epidermis bearing "single" bristles on a normal background. Each pattern presumably derives from a single clone, because its outline is entire and cells are never individually determined.

From experiments in which the legs were transected, Dr Bryant showed that there was good evidence for an axial developmental gradient which could partially regulate. The upper part of the limb tends to develop normally, the lower half to duplicate with mirror symmetry. This is as if a single gradient is halved: the low end of the top half relaxes towards zero, presumably because of diffusion of the substance in the gradient, the high end of the bottom half doing the same. Some positional values for specifying the limb structure thus only occur in the original top portion of the gradient, whereas those in the relaxed lower portion are duplicated. (Schubiger has reported similar results and it is interesting that there is a lethal mutant with giant disks in which structures tend to duplicate, possibly because the disk becomes too large to be covered by a single gradient.)

The most significant result of the conference was the rejection, by Dr R. M. Gaze (National Institute for Medical Research, Mill Hill) and others, of the ideas of neuronal specificity and modulation. By neuronal specificity is meant the possession of specific chemical labels by neurones and their processes. Correct recognition of such labels is supposed to be instrumental in the formation of ordered connexions between, for example, the optic nerve and the rectum in amphibians. Remodulation is the relabelling of central neurones as a function of their peripheral connexions. Neuronal specification came to be discussed because in those situations for which it has been theoretically required it now seems that there is relatively little specificity involved.

Furthermore, connexion patterns can regulate after damage in such a way that axons become inputs to neurones that they would not originally have contacted. For example, if half the optic tectum is removed and the optic nerve regenerates, the system regulates to preserve a retinotopic projection. As Gaze has shown, normal retinal growth is by division of cells in a ring at the ciliary margin. It is likely that each cell divides to leave a central daughter which will differentiate and a peripheral stem cell which will divide again. The axes whereby the position of retinal ganglion cells are specified are determined when the retina is only twenty cells in diameter, so that the specificity involved might not be very great—connexions subsequent to those of the first disk of cells could be made in the order in which ganglion cells mature and send out their axons. The tectum grows

from a single line of dividing cells, however, so that the actual geometry of connexion formation is still difficult to envisage.

Most experiments in which remodulation is supposed to occur can apparently be reinterpreted as if random neuromuscular connexions are made after a motor nerve is cut. The patterns of movement of a reinnervated limb are in fact so limited that they cannot afford evidence for either specific reconnection in detail, or for remodulation. Indeed, Dr L. Marotti (Monash University) showed that in the goldfish the inferior and superior oblique eye muscles can both be reinnervated by the nerve supplying the inferior oblique. Apparently, however, even though "incorrect" synapses are formed they are not functional under physiological conditions, though she has not yet checked to see whether they are electrically excitable.

RNA SYNTHESIS

Messenger Mathematics

from our Cell Biology Correspondent

THERE are obviously two potential ways in which a bacterial cell might increase or cut back its synthesis of RNA and protein in response to changes in its environment which either increase or decrease the growth rate. The rate of elongation of RNA and polypeptide chains could be altered, or the number of new chains initiated could be regulated while the rate of elongation of chains once initiated remained constant. During the past several years at least half a dozen groups have grappled with this question and the majority opinion is that the rates of elongation remain more or less constant in cells which are growing at rates differing by up to six-fold. The implication of these results is, of course, that regulation occurs at the initiation step. But one or two dissenters have reported evidence which suggests that rates of elongation may vary and this evidence, together with the fact that in most previous experiments the range of growth rates of the cells was restricted, prompted Coffman, Norris and Koch (*J. Mol. Biol.*, **60**, 1; 1971) to measure the kinetics of appearance of β -galactosidase after the addition of inducer to cultures of *Escherichia coli* with doubling times ranging from 50 minutes to 24 hours.

Exploiting the sophisticated techniques now available for measuring the early kinetics of enzyme induction and a sensitive fluorometric assay for β -galactosidase, Coffman *et al.* found that the delay time—the interval between the addition of inducer and first appearance of detectable β -galacto-

sidase activity—was 95 ± 5 seconds in cells with doubling times ranging from 50 minutes to 12.5 hours. And even in cultures doubling extremely slowly (doubling time 24 hours), the delay time was a mere 150 seconds and in this extreme case the binding and penetration of inducer may be retarded.

In short these experiments confirm that over a thirteen-fold range of growth rate the elongation of RNA and polypeptide chains in *E. coli* is invariant. Furthermore, the average lag between adding inducer and the achievement of a steady-state of β -galactosidase activity does not vary significantly with changes in the growth rate; this finding presumably means that messengers survive for about as long in cells doubling every 50 minutes as in cells doubling every 12.5 hours.

In an appendix Koch presents an algebraic analysis of the induction curves for β -galactosidase, obtained when cells are either pulsed with inducer or allowed to grow in the continued presence of inducer, in an attempt to decide between the various models proposed to explain the decay of a messenger RNA. He claims that the results of experiments in which inducer is added and not removed from the medium exclude models which envisage that each messenger is read for a fixed number of times before it is degraded. The data are, however, compatible with a model which envisages that messenger decay is random with respect to time and place, or a model which envisages that there is a constant probability that a "killer" ribosome will initiate translation and inactivate the messenger as a result.

While Coffman and his colleagues have been measuring the kinetics of expression of the *lac* operon—and the objection that their data are relevant only to inducible operons cannot as yet be ruled out—Eron, Morse, Reznikoff and Beckwith (*ibid.*, **60**, 203; 1971) have been looking at the transcription of the *lac* genes in a strain of *E. coli* which because of a deletion has the structural genes of the *lac* operon fused to the *trp* operon. In this strain the expression of the *lac* genes is regulated by the controlling elements of the *trp* operon, and Eron *et al.* have tested to see if a *trp/lac* fused messenger RNA is ever made. They find that some 4–10 per cent of the messengers made from these two fused operons are indeed covalently linked. They conclude that an RNA polymerase can initiate at the *trp* promoter and read through the *trp* and into the *lac* operon. But why is the amount of fused messenger so small? Either read through is rare, or it is the rule, but for one reason or another the fused messenger is broken during isolation or its 5' end is rapidly degraded *in vivo*.