tell secrets and problems of their lives to doctors which their families and clergy never hear—even to a new and strange doctor. It bespeaks long years of correct dealing, fine ideals and good service. This faith of the people is the one thing that keeps the profession of medicine as a whole at a high level. Doctors are no different from other folk, but their form of service, their work and the faith of people in them are calculated to bring out the best there is in them. There is something about suffering that strikes home at the best fibers. It is something that makes one glad to miss a night's sleep or a friend's dinner.

But pictures of rewards are not what should be shown to those electing a career. What you should see is the various phases of the work, so that what may interest you may be selected. Medicine needs no proselyting. It is a profession that deals with life, other than which man has no greater interest. It is rather that men should be discouraged from entering this field unless they profess a great interest and like work.

Those who contemplate entering medicine should have some preliminary scientific training. Unfortunately the major part of our early education is chiefly a practice in memory, that is, languages, history, geography, etc. Logic is of much assistance, but mathematics are scarcely as well drilled into students now as they used to be. And there is almost no training in the scientific method of accurate observation, the correlation of facts, the drawing of deductions from facts and the synthesis of facts. One of the greatest difficulties in first-year medical students is to teach them the value of a correct observation. It is true that chemistry and physics are gradually creeping into precollege curricula. But should we stop there? Why not actually teach students some of the facts of life and sacrifice a little syntax? Even if they never heard of medical schools, they might all be wiser, healthier and happier citizens for it.

May I again in closing ask you to consider your own qualifications before you reach any decision as to your choice of a career? Remember that it is extremely difficult to change one's field of work in the future. In medicine you can choose a very varied career; those of you with great curiosity, a wide vision and some ingenuity will doubtless be happier in some laboratory field; the more patient and philosophical will enter that most honorable career of a general practitioner; the less patient may become specialists.

The final choice must rest with one's interest—that interest can only be determined by actual contact. As regards an opportunity to advance the science of medicine and leave a lasting contribution for the good of mankind, all branches hold an equal opportunity. But no two students receive the same reaction. In one sense pathology and obstetrics are at opposite ends of the medical spectrum. Thus, pathology deals with the dead or critically ill and to a large degree deals with people on the downward trend of life, whereas obstetrics deals with the beginning of life, with young people and a period of life when there is usually much rejoicing. People reflect their lives. Pathologists are rarely boisterous folk, obstetricians are proverbially jovial and stout. Pathologists on the other hand have done a great deal more to advance our knowledge of disease. To some this difference of surroundings may be a matter of importance. You must see these different fields yourselves in order to choose wisely.

> The doctor has always been somewhat cloistered from the world of affairs. Untrained in executive and business matters, and traditionally unsuccessful in these as a rule, he has been separated by his unsuitable training and by the urgent character of his work from any active part in public affairs. Indeed, he has been excused by law from some public duties that other men are obliged to do, and by common tradition has been free of criticism if he took less part in other such matters than do most men. Medicine has in fact attracted very largely men who temperamentally shun public activities. Besides this, one of the more or less definitely recognized large compensations in medicine, and one that has been jealously guarded and perpetuated, is that the doctor owes obedience to the law and to his own conscience, and is not subject to human masters.[2]

This sense of freedom from control with its obvious assumption of great individual responsibility may be a determining factor in the final choice of a few individuals. It may be that this constitutes one of the greatest differences between business affairs and the profession of medicine.

ELLIOTT C. CUTLER
WESTERN RESERVE MEDICAL SCHOOL

AN OBJECTIVE DEMONSTRATION OF THE SHAPE OF CELLS IN MASSES[1]

IF the cells of plants or animals, whenever they are grouped in masses, are typically fourteen-sided bodies of a particular pattern, ought not that fact to find a place in every elementary presentation of structural

[2] Edsall, D. S., "Movements in Medicine." *Boston Med. & Surg. Jour.*, 1916, CLXXIV, 891–892.

[1] This review, written at the request of the editor, is a partial synopsis of two papers obtainable from the American Academy of Arts and Sciences, Boston: "The Typical Shape of Polyhedral Cells in Vegetable Parenchyma and the Restoration of that Shape following Cell Division" (Proc., Vol. 58, No. 15, 1923); "A Further Study of the Polyhedral Shapes of Cells: I. The Stel-

botany or zoology? Even before the cell theory had been established—when cells were of less significance than at present—Kieser thought what a fine discovery it would be if some three-dimensional shape could be assigned to them, which would account for their prevailing hexagonal form in sections. There are two reasons for the present lack of interest in the problem.

