It has been stated, in the commencement of this lecture, that alcoholic fermentation takes place between certain rather extended limits of temperature, but that the action is most regular and vigorous between 18° and 21° C. (65° and 70° F.) Between these temperatures, glucose appears almost entirely converted into alcohol and carbonic acid; I say almost, because, even then, minute quantities of foreign substances are produced, or, perhaps, better expressed, a minute portion of sugar appears to undergo a transformation different from true alcoholic fermentation.

If, during the process, the temperature rise much above 21° C. (70 F.), the quantity of alcohol produced sensibly diminishes, and the character of the transformation gradually changes altogether. If the temperature rise to between 30° and 10° C. (86° to 104° F.,) the alcoholic fermentation ceases entirely, being replaced by what is called the *viscous fermentation*.

A saccharine liquid undergoing viscous fermentation does not present the same appearance which is exhibited by the liquid during the progress of alcoholic fermentation. The former process is usually attended with an evolution of carbonic acid; and, if the liquid be distilled after the action has terminated, a very trifling quantity of alcohol is obtained. The liquid is found to be strongly acid, and this acid reaction is due to the fermentation of a very important organic acid,—viz., of lactic acid, of which I may have to treat more in detail hereafter, since it has been lately produced by a very remarkable and interesting process. But carbonic and lactic acids are by no means the sole products; in addition, there are found two indifferent substances. The first, mannite, is a compound crystallising in beautiful needles; it is the chief constituent of manna, and is present, in smaller or larger proportion, in the juices exuding from many fruit-trees, in several varieties of fucus and mushroom. And, secondly, a gum-like substance, which is either gum (arabic,) or closely allied to it, possessing, in fact, all the properties, and also the composition of this substance. It is from the constant formation of this substance, which is precipitated in white curdy flakes from the solution on addition of alcohol, that the name of *viscous fermentation* has been derived. The nature of this fermentation is readily intelligible, if we examine the composition of the substances which are produced. The formula of gum is $C_{12}H_{10}O_{10}$, that of lactic acid $C_{12}H_{12}O_{12}$ (isomeric with anhydrous glucose); that of mannite lastly, $C_6H_7O_6$ or $C_{12}H_{14}O_{12}$ Gum and lactic acid are formed from glucose simply by an elimination of water.

$$\underbrace{C_{12}H_{14}O_{11}}_{\text{Glucose.}} = \underbrace{C_{12}H_{10}O_{10}}_{\text{Gum.}} + \underbrace{4HO}_{\text{Water.}}$$

$$\underbrace{C_{12}H_{14}O_{14}}_{\text{Glucose.}} = \underbrace{C_{12}H_{12}O_{12}}_{\text{Lactic acid.}} + \underbrace{2HO}_{\text{Water.}}$$

Mannite lastly contains the elements of glucose, minus 2 equivalents of oxygen.

$$\underbrace{C_{12}H_{14}O_{14}}_{\text{Glucose.}} = \underbrace{C_{12}H_{14}O_{12}}_{\text{Mannite.}} + O_2$$

It appears to be produced by the partial deoxidation of sugar, the oxygen of which may participate in the combustion of the ferment originally induced by atmospheric oxygen.

I have briefly to notice two other fermentative processes, which are not less interesting than the viscous fermentation. The character of fermentations, and of the products to which they give rise, is by no means exclusively dependent upon the temperature; the nature of the ferment exerts, likewise, a very decisive influence. Thus we find, that sugar, at the very temperature of alcoholic fermentation, when submitted to the action of cheese-ferment, instead of beer or wine-ferment, *i.e.*, to the action of casine, in that state of decomposition which is effected by protracted exposure to the atmosphere, furnishes no longer a trace of alcohol. Under these circum-