eight hours and chloroform be given for four hours, a central injury to the liver lobule develops. These observations are of particular interest in that they show that a shift in cell type may develop in the liver without the use of an agent distinctly abnormal to this tissue, that the change may be acquired as a product of senility and that when it develops it imparts to the liver a degree of resistance to chloroform comparable to that induced by a process of repair following a severe hepatic injury from uranium nitrate.

CONCLUSIONS

(1) The observations which have been made concerning an acquired resistance of fixed tissue cells to chemical injury should be considered of a gross order and perhaps superficial in their nature. Studies of the mitochondria, the Golgi apparatus and the chemical constitution of such resistant cells afford important suggestions for investigation.

(2) The type of fixed cell response which develops in both the kidney and liver as a reaction to injury induced by uranium nitrate depends upon the severity of the injury to the epithelial structure of these organs. If the injury which is inflicted be slight as indicated by cytological changes of degeneration and in the case of the liver by but minor interference in one manifestation of its function, the process of repair results in the formation of a normal type of epithelial cell. This type of repair process is not associated with the acquisition on the part of the kidney of any degree of protection against subsequent intoxications by uranium or in the case of the liver against the toxic action of chloroform.

(3) If the injury to the epithelium of the kidney or the liver be of a sufficiently severe order, there occurs in such animals the development of a process of epithelial repair which is atypical in character and which imparts to the kidney a relative resistance against subsequent intoxications by uranium and in the liver a similar protection against the toxic action of chloroform.

(4) This protection is not dependent upon the development during the process of repair of a type of cell which is functionally inert and therefore one which does not subject itself to the action of the toxic agents. The morphologically altered hepatic epithelium maintains its functional effectiveness, as is indicated by its ability to remove phenoltetrachlorphthalein from the plasma and furthermore when such changed fixed tissue cells in the liver are subjected to the toxic action of chloroform in a concentration and for a duration far in excess of that employed under standard conditions, they show evidence of injury and liver function becomes depressed.

(5) The observation has been made of the natural occurrence in the livers of certain senile animals of a type of morphologically altered epithelium similar in its configuration and staining reactions to the cells which may develop in the liver reacting to a severe injury from uranium nitrate. Such cells impart to the livers of senile animals an acquired resistance to the toxic action of chloroform.

(6) It would appear from these experiments that a tissue resistance to certain chemical substances may depend upon the development in tissues as a process of repair following injury of an altered type of resistant fixed tissue cell which maintains a sufficient degree of functional effectiveness to enable the organism as a whole to survive.

OBITUARY

EDWIN BRANT FROST

1866–1935

EDWIN BRANT FROST was born on July 14, 1866, at the pleasant town of Brattleboro in the southeastern corner of Vermont. It was here or in the immediate neighborhood that most of his forbears for several generations had lived and flourished. The first of the name in this country was Edmund Frost, who came to Boston in 1634, his grandchildren moving west to New Hampshire and Vermont. Edwin was the second son of Carleton Pennington Frost (1830–1896), who practiced medicine in Brattleboro and neighboring towns until 1871, when he moved with his family to Hanover, New Hampshire, there to be a professor in the Dartmouth Medical School and afterwards dean of the school and a trustee of the college.

Edwin was graduated A.B. at Dartmouth in 1886. The year following he continued postgraduate work at Dartmouth, taught school in a nearby village and at the end of the year spent a few months at Princeton, where he came under the influence of Charles Augustus Young (1834–1908), then perhaps the leading teacher of astronomy in this country. An appointment to an instructorship at Dartmouth came in 1887. At that time advanced work in astronomy and in almost every other branch of science meant a year or more in Europe. Accordingly, Frost secured a two-years leave (1890–1892) to visit most of the European observatories and to spend the second year at Potsdam in Germany, where Vogel was establishing an observatory devoted especially to the new science of astrophysics and where he had gathered around him an exceptionally brilliant staff, all of them leaders in their chosen fields: Scheiner, Müller, Kempf, Wilsing, Hartmann, Ludendorff, Eberhard, Lohse. Frost thus had an opportunity to come into contact with a group that it would have been difficult to match at a single institution either in that day or during the twenty years to follow. When he returned to Dartmouth in 1892 it was as assistant professor, and this promotion was followed in 1895 (when he was only twenty-nine years of age) by a full professorship and the directorship of the Dartmouth Observatory.

