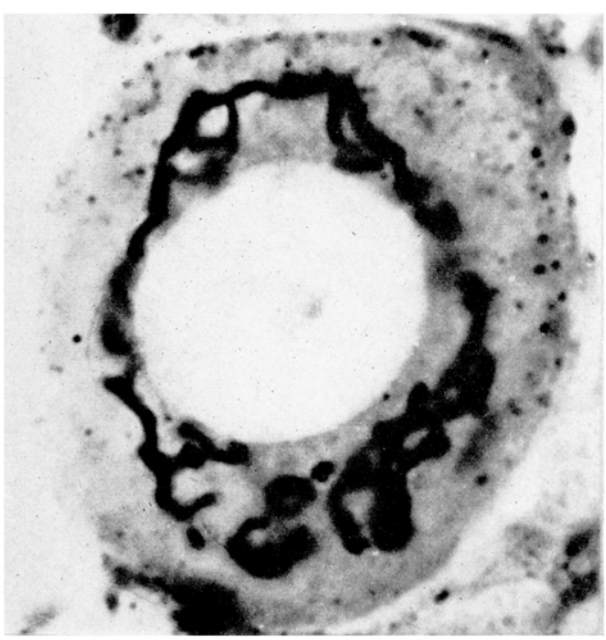
The Classical 'Golgi Apparatus' in the Vertebrate Nerve Cells

The name 'Apparato reticolare interno' ('Golgi apparatus'), was introduced by GOLGI[1] in 1898 while studying the Purkinje cells of the cerebellum of the barn-owl, *Strix flammea* with his 'reaziona nera'—the black reaction. Since then this term has been in constant vogue for an irregular and tortuous, usually perinuclear, reticulum that is formed after the application of particular techniques, popularly called the 'classical Golgi techniques'. But, during the past decades, while most of the cytological research was oriented by the 'Golgi apparatus' and the associate controversy, the word Golgi apparatus came to be used for the various cell inclusions entirely unrelated to one another histochemically. The authors have conducted a detailed histochemical analysis of the ageing spinal neurones of fishes (*Periophthalamus* sp., *Heteropneustis fossilis*, and *Ophiocephalus striatus*), amphibians (frog, *Rana tigrina*), reptiles (lizards, *Hemidactylus* sp. and *Uromastix hardwickii*, snakes, *Natrix* sp. and *Eryx johnii*, and the turtle, *Lissemys* sp.), birds (*Gallus domesticus* and *Columba livia*), mammals (*Rattus norvegicus* and *Oryctolagus cuniculus*) and have paid optimal attention to the classical Golgi techniques to find out the exact site as well as the nature of the 'Golgi apparatus'.

Excepting *Periophthalamus* sp., *Heteropneustis* and *Eryx*, the nerve cells of the rest of adult and old animals studied have shown a typical picture of the argentophil and osmiophil conventional Golgi apparatus (Figure), although the neurones of the young animals characteristically lacked it. The period of osmication and silvering was varied from 2–12 days and from 15–20 h respectively to observe gradual osmication and silvering of the inclusions forming the 'Golgi apparatus'. In all the animals studied the 'Golgi apparatus' carved out an asymmetrical, usually perinuclear, configuration. The various osmium and silver preparations were also deosmicated as well as desilvered gradually with a saturated solution of potassium persulphate and 0.5% iodine solution respectively and studied at intervals to confirm the exact site of the 'Golgi apparatus'.



Photomicrograph of the Kolatchev preparation of a mammalian spinal neurone showing the perinuclear reticulum. Many uncumbered lipid spheroids can be made out clearly, but the mitochondria are not clear. 1,700ma × gn.

