also have some apparently common biological activities which interact one with the other. The animal hormones are chemically quite distinct from the plant compounds. Most animal hormones are relatively large molecules, some of them small proteins. The plant compounds that have been recognised so far are relatively simple molecules.

REGULATION OF METABOLISM

One of the outstanding results of modern microbiology is the recognition that many micro-organisms, particularly bacteria, show a marked regulation of their own metabolism. It is now known that the metabolic pattern in microbial cells is not something that is fixed and constant. The pattern of enzymes present changes according to different situations. Some enzymes are present all the time; others are produced only when they are necessary. It is becoming increasingly apparent that in microbes there is a precise control of many aspects of metabolism. An outstanding recent achievement of molecular biology has been the working out of the nature of some of these processes in bacteria.

It is now of considerable interest to the plant physiologist to know whether similar phenomena occur in higher plant tissues. Here our knowledge is pretty meagre, but in recent years some information has come to light. In the nitrogen nutrition of higher plants we now have two instances of adaptive enzymes, that is, enzymes that are apparently not normally present but can be produced by the plants when needed.

The first example of these concerns the utilisation of nitrate as a source of nitrogen for plant growth. Plants are known to be able to use either nitrate-nitrogen or ammonium-nitrogen for growth. With either of these sources of nitrogen many plants will grow equally well. When nitrate is the source it is first necessary for the plant to reduce nitrate to ammonium before further metabolism can occur. The first step in this reduction of nitrate is effected by the enzyme nitrate reductase. It has now been shown clearly that this enzyme is not usually present in plants. For example, if we grow *Spirodela* with ammonium in the culture medium we find a negligible level of nitrate reductase in the plants. If, however, we grow the same plant with nitrate as the source of nitrogen a considerable level of this enzyme is found in the plant. The appearance of this enzyme when required is an example of the phenomenon of enzyme induction, and we say that the enzyme nitrate reductase is induced by the presence of nitrate.

A similar situation has also been shown to occur when we grow *Spirodela* with urea, an organic nitrogen compound, as sole source of nitrogen. In this case, the enzyme urease, which is normally not present in *Spirodela,* is found in quantities when the plants are growing with urea. The enzyme urease is responsible for the production of ammonia from the organic compound urea. Here apparently is a second example of an induced enzyme in higher plants. Interestingly enough the same two enzymes—nitrate reductase and urease—are now known to be induced enzymes in bacteria.

Let us look a little closer at the utilisation of ammonium or nitrate as sources of nitrogen for plant growth. If *Spirodela* is supplied with both ammonium and nitrate at the same time we find that ammonium is used first, and not until all the ammonium has been removed from the medium is there any considerable utilisation of nitrate. This means that, in *Spirodela,* the utilisation of nitrate must be controlled so that it cannot occur if ammonium ions are also available. The utilisation of nitrate can be divided into two stages; uptake of this material from the medium, followed by its reduction and assimilation to ammonium. The assimilation of nitrate to ammonium can be further divided into two stages: reduction of nitrate to nitrite, and subsequent reduction of nitrite to ammonium. Thus control of the utilisation of nitrate could be effected by control of the uptake of nitrate, the reduction of