While at Potsdam Frost made arrangements with Scheiner to translate into English the latter's "Spectralanalyse der Gestirne" (1891). Frost's work appeared in 1894. It is more than a translation, for although there was only three or four years between the two books, much progress had been made in astronomical spectroscopy in the interval, and Frost brought the work up to date, besides incorporating some new matter in the form of tables. Frost's book played an important part in the rapid development of the science in this country, and until very recently it remained the standard work on the subject in our language.

The lines along which Frost's career was likely to develop must have seemed unusually clear to him at this time, and doubtless he looked forward to a long term of usefulness to his Alma Mater. But a series of apparently remote events rapidly and completely changed his outlook. James Edward Keeler (1857–1900) had left the Lick Observatory in 1892 to take charge of the Allegheny Observatory in Pittsburgh. There he at once made a striking series of spectroscopic observations with the meager equipment at his disposal. One effect of this success was to give great impetus to a movement to erect a new Allegheny Observatory, with a thirty-inch refractor as its principal instrument. When something more than half of the amount of money necessary for this project had been raised, business conditions in Pittsburgh caused the fund to halt, and Keeler had to look forward to some additional years with the old equipment. Those were the days when Catherine Bruce, of New York City, was devoting a good deal of her income to further astronomical research in all quarters of the globe. In 1897, Dr. George E. Hale, director of the recently completed Yerkes Observatory at Williams Bay, Wisconsin, successfully applied to Miss Bruce for a grant sufficient to bring Keeler to the Yerkes Observatory for five years and to set on foot an extensive program of spectroscopic observations of the stars. He was to go to the Yerkes in the summer of 1898, but in the spring of that year he received a most unexpected call to succeed Holden as director of the Lick Observatory. In common with every one else concerned he felt that he could not refuse this call. For the place thus left open at the Yerkes Observatory Dr. Hale naturally turned to Professor Frost, who took up his duties at Williams Bay in the summer of 1898, expecting to stay for five years only. But before the end of this term the outlook had again changed, for Hale had been organizing what was at first an expedition from the Yerkes Observatory to California to observe the sun under more favorable climatic conditions. As every one knows, this expedition grew into the Mount Wilson Observatory. In the two years following 1903 much of the responsibility for the conduct of the Yerkes Observatory fell to Frost. On Hale's resignation as director in 1905, Frost was appointed to succeed him in June of that year.

The late Dr. de Sitter once remarked to me that American astronomers were, with a few conspicuous exceptions, a group of specialists; and he added with a smile that he did not know whether this was an element of weakness or of strength for the general progress of the science. His remark would have applied with much force to Frost, who persisted in devoting his energies to the spectroscopy of "early-type" stars to the practical exclusion of every other subject. Primarily for this purpose the Bruce spectrograph was constructed in 1900 largely from his specifications and under his supervision. With this instrument and with the able collaboration of Walter S. Adams, now director of the Mount Wilson Observatory, he measured the radial velocities of many "helium stars" or "Orion stars," as they were then called (now they are more logically designated as B-stars, following the Draper Classification), and discovered their most important characteristics. It was shown that their space velocities are small as compared with those of later-type stars and that there is a slight but unmistakable tendency for these stars to recede from our system as a whole, as if they formed an expanding group. These facts were later more fully developed by Campbell; their explanation is closely interwoven with recent important discoveries in astronomy and physics.

Frost also showed from changes in radial velocity that a surprising number of B-type stars are close binary systems, perhaps as many as one in every three. On several occasions I have witnessed his discovery of such a binary from a single photograph of its spectrum. This sounds like an impossibility, but the explanation is simple. Even in those days (around 1904) he was extremely nearsighted, and could see well an object not more than an inch from his eye; thus, as he used to say, by simply pushing his glasses up he always had at his disposal a magnifying power of about ten diameters. After he had secured a spectrogram and developed it the next morning, he would examine it in this way, sometimes before it was dry. If he saw the lines considerably displaced from their normal positions, he knew that it was extremely unlikely that this was because of the star's large space velocity, since, as we have said, he had found that such velocities are always small for B-type stars; the displacements must then be due to orbital motion, and so indeed they invariably proved to be when later he could examine a series of plates of that star.

Frost's place in astronomy is not to be judged on the basis of his researches alone. We have already mentioned his translation of Scheiner's work and the part this translation played. For more than thirty years his was the chief responsibility for editing the *Astrophysical Journal,* "an international review of spectroscopy and astronomical physics," founded in 1895 by Hale and Keeler, and now in its eighty-first semiannual volume. One might say of Frost as Frost used to say of Burnham, "he is the best skeptic I know." As a result of this quality of judicious conservatism, the *Astrophysical Journal* has had little to regret in the way of hasty or ill-advised publication. In addition, he had an unusually sensitive feeling for language, which showed itself not only in his English but quite as well in German and nearly as well in French.

The last years of his life form a sad story, but an inspiring one as well. From early childhood he had had trouble with his eyes. This became acute by 1907 and necessitated long periods of complete rest for his eyes. In 1915 the retina in one eye became detached and within a few months he completely lost the sight in this eye, never to regain it. A few years later a cataract began to form in his other eye and grew worse and worse until he became totally blind. In spite of this heavy handicap, he managed for several years to continue his work as director of the observatory, but finally felt compelled to retire in 1933.

In the first year of his retirement he dictated to his wife, and dedicated to her, his autobiography, under the title "An Astronomer's Life."[1] The volume is important as a contribution to the history of present-day science. His story is told with fascinating charm, and I for one found it impossible to put it down before I had finished it. It is much more than a setting down of facts or a collection of well-told stories. As a record of courage and good sportsmanship in the face of one of life's severest disasters it can not fail to move every reader. In all his years of complete darkness he never lost his sense of humor. To the last he had a way of ignoring his blindness in conversation and whimsically using terms and expressions that one should ordinarily expect only from those who can see.

Early in April of this year Frost went to a Chicago hospital for observation. The cause of his ailment was diagnosed as gallstones. After some hesitation on account of his age (he was in his sixty-ninth year), an operation was performed on May 6. His condition improved for a few days but then his strength rapidly waned until the end came on May 12.

Among the honors that came to him were honorary degrees from Dartmouth and Cambridge; membership in the National Academy of Sciences, the American Philosophical Society and the American Academy of Arts and Sciences; honorary membership or the equivalent in the Royal Astronomical Society (London), Societa degli Spettroscopisti Italiani, astronomical societies in Mexico, Canada and Russia.

Dr. Frost was married in 1896 to Mary Hazard, of Boston; she and their three children survive him, as does his elder brother, who, like their father before them, is a professor in the Dartmouth Medical School.

FRANK SCHLESINGER
YALE UNIVERSITY OBSERVATORY
JUNE 4, 1935

[1] Houghton Mifflin Company, Boston and New York.

REGINALD OLIVER HERZOG

R. O. HERZOG was born in Vienna in 1878. His father was a newspaperman. After finishing his secondary education, Herzog studied chemistry at the University of Vienna under Lieben and there took his doctor's degree with a paper on organic chemistry. His interest, however, was at that time in physiological chemistry and so he went first to Heidelberg, where he worked in the Physiological Laboratory under Kossel, then to Utrecht and to Kiel. His first papers of this interval (1902–1905), nine in number, were concerned with straight physiological chemistry. But soon his interest branched out. He started to work on fermentation and the action of fungi. That led him deeper into industrial questions and he published papers on the theory of tanning and disinfection. On the other hand, he began to apply the methods of physical chemistry to ferment reactions, studying their kinetics and the influence of temperature upon them. In the meantime, he had moved to the Technische Hochschule at Karlsruhe, where he became first privatdozent, then ausserordentlicher (associate) professor. At that time, Haber was professor of physical chemistry there, working on the synthesis of ammonia. With him, Herzog formed a friendship that lasted until Haber's death in 1933.

In Karlsruhe, Herzog continued along his previous lines (physiological chemistry in general, fermentation), but he started also on two new subjects that were to occupy him through the rest of his life. He attempted to get a better insight into the constitution of the natural substances, many of which are colloidal, by physico-chemical methods. With this in mind, he instigated a number of experimental and theoretical