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REFLECTIONS OF A CHEMIST[1]

Anthropologists divide the era of human existence into ages according to the material of the implements used during a given period—the Stone Age, the Bronze Age and the Iron Age. Far be it from my thoughts to dispute the correctness of this classification, but it does seem a misrepresentation or a wrong characterization to continue the present, or even the preceding, century in the iron age. With the advent of the twentieth century, at the latest, the count of a new age begins. What shall be the name of this age? Your reply may well be anticipated—chemistry. Not your partiality or mine prompts this reply. It is the verdict of facts, for the advances from the stone to the bronze and from the bronze to the iron age are really the results of the progress of the art of chemistry.

The rôle chemistry is playing in the world affairs is too well known to require elaboration. In its broadest embrace—colloidal, catalytic, biological, therapeutic and what not—chemistry is the moving principle of this world of ours. It is nothing less than life and death! We all know the wonders chemistry has accomplished within the short space of time it has been given a systematic unprejudiced trial. These accomplishments and the potentialities of chemical science have also been well advertised, perhaps a little too much. The chemically untutored will expect too much and too soon, with resulting disappointment and reflection on the science and its followers.

Importance of Pure Science

A far more important problem and one requiring our immediate and undivided attention is so-called "pure chemistry." I should rather like to call it "science of chemistry" in contradistinction to the practical application of chemistry which would be more correctly designated as the "art of chemistry."

Pure science is the protoplasm of applied science. It is the brick and mortar of our sky-scraping buildings of industry and commerce. Our civilization of which we are so proud, the comforts of life we are enjoying, are wholly built on discoveries emanating from the search for scientific truths, from the pursuit of science for the sake of the science itself. As Secretary Hoover has very tersely put it, "It is in the soil

[1] Presidential address delivered at the seventy-fourth meeting of the American Chemical Society, Detroit, Mich., September 5 to 10, 1927.

of pure science that are found the origins of all of our modern industries and commerce."

The relationship between the "science" of chemistry and its varied and multitudinous applications is quite apparent to the chemist, but one or two of the thousands of examples may be cited here. About one hundred and twenty years ago, Sir Humphry Davy, in his pursuit of scientific knowledge for the sake of knowledge, discovered a method of separating the "refractory" metals potassium and sodium from their combinations. Based on this fundamental discovery, Hall, an American, and Heroult, a Frenchman, prepared the metal aluminum. But for the availability of this metal, aviation would still have been a midsummer night's dream. This metal has also added immensely to family happiness. Aluminum kitchen utensils are easy to wash and keep clean, making less work in the household and consequently stabilizing domestic felicity.

This year is the sesquicentennial of the revelation of a simple and great scientific truth. This revelation, known to few and appreciated by still fewer, is the foundation of a very live branch of the applied science of chemistry. In 1777, a French chemist, immortal Lavoisier, enunciated the principle of exchange of gases in respiration. He demonstrated that oxidation in the body and ordinary combustion are analogous processes. This simple scientific discovery marks the real beginning of the science of metabolism. This offspring science of Lavoisier's investigation is, to be sure, still in its infancy, but it is of incalculable importance. It is the very foundation of our existence. What blessings are in store for future generations when this science will have grown to manhood? Disease may then be an unknown term.

We are living on the scientific researches of a hundred or more years ago. We are plucking the fruit of trees of knowledge planted by our forebears. We have worked hard and fast to get all we can out of the funds of discoveries of past centuries, but we can not much longer go on harvesting without planting. We owe to posterity what past generations have provided for us. Shall we fail in our duty and shall we go back on our indebtedness? Our country is spending large sums of money to make available and to extract all the good from the accumulated stores of science, but we are slow to replenish these stores for future generations with fresh materials.

Nature is loath to reveal her secrets. She yields her treasures of knowledge only to those who have consecrated themselves to their quest. No scientific discovery has ever been made by accident or overnight. Archimedes spent many a sleepless hour before he discovered the simple law of displacement of liquids —specific gravity. The falling of an apple did not drop the laws of gravitation into Newton's head. It took him years of hard and patient labor to investigate and propound this law. Nor did the ring formula of benzene come to Kékulé in a dream.

Scientific discovery is the product of three elements —effort, time and genius. Genius is a gift Heaven rarely bestows upon us. We can not bank on it. But we have learned from the laws of physical chemistry that the lack in one factor can be made up by increasing the other. Owing to the enormous benefits we are deriving from scientific discoveries bequeathed to us in the past, we, especially in this country, are in a position to increase the effort factor in the equation.