First, it was recognized that free cells take the form which has a minimal surface for its mass, and are spherical; and Kieser, in 1815, announced that cells, when pressed together, preserve a minimal surface in so far as conditions allow. This has been universally accepted, and many think that if the determining physical factor is known, what matters the particular shape assumed in various cases?

The second reason for evading so fundamental a question has been the assumed incompatibility between the irregularity of actual cells and the precision of the interpretive diagrams. After studying Brisseau-Mirbel's figures, Kieser declared that cells in masses are either rhombic dodecahedra (which have twelve quadrilateral facets) or more usually are truncated rhombic dodecahedra, with eight quadrilateral and four hexagonal facets. This conclusion, accepted at first, gradually disappeared from the books, not because it was disproven, but because it seemed too schematic and artificial. Its latest advocate is perhaps Sir D'Arcy Thompson, in "Growth and Form," who makes the guarded statement that "very probably" the rhombic dodecahedral configuration is "generally assumed." Schaper, apparently unaware of the earlier literature, thought that massed cells are *regular* dodecahedra, with twelve pentagonal facets. These have less surface than rhombic dodecahedra, but they can not be stacked, so that Kieser considered them eliminated, and Schaper must have assumed that actual cells are nothing better than malformed approximations of that shape. Von Mohl's safe verdict was, "Better than *dodecahedral* is the designation *polyhedral*."

Meanwhile Lord Kelvin had found that a fourteen-sided figure—a cube truncated by an octahedron—having six quadrilateral and eight hexagonal surfaces, solves the problem of dividing space without interstices into uniform bodies of minimal surface. If the surface area of a sphere is taken as a unit, the non-stackable pentagonal dodecahedron of the same volume has a surface area of 1.0984, the orthic tetrakaidecahedron's surface is 1.0987, and that of the rhombic dodecahedron is 1.1050.

late Cells of *Juncus effusus;* II. Cells of Human Adipose Tissue; III. Stratified Cells of Human Oral Epithelium'' (Proc., Vol. 61, No. 1, 1925). An extensive group of sections and models of these cells was demonstrated at the recent meeting of the anatomists, in New Haven.

The studies at the Harvard Medical School include the counting of the surfaces of two hundred cells. The cells are indeed irregular, and the number of surfaces per cell varied from six to twenty, but the average number was 13.97. Altogether seventy cells were reconstructed in wax, so that their volumes and surface areas could be measured, and the shape of their facets studied in detail. Nothing suggestive of the rhombic dodecahedron was found, but in a number of instances the typical alternation of quadrilaterals and hexagons, characteristic of the tetrakaidecahedron, was strikingly exhibited. Further, it was determined by Professor Graustein—to whom, and to Professor Davis, I am indebted for the entire mathematical part of the work—that there is no transition between the twelve-sided and fourteen-sided forms. It is impossible by any maneuvering, as it were, to insinuate two additional surfaces and change dodecahedra into tetrakaidecahedra. The arrangements of spheres to produce these two forms differ at the outset. Spheres which make dodecahedra are stacked like cannon balls, which is the "normal piling" of engineers. For tetrakaidecahedra the spheres can not be so closely packed. In certain planes they stand apart from each other by .31 of their radius, and so avoid a deformation which would increase their surface area by only fifty-eight one-hundredths of one per cent. If so slight a difference in area controls the shaping of cells, surface tension is a factor of unexpected potency.

The cells studied include those of elder pith and human fat. The former are produced by division of pre-existing cells. A mass of tetrakaidecahedra, arranged with hexagonal surfaces above and below, has the surprising property of retaining the fourteen-hedral form if every cell divides horizontally and constricts at the plane of division. Division in a vertical plane destroys the pattern and necessitates a complex readjustment for its restoration. Elder cells show a great variety of modifications of the typical pattern due to cell division.

Fat cells enlarge after they have ceased to multiply, and assume forms quite like those of elder pith, except that they are not oriented in relation to an axis. In both cases pentagonal surfaces are frequently substituted for alternating quadrilaterals and hexagons, with a resulting diminution of surface area, as determined by measuring the models. Through irregularity, cells have advantages greater than that of the geometrical type from which they deviate.

