

Deoxyribonucleic Acid Synthesis during Cell Division in Mouse Epidermis

A STUDY of the energy relations of epidermal mitosis in the adult mouse has shown that active production of energy is of vital importance only during that period which immediately precedes the prophase and for which Bullough¹ has suggested the term 'antephase'. By the time an epidermal mitosis becomes recognizable, it is so highly independent of external conditions that it may be regarded as a classical example of an all-or-none reaction. It appears that the critical importance of the active production of energy in the antephase may be related either to a demand for energy at this time, or to the necessity for energy storage for the maintenance of the cell during some two hours of division and reconstitution².

In examining the first of these alternatives it was noted that the view is widely held that an increase in the nucleic acid content of the nucleus occurs during early prophase. Thus Ris³, using the photometric method of Pollister and Ris⁴ for a study of the total nucleic acid content and the deoxyribonucleic acid content of the cells of onion roots and grasshopper testes, has concluded that "during the mitotic prophase and the first meiotic prophase the constituents of chromosomes increase about twofold". It was suggested by Bullough² that this conclusion, if it is also applicable to mouse epidermis, may suggest a reason for the active production of energy in the antephase, since any substantial increase in the nucleic acid content of the cell at this time must involve a significant amount of work.

In contradiction to this, however, Pasteels and Lison⁵, using the technique of Lison⁶, have shown in the erythrocytes of embryo rats, the crypts of Lieberkühn of adult rats, and chick heart fibroblasts "qu'il n'y a pas de modification de la teneur en D.N.A. au cours de la prophase; qu'à l'anaphase cette teneur tombe de moitié pour chaque noyau; que la teneur initiale se reconstitue immédiatement au moment de la reconstitution du noyau". Lison and Pasteels⁷ have also described a similar pattern of deoxyribonucleic acid synthesis during mitosis in sea urchin eggs. It was therefore necessary to determine the conditions in mouse epidermis before attempting to relate energy production to deoxyribonucleic acid synthesis, and measurements have now been carried out on the ear epidermis, the tissue in which the original observations on energy production were made. The mice used were four-month old Kreyberg white label males. These were killed while asleep in order to obtain a high number of epidermal mitoses, their ears were sectioned, and the deoxyribonucleic acid content of their epidermal nuclei was estimated by the method described by Lison⁶ (see table); for comparison, the deoxyribonucleic acid content of lymphocyte nuclei is also shown.

DEOXYRIBONUCLEIC ACID CONTENT OF NUCLEI IN THE MALPIGHIAN LAYER OF THE EAR EPIDERMIS OF ADULT MALE MICE (ARBITRARY UNITS)

| Type of nucleus | Number of nuclei examined | Deoxyribonucleic acid content | |
|-----------------|---------------------------|-------------------------------|-------------------------|
| | | Extreme values | Mean and standard error |
| Interphase | 150 | 123-642 | — |
| Prophase | 1 | 362 | — |
| Metaphase | 20 | 333-457 | 338.7 ± 7.5 |
| Telophase × 2 | 28 | 384-568 | 460.0 ± 10.6 |
| Lymphocyte | 26 | 230-327 | 276.9 ± 5.3 |

The measurements showed that in the Malpighian layer, which alone contains cells capable of division, the deoxyribonucleic acid content of interphase nuclei varied widely. Clearly the Malpighian cells were not homogeneous, and, using lymphocyte values as standard, it was found that they could be roughly divided into three groups: those with a deoxyribonucleic acid content equal to that of the lymphocytes, those with a lower content, and those with a higher content. It was apparent that only the cells of the last group, those with the highest deoxyribonucleic acid content, could undergo division, since all the nuclei measured in prophase and metaphase showed similarly high values. During early anaphase each of the two newly forming groups of chromosomes had only half the deoxyribonucleic acid content of the metaphase nucleus. During late anaphase and telophase, however, deoxyribonucleic acid synthesis was rapid so that, by the time each daughter cell entered the interphase, it again showed the high level typical of the prophase.

Evidently, conditions in the ear epidermis of the adult male mouse closely resemble those in the crypts of Lieberkühn of the adult rat, concerning which Pasteels and Lison⁵ have concluded that "au cours de l'intercinese, les cellules ont des teneurs très différentes; en revanche, les valeurs observées à la métaphase sont d'une très grande homogénéité; la synthèse en D.N.A. débute à l'ana-télophase et se poursuit au cours de la reconstitution du noyau; la valeur anaphasique est ainsi progressivement doublée; et une valeur égale à celle de la métaphase est rétablie au début de la nouvelle intercinese".

These conclusions appear to contradict any suggestion that the high production of energy observed during the antephase may be related to active nucleic acid synthesis at that time, and to be in agreement with the alternative hypothesis that the antephase is the period when energy is stored for the support of all the various cellular activities, including synthesis of deoxyribonucleic acid, which occur during the ensuing division. A fuller account of these observations will be given elsewhere, together with a description of conditions in the superficial epidermal layers.

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¹ Bullough, W. S., *Biol. Rev.* (in the press).

² Bullough, W. S., *J. Endocrinol.*, **6**, 350 (1950).

³ Ris, H., *Cold Spring Harbor Symp.*, **12**, 158 (1947).

⁴ Pollister, A. W., and Ris, H., *Cold Spring Harbor Symp.*, **12**, 147 (1947).

⁵ Pasteels, J., and Lison, L., *Arch. Biol., Liège*, **61**, 445 (1950).

⁶ Lison, L., *Acta Anat., Basel*, **10**, 333 (1950).

⁷ Lison, L., and Pasteels, J., *Arch. Biol., Liège*, **62**, 1 (1951).

A New Biological Method for Evaluating the Efficiency of Insecticides for the Protection of Sheep against Blowfly Strike

THE protection afforded to sheep against blowfly strike by the new synthetic chlorinated hydrocarbon insecticides applied to the fleece has been shown to be the result of two different actions. Insectary tests have demonstrated distinct repellent effect and the prevention of oviposition in the case of gravid female