, matter is formed of indivisible elementary entities: atoms separated by empty spaces and grouping together at random mechanically. The cohesion of a solid would be considered as a result of the close intertwining of hooked atoms (from which the expression "to have hooked atoms" has come to mean "to have affinities"). Liquids would be seen as characterized by round, smooth atoms that flow more easily. This philosophical theory was not adopted at the time, however, since it had not been proven by experimental method.

CIRCA –450 Introduction of the idea that all matter is composed of four elements: air, water, earth and fire

Philosophers in ancient Greece believed that the world was made up of a combination of four fundamental elements: air, water, earth and fire. This theory was first formulated by Empedocles and it was the basis for the practice of alchemy, a mysterious science that combined techniques of chemistry with more esoteric theories. Later, circa –380, Plato associated the four elements with geometric shapes: air was associated with the octahedron, water with the icosahedron, earth with the cube and fire with the tetrahedron.