A very attractive and highly exceptional form of cell is found in the pith of Juncus. Each cell is typically a star with six bifid rays, so that it has twelve contacts with other cells. But it is derived from a fourteen-sided parenchymal cell, which regularly loses two of its contacts, namely, those with the cells immediately above and below. A curious result is that the intercellular spaces become themselves tetrakaidecahedral enclosures, bounded by the arms of eight surrounding cells.

The smaller cells of stratified epithelium were modeled to a limited extent. They also are primarily tetrakaidecahedral, and sustain the conclusion that this is the typical form whenever cells occur in masses.

What further studies are suggested by these observations? Since the modeling of vegetable cells is relatively easy, an extension of this research to other tissues of plants is entirely practicable and promises interesting results. But instead of undertaking this at present in the Harvard laboratory, we are considering the eight-surfaced cells of the simple epithelium of animals. When this epithelium is spread in a flat sheet, its cells are commonly hexagonal prisms with flat or more or less rounded ends. But when such an epithelium forms the wall of a cylindrical tube or duct, its cells necessarily become compressed at their inner ends and somewhat expanded basally—more so when they line a spherical alveolus. Professor Graustein is calculating the changes in surface area that accompany these three arrangements, and this is apparently a new problem. The appearance of the cells in sections suggests that surface tension may cause the narrowed ends to tend to withdraw from the lumen, leading to the production of basal or parietal cells; and it may be that the terminal bars or "Schlussleisten" serve to counteract this effect by holding the narrow ends in position.

The problem of the endothelial cell also is seen in a new light, if attention is given to the shape of the cells. They are remarkable departures from the spherical form which free cells tend to assume, and the cause of their flattening has not yet been determined. If a capillary wall consists of active protoplasmic cells flattened because of tension, it is quite possible that the capillaries possess a tireless contractile force apart from any Rouget's or muscle cells. This also is under investigation; and the two problems here outlined may suggest still other applications of the conclusion that cells in masses are typically tetrakaidecahedral.

FREDERIC T. LEWIS

HARVARD MEDICAL SCHOOL

WILLIAM OTIS CROSBY

IN the early dawn of December thirty-first, as the year 1925 drew to its end, the spirit of William Otis Crosby returned to Him who gave it. Thus ended a life spanning three quarters of a century and a geological career of more than fifty years.

It was in the little village of Decatur, Ohio, that Crosby was born on the fourteenth of January, 1850. He came of all-English stock, and his ancestors settled in eastern Massachusetts shortly after the landing of the Pilgrims. From Ohio Crosby's parents moved to Toledo, Iowa, when the child was five years old. Later came the Civil War, and a boy of eleven watched his father march away to defend the Union, leaving heavy responsibilities upon very small shoulders; for three younger children now looked to him for help the father could no longer give.

Peace restored, the father became superintendent of a gold mine in North Carolina and soon brought his family to the new field of labor. Here in the Carolina hills the eyes of young Crosby opened to the wonders of nature, and he began to read such books on geology as he could secure. A clerkship in the Pension Bureau at Washington took the boy for two years into a less romantic atmosphere; but the evenings were his own, and geological literature was here more accessible. It is not surprising, therefore, that when in the early spring of 1871 young Crosby journeyed westward with his father, it was with a mind keenly alert to the geological features passed on the way. A carefully kept journal records not only his interest in the herds of wild buffalo seen on the plains and his enthusiasm for the vision of snow-clad Rockies looming on the western horizon, but likewise a host of geological observations which show that the youth of twenty-one had also scientifically "come of age."

During the summer Crosby twice ascended Gray's Peak, the last time in company with a party from the Massachusetts Institute of Technology, which included President Runkle, four professors and twenty students. Before the party left Crosby had made up his mind to enter the institute that same fall. Leaving the assay office in Georgetown where he had found employment, he journeyed eastward in November, quickly made up lost work and carried through his program of studies, although not without an interruption of one year spent with his father in a silver mill near Georgetown. It was to the Colorado home also that he returned for most of the summers during his years as an undergraduate at the institute. But the summer of 1873 found him a student of the great Agassiz in the summer school at Penikese, an experience which made a deep impression upon the maturing young scientist.

On his graduation from the institute in 1876, Crosby obtained a position as assistant in geology and mineralogy in the Boston Society of Natural History, where he served under the distinguished paleontologist, Alpheus Hyatt. At the same time he was made assistant in geology at the Massachusetts Institute of Technology, where he became instructor two years later, soon rising to professorial rank, which position he held until 1907, when increasing deafness caused