related to disease response. Light intensity and photoperiod can influence cytochrome and enzymatic systems as well as many other biochemical and metabolic activities. The proposed hypothesis would have more credance if the experiments described had been markedly reversed or altered by the addition of plant hormones.

It is also well known that many bacteria and fungi are themselves photosensitive so that changes in photoperiod and light intensity may have a pronounced effect on their pathogenicity as well as the plants' response. Thus it is premature to equate fungal pathogenicity or the severity of a fungal disease with a hormonal response in the plant induced by intermittent light.

It seems likely, however, that further studies along these lines may provide a better undersanding of the complex of plant and pathogen and disease induction. Research workers studying the development of diseases or the assay of fungicides should now be acutely aware of the importance of incident light as well as the other environmental factors such as temperature and humidity, in order to obtain reproducible results.

From a Correspondent

New theory of evoked responses

THERE is a kind of computational equivalent of Parkinson's law, that computation expands to fill the space available. Putting it another way the computer seems to be seen by some as a helpful amplifier of the seriousness and scientific value of research; and at best as a guarantee that the frontiers of knowledge really are being rolled back. In this context it is hardly surprising that the computer has become one of the most significant, and indeed symbolic, denizens of laboratories undertaking research in neurophysiology and psychology. The suspicious might wonder whether the uses of the computer in its symbolic role are quite as well thought out as they ought to be.

The particular function that computers usually play in neurophysiological and psychological research is that of doing statistics on various biological signals, a typical instance being the averaging of electroencephalogram (EEG) activity following the application of stimuli. The argument is that the shape of the electrical response to the stimulus is not discernible in the single recorded trace, because it is buried in uncontrollable spontaneous activity which irritatingly obscures the actual response to the stimulus, but at the same time also obligingly provides the requirement for a computer. By recording the responses to several dozen stimuli, digitising and summing the resultant waveforms in a computer, the consistent features of a response will add together. As the sum of these consistent features grows larger, the inconsistent fluctuations tend to sum to zero, and the signal stands out dramatically from the noise. The procedure seems both logically straightforward, and with the advent of small computers, even indispensable for serious research on the nature of the electrical responses of the brain to stimulus events. Sayers, Beagley and Henshall who are perhaps better versed than many on analysis of biological signals analysis have, on page 481 of this issue of *Nature*, gone directly, if somewhat iconoclastically to the heart of this matter by quite rightly questioning the apparently unassailable logic of this, by now standard, procedure.

Sayers *et al.* point out that underlying the averaging technique is the idea that the electrical response to a stimulus is added to the background of spontaneous activity, so that summing the responses actually selects out this additive component. But this, they declare, is an unexamined assumption, and upon examination, it turns out, a mistaken one. They conclude that what the stimulus probably does is to reorganise already existing components of the spontaneous EEG pattern, and not provoke a new electrical event superimposed upon it.

They cast the problem into the Fourier domain. The

Evolution in action

IF current views on evolution are correct, it must be the case that on occasions a gene changes so as to produce an enzyme with an altered function. It is therefore a challenge to experimentalists to produce such a change by selection in the laboratory. The obvious approach to this problem would be to keep a bacterial population capable of using substrate S, and also capable of using a related substance S^1 but with low efficiency, on the latter substrate, and at the same time to expose the population to a mutagenic agent. Bacterial populations do adapt to such circumstances, but they usually do so by producing enormous quantities of the original inefficient enzyme rather than by evolving a better one. Typically, a 'constitutive' mutation takes place in the system regulating the activity of the gene, so that the gene is permanently switched on; in this state, up to 20% of the bacterial protein may consist of this one enzyme.

Betz, Brown, Smyth and Clarke (*Nature*, **247**, 261; 1974) recently summarised some experiments in which an understanding of the mechanisms of gene regulation have made it possible to bring about in the laboratory the evolution of a new enzyme specificity. The bacterium was *Pseudomonas aeruginosa*, and the substrates were amides used as a source of nitrogen. Normal strains can use acetamide and propionamide; their enzyme acts with very low efficiency on the 4-carbon compound butyramide, but the bacteria cannot utilise this substrate, because butyramide does not induce the production of the enzyme, and in fact acts as a competitive inhibitor of its production. The enzyme is inactive on the 5-carbon compound valeramide.

Betz *et al.* obtained several new strains, including some capable of utilising valeramide, by way of two intermediate steps. The first step was a constitutive strain C11, obtained by selection on formamide—a substrate used with low efficiency by the species. Strain C11 cannot grow on butyramide, because the gene producing the enzyme is repressed by this substrate. From strain C11 a mutant B6 was obtained with a much higher activity on butyramide, but still retaining its activity on acetamide. A third mutational step, starting from B6, gave rise to a class of mutants able to utilise valeramide for growth. A number of other enzymes were obtained by this and other routes, including enzymes active on phenylacetamide.

For biochemists, the existence of a group of very similar enzymes with different specificities may be a useful tool in studying mechanisms of enzymation. For evolutionists, it is both important and reassuring to know that a new enzyme specificity can be produced by very few mutational steps. It is also interesting that each step could in certain circumstances be selectively advantageous, so that there is no need to postulate a long 'random walk' before a new function is achieved.

From a Correspondent