what had happened in the intervening score of years.

The historical glance backward has shown us the great forward strides made since earlier times by American chemistry. We are quite aware too that scientific discovery and invention are proceeding at an ever-increasing rate, and in the light of history our progress in the future is to be more rapid than in the past.

The functions, then, of chemistry in the future must be more comprehensive than at present and must certainly embrace an understanding of its economic importance. The service of chemistry must be not only in the discovery and the application of scientific and technological facts, but chemistry must also serve by solving the larger problems of distribution in its broadest sense. We must lay more emphasis upon the commerce of chemistry, upon the economical distribution of chemical wares. New uses must be found for old products. Old industries may justify expansion, and new ones would logically be inaugurated if deemed advisable.

It is not enough to visualize the great potential awaiting development—to view the perspective—and stop at that. Practical and efficient methods for bringing about the desired ends must be formulated, and happily, chemical industry itself, as well as governmental institutions, have made a beginning along this line.

A general method of approach, capable of specific application, of arriving at a program of effort, is through the chemical-economic survey. Such a survey, when completed, should show fairly conclusively whether or not a given material shall go into production, how long an industry can continue its current program, whether it should switch immediately or gradually or whether it should pick up and move to some other part of the country.

In building the survey structure the technique to be followed will, of course, depend upon the problem at hand, but no matter what the survey, whether of some particular branch of industry or of some particular commodity or group within the industry, the foundation upon which the superstructure is to be raised must consist of immediate, reliable, adequate and permanent records.

VIII

The Department of Commerce, because of its relation to other government establishments and to industry, has at hand or can point the way to the many sources of information so important in determining the position or status of a specific chemical industry or commodity, or in determining their trends. Cooperation in this respect is gladly accorded through the Chemical Division of the Bureau of Foreign and Domestic Commerce, which, established eight years ago by Mr. Hoover when he was Secretary of Commerce, with Mr. Concannon as chief, endeavors to render practical service in the application of commerce to chemistry.

Nearly every day one or more interesting problems are presented. Some one may ask, "How are the solvents?" or "What is the future of acetic acid and how?" Or the question may be, "Where and in what quantities can rotenone-containing plants be found? Has it been synthesized yet?"

The functions of the division are essentially trade promotive and do not include any of a regulatory nature. Through regional surveys and immediate services available in fifty-eight American cities the bureau assists domestic commerce. To promote foreign commerce the bureau also has available the services of its fifty-six offices abroad and the collaboration of the consular service.

The information thus made available covers a multitude of points: Magnitude of the situation as affected by foreign competitors, climatic conditions, advertising, make-up and habits of the population, purchasing power, chemicals and allied products manufactured locally or other sources of supply. Questions related to transportation facilities, customs tariffs and internal regulations affecting the importation or sale of American products in oversea countries are looked into and reported upon.

In addition, the bureau maintains lists of prospective agents in each country and keeps a complete commercial report on each one for the confidential use of American firms. Not only is up-to-date information given regarding trade conditions, but each week the bureau publishes a number of "trade opportunities," which are inquiries from parties with a definite interest in buying who wish to get in touch with manufacturers here.

A thousand men are at your service in the four corners of the world to gather together data bearing directly upon foreign trade promotion, and at the Washington headquarters and the district and cooperative offices throughout the country you will find the department's facilities at your disposal.

OBITUARY

GEORGE NEIL STEWART, PHYSIOLOGIST

April 18, 1860, to May 28, 1930

BY Stewart's death science has lost a brilliant physiologist "of the old school," a pioneer, a builder of bridges between the founders of modern physiology of the modern era. He was a pupil of the old masters, but most of all he was a scientist of high merit in his own right and a man of personal great-

ness. He was a constructive force in physiology, a master of the subject, of its literature and its technique; an independent and critical thinker of deep insight, a conscientious and resourceful investigator, a brilliant educator of students and teachers and investigators, the author of a classic text-book.

