formerly exclusively derived from plants and animals, are now prepared in our laboratories by artificial means. I do not allude here to a great variety of metamorphoses or re-arrangements of the constituents of substances, which we are daily accomplishing in the laboratory, and which really are no artificial formations of vegetable and animal compounds, at least not from their elements. If we have succeeded in preparing œnanthic acid, which constitutes the *bouquet* of certain wines, from oleic acid, the principal ingredient of olive oil—if it has been possible to obtain the volatile acid of Valerian root, or the fatty acid of butter, by means of ordinary sugar,—we are still far from being able to build up these substances from their elementary constituents; for the power of inducing carbon, hydrogen, and oxygen to assume the form of oleic acid, or of sugar, is as yet possessed by plants alone. Again, the essential oil, to which the aroma of the spirea ulmaria (the queen of the meadows) is due, is no longer extracted from the flowers of this plant; we prepare it more conveniently, purer, and cheaper from salicin, the crystallizable principle of willow-bark. But are we, on this account, independent of the vitality of plants? Certainly not, we have only substituted one plant for another. The cases which I have just given you are only chemical transformations of one vegetable substance into another. If you compare the composition of the substances transformed with that of the products obtained, you will at once perceive that these changes invariably consist in the removal from the original compound of a certain quantity of carbon, of hydrogen, and even oxygen, frequently eliminated in the form of carbonic acid and water; that they consist in a simplification of the original compound, which, being generally of a complicated nature, is broken up into atoms of less intricate composition.

Oleic acid	C_{36}	H_{34}	O_4
Œnanthic acid	C_{18}	H_{16}	O_4
Sugar	C_{12}	H_{12}	O_{12}
Valerianic acid	C_{10}	H_{10}	O_4
Butyric acid	C_8	H_8	O_4
Salicin	C_{26}	H_{18}	O_{14}
Spirea oil	C_{14}	H_6	O_4

In all these transformations we descend from more complex to simpler compounds.

But it is not difficult to show that frequently we move in the opposite direction; that we actually can rise from the simple to the complex; that a variety of substances of vegetable and animal origin have in reality been compounded, if I may use this expression, from their very elements. Among these may be mentioned oxalic acid, the normal constituent of several varieties oxalis, rumex, and rheum, and the frequent product of the animal organism; formic acid, the acid exercted by certain species of ants; urea, the crystalline principle of the urine of the mammalia; and, lastly, acetic acid, which, in combination with potassa or lime, is present in the juice of a great many plants, and which the vegetable kingdom furnishes us more indirectly in the destructive distillation of wood, or in the acidification of alcoholic liquors, derived from sugar by the process of fermentation. All these and many other compounds, originally obtained with the aid of the vegetable or animal economy, are now produced without their assistance, by processes perfectly analogous to those which we are in the daily habit of performing in mineral chemistry. But how are these formations accomplished? I need not tell you, Gentlemen, that such remarkable results cannot be obtained simply by bringing the elements concerned into contact. By placing diamond into a mixture of hydrogen and oxygen, you will never produce either oxalic, formic, or acetic acid. These triumphs of constructive chemistry can only be reached through a series of circuitous processes. We have to follow the path which is indicated to us by the behaviour of the plant itself. The vegetable organism rejects the free nitrogen or oxygen of the atmosphere with which it is surrounded as unfit for its use; free carbon and free hydrogen are never presented to it in nature; but the combinations