Distribution of Nucleic Acids

A QUESTION of great interest has been raised by Gulland, Barker and Jordan when they object to a nucleic acid terminology proposed by us[1]. We suggested that the terms 'chromonucleic' and 'plasmonucleic acid' be used as synonyms for 'desoxyribose' and 'ribose nucleic acid' respectively[2]. The latter terms are useful because they clearly denote an essential difference in *chemical* composition of the two known types of nucleic acid; the former terms would be useful because they describe the striking *biological* distribution of the two nucleic acids.

In recent years it has been shown, contrary to what had been believed previously, that both types of nucleic acid are present in both plant and animal cells. There is indeed a profound difference in the distribution of the two types of nucleic acid; but the difference is discernible within each plant and animal cell. In all plant and animal cells on which careful observations have been made, one type of nucleic acid has been detected in the chromatin only, and we have accordingly suggested the name 'chromonucleic acid' for this type. The other type of nucleic acid, 'plasmonucleic', occurs in the cytoplasm, in the plasmosome (nucleolus) and possibly in minute quantities in the chromatin[3,4]. The distribution of the two nucleic acids provides a biochemical basis for the now classical cytological distinction between chromatin and other constituents of the cell. 'Chromonucleic' and 'plasmonucleic acid' are terms that epitomize the point of view of the cyto-geneticist, much as the term ascorbic acid does the point of view of another group of biologists—better than does the chemical term 2,3-enediol-*l*-gulono-1,4-lactone! Gulland, Barker and Jordan object to the terms we have suggested because nucleic acids are present in viruses and bacteria as well as in cells with clearly defined nuclei. 'Chromonucleic' and 'plasmonucleic' are terms based on a distribution of the two acids within cells in which certain morphological features are visible. The presence of nucleic acids in viruses and bacteria is regarded by Gulland, Barker and Jordan as an "exception" to this distribution. This, in our opinion, is altogether too narrow a view to take, and it becomes apparent at once when we consider the presence of 'chromonucleic (desoxyribose) nucleic acid' in bacteria.

The existence of nuclei in bacteria has been a moot question for years. In the nuclei of many animal and plant cells, chromatin forms by far the bulk of the nuclear substance, and in some nuclei more than 90 per cent of the chromatin consists of desoxyribose nucleoprotein (chromonucleoprotein)[5]. The presence of desoxyribose nucleic acid in bacteria[6,7] and the preparation from bacteria of a desoxyribose nucleoprotein strikingly similar to those prepared from all nuclei[5] indicates that the chemical equivalent of chromatin is present in bacteria; and whether or not this chromatin is organized in a morphologically distinct nucleus becomes, in a sense, a secondary matter. The discovery that a chromonucleoprotein, like that present in the nuclei and not in the cytoplasm of animal and plant cells, and forming the bulk of their chromatin, also exists in bacteria, is surely not so much an exception to the statement that such nucleoproteins exist in the nuclei of cells of higher animals and plants as an indication that bacteria contain chromatin.

It appears fruitful at present to compare the viruses with the self-duplicating bodies known to be present within the cells of plants and animals. Some viruses (vaccinia, bacteriophage) contain desoxyribose nucleic acid; others (the tobacco mosaic virus, for example) contain ribose nucleic acid[3]. The suggestion arises at once that some viruses may be related to those self-duplicating bodies, the genes, that are so closely associated with the chromonucleoproteins (desoxyribose nucleoproteins) of chromatin and that other viruses may be related to self-duplicating bodies in the cytoplasm, such as the chloroplasts, which contain plasmonucleoproteins (ribose nucleoproteins).

The nucleic acid terminology which we have proposed does not ignore the presence of nucleic acids in bacteria and viruses; on the contrary, this terminology implies that the distribution of nucleic acids has a profound biological significance.

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Carbonic Anhydrase

IN a recent letter in NATURE[1], Keilin and Mann question the zinc content of carbonic anhydrase reported by us. The facts seem to be that they have obtained an enzyme preparation (which they believe is highly purified) having a zinc content of 0·3–0·33 per cent[2], and we have obtained a preparation (which we likewise feel we have shown to be highly purified) having a zinc content of 0·2–0·23 per cent[3]. Realizing that criticism can be directed against the determination of any low zinc content, whether the method used be the dithizone method employed by Keilin and Mann or the method of Sahyun and Feldkamp used by us, we conducted preliminary experiments and reported[4] that "Before zinc estimations were conducted on the enzyme, analyses were made on a sample of zinc-insulin crystals with the same technique as was used in estimating the zinc in the enzyme. Duplicate results agree within 4 per cent. Moreover, these results were in good agreement with the metal content of the crystals as calculated from ash determinations. Along with each estimation of the zinc content of an unknown sample it was routine procedure to determine likewise the zinc content of a standard zinc solution". In all our estimations of the zinc content of the enzyme preparations, care was taken that a reasonable quantity of material was used. Recently Prof. Thode of McMaster University made polarographic determinations of the zinc content of our enzyme preparation and found it to be 0·22 per cent. We feel that the comparatively low zinc values reported by us are not attributable to the method of determination used in our work.

Keilin and Mann direct attention to the fact that the carbonic anhydrase content of ox blood as determined in our laboratory[5] was approximately twice that reported by them for washed ox red blood