DNA COLIPHAGES

Another Unwindase

from our Cell Biology Correspondent

T4 GENE 32 protein, the Alberts protein, T4 unwindase, call it what you will, is one of the more celebrated of coliphage proteins. It is, of course, as Alberts and his associates have elegantly demonstrated, the protein, specified by gene 32 of phage T4, which apparently unwinds the double stranded T4 DNA and aligns the two parental, template strands in advance of DNA polymerase replicating the molecule.

Since the discovery of T4 gene 32 protein, other proteins with similar properties *in vitro* have been identified in organisms as diverse as *Escherichia coli* and calf thymus cells, and it is beginning to look as though cooperatively binding proteins capable of denaturing double stranded DNA are a universal prerequisite of DNA replication. It is not perhaps surprising, therefore, that Alberts, Frey and Delius and Oey and Knippers can now report (*J. Mol. Biol.*, **68**, 125 and 139; 1972) that the synthesis of progeny, single stranded circular genomes of the male specific filamentous phage fd depends upon the presence of a phage protein, specified by fd gene 5, which binds cooperatively to single stranded DNA and denatures double stranded DNA. In spite of these similarities, however, gene 5 protein of phage fd and gene 32 protein of phage T4 probably have different roles in the replication of their respective phages.

Alberts *et al.* knew from the work of others that the fd gene 5 protein is required for the synthesis of progeny genomes but does not form part of the virion, so that they labelled fd infected and uninfected *E. coli* with ^{14}C and ^{3}H-arginine respectively, made extracts of the cells and passed them through single strand DNA-cellulose affinity columns to pick out any fd protein which binds to single stranded DNA. Sure enough they found such a protein which has a molecular weight of 10,000 and of which there are about 150,000 copies in each fd infected cell. Alberts *et al.* then used amber and temperature sensitive mutants of fd to prove that this protein is indeed specified by gene 5 of fd.

Alberts *et al.* then established, using the techniques developed to characterize T4 gene 32 protein, first, that the binding of fd gene 5 protein to single stranded DNA is highly cooperative and, second, that one protein molecule binds for about every four DNA bases. At this point Alberts *et al.* probably thought that the fd protein was virtually identical to the T4 protein, and the electron micrographs of gene 5 protein bound to fd DNA taken by Delius may have come as something of a surprise. When gene 5 protein binds to single stranded circular fd genomes it causes them to coalesce in pairs into helical, rod-like structures; it does not force the DNA into extended linear conformation as does T4 gene 32 protein.

From these and other data it seems likely that one of the functions of gene 5 protein is to coat newly synthesized progeny single stranded genomes, which are never found free in infected cells, and thereby prevent them from being immediately converted into more double stranded replicative forms. Presumably during the final encapsidation of progeny fd particles, which occurs at the cell membrane of the infected cells, the gene 5 proteien is replaced by authentic coat protein.

Oey and Knippers have independently isolated gene 5 protein and characterized some of its properties. Their estimates of its molecular weight, the number of copies in each infected cell and its binding properties are essentially identical to those reported by Alberts. Furthermore, Oey and Knippers have found that gene 5 protein partially blocks the activity of *E. coli* exonuclease I and completely inhibits exonuclease III, and at low concentrations it promotes the template activity of the fd replicative form DNA for *E. coli* DNA polymerase II.

At this early stage in the characterization of the fd gene 5 protein, the various functions, apart from simply protecting progeny single strands from being converted into replicative forms, that have been ascribed to it remain. The protein might, for example, act as a repressor for the synthesis of the strand complementary to the progeny viral strand in some rolling circle intermediate—an idea proposed by Marvin's group—or it may be part of the replication apparatus which synthesizes progeny viral strands asymmetrically. No doubt when more is known of the properties of this protein, and of the enzymology of replication of single-stranded DNA, some of these ideas will either be eliminated or substantiated.

STELLAR RADIATION

Infrared Excesses

from a Correspondent

SINCE the discovery of stars which emit unexpectedly large amounts of energy in the infrared ($\lambda \gtrsim 1$ μm) it has been thought that the emission arises primarily from thermal re-radiation by circumstellar dust of absorbed stellar radiation. This view came under serious challenge at the symposium on infrared excesses in stars held at Santa Cruz under the auspices of the Astronomical Society of the Pacific on June 26–29.

A stimulating review by Drs H. M. Dyck and R. W. Milkey (Kitt Peak National Observatory) suggested the importance of electron-proton and elec-

Growth of Aquatic Plants

THE promotion of stem extension in plants is generally thought to be regulated by two groups of growth hormones—the auxins and the gibberellins. Two reports to be published shortly in *Nature New Biology* show that the so-called growth inhibitory hormones ethylene and abscisic acid may actually regulate shoot growth in aquatic plants.

In *Nature New Biology* (July 19) Musgrave, Jackson and Ling report their findings on internode elongation in *Callitriche platycarpa*. This is a common freshwater perennial which consists of a floating rosette of leaves and telescoped internodes, attached to the waterbed by a slender stem. If the rosette is submerged then the growth of the immature internodes is greatly enhanced. McComb previously attributed this pattern of growth to enhanced synthesis of, or sensitivity to, gibberellin (GA) in the submerged rosettes. Musgrave *et al.* report that the sensitivity of the tissue to gibberellin is increased by ethylene and the quantity of ethylene to which the plant is subjected rises when the rosettes are submerged. This may relate to slower diffusion of the ethylene out of the air spaces in the leaves when the plant is totally immersed in water.

Musgrave *et al.* find that GA_3 promotes internode elongation but not to the same extent as submergence, whereas ethylene treatment is at least as effective as submergence. Applied ethylene gas stimulates internode elongation of floating rosettes but has no effect when they are submerged. On the other hand, ethylene applied with GA_3 produces a greater response than submergence alone. Ethylene could, therefore, increase the response to GA by enabling the plant to achieve its full potential for elongation.

Musgrave *et al.* also briefly mention the stimulation of petiole growth by ethylene in the aquatic form of the celery-leaved buttercup, *Ranunculus sceleratus*. This finding, taken together with the results of earlier workers on the semi-aquatic plant, rice, would indicate that the regulation of cell extension by ethylene may be a common feature of aquatic plants. In the same issue of *Nature New Biology* Takahashi's report on mesocotyl growth in rice seedlings suggests that abscisic acid may also act as a stimulator of extension growth. It is significant that in both articles the action of ethylene and abscisic acid is seen in terms of an effect of gibberellin metabolism.