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Nobel Prize in Chemistry 1902

Hermann Emil Fischer

The Nobel Prize in Chemistry 1902 was awarded to Emil Fischer *"in recognition of the extraordinary services he has rendered by his work on sugar and purine syntheses"*.

RESEARCH INFORMATION:

The Royal Academy of Sciences has resolved to award the 1902 Nobel Prize for Chemistry to Dr. Emil Fischer, Professor at Berlin University and Geheimrat, for "the extraordinary services he has rendered by his work on sugar and purine syntheses".

One of the main tasks of organic chemistry is to investigate and reproduce artificially those processes occurring in living matter, both animal and vegetable, in order thereby to provide a firm basis for the concepts regarding biological phenomena. Apart from the protein substances there is no group of carbon compounds more important for organic life than the carbohydrates. For that reason the carbohydrates, and in particular the sugars, have been the object of countless studies since the beginning of organic chemistry. Owing to the nature of these substances their study was fraught with great difficulty and until a few years ago appeared an impossible task.

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On the basis of his discovery of the hydrazine derivatives, a significant discovery, Professor Fischer succeeded in finding a brilliant solution to the problem. With surprisingly acute judgement and with brilliant discernment in choosing his ways and means Fischer not only reproduced synthetically natural grape- and fruit-sugars, but also some thirty other sugars and an abundance of closely related compounds. Whereas of the naturally occurring, simple sugars only those with 5-6 carbon atoms have been found, Fischer synthesized a continuous series containing from 2 to 9 carbon atoms. Furthermore, by his elegant method of making glucosides artificially, he has also added to the achievements of organic synthesis this group which is so extraordinarily important for vegetable physiology.

These studies have been significant especially for the theory of the spatial arrangement of atoms as elaborated by Van't Hoff and Le Bell. In the case of the compounds under discussion Fischer succeeded in determining fully not only the way in which the atoms are bound in the atomic complexes, the molecules, but also the position of the atoms relative to one another or, in other words, the stereometric configuration of the molecules. Since the degree of complexity here is great and the theory is verifiable down to the finest details, our conception of atomic grouping has attained such a degree of certainty through these studies that we can be convinced that the conception will never be substantially weakened, even were the conception of the nature of the atoms and particularly of valences to undergo radical change in the future.

These studies have been no less important for physiology. One of the most superb processes occurring in nature is the formation of carbohydrates in the green parts of plants. This process is, in fact, the prime source for any organic substance, consequently its elucidation is one of science's key tasks. As early as 1870 A. von Baeyer formulated the hypothesis that carbon dioxide and water are reduced to formaldehyde (formalin) in the cells which contain chlorophyll and that this is immediately condensed to form sugar. As Fischer has now succeeded in preparing from formaldehyde both grape- and fruit-sugar which occur universally in plants and beyond doubt constitute the parent substances for

the other carbohydrates, the hypothesis in question has thereby acquired experimental confirmation of obvious value. These sugar syntheses are furthermore associated with inorganic carbon, hydrogen and oxygen via formaldehyde.

Enzyme actions, which have such a profound bearing on the vital processes, appear in an altogether new perspective as a result of these studies. It was found that synthetic sugars with three and nine carbon atoms are converted into alcohol and carbon dioxide by yeast as readily as grape sugar which contains six carbon atoms, but that, after slight modification in the stereometric configuration of the molecule, the latter is completely unaffected by the same enzyme. Here we encounter the important discovery that *a vital function depends more on the geometrical configuration of the molecule of the nutritive substance than on the composition in other respects*. Fischer determined a similar sensitivity to so-called asymmetric structure for other enzymes, too, and for the glucosides. Through this observation molecular asymmetry has gained formerly unsuspected importance. It was found that the enzymes themselves, in common with the most important products of plant life, carbohydrates, proteins, chlorophyll granules and protoplasm itself, are, without exception, optically active substances or else are composed of them, and that all *essential chemical transformations in the organism depend on asymmetry*. Our insight into Nature and the conditions governing the vital functions has thereby gained considerably. These sugar syntheses are indeed the very first processes in which the action of enzymes can be verified in detail and with accuracy. For physiology these studies have thus opened a new field, the treatment of which has already started and whose implications cannot yet be fully grasped.

Simultaneously with these studies and particularly after the most important results had been obtained, Professor Fischer completed another investigation which is one of the finest and, in terms of findings, one of the most prolific ever conducted in organic chemistry.

For animal life the nitrogenous substances occurring in the organism are the most important. Protein substances apart, the animal body contains a substantial amount of other nitrogenous substances. Their study is of great value for physiological chemistry

because they are either products arising from the use of proteins or, together with simple proteins are contained as components in the most complicated compounds of the organism, the *proteides*, as they are called.

Even since 1776 when Scheele found uric acid in urinary calculus, several substances closely related to it such as *xanthine, adenine* and *guanine*, etc. have been detected in animal secretions. The same group additionally includes *theobromine, theophylline* and *caffeine* which occur in the vegetable kingdom and constitute the stimulants in our staple beverages cocoa, coffee and tea. With the keen perception of the excellent scientist and a masterly technique Professor Fischer brought order and clarity to this field as well. He demonstrated that all those substances are derivatives of the same parent substance, purine, which he had discovered. He successfully prepared them from one another and from simpler constituents in such a way that here, too, the synthesized chain goes back to inorganic carbon, hydrogen and oxygen, and besides these he prepared a large number of new, closely related substances so that the purine derivatives studied by Fischer must now number about 150. The intrinsic composition of each has been fully determined.

For physiology the experimental proof that uric acid and the xanthines originate from one and the same parent form is of the greatest importance as it has provided the strongest support for the modern theory of the formation of uric acid from the nucleoproteins of the cell nucleus and from the purines contained therein.

As certain representatives of the group - caffeine and theobromine - are not solely esteemed in beverage form but have also been used medicinally down the ages, it is reasonable to expect that several of the new purine derivatives will prove to have a *medicinal value*. The chemical industry, too, has already made initial attempts to work out for its own purposes Fischer's syntheses of these substances which are so greatly appreciated in daily life.

The specific type of research which characterized organic chemistry during the final decennia of the century that has just closed attained its zenith of development and its finest

form in Fischer's studies of sugar and purine. From the experimental point of view they are unsurpassed.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1902/press.html