Devoted to his work, he led a very retired life, especially in his later years, and made few personal contacts outside of the immediate circle of his friends and pupils. Toward the end he became a rather remote figure, especially to the younger generation of physiologists—and to their loss, for he was a great and inspiring teacher. Even in this personal remoteness, however, he exerted a great influence on the development of physiology in English-speaking countries, by the pupils whom he has formed and by his text-book, which introduced so many medical students to the subject. The book was the man and the subject. It breathed and lived the spirit of modern physiology, of the science and functions of life. It presented the point of view, the methods, the results, of the science in a simple, lucid style which made the most difficult things plain and interesting, and within the reach of all. It supplemented the didactic exposition with "practical exercises" which motivated and recast the laboratory teaching of physiology. In the book and in himself, Stewart typifies an important period in physiology, the transition from the dawn of physiology as an exact science of broadly applied physics and chemistry, to the present period of more detailed specialization. He carries us back to the days of largely diversified interests, when a man could still claim all physiology as his province; he helped to carry its spirit into a new country and into a new century. In this he was not alone; there were other pioneers and other bridge builders, and we are grateful that a goodly number of these are still with us. However, Stewart's significance went beyond his period; it lay largely in his personality, and its reactions with science.

I had started this memorial with a chronologic history of events in Stewart's life; but with a man of his inner individuality, externals are mere accidents, and so he regarded them. This small esteem is illustrated by the minor disagreement of the dates in his biographic calendar, in "American Men of Science" and in "Who's Who." What matter to the man whether he received his M.A. in 1881 or in 1883; one would serve him as well as another. External events were but a net on which to weave the pattern of his life. They were not vital, they scarcely show through the final design, and yet they must have guided it to a large degree. Man is like Faraday's atoms, a mere meeting point of forces, external and internal, and is formed by their interaction. To understand Stewart, therefore, it is well to attempt to list the chief external events in the order of time:

Born, London, Ontario, April 18, 1860.
Assistant in physics, University of Edinburgh, 1879–1880.
M.A., University of Edinburgh, 1881 or 1883.
Mackay Smith scholar, 1883–1884.
B.S., University of Edinburgh, 1886.
Studied in Berlin, 1886–1887 (with du Bois-Reymond).
D.Sc., University of Edinburgh, 1887.
Demonstrator of physiology, Victoria College, Manchester, 1887–1889 (under Wm. Stirling).
M.B., University of Edinburgh, 1889.
George Henry Lewes student, University of Cambridge, 1889–1893.
Examiner in physiology, University of Aberdeen, 1890–1894.
D.P.H., University of Cambridge, 1890.
M.D., University of Edinburgh, 1890 or 1891.
Studied in Strassburg, 1892.
Instructor in physiology, Harvard University, 1893–1894 (under Bowditch).
Professor of physiology and histology, Western Reserve University, 1894–1903.
"Manual of Physiology," first edition, 1896.
Professor of physiology and head of the department, University of Chicago, 1903–1907.
Married, to Louise Kate Powell, September 20, 1906 (four children).
Professor of experimental medicine and director of the H. K. Cushing Laboratory, 1907–1930.
"Manual of Physiology," last revision, 1918.
LL.D., University of Edinburgh, 1920.
Died at Cleveland, Ohio, May 28, 1930.

Stewart was born in Canada, but the family soon returned to Scotland, and he was brought up in Lybster, Wick, a little fishing village on the North Sea. The character and occupation of the people left a powerful impress upon him. He was fond of recalling the romantic adventure and hard work of the herring fisheries, the bustling markets and the cooperage. By race and contact and inclination he took on the strongly marked characteristics of the Scotch villagers, their sturdy gospel of hard work and stern devotion to duty, asking little of life and giving much; their industry and self-control and self-denial and honesty and self-respect and independence and veneration of learning. The scholar was the man respected, and Stewart early showed that he was a diligent learner and a clear thinker. He gathered a goodly stock of honors, prizes of books and medals, which pleased his family, and later of scholarships and posts of more substantial worth. Thus he laid the foundation for his career, in the medieval manner of the small village, and carried a load of boyish learning to that medieval citadel of classicism, old Edinburgh, the greatest city of Scotland, and thus of

the world. It impressed him much as the medieval university towns impressed the medieval students. The training began with the classics and philosophy and history and mathematics. The classical languages were probably a duty rather than a choice, but when he went to the Continent and presented himself to a professor whose knowledge of English was as theoretical as Stewart's training in German, they both found it easier to converse in Latin—a striking illustration of the educational changes of the last fifty years. History remained a means of relaxation to the end. Mathematics ever appealed to his sense of order and clearness and logic. It is often the gate through which a studious mind is introduced to science, and as is so often the case with a studious mind, it led him into science by way of physics. With his industry and intelligence, he stepped quickly across the gulf that separates the receptive from the active student, and became assistant in physics, to Tait, the brilliant experimenter and popular lecturer and writer.

