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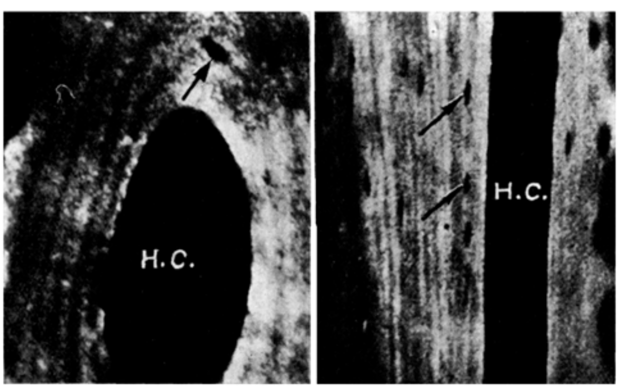
Zusammenfassung

Auf Grund von Untersuchungen mit Röntgen-Kleinwinkelstreuung an myelinhaltigen Nervenfasern wird ein erweitertes und verfeinertes Molekül-Modell beschrieben.

Lamellar Structure of Osteons Demonstrated by Microradiography

Microradiography with soft X-rays has been used to demonstrate the content of mineral salts in the different structures of bone[1]. It has been possible to prove that the osteons have a varying content of mineral salts and that within an osteon the mineralization has its highest value close to the HAVERSIAN canal and diminishes towards the periphery. In general the young osteons formed in the resorption cavities have a much lower content of mineral salts than the old osteons (fragments of old bone). There is a continuous increase of the amount of mineral salts in the osteon with its increasing age[2].



In a series of investigations dealing with electron microscopy of bone[3] the lamellae of the osteons have been demonstrated at high magnification. Based on electron microscopic investigations of replicas of bone tissue the conclusion was drawn that the osteons are built up of alternating "fibrillar" and "cemented" lamellae[4].

From the above it is evident that it would be of great interest if microradiographs could be registered with such high resolving power that the mineral content of the lamellae could be demonstrated by X-ray absorption.

Cross and longitudinal sections 5 to 10 μ in thickness were prepared from human femur (compacta). The sections were ground on glass plates under absolute ethanol[1]. These sections were placed in close contact with a fine grained LIPPMAN photographic emulsion and exposed with 4 kV X-rays in vacuo. The X-rays were filtered in 9 μ of aluminium. Thus an 1 : 1 scale image of bone section was produced by the X-rays on the LIPPMAN emulsion. This image was enlarged by photomicrography. In the figure there are shown two such enlarged microradiagrams registered from cross and longitudinal sections. The whiter a structure is in the figure the higher its content of mineral salts. The arrows point to osteocytes. The osteocytes are not mineralized. H.C. indicates the HAVERSIAN canal. *From the pictures it is evident that the X-ray absorption varies in the different lamellae.* In agreement with earlier investigations[2] we again find a higher mineralization in the part of the osteon that is closest to the vascular channel, and that the young osteons are less mineralized than the old parts of the bone. At the wavelengths used, the major X-ray absorption is caused by both the organic and inorganic components of the bone tissue. The greatest part of the radiation generated at 4 kV and filtered in 9 μ Al lies at wavelengths between 8 and 12 Å with a small portion with wavelengths about 3 Å[3]. The former wavelength range lies beyond the K-absorption edges of calcium and phosphorus, which somewhat reduces the inorganic contributions to the absorption. For X-rays of 8·32 Å wavelength the mass absorption coefficients for protein and tricalciumphosphate are 1000 and 1400 (to the nearest hundred). A 5 μ thick section of protein transmits about 60% of 8·32 Å X-rays while a 5 μ thick layer of tricalciumphosphate transmits about 12%. Some complementary experiments were performed with 3 Å X-rays and the lamellar structure could be seen also with this radiation although not so clear as with the 8–12 Å X-rays. At 3 Å the mass absorption coefficient for calcium is about 1000 but for protein only about 50. In this wavelength (3 Å), therefore, practically all absorption is caused by the mineral salts.

From the experiments and consideration presented above it is clear that the X-ray absorption varies in different lamellae. *Thus there are lamellae with a high content of substances (organic + inorganic material) alternating with those having less substance.* The ratio inorganic to organic material is probably higher in the lamellae with a high X-ray absorption than in those with less absorption. The latter conclusion is in agreement with electron microscopic observations[4].

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Zusammenfassung

Die Lamellen des Haverschen Systems wurden durch Röntgenmikroradiographie demonstriert. Lamellen mit hoher Röntgenabsorption wechseln mit solchen niedriger Absorption ab.

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