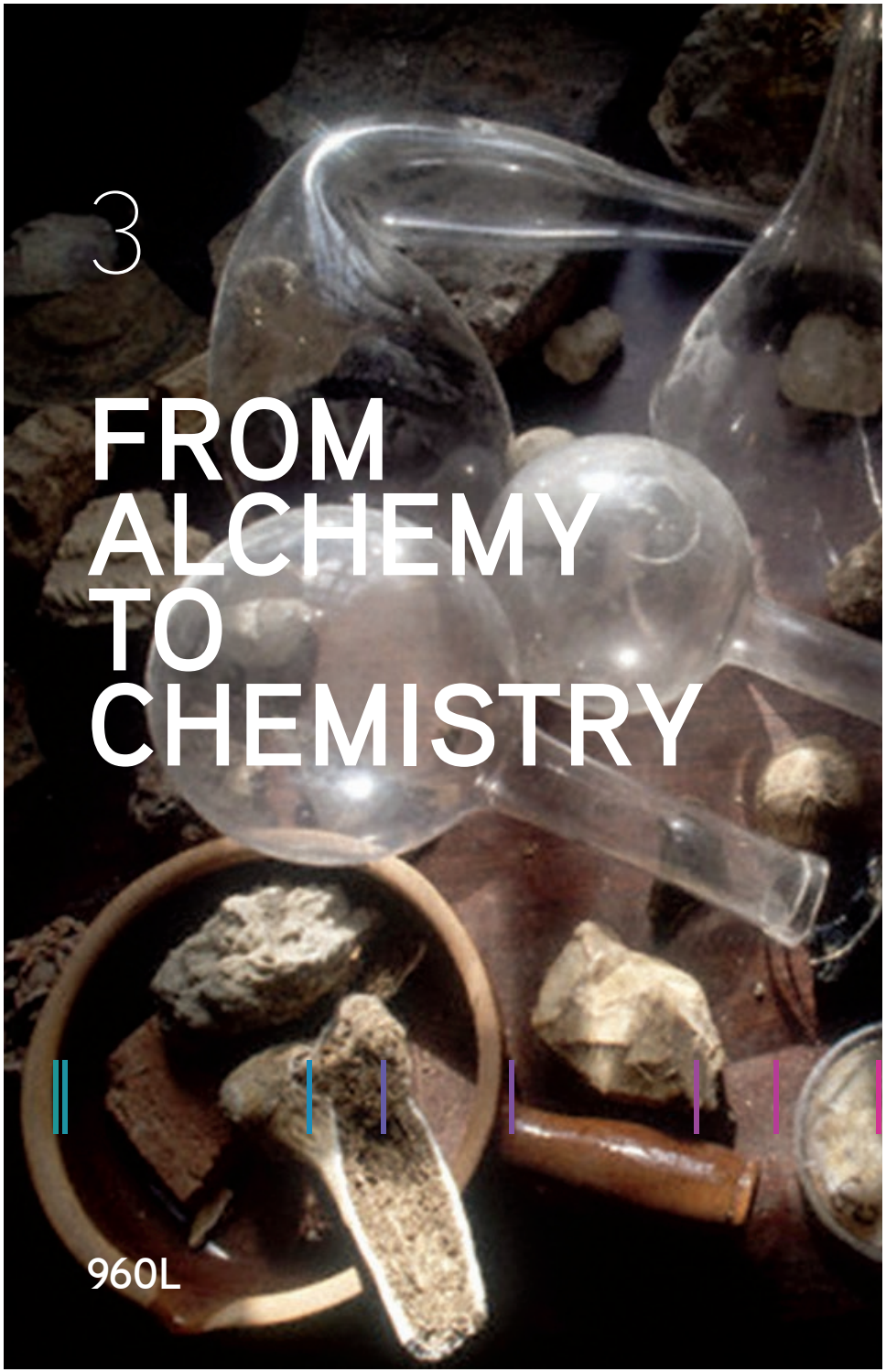

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FROM ALCHEMY TO CHEMISTRY

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FROM ALCHEMY TO CHEMISTRY

THE ORIGINS OF TODAY'S CENTRAL SCIENCE

By Michelle Feder, adapted by Newsela

Many of the earliest chemists, physicians, and philosophers were also alchemists.