As most scientists of those days, he took up the study of medicine to assure his future bread and butter. At that time, physiology was taught at Edinburgh entirely by formal lectures, as if it were history or philosophy; but Rutherford had done some experimental research, especially on bile flow, and a small group of students persuaded him to give them a course of demonstrations. This was Stewart's initiation into physiology. He was attracted by its boundless possibilities for the application of exact scientific methods of working and thinking to problems that appeared worth while, and he turned aside and stretched out his medical course so that he could devote himself to physiology. Through his training in physics he became particularly interested in the electrophysiology of nerve, and he spent his first year abroad with the master of that subject, du Bois-Reymond, in Berlin, in 1886 to 1887. On his return he took the doctorate of science at Edinburgh, and launched definitely on the physiologic career, but later, with Sotch caution, took also the M.D. at Edinburgh and the D.P.H. at Cambridge.

The next two years, after his return from Germany, he spent as demonstrator of physiology with William Stirling at Manchester, and obtained excellent experience in teaching methods. Stirling made a sacred cult of the illustrated lecture; and there is perhaps no better method of learning the technique and the phenomenon of a science than that of being responsible for a demonstration course. One learns to feel the importance of visualization, of the senses, as aids to understanding; one learns to think in terms of actualities instead of abstractions; and the variety of technique calls forth ingenuity and inventiveness. The wide field which must be covered in a limited time prevents narrowness and pigeon-holing. Matters are brought into apposition while they are still fresh in the mind, and in the best condition for forming connections. There is no method of preventing narrowness in a science more effective than the yearly repetition of a course illustrated by experiments. Such experiments never grow stale, at least in the biologic sciences. Incidentally, the department of physiology was further broadened by the inclusion of histology, and much of what now goes to biochemistry. The subjects have meanwhile grown so much that their union under one man would lead to superficiality; but so long as it was feasible, the inclusion of these three aspects of life, morphology, physics and chemistry, did tend to prevent narrowness of vision and specialization. Perhaps that is one reason why the investigators of that generation were apt to diffuse themselves. Nature appeared so full of various things that it was difficult to set bounds to one's interest. There were continents to be explored, while now the task is more that of the intensive development of a territory, or a mine or a chamber of a mine.

After his apprenticeship in teaching, Stewart devoted himself to research, chiefly at Cambridge, with another experience in Germany, this time at Strassburg (1892) where he formed a friendship with Cushing. In 1883 he accepted an invitation of Bowditch to come to Harvard as instructor of physiology. The experience was a happy one. He was charmed by the kindly, high-minded Bowditch, whose cordial hospitality made a stranger at home; and his imagination was captivated by the possibilities of the land, still so virginal in regard to science, so unsophisticated, so eager. He desired to prolong his stay, and embraced the opportunity which presented itself, before the year was up, by the tender of the chair of physiology and histology at Western Reserve University. Thus end Stewart's wander-years, those years of flowering freedom, when experiences and impressions are gathered and stored and worked over, when the character is forming, and plans are pushing forward, waiting for realization, crystallizing from dreams to substance.