It has been concluded after meticulously careful observations that the 'classical Golgi apparatus' in the nerve cells of the adult and old animals is formed as a result of deposition of reduced osmium or silver on the basophil Nissl patches and the associate canaliculi and spaces (homologous to the endoplasmic reticulum of PALAY and PALADE[2], and MALHOTRA and MEEK[3]). The excellent investigations of LEGENDRE[4], showing that the silver-impregnated Nissl bodies have exactly the same appearance as the 'classical Golgi apparatus', corroborate our present findings beyond doubt. A network of anastomosing canaliculi and spaces in the cytoplasm can easily be observed in the living cells studied under the phase contrast microscope and in the Kolatchev deosmicated preparations. These structures are, in all probability, the broad cisternae of the endoplasmic reticulum.

The present findings have, to a great extent, refuted the claim of THOMAS[5-7] that the conventional 'Golgi apparatus' is formed by a deposition of the metallic ingredients on the mitochondria: these organelles are too small to evoke the formation of big reticuli[8,9]. MOUSSA[10] has also affirmed that there exists practically no morphological connection between the mitochondria and the 'Golgi apparatus'. The neutral red bodies or the lipid particulates, either alone or together with the mitochondria, are also not solely responsible for the formation of networks, as believed by a host of eminent workers[5-7,11]. The present authors believe that the strongly argentophil and osmiophil lipid bodies and the mitochondria, although they get impregnated very readily, take part in the formation of the networks only to the extent that several of them get engulfed during the process, otherwise most of them are seen lying not only in the uncumbered cytoplasm but also in between the meshes of the reticulum.

The argentophil and osmiophil networks observed during the present investigations cannot, at all, be homologized with the 'classical Golgi apparatus' of GATENBY[12], and MOUSSA and BANHAWY[13], because the networks here are conspicuously absent in the neurones of the young animals, whereas, according to these workers, they are invariably in a full-fledged condition in the nerve cells of the young animals, but are absent from those of the old and senile ones. The present investigations have also invalidated the claim of MOUSSA and BANHAWY[13] that the lipid bodies are the secretion or the transformation products of the disintegrating Golgi apparatus of the neurones of the old animals.

In conclusion the 'classical Golgi apparatus' in vertebrates is an artifact formed as a result of deposition of osmium or silver on the patchy Nissl substance and the

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associate canaliculi and spaces; the lipid bodies and the mitochondria are but the secondary associates.

Zusammenfassung. Der 'Golgi-Apparat' in den Neuronen des Rückenmarks der Wirbeltiere entsteht aus Ablagerungen von Osmium oder Silber an Nissl-Körperchen und an mit ihnen verbundenen Canaliculi und Spaltsystemen. Lipoidkörperchen und/oder Mitochondrien sind in bezug auf Bildung von sekundärer Bedeutung.

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Elektronenmikroskopische Beobachtungen an den Hülsenarteriolen in der Milz des Hundes

Die einzige uns bekannte elektronenmikroskopische Beschreibung von Hülsenarteriolen in der Milz ist bis jetzt diejenige von WEISS[1], der ebenfalls Hundemilz untersuchte. Während wir seine Befunde bestätigen können, dass es sich bei den Hülsenzellen um pleomorphe, phagocytierende Zellen handelt, zwischen denen Plasmazellen vorkommen können, und dass das Endothel kontinuierlich ist, sind wir in der Lage, an Hand der elektronenmikroskopischen Untersuchung einer Hundemilz zusätzliche Angaben zu machen, insbesondere über die Feinstruktur des Endothels.

Kleine Stücke aus der Milz eines Schäferhundes, der wegen eines Hautsarkoms mit Nembutal getötet wurde[2], wurden in gepuffertem Acrolein nach LUFT[3] fixiert, im Phosphatpuffer gewaschen und weiter zerkleinert, mit gepufferter Osmiumtetroxydlösung nach PALADE[4] nachfixiert, in Äthanol entwässert, in 1%iger Phosphorwolf-

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Fig. 1. Filamente im Cytoplasma einer Endothelzelle einer längs getroffenen Hülsenarteriole. Anliegender Erythrocyt im Gefässlumen links oben.

Fig. 2. Ausschnitt aus einer Schweigger-Seidelschen Hülse. Arteriole (oben) quer getroffen. Phagozytiertes Material (Mitte links) in einer Hülsenzelle.