totle's lost writing *Against Alcmaeon* apparently concerned Alcmaeon as a philosopher.

In the history of science Alcmaeon is especially important for two reasons: he may have written the very first Greek prose book, a *physikos logos;* and he furnished medicine with the first material for a fundamental intellectual mastery of the nontraumatic internal diseases. He defined health as "the isonomy [balance] of forces" (that is, a balance of the opposite bodily qualities of cold and warm, bitter and sweet, and so forth) and internal disease as the "monarchy" of one of these "forces." He further divided the causes of disease into disorders of environment (climatic factors and the like), of nutrition, and of physical mode of living (exertion and such). From these definitions he formulated the bases of a general pathophysiology of internal diseases; similar hypotheses were made by the Hippocrateans. Apparently Alcmaeon clearly recognized the conjectural character of his formulae; they constituted, for him, an "opinion about the invisible."

Alcmaeon also seems to have engaged in dissection, especially ocular dissection for the investigation of the visual process. Obviously, the word *exsectio* in Chalcidius' report is to be taken in this sense; it could hardly refer to a surgical operation on a man since human dissection in a systematic form was, for religious reasons, neither then nor until much later possible in Greece. Among the pre-Socratic philosophers of around 500 B.C., Alcmaeon is the one most closely connected with medicine and therefore had the greatest significance for medicine *per se,* although he himself did not practice as a physician.

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FRIDOLF KUDLIEN

ALCUIN OF YORK (*b.* York, England, *ca.* 735; *d.* Tours, France, 19 May 804), *education.*

Alcuin is not famous for contributing to a specific scientific discipline; rather, his reputation and renown are based upon more general accomplishments. As Charlemagne's educational advisor, he brought Anglo-Saxon learning and teaching methods to the Franks.

Alcuin was born of a noble Northumbrian family. His English name was Ealhwine (Alchvine), but he preferred the Latin form, Albinus; at the court of Charlemagne he acquired the surname Flaccus. Educated at the cathedral school of York under the supervision of the archbishops Egbert and Aelbert, he was exposed to the best traditions of the early English schools. The school of York was heir to the rich pedagogical legacy of the Venerable Bede, and by the beginning of the eighth century its library was the finest in England. The methods and curriculum developed at York brought vitality to early medieval learning.

Alcuin's abilities attracted the attention of his teachers, and he became the protégé of Aelbert. At the death of Egbert in 766, Aelbert became archbishop and Alcuin assumed a major role in the leadership of the school; in 778 he became head of the school and library. When Eanbald became archbishop in 780, Alcuin was sent to Rome to receive the *pallium.* On his return journey the following year, he met Charlemagne at Parma. By this time Alcuin's fame as an educator and scholar had spread to the Continent. The Frankish king needed a competent educational advisor, for education in his kingdom was in a state of decline; he therefore invited Alcuin to become his minister of education. Upon accepting the offer in 782, Alcuin initiated a reform of the Frankish schools. He now became the guiding force behind Charlemagne's educational policies and the leading spirit of the palace school. Charlemagne rewarded Alcuin well for his services: he was granted the abbeys of Ferrières, Troyes, and St. Martin at Tours.

Alcuin popularized the study of the seven liberal arts in France and wrote elementary textbooks on these subjects. While these works do not demonstrate brillant philosophical insight, they do reflect the mind of a creative teacher. His dialogue method of instruction brought needed vitality to teaching; there was now more give and take between teacher and pupil. The emphasis on the elementary subjects of the *trivium* and *quadrivium* encouraged both secular and sacred learning—indeed, the schools themselves were opened to both clerics and laymen, for both church and state needed educated servants.

The knowledge of science imparted by the schools was restricted, and Alcuin's works show only a limited awareness of the physical world. In his *Disputation of the Royal and Most Noble Youth Pepin with Albinus, the Scholastic,* there is a very general discussion of man, the universe, and the natural world. This work

is presented in the form of 101 questions, problems, and riddles, with symbolic answers. There are almost no natural or scientific answers; the explanations are in terms of effects rather than causes:

> Pepin: What is the sun?
> Albinus: The splendor of the universe, the beauty of the sky, the glory of the day, the divider of the hours.

Alcuin expressed some interest in astronomy, but it was an interest based on the need for an understanding of calendrical calculations. He helped to develop the Continental interest in the *computus,* and to aid the development of the skills needed to establish the date of Easter, he encouraged the study of mathematics.

In a work ascribed to him, *Propositions for Sharpening the Minds of Youth,* Alcuin presents fifty-three mathematical puzzles. While some can be solved through elaborate and ingenious calculations, many of them require geometrical and algebraic solutions. His encouragement of education was a valuable stimulant to the culture of Charlemagne's realm, and thus he left a lasting legacy to both the culture and the science of Europe.

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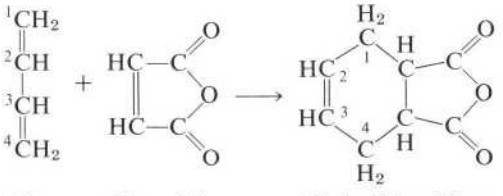
Phillip Drennon Thomas

ALDER, KURT (*b.* Königshütte, Germany [now Chorżow, Poland], 10 July 1902; *d.* Cologne, Germany, 20 June 1958), *organic chemistry.*

Alder, the son of a schoolteacher in the heavily industrialized area around Kattowitz (now Katowice) in Upper Silesia, received his early education in the German schools of Königshütte. When the region became a part of the new Polish nation after the end of World War I, his family left in order to remain in Germany. After completing the Oberrealschule in Berlin, Alder studied chemistry at the University of Berlin and later at the University of Kiel, where he received the doctorate in 1926. His dissertation, "On the Causes of the Azoester Reaction," was carried out under the direction of Otto Diels. Alder continued his work at Kiel, being made a reader in organic chemistry in 1930 and extraordinary professor of chemistry in 1934. He became a research director at the Bayer Werke in Leverkusen, a branch of I. G. Farbenindustrie, in 1936. In 1940 he returned to academic life as ordinary professor of chemistry and director of the chemical institute at the University of Cologne, where he served until his death. In 1949–1950 he was dean of the Faculty of Philosophy. With Diels, he received the Nobel Prize for chemistry in 1950.

Alder's principal contributions to organic chemistry are associated with the diene synthesis, which grew out of his studies in Diels's laboratory and was first reported in 1928. The synthetic method, frequently referred to as the Diels-Alder reaction, involves the addition of dienes (compounds with conjugated unsaturation, i.e., double bonds on adjacent carbon atoms) to dienophiles (compounds having a double bond activated by nearby carbonyl or carboxyl groups). A simple example is the addition of butadiene to maleic anhydride:



Diene Dienophile Diels–Alder adduct

Although a few reactions of this type had been reported over a period of more than 30 years, Diels and Alder recognized the widespread and general nature of the reaction and subsequently spent much of their lives in developing the consequences. They called particular attention to the ease with which such reactions take place and the high yield of adduct.

Their earliest work involved the addition of cyclopentadiene (I) to *p*-quinone (II). The nature of the product (III) of this reaction was the subject of controversy from the time of its preparation by Walter Albrecht in 1893. Diels and Alder, utilizing the corresponding addition of cyclopentadiene to azoester