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# Nerve cells and synapses in the human foetal hypogastric nerves

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*The hypogastric nerves of a human foetus of 220 mm C-R length (23rd week) were investigated with an electron microscope. These nerves were composed mainly of bundles of unmyelinated fibres and single myelinated fibres. Small ganglia and single ganglion cells were observed in the hypogastric nerves. Light and dark cells were found among the nerve cells. The two types of cell differed in the number of ribosomes and the amount rough endoplasmic reticulum. In the period of development investigated protosynapses and mature synapses were observed in the hypogastric nerves.*

**Key words: human neuroembryology, hypogastric nerves, nerve cells, synapses**

## INTRODUCTION

The hypogastric nerves are formed by the bifurcation of the lower part of the intermesenteric plexus [28].

This lower part of the intermesenteric plexus is often described as the "superior hypogastric plexus", located anterior to the bifurcation of the aorta and 5th lumbar vertebral body and sacral promontory. It is also termed the "presacral" nerve.

However, its sympathetic and parasympathetic sources are the same as the other parts of the intermesenteric plexus. The hypogastric nerves diverge, curving outwards, downwards, and backwards into the pelvis, at first lying medial and almost parallel to the internal iliac vessels and then medial to its branches [17]. The angle between the diverging nerves is often bridged by delicate interlacing fibres. The hypogastric nerves may be single or may consist of 2 or 3 nerve bundles interconnected by oblique anastomosing strands to form a narrow elongated plexus [17, 28].

These interconnecting rami are important in distributing preganglionic fibres to both pelvic plexuses, enabling bilateral control of the pelvic organs [12].

Each nerve terminates in the corresponding pelvic plexus and provides its chief complement of sympathetic fibres. In addition to sympathetic fibres, the hypogastric nerves also contain parasympathetic fibres from the pelvic nerves.

Visceral afferent fibres from the pelvic viscera and blood vessels also pass along the hypogastric nerves, as has been shown with HRP tracing techniques [19] and electrophysiological studies [19, 20]. They may contribute branches to the distal colon, the testis or ovary, the ureter, and the iliac arteries or their branches.

The composition of nerve fibres in the hypogastric nerves and their range of innervation is evidence of their important role in several important reflex functions of the urinary and genital organs [2, 5, 6, 15, 22, 23, 25, 29].

The aim of the present study is to investigate the structure of neurons in the hypogastric nerves in the human foetus.

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## MATERIAL AND METHODS

Examination was made of the hypogastric nerves of a human foetus of 220 mm C-R length, aged 23 weeks. The hypogastric nerves were removed immediately after surgery and immersed in 1.2% chilled glutaraldehyde for 1 h. The material was then placed for 2 h in 2% glutaraldehyde buffered to pH 7.4 with cacodylate. After being washed in cacodylate buffer for 24 h, parts of the hypogastric nerves were fixed in 1% osmium tetroxide. Thin and semi-thin sections were made on Reichert ultramicrotome. The semi-thin sections were contrasted with uranyl acetate and lead citrate. The thin sections were examined in JEM-7A and Philips electron microscopes.

## RESULTS

In the foetus investigated the hypogastric nerves were composed mainly of bundles of unmyelinated fibres and single myelinated fibres at different phases of myelination (Fig. 1).

Endoneural spaces containing collagenous fibres, fibroblasts and blood vessels were observed between the bundles of axons (Fig. 2). Small ganglia and scattered nerve cells were observed in the hypogastric nerves. Among the nerve cells two types are found, viz. light and dark cells (Fig. 3). The two types of cell vary in the number of ribosomes and the amount of rough endoplasmic reticulum. The ganglion cells were separated by lemmocytes and nerve fibres, and they were also observed on the periphery of blood vessels (Fig. 4). The cells had irregular contours and had oval or irregular nuclei with dispersed chromatin and nucleoli. The nucleoli had light spaces, the so-called "nucleolar vacuoles" (Fig. 5, 6). The cytoplasm of the light cells contained dispersed ribosomes and channels of the rough endoplasmic reticulum, which were also located at the periphery of the cell, forming Nissl's substance (Fig. 6, 7). Clusters of polyribosomes, a very few mitochondria and lysosomes, smooth endoplasmic reticulum and large areas of neurofilaments were also present.

The dark cells were smaller than the light cells and had irregular contours. In the nucleus small clumps of heterochromatin were found (Fig. 1, 3, 8). The structure of the nucleoli was the same as in the light cells. The cytoplasm of the dark cells contained a large number of ribosomes, which formed rosettes. The rough endoplasmic reticulum was more abundant, especially on the periphery of the cell. The large number of ribosomes and the amount of rough endoplasmic reticulum resulted in a dense and dark cytoplasm.

The ganglion cells were surrounded by the processes of satellite cells (Fig. 2–5). The single nerve cells found in the hypogastric nerves located close to the blood vessels may be regarded as SIF cells.

Small ganglia and single ganglion cells present in the hypogastric nerves may be relay stations for preganglionic fibres which make synaptic contacts within the nerve. This was also confirmed by the presence of synapses in the nerves investigated. Primitive synapses (protosynapses) and mature synapses were observed in these nerves (Fig. 9, 10). The protosynapses are characterised by the density of the presynaptic and postsynaptic membranes, spherical synaptic vesicles, and differences in the thickness of the synaptic membranes, the presynaptic membrane being thicker.

Synaptic junctions were found between axon and dendrite. Mature synapses contain spherical synaptic vesicles on the presynaptic side.

## DISCUSSION

The hypogastric nerves are composed predominantly of thin myelinated and unmyelinated fibres. This was shown in our previous study as well as by other researchers [4, 20, 28]. Preganglionic sympathetic fibres pass along these nerves from the lumbar ganglia of the sympathetic trunks to the pelvic plexuses and the plexuses of the pelvic viscera.

Scattered nerve cells and small ganglia in the nerves form an important link in the reflexes from the pelvic organs.

The hypogastric nerves, which arise from the intermesenteric plexus to the pelvic plexuses, form an important centre regulating the function of the pelvic viscera [12–14, 18, 26]. The light and dark cells have been described by several authors in the sensory ganglia of the cranial and spinal nerves [1, 7, 16, 21]. They are observed during prenatal development [3]. Tennyson [24] observed both types of cell in the spinal ganglia of the foetal rabbit. She noted that a larger amount of the rough endoplasmic reticulum is characteristic of more mature cells [24]. Altman and Bayer [1] found that the light cells appear first during development. Forbes and Welt [11] distinguished 3 types of cell in the trigeminal ganglion of the rat. These differ in the amount of Nissl's substance, which may point to functional differences in the cells.

The synaptic junctions described within the hypogastric nerves prove that the nerves are the relay station [8–10, 27] in sympathetic fibres to the pelvic viscera.


**Figure 1.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 3320. Ax — axon, D — dark cell.