In 1887 Mr. John L. Woods, of Cleveland, who had made a fortune in lumber, conceived the then revolutionary idea that a most useful application of wealth to the benefit of humanity would be its investment in medical education, a commodity which stood in great need of improvement. To this end, he built a monumental stone building, in the perfection of the period, for the Medical School of Western Reserve University, and founded an unconditional endowment of $125,000, one of the very few and one

of the largest medical foundations of the time. The Medical Faculty accepted the princely gift with grateful appreciation, and doubtless also with some misgivings; there was so little precedent! Some thought that the income should be distributed to the teachers, which meant the practitioners who were giving part-time clinical instruction. Others felt that this was a great opportunity to install the laboratory system, whose sun was shining abroad, especially in Germany. Could not the sun be brought to rise also in America, in Cleveland, at Western Reserve? The visionaries won; as usual, the visionaries were chiefly the younger men; and as usual, they had no fear of youth. In 1893 they secured Carl A. Hamann, aet. 25, for the chair of anatomy; and in the next year, William T. Howard, aet. 27, for pathology; and Stewart, aet. 34, for physiology. Stewart came to Cleveland to size up the situation. He liked the faculty, and he was greatly impressed with the building. Here, he told later, was a substantial place that would withstand the siege of the Indians, aye, and would be sturdy for centuries to come. It might, were progress not more destructive than the Indians. The building has been razed, and salt sown in the furrows, because the parking space was more valuable than the fortress.

Stewart took hold of the job with the enthusiasm of the young wrestler. The chance to do stirred his imagination; the task to be done spurred his sense of duty; the warm admiration of the students called for his affection; a group of younger workers, Howard, Hamann, Hoover, supplied the comradeship, the understanding; the friendly deference of the older colleagues gave him confidence. All that was Stewart warmed to the occasion. He was busy, supremely busy, but perfectly happy. The conditions, physiologically speaking, were those of the frontier, and Stewart would have been justified in spending a year in studying the situation and laying plans, and perhaps starting to develop some one feature; but his conscience did not permit him to slight anything, to defer to next year what could by any chance be done now. He had few resources except in himself, but that was enough. For apparatus, for personnel, he had chiefly his own boundless energy. It served him as the genii of the fables. He was roughing it—the greatest stimulus to men of strength and independence. The tale of his first year would be as a tale of Crusoe to these modern days. We have become dwellers in civilized and populous cities. We have gained much in externals, in machinery, in speed, in directness, in accuracy; but we have lost something of the spirit of things, of self-reliance, of adventure. Have we gained more or lost? Perhaps the question is unanswerable, or not worth answering. Our lives are cast in the present, and our dreams are dreams. The current of time and events sweeps on; the towered castles that were picturesque in the upland become vain ostentation in the plain.

The first year in Cleveland was filled and over filled with teaching; but on top of this Stewart managed to write his text-book, which he put through the press during the next summer's "vacation." It is a measure of Stewart that the book bears no trace of the pressure under which it was produced. Substance, style and proof-reading are as nearly perfect as if they had been the author's sole occupation, with time unlimited. When the book was completed, Stewart took no time for rest, but turned to research the energy and time that was released. Aside from these activities in physiology, Stewart took an active part in the forming of the important faculty policies, including the lengthening of the course from three to four years, and the requirement of an academic degree.

Thus passed ten full, busy, happy years. In the meantime Harper had started a great university in Chicago, with emphasis on graduate work. There Jacques Loeb had founded a school of physiology, temporarily divorced from medicine, with brilliant disciples. Loeb, however, desired to be relieved from all teaching duties, and had gone to a post of pure research in California. Harper was planning a medical school, and with the assistance of Barker, was seeking as successor to Loeb a physiologist who would be interested in the medical school as well as in physiology. Their choice fell on Stewart, and he again saw another, a broader opportunity and accepted. The change did not come altogether easy to him. The greater centralization was somewhat irksome to his individualistic temperament. The restrictions which were deemed necessary to the effectiveness of the larger organization cramped the man who had become accustomed to the complete liberty which prevailed in Cleveland. These matters were gradually adjusted, but in four years Cleveland secured Stewart's return by organizing a somewhat novel experiment, the H. K. Cushing Laboratory of Experimental Medicine, for the application of the method of scientific investigation to the problems of the clinic. Clinical research was lagging definitely behind the advance of the laboratory subjects, chiefly because the active practitioners who were in charge of the clinics lacked the time and often the special training for the application of the methods of physiology, of physics and of chemistry. There were no full-time salaries in the clinical positions; and even had these been available, there were few if any men who would have been properly prepared to take them. It appeared necessary to try another experiment; and it seemed worth while to establish special liaison