The word “alchemy” brings to mind colorful imagery. Think of witches hovering over a boiling brew. Or, perhaps sorcerers in smoky labs or dusty libraries. Despite these mystical images, alchemy played an important role in the evolution of modern science.

Alchemy was an early philosophical and spiritual field of study that combined chemistry with metalwork. But it was also an investigation of nature. Alchemy included physics, medicine, astrology, mysticism, spiritualism, and art.

The goals of alchemy were:

- to find the “elixir of life” (it was thought that this magical elixir would bring wealth, health, and eternal life);
- to find or make a substance called the “philosopher’s stone.” When heated and combined with copper or iron it would turn it into gold, thought to be the highest and purest form of matter; and
- to discover the relationship of humans to the cosmos and use that understanding to improve the human spirit.

Alchemy was scientific, but it was also spiritual. Some of its practitioners had good hearts. For instance, if alchemists could learn the secret of “purifying” copper or iron into gold, they might gain the ability to purify the human soul. At the same time, many alchemists were viewed as con artists and fakes. But many alchemists were in fact serious-minded practitioners. Their work helped lay the foundation for modern chemistry and medicine.

The central science

Alchemy began as a quest to know the world around us. That quest for knowledge required an understanding of how chemicals worked. Alchemy itself died out during eighteenth century with the rise of modern science. Yet, the quest it began continues today in chemistry. Chemistry is sometimes called "the central science" because it connects sciences like physics, geology, and biology. To understand the field of chemistry, we must grasp its beginnings.

Alchemists contributed to an incredible number of future uses of chemicals: metalworking, inks, paints, and cosmetics, and the preparation of extracts and liquors. It was alchemists who first figured out how to isolate zinc and phosphorus. A German alchemist developed a porcelain material. It's creation broke China's centuries-old control over one of the world's most valuable products. These contributions proved valuable to the societies in which alchemists lived. And they advanced civilization.

But alchemists often made no separation between their work with chemicals and what we might call magic. They borrowed symbols and words from the Bible and myths. Even the simplest formula read like a magic spell or ritual. And although there were commonly used techniques, alchemists shared no standardized scientific practice.

Roots in the ancient world

The origins of alchemy are difficult to track down. In the East, in India and China, alchemy started sometime before the Common Era (CE). They began with meditation and medicine designed to purify the spirit and body and to thereby achieve immortality. In the West, alchemy probably evolved from Egyptian metallurgy as far back as the fourth millennium BCE.

Aristotle (384 — 322 BCE) believed all matter was made of the four "elements" — earth, air, fire, and water. His ideas began to influence alchemy when his student Alexander the Great (356–323 BCE) established Alexandria in Egypt as a center of learning. Alexander is said by some to have discovered the Greek god Hermes's famous Emerald Tablet. reputed to contain the secret of the philosopher's stone.

Islamic Arabs took over Alexandria in the seventh century CE. They shifted the center of learning to Damascus and the newly founded Baghdad. Alchemical texts were translated from Greek to Arabic. A famous figure of that time was Jabir ibn Hayyan (721–815), a royal alchemist in Baghdad. Jabir's writings were the first to mention important metallic compounds. Like Aristotle, Jabir believed metals grew in the Earth.

But Jabr came up with something new. He believed that the key to the differences between metals was how much mercury and sulfur they contained. Making gold thus required the purification of these two ingredients. Scholars in the West first learned about alchemy in roughly the twelfth and thirteenth centuries as they copied and translated Arabic texts into Latin. Medieval science was still dominated by the ideas of Aristotle.

Robert Boyle is often considered the father of modern chemistry

Alchemy after the Middle Ages

Among the most important of the European alchemists was Paracelsus (1493 – 1531). He was the first toxicologist, a person who studies poisons. Paracelsus believed that the body's organs worked alchemically. That is, their function was to separate the impure from the pure. He proposed that a balance of three substances (mercury, sulfur, and salt) was necessary for maintaining health. Paracelsus treated the plague and other diseases with an alchemical approach. It included administering inorganic salts, minerals, and metals. He believed that what he called the "alkahest," the supposed universal solvent, was the philosopher's stone. But he had no interest in metals, writing, "Many have said of Alchemy, that it is for the making of gold and silver. For me such is not the aim, but to consider only what virtue and power may lie in medicines."

In 1662, Robert Boyle (1627 – 1691) came up with what we call Boyle's Law. It states that the volume of a gas decreases as the pressure on it increases — and vice versa. For this discovery and others, Boyle is sometimes called the father of modern chemistry. But he was not a scientist as we think of them. Rather, he was a natural philosopher, someone who studied fundamental questions about nature and the universe before the nineteenth century. After his time, dramatic advances in technology began to revolutionize how we approached these questions.

Boyle studied the transmutation of the elements. He claimed to have changed gold into mercury by means of "quicksilver," the ingredients of which he did not reveal. This caught the attention of Isaac Newton, another enthusiastic alchemist. Like Boyle, he was motivated in his research "by the good it may do in the world." The two struck up a correspondence.

Central to Boyle's efforts was his "corpuscularian hypothesis." Boyle believed that all matter consisted of arrangements of tiny identical particles called corpuscles. Transforming copper to gold seemed to be just a matter of rearranging the pattern of its corpuscles into that of gold.

Aristotle's four-elements theory was still around. Boyle sought to overthrow it. Boyle recognized that certain substances decompose into other substances. At some point though there are substances that cannot be broken down any further. For instance, water decomposes into hydrogen and oxygen when it is shot through with electricity. But hydrogen and oxygen can't be broken into anything smaller. These fundamental substances that couldn't be broken down further he called elements.

Boyle was a constant experimenter who kept accounts of both his failures and successes. He was a pioneer of the scientific method. He endlessly repeated his experiments with slight variations to obtain better results. Unheard of among earlier alchemists, he always published the methods and details of his work in clear terms that could be widely understood.

A new framework

By the late eighteenth century, the field of chemistry had fully separated from traditional alchemy. Yet chemistry sought to tackle the same questions alchemy once did. Experimentation based on the scientific method, the publication of research results, the search for new elements and compounds and their application in medicine to help mankind, were all concerns first addressed by alchemists. Now they were part of modern science.

Among the most significant of the post-alchemical chemists were the Frenchman Antoine-Laurent Lavoisier (1743 – 1794) and Russian chemist Dmitri Mendeleev (1834 – 1907). In 1789, Lavoisier wrote the first true chemistry textbook. Like Boyle, he is often referred to as the father of modern chemistry. Lavoisier agreed with Boyle that Aristotle's four-elements theory was wrong. In his textbook, he made a list of metallic and nonmetallic elements.

It was Mendeleev who would organize all those elements into the periodic table. In 1869, he showed that the elements could be arranged in a periodic — regular and recurring — relationship to each other based on their atomic weights. His periodic table also could accurately predict the properties of elements that had yet to be discovered. Mendeleev's table is still used today.

Chemical questions: Our best hope for tomorrow

Just as alchemy was a touch point for many crafts, chemistry is at the center of the sciences. It's a field of study that looks for answers to big questions.

Chemists around the world are developing new techniques and inventions. Like alchemists, sometimes they isolate or purify specific components. Other findings might come from developing new compounds.

Some recent research:

- University of California–San Francisco biochemists identified a memory-boosting chemical in mice. One day it may be used in humans to improve memory.

- Cheaper clean-energy technologies could be made possible thanks to a new discovery by a chemistry professor at Penn State University.

- The Duke Cancer Institute found that an osteoporosis drug, meant to prevent the weakening of bones, actually stopped the growth of breast cancer cells. It even worked in resistant tumors.

These are just a few examples of how modern chemistry carries on the alchemical quest for the elixir of life.

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