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Antoine Laurent Lavoisier

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The French political revolution occurred simultaneously with another revolution, that is, a scientific one. The political revolution delayed the progress of the scientific one by causing the death of one of the greatest minds of that century.

In the history of science before the twentieth century three great revolutionary periods stand out. The first was initiated by Newton's publication of *Mathematical Principles of Natural Philosophy* in 1687. The second began in 1789 (the year of the fall of the Bastille) with the publication of Lavoisier's treatise, *Elements of Chemistry,* and the third was occasioned by Darwin's *Origin of the Species* in 1859. Lavoisier changed the entire outlook of chemistry.

Antoine Laurent Lavoisier was the son of a prosperous French merchant. He was born on Aug. 26, 1743. His early education was excellent, and later he was trained in the law. He developed an interest in politics which remained with him for the rest of his life. He used his political position to institute many social reforms in the life of the oppressed French peasant.

Among his achievements he demonstrated the importance of scientific farming. He created credit bureaus to relieve the burden of debt, and spent much of his own money in these ventures. Correspondence found in his desk bears out his extensive world-wide acquaintanceship. Among his correspondents were Benjamin Franklin, Cavendish, Black, Priestley, and Scheele in Sweden.

On May 8, 1794, he was guillotined at the order of the Revolutionary Tribunal, a fate that he had anticipated.

During his early life the phlogiston concept was the

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accepted philosophy. The four element theory had been expounded at least 400 years before the birth of Christ and was still being taught in the universities as late as the early nineteenth century. This theory was very simple—all substances were composed of four elements, earth and water, air and fire. It was Lavoisier in the last third of the eighteenth century who showed that substances burn by combining with the element oxygen, not by releasing fire-stuff.

It is true that Boyle had known of oxygen and that Priestley and Black in England also were experimenting along these lines. Cavendish had discovered the composition of water at about the same time as Lavoisier. What made Lavoisier great was his ability to recognize the importance of these discoveries. Priestley merely called his product "de-phlogistinated air" and tried to fit his discovery into the old four element theory. Lavoisier built a whole new concept of chemistry and physiology.

Lavoisier is generally accepted as the father of the present day science of metabolism. The lineage is easy to trace. His pupils were Berthollet and La Place. They in turn had as one of their pupils Gay-Lussac. From Germany came Liebig to work with Gay-Lussac and bring back to his native country the stimulation of these brilliant imaginative minds. Liebig's pupil was Voit. Graham Lusk went to Germany to study with Voit and returned to these United States with the accumulated experiences of the German school. Lusk served as the stimulating focus for the greater part of the early development of the field in this country.

One day, while browsing in a London book shop, I chanced across the *Medical Commentaries* for the year 1785 (Vol. X), edited by Andrew Duncan, M.D. The index attracted my attention. It listed an account of new books by Abbe Spallanzani, M. Lavoisier, Thomas Fowler, M.D., and William Withering, M.D., and a series of original medical observations.

The reviewer of M. Lavoisier's book, titled *Experiences fur la Respiration des Animaux, et fur les Changements qui arrivent a l'air en passant par leur Poumon,* recognized the importance of what he read. He pointed out that while Priestley had described the properties of oxygen a few years previously, his interpretation was not entirely correct. Lavoisier showed that mercury when heated in air removed a part of the air and the residue ceased to be fit for respiration or combustion, and that this residue did not render limewater turbid. When this calcined mercury was heated the gas given off restored the air to all of its former properties. He further showed that when an animal is placed under a bell-glass it perishes in a short time. The remaining air had the properties of the air remaining after calcining mercury as described above. It had one further property; it rendered limewater turbid. Furthermore he showed that he could restore the life-maintaining power of the air exhausted by an animal by adding to it the "vital air" recovered from heating the calcined mercury. He concluded that "while calcination of mercury produces no other change on atmospheric air than that of depriving it of vital air, the respiration of animals besides this effect produces in the atmospheric air a portion of fixed air." After performing various other experiments with charcoal burning in the air he further concludes, "that during animal respiration there is an absorption of vital air which is converted in part in the body to fixed air which is excreted by the lungs."

From these early experiments Lavoisier developed the concept of the importance of oxygen. It was he who gave this element its name. He proposed the concept that life depended on a series of oxidative processes with the resultant production of heat. By a series of ingeniously devised experiments he measured the amount of oxygen consumed by man and animal during rest, after eating, when exposed to cold, and during a period of work and exercise. The values he found with his crude melting ice calorimeter are in strict accord with modern day concepts. Lavoisier demonstrated to his own satisfaction that perspiration regulated the heat lost from the body and that digestion replenished the blood with materials.

Today the technics have been refined; instead of weighing melted ice water, electronic gadgets are employed. The newer results are more accurate but the basic principles remain those developed by Lavoisier from 1770 to the time of his death in 1794.