On the organisation of collagen fibrils in bone

An alternative structure for the Haversian Systems in bone is suggested by observations of decalcified sections of bone under the polarising microscope, a typical section being shown in Figs. 1 and 2.

The appearance of sections of compact bone cut perpendicular to the length of the Haversian Systems closely resembles that of spherulites formed by certain artificial polymers. The extinction patterns of these spherulites can be explained[1] if the direction of the maximum refractive index winds in a helix with its axis directed radially from the centre of the spherulite. Spherulites with helical angles from 0 degrees to 90 degrees have been obtained; those with small helical angles show concentric birefringent and isotropic rings and a dark extinction cross between crossed nicols.

The birefringence in sections of decalcified bone is mainly positive form birefringence and not intrinsic birefringence of the collagen. This is due to the presence of submicroscopic rodlet-shaped spaces previously occupied by the inorganic hydroxyapatite crystals, which have been shown by FINEAN AND ENGSTROM[2] to have their long axes parallel to the 640 Å spacing of the collagen molecules. The direction of the maximum refractive index is consequently parallel to the collagen molecules and also to the fibrils. In view of the resemblance between spherulites and Haversian Systems between crossed nicols it is suggested that the direction of the collagen fibrils winds in a helix of small helical angle with its axis directed radially from the central canal. This structure explains further observations (Fig. 3) of the extinction pattern such as the uniform change in birefringence across the birefringent rings, and also the change in direction of the birefringence in the plane of the section. This latter can be obtained from the direction of the dark lines which cross the birefringent rings to form the extinction cross. The generally accepted concept of the fibrils forming helices concentric with the central canal, where each birefringent and isotropic ring corresponds to a separate helix[3], does not account for the

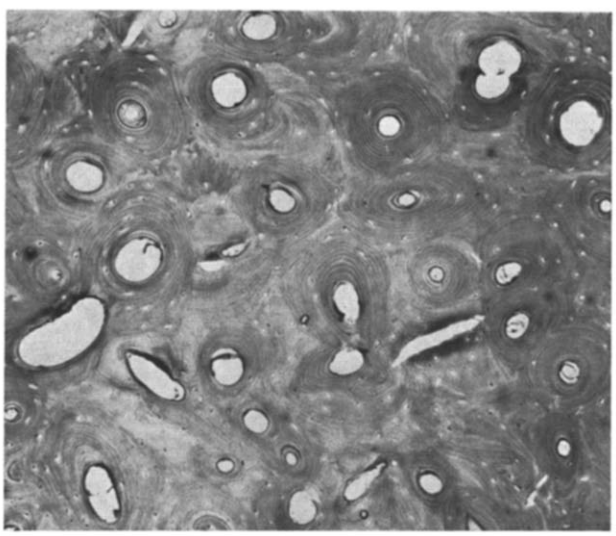

Fig. 1. A typical field in a section of decalcified bone cut perpendicular to the length of the Haversian Systems, Magnification × 60. Stained with Haematoxilin, Phloxine and Tartrazine

Fig. 2. Same field as Fig. 1 but with Polars crossed

observations. In order to do so it is necessary to postulate a very large number of helices with the helical angle increasing continuously in successive helices. There is, however, no further evidence for such a structure.

Fig. 3. Single Haversian System in unstained section with Polars crossed showing birefringent and isotropic rings and the dark extinction cross

In Haversian Systems the variation in direction of the fibrils suggested by the structure of pherulites is supported by the similarity in chemical structure of collagen and the artificial polymers. They are all long chain molecles, while nylon, one of the polymers studied by KELLER, and collagen are polypeptides. Furthermore, the formation of Haversian Systems takes place slowly in the primary bone which has been previously laid down and in this respect resembles[1] the formation of spherulites which are obtained when the polymer is kept at a temperature a few degrees below its softening point. Moreover, spherulites of inorganic salts such as barium carbonate are only obtained if the rate of crystallisation is slow, as for instance by allowing a solution of barium chloride to diffuse into a gel containing dissolved sodium carbonate.

This structure offers a straightforward explanation for the existence of Haversian Systems in bone as being a form of crystallisation of collagen analogous to the formation of spherulites from artificial polymers.

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On the phosphamidase activity of human seminal phosphate

The idea that the phosphamidases form a group of enzymes distinct from the phosphatases[1,2] seems no longer valid. There do exist perhaps specific phosphamidases that do not attack the P–N compounds and specific phosphamidases that do not attack the P–O compounds analogous to their own substrates, but so far in all cases where the so-called unspecific phospho-mono-esterases have been investigated carefully, they have also displayed phosphamidase activity.

Preparations of alkaline phosphatases, more or less purified, have been shown to catalyze the hydrolysis of P–N compounds[3,4,5,6,7] and also to catalyze the transfer of phosphate from a P–N donor to certain acceptors[4,5,7].