The "Philosophy" of Chemistry

The significance of chemistry in life processes and its relation to health and disease are beginning to dawn upon us. The achievements and potentialities of the science in peaceful pursuits are becoming recognized and appreciated. Of its force and potency in war we need not be reminded. In our pursuits of the material advantages of chemistry we are liable to overlook and forget its spiritual side, its cultural and educational qualities. Education and culture, terms so commonly used, are but incompletely understood and still less definable. Although at times the conception of culture is purposely corrupted, education misinterpreted and pseudo-cultures substituted and worshipped, honesty and truth are *a priori* the first and last prerequisites of genuine culture and education. The first, uppermost and last principle in chemistry is veracity and honesty. Said Goethe, "The history of a science is the science itself." The history of chemistry clearly shows that success results when truth, and truth only, is courted and adhered to. Disappointment and failure to themselves, their friends, if any they had, and in the long run to the world at large, have followed those—alchemists and their ilk— who pursued the dishonest method of making gold. The names of some of these have survived in history only as object lessons of ridicule. But immortality to themselves, and untold treasures of genuine gold to the world, have come to those who followed the truthful path of science. The first commandment in the curriculum of the study of chemistry is honesty and truth. Such is the irresistible force of this precept in our science that when a student fails to heed it he is automatically eliminated.

Some classes of business people—though to be sure they are back numbers, and in the minority—maintain that chemists make poor business men, because they are too honest and truthful—an unconscious tribute to the science and the high culture of its propounders and followers.

Besides the material advantages it brings to the world, chemistry is a truly "philosophical" science, in the sense of philosophy as conceived and defined by the great and pure philosophical minds of Socrates, Plato and Seneca. To them philosophy is to teach men to form their souls; knowledge is to be sought for the good of the mind. Our science preeminently fulfils these requirements. Knowledge and contemplation of chemical phenomena, the very varied manifestations of the science, and the subtle and wonderful forms it assumes can not fail to uplift the soul and broaden and purify the mind.

THE CHEMIST'S EDUCATION

The education and training the industrial chemist should have to make him fit and competent in his career is receiving much attention, both from educators and industrialists. Because of the great share of responsibility that is more and more devolving upon the chemist, the importance of this question is self-evident. But in our zeal to hit the spot we are perhaps shooting a little over the mark. The tendency in our curriculum is to stress the applied and industrial chemical courses. I very much doubt that this path will lead to the desired goal. Let me repeat that the industrial achievements of the chemist have resulted from the inspiration he received from his knowledge of the science. Our great and well-known chemical engineers of to-day have been raised on the undiluted milk of the pure science.

Just as in the nutrition of the body a properly balanced food diet must be maintained to insure health and normal development, so it is with the education of the chemist. He must be given a carefully balanced training in the science of chemistry and its application. And I am of the opinion there is decidedly less danger when the ration is increased in the science than the reverse. The greatest names known to science, and to scientific professions, have not during their college careers specialized in the fields they made famous. Overspecialization in youth narrows the mind and stunts its development. Give the chemist student the tissue-building material, the fundamentals of science, impart to him its spirit; then when he goes out to accomplish his life work he will shape and mold the materials according to the need of time and place and will breathe life into them. As in the words of Lowell:

New occasions teach new duties;
Time makes ancient good uncouth;
They must upward still and onward,
Who would keep abreast of truth.

GEORGE D. ROSENGARTEN

DOES THE NET ENERGY VALUE OF FOOD DEPEND UPON THE PURPOSE FOR WHICH IT IS USED IN THE BODY?

THROUGHOUT his work on the net energy values of feeds for cattle, Armsby[1] has continually kept in mind the probability that the net energy value of a feed varies with the nature of its disposition in the body, for example, varying when used for fattening or for milk production. This probability of a variable utilization of food energy was based in his mind upon the difference in composition of the products formed, indicating differences in the metabolic reactions concerned in the use of food in the basal metabolism and in its conversion into tissue, fat, milk, etc. In the case of milk production, for instance, certain conversions of nutrients are considered as occurring with no loss of energy as heat, while the conversion of carbohydrates to fat is supposed to involve a definite heat liberation. This conception appears to be equivalent to the assumption that the heating effect of food on the animal is determined to a considerable extent by the chemical reactions to which it is subjected after absorption, since the use to which the food is put could obviously have no effect upon the reactions occurring within the alimentary canal.

This conception of Armsby seems to be quite generally held among those laboratories in this country and Europe that are doing calorimetric work upon farm animals, and a number of experiments recently appearing in the literature[2] have been specifically concerned with the relative utilization of the energy of farm feeds in maintenance, fattening and milk production.

It becomes a matter of importance, therefore, to consider what experimental evidence may be cited in favor of the belief that the stimulating effect of ingested food upon animal metabolism is due to the nature of the metabolic reactions to which it is subjected and whether some other conception may not be more readily defended. The theory appears to assume that certain metabolic reactions liberate energy which can be used in maintaining cellular life and activity before being dissipated as heat, while

1 Armsby, H. P., "The Nutrition of Farm Animals," New York, 1917, pp. 361, 395, 497–8, 563.

2 Hanson, N., Kungl. Landtbruksakademiens Handlingar och Tidskrift, 1923; Fries, J. A., Braman, W. W., and Cochrane, D. C., U. S. Dept. Agr. Bul. 1281, 1924; Forbes, E. B., Fries, J. A., Braman, W. W., and Kriss, M., *J. Agr. Res.*, 1926, xxxiii, 483; Møllgaard, H., "New Views regarding the Scientific Feeding of Dairy Cattle," Copenhagen.