

CRYSTALLINITY IN SPERM HEADS: MOLECULAR STRUCTURE OF NUCLEOPROTEIN *IN VIVO*

by

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It is often supposed that the specificity of genes may be associated with structural characteristics of desoxyribose nucleoprotein molecules in the cell nucleus. X-ray diffraction can give information on the molecular structure of such nucleoprotein and for this purpose one chooses materials in which the degree of molecular order is as high as possible. The large optical anisotropy of some sperm heads¹ indicates parallelism of the nucleoprotein molecules and suggests a possible crystallinity². RINNE³ made X-ray diffraction studies of the anisotropic sperm heads of *Sepia* and concluded that the nucleoprotein consisted of a liquid crystalline arrangement of parallel rod-shaped molecules.

We have obtained X-ray diffraction photographs of fibres of oriented *Sepia* and *Loligo* sperm (the fibres were made from spermatophore⁴) which show that RINNE's conclusion is not correct and that the sperm heads consist of material containing three-dimensional periodic order and in that sense are crystalline and not liquid crystalline. The periodicities observed in the sperm heads range from ~ 3.5 to 30 Å but are not very sharply defined. This crystallinity is probably due to periodic repetition of the general size and shape of the molecular units in the sperm head, the imperfection of crystallinity may be due to differences on the atomic scale from one molecule to the next. On the X-ray photograph all the diffraction spectra appear as arcs of circles of equal angular length, the common centre of the circles being at the point corresponding to the direction of the incident X-ray beam. Such a photograph is to be expected from an aggregate of oriented microcrystals when the axes of the crystals are almost but not exactly parallel. Hence each individual sperm head may consist either of a single imperfect crystal or an aggregate of parallel microcrystals.

We have also obtained X-ray photographs of trout (*Salmo* sp.) sperm heads which are optically isotropic (sperm kindly supplied to us without tails by Dr A. FELIX of Frankfurt). These sperm heads were unfixed and undried and we expect their structure to be similar to that of sperm in the living state. The photograph is similar to that of *Sepia* except that each arc has become a complete ring. This suggests that both the isotropic and anisotropic sperm heads are composed of similar crystalline bundles of long-chain nucleoprotein molecules. These bundles are all parallel to each other in the anisotropic sperm heads, whereas in the isotropic heads they lie in all directions, possibly due to folding in chromosomes.

The most significant aspect of these observations is probably the similarity between the X-ray photographs of the sperm heads and those of fibres of pure sodium thymonucleate. Apparently the basic geometry of the desoxyribose nucleic acid molecules in living cells is preserved after careful chemical extraction of the nucleic acid. One may reasonably hope to make an unambiguous structure determination of the nucleate fibres because of their high degree of crystalline perfection, and then by comparison the molecular structure of the sperm head nucleoprotein may be derived. It should be noted that in this way one determines only those aspects of the molecular structure which are repeated regularly throughout the sperm head; clearly the specific differences of gene structure cannot lie therein but may exist rather in the non-repetitive aspects of the structure which, however, are not amenable to study by these methods.

A full account of this work will be published later.

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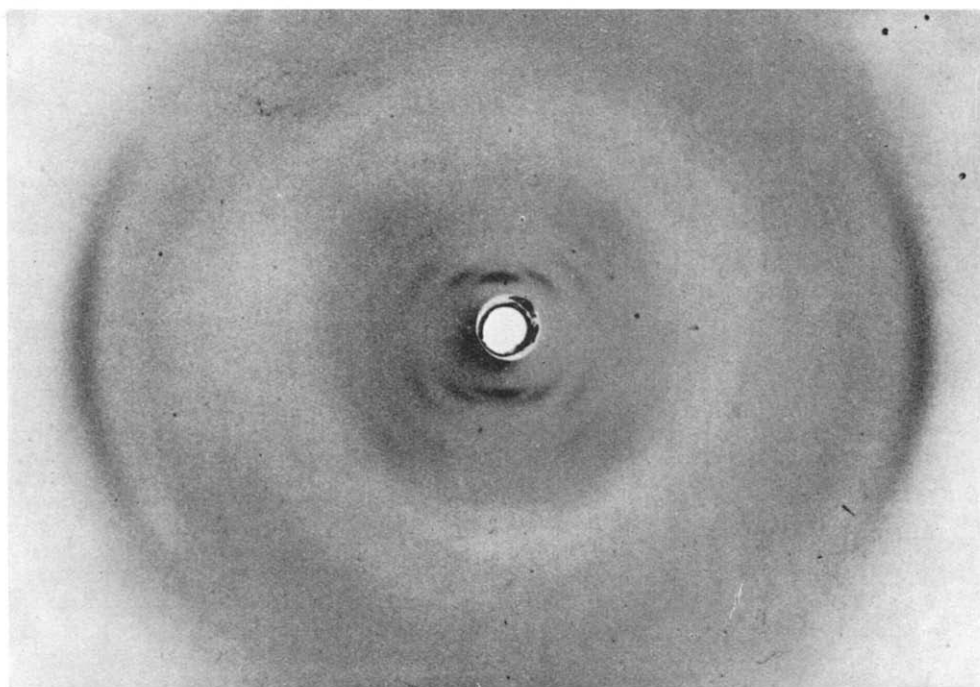


Fig. 1. X-ray photograph of *Sepia* sperm at 98% humidity. Long axis of sperm heads horizontal.

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MÉTHODE PERMETTANT L'ÉTUDE CONJUGUÉE DES PROPRIÉTÉS ÉLECTROPHORÉTIQUES ET IMMUNOCHIMIQUES D'UN MÉLANGE DE PROTÉINES. APPLICATION AU SÉRUM SANGUIN

par

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Bien que l'électrophorèse soit une des méthodes les plus douces pour analyser un mélange de protéines, il n'est pas exclu qu'elle entraîne des altérations ou des dissociations des constituants naturels. Les méthodes immunochimiques au contraire ne font pas courir ce risque. Leur plus grande sensibilité, d'autre part, permet d'affirmer avec plus de certitude que l'électrophorèse, l'individualité d'une protéine. C'est pourquoi nous avons tenté à la fois: 1. de confirmer l'individualité des constituants électrophorétiques grâce aux méthodes immunochimiques, et 2. inversement, de classer les constituants décelables immunochimiquement parmi les fractions électrophorétiques définies par leur vitesses de migration. La méthode qui suit a été élaborée dans ce double but.