that photolysis was occurring with the absorption of two quanta, as though at an effective wavelength of 347 nm. The two-photon reaction cross-section proved to be $6.5 \pm 2.5 \times 10^{-52}$ cm^4 s/photon mole, probably the first measurement of its kind.

Two-photon effects have been demonstrated before in solution reactions (for example, see S. Speiser and S. Kimel, *J. Chem. Phys.*, **51**, 5614; 1969), although in these the unpleasant complication of solvent effects is worsened by the strange phenomenon of self-focusing in the laser beam. This occurs when the light intensity becomes so great as to modify the refractive index of the liquid and cause a lens-like focusing towards the beam axis. Although this, if anything, increases the tendency to two-photon reaction, it complicates considerably the calculation of effective cross-sections, because the true intensity profile must be estimated through the nonlinear optics involved.

Although a satisfactory theory of multi-photon rate processes may be some time in arriving, it is perhaps not too soon to ponder some of the problems which are raised by the existence of such processes. The first will not worry anyone unduly, although it is amusing: where ultra-high intensities are involved one must now exercise some caution in referring to a substance as "transparent" to a certain wavelength so long as an absorption band is present higher up the energy-scale. Second, and more serious, it is perhaps time to ask whether quite new photochemical influences may be at work under these conditions where the magnitudes of electric and magnetic field vectors in the neighbourhood of the molecules become so enormous. Any peculiarities which may emerge as the theory of dielectrics at extreme fields develops may well prove to have chemical effects not simply connected to the transition probabilities for photon absorption.

ZOOLOGY

New NERC Unit

THE Insect Pathology Unit (under Dr T. W. Tinsley) at the University of Oxford, which has been supported for the past five years by a grant in aid from the Natural Environment Research Council, has now been brought directly under the council with the title of Unit of Invertebrate Virology and with Dr Tinsley as director. The unit will carry out basic studies on the viruses and viral diseases of invertebrates.

PLANT ENZYMES

Coordinate Induction?

from our Phytochemistry Correspondent

SUBSTRATE induction of enzymes (that is, their synthesis in response to the presence of their substrates) is now commonplace in microorganisms and not infrequent in higher animals. In higher plants, however, substrate induction is a rare phenomenon and it is therefore gratifying to see significant progress being made towards the full understanding of the one well authenticated example, the induction by nitrate of the nitrate assimilation system. The latest advance in this campaign is the demonstration by Kelker and Filner (*Biochim. Biophys. Acta*, **252**, 69; 1971) that nitrate induces both nitrate and nitrite reductase in a simultaneous rather than a sequential manner. It has been known for several years that the application of nitrate to plants previously grown on nitrate-free medium led in many cases to the appearance of high levels of nitrate reductase and nitrite reductase, the enzymes which catalyse the first two reactions in the reductive assimilation of nitrate. In 1966 Ingle, Joy and Hageman (*Biochem. J.*, **100**, 577; 1966) reported a three-hour lag between the induction of nitrate reductase and that of nitrite reductase in radish cotyledons and proposed that the rise in nitrite reductase activity was dependent on the prior formation of nitrite by the action of newly formed nitrate reductase. In other reports, however, identical time-courses for the appearance of the two enzymes in response to nitrate were found, supporting a simultaneous rather than a sequential induction mechanism.

To test this question critically, use was made of the knowledge that tungstate inhibits the development of nitrate reductase (a molybdo-protein), probably by being incorporated in place of molybdenum, thus forming a non-functional enzyme (Wray and Filner, *Biochem. J.*, **119**, 715; 1970). Using exponentially growing tobacco cells in suspension culture, Kelker and Filner showed that transference from a nitrate-free medium to a medium containing both nitrate and tungstate led to normal appearance of nitrite reductase in the absence of any increase in nitrate reductase activity. In these conditions, added nitrate could not be converted *in vivo* into nitrite and the authors logically conclude that nitrate directly induces nitrite reductase. Earlier this year, the same group provided evidence that nitrate induces the formation of the nitrate-uptake system in tobacco cells (Heimer and Filner, *Biochim. Biophys. Acta*, **230**, 362; 1971) while in barley shoots nitrate also induces an NADH-cytochrome *c* reductase (Wray and Filner, *ibid.*).

It seems clear, therefore, that the development of several biochemical activities intimately involved in the

Genes to Switch off Host

WHEN bacteriophages such as P22, λ, or the T even phages infect bacteria the overall RNA and protein synthesis of the infected cell is either transiently or permanently depressed. Where a lysogenic phage such as P22 is involved this depression of the host's macromolecular metabolism is permanent if the infection leads to cell lysis, but transient if it leads to lysogeny. The possible role of phage genes in these changes has been widely debated for many years and in next Wednesday's *Nature New Biology* Chakravorty and Bhattacharya of the Banaras Hindu University report experiments which clearly implicate genes of phage P22 in the inhibition of RNA and protein synthesis in *Salmonella typhimurium*.

Exploiting mutant as well as wild type phage, Chakravorty and Bhattacharya established that the extent of inhibition of RNA and protein synthesis depends on the multiplicity of infection and also that RNA and protein synthesis can be independently depressed. They then measured the depression of macromolecular synthesis when *S. typhimurium* cells, lysogenized either by wild type P22, which has an intact *sie*$^+$ gene and specifies an active sie protein, or by mutant *sie*$^-$ phage, are superinfected with wild type P22. The RNA and protein synthesis of lysogens carrying the mutated *sie*$^-$ gene is transiently depressed on superinfection. By contrast, superinfection with P22 does not depress the metabolism of *sie*$^+$ lysogens. In other words, cells which carry a *sie*$^+$ gene and make active sie protein—which may well be analogous to the *C* gene repressor protein of phage λ—do not suffer transient depression of their macromolecular synthesis on superinfection, because the sie$^+$ protein prevents expression of any of the genes of the superinfecting phages, including those which somehow interfere with host metabolism. Experiments with a mutant of P22, which is virulent probably because it does not respond to the *sie* gene repressor, support this argument. Superinfection of a *sie*$^+$ lysogen with the virulent mutant P22 results in a transient depression of RNA synthesis.

In summary then, the depression of cellular RNA and protein synthesis following infection with P22 appears to depend on the expression of some P22 genes, which is probably regulated by the product of the *sie* gene.