foundations, and Stewart, with his broad interests, appeared the man to place in charge of such an experiment. It appealed strongly to him, and he accepted. He was happy to return to Cleveland and to found a field of useful activity, although the experiment did not work out quite as it had been planned. The difficulty was largely intrinsic. The condition of success was enthusiastic collaboration between the laboratory and clinic on a basis of equality. Collaboration may be fruitful on a basis of subordination; but equal partnerships remain enthusiastic only if they are spontaneous. They are chilled by official assumption, and as enthusiasm wanes, difficulties arise. Stewart, therefore, made the activities of the laboratory self-containing and turned especially toward the functions of the adrenal gland. His later years were afflicted with ill health, an anemia with progressive spinal degeneration, which hampered his physical activity; but he kept mentally alert, and in our last conversation he repeated to me how much he liked to continue in the work.

And so, having completed the course, let us turn back and attempt once more to seize Stewart's significance to physiology. His career started when that science was passing through a formative period, especially in America. Such periods bring out the strength in men; the stuff is more plastic and takes impressions more easily; and there being fewer competitors, the impressions stand out more strongly. But Stewart's significance went beyond his period. It was a part of his personality, a something which contains intangible elements, but which also has some tangible features. Stewart's was an impressive figure in science, chiefly because he possessed to a high degree the chief characteristics of the scientist. It may, therefore, be worth while to examine these features in him. First, I would place intellectual curiosity, eagerness to know, to comprehend, this wonderful world. This desire was insatiable; everything was full of interest, presented questions, pressed for solution. His was the religion of the investigator, the scientist's faith in the value of knowledge, *per se,* of facts—provided that they be facts. This was the second feature in the personality: rigorous conscientiousness in the pursuit of truth and punctilious devotion to duty. The third feature was a keen mind, analytical, critical and logical, which led his path through the mazes of data and theory. Then came an exhaustive, encyclopedic command of the literature. To the end, the journals were conscientiously read, each paper critically sifted, abstracted and filed in due order. His judgment was reliable, severe but just in all his relations, every fact and every action received its exact due, no more, but also no less. One of his most strongly marked features was his clear exposition, the natural projection of his own mental processes. What he thought, he thought clearly; the lights and twilights and shadows each had their exact value; and what was so clear to him, he had no trouble in making clear to others; he need merely to lay it forth, to open his mind to inspection. In his teaching, as in his book, there was never a doubt as to Stewart's meaning; nothing was slurred; each datum was set forth, weighed and appraised, each argument defined. This was settled, that dubious; so much was on this side, so much on that; you could lay a wager on the odds. There was still something further, an unusual facility of thinking. To Stewart's mind, direct and logical thinking was as natural, as easy as breathing. The current of his thought flowed smoothly and rapidly and clearly. He could write and talk extemporaneously as well as after long preparation, or indeed better, for the extemporaneous had the warmth of life, and his delivery was enlivened by his whimsical dry humor, supported by an inexhaustible fund of anecdotes. The extemporare in Stewart's delivery and writing, however, was merely in the form, in the expression, in the vestment. Behind it lay thorough preparation of the substance. The material for his lectures and demonstrations was prepared with the thoroughness and attention to details which he had learned in the Stirling days. He exacted similar thoroughness from his students, and he was a master in exposing the slipshod. With a few artistic moves he peeled off the cloak, the skin, the muscles, the bones, and reduced the hapless victim to a shadowy cloud; and all this with such evident absence of malice that a culprit learned an unforgetable lesson without taking offense; the lesson of clear, straight, logical thinking, based on facts obtained from reading and from the original source in the one true sense, experimentation. The latter was the special aim of the practical course, to give to the students the opportunity of first-hand observation of phenomena, of as many phenomena as possible, to acquire an ample fund of experienced and visualized things as stuff for thought. The importance of this was especially great in the earlier days, when it furnished the only direct contact with life, in the entire medical course; even the clinical work was then taught almost entirely by "theater" demonstrations. Stewart, therefore, introduced considerable work on mammals, an innovation in those days, and of experiments on the students themselves. Times have changed; the medical course now includes much more laboratory work, but it is distributed among all the subjects, and, therefore, must be supplemented more extensively by demonstrations.

Research, Stewart regarded as indispensable to the self-respect of the scientist; as the thing that lifted

him above the common herd, and by which he set a marker in the flow of time. It was his religion. To it he brought conscientiousness, logic, imagination, ingenuity and a background of reading and wide knowledge of what had been done and thought and erred. The diversity of his interests is illustrated by the subjects that come to my mind. In the pre-Cleveland days: color vision, electrophysiology, cardiac nerves, circulation time estimations by the dye method; in the first Cleveland period: otoliths, muscle proteins, electric conductivity and its application to the circulation time, permeability of the blood corpuscles as simple forms of life; in the Chicago period: resuscitability of the central nervous system; in the Cushing Laboratory: further studies of permeability, calorimetric measurements of blood flow, epinephrine output, suprarenal deficiency. All these show careful work and diligent accumulation of data. It is too early to judge their ultimate usefulness.

After all, however, the greatest significance of Stewart is his influence on his students, his pupils and his associates. They are all different, and better, for having been exposed to him, his high standards, his meticulous methods, his comprehensive points of view, his critical logic. I had the privilege of being the first in time; most of his other Cleveland pupils went into practice, except Guthrie, who followed him to Chicago. There his chief disciples were Carlson and Pike, and many others were partly formed by him. In the Cushing Laboratory he became associated with Marine and Rogoff and Dominguez.

To attempt once more a final evaluation, Stewart stands forth as a notable scientist of high ideals and eminent ability. His importance was not so much in his discoveries as in the standards which he inculcated. He promoted physiology as a whole. His teaching set a model of logical exposition, of clear thinking, of critical evaluation of data. He expanded the capabilities of the laboratory in the teaching of physiology. He hastened the appreciation of the experimental point of view in teaching and thinking. All who came in any contact with him were the better for the experience—which is perhaps the highest praise that can be given to any man.

TORALD SOLLMANN

SCHOOL OF MEDICINE,
WESTERN RESERVE UNIVERSITY

SCIENTIFIC EVENTS

THE DEPARTMENT OF ANIMAL GENETICS AT THE UNIVERSITY OF EDINBURGH

THE *British Medical Journal* reports the opening of the new department of animal genetics of the University of Edinburgh on June 30 by Sir Edward Sharpey-Schafer, F.R.S., under the presidency of Principal Sir Thomas Holland. Sir Edward Sharpey-Schafer, before declaring the buildings open, gave an address. Professor F. A. E. Crew, in presenting Sir Edward with a key to perform the opening ceremony, referred to the important work of Professor Cossar Ewart, who, he said, was fortunately present that day. Professor Ewart might well regard this department as his own creation and the realization of his dreams. The ceremony also included the conferment of the honorary degree of LL.D. upon Mr. Thomas Bassett Macaulay, president of the Sun Life Assurance Company of Canada, who had made a series of gifts to the department. In presenting him the dean of the faculty of law mentioned that, like Lord Macaulay, the present recipient of the degree was descended from the Macaulays of Uig in the island of Lewis. His father had emigrated to Canada, where their guest had built up one of the foremost insurance corporations in the world. After the degree had been conferred Mr. Macaulay said that the study of endocrinology had been one of his hobbies for at least twenty-five years. This might seem a strange recreation for a layman, but his object had not been the acquisition of knowledge of merely theoretical value. Medical science had made marvelous progress during the last two generations in combating disease, chiefly in improved sanitation and in the knowledge of the nature of infection, but he thought that most of the great problems of non-infectious degenerative diseases of the latter third of life still remained unsolved. Great advances he felt reasonably certain would be made in the understanding of the endocrine glands during the next twenty-five years. He had been deeply interested in the splendid work that was being done in the animal genetics department of Edinburgh University and he was pleased that the biochemical department of McGill University was now actively cooperating with Edinburgh. He congratulated the University of Edinburgh on the part it was taking in the great work of the future. At a luncheon which followed the ceremony in the Library Hall of the Old University, Sir Thomas Holland mentioned that during the past two years Mr. Macaulay had given to the genetics department of the university contributions which amounted in all to £67,000; the university, he said, would endeavor to justify the confidence he had shown in its work.

The new buildings of the animal breeding research department of the University of Edinburgh are situated at West Mains Road. The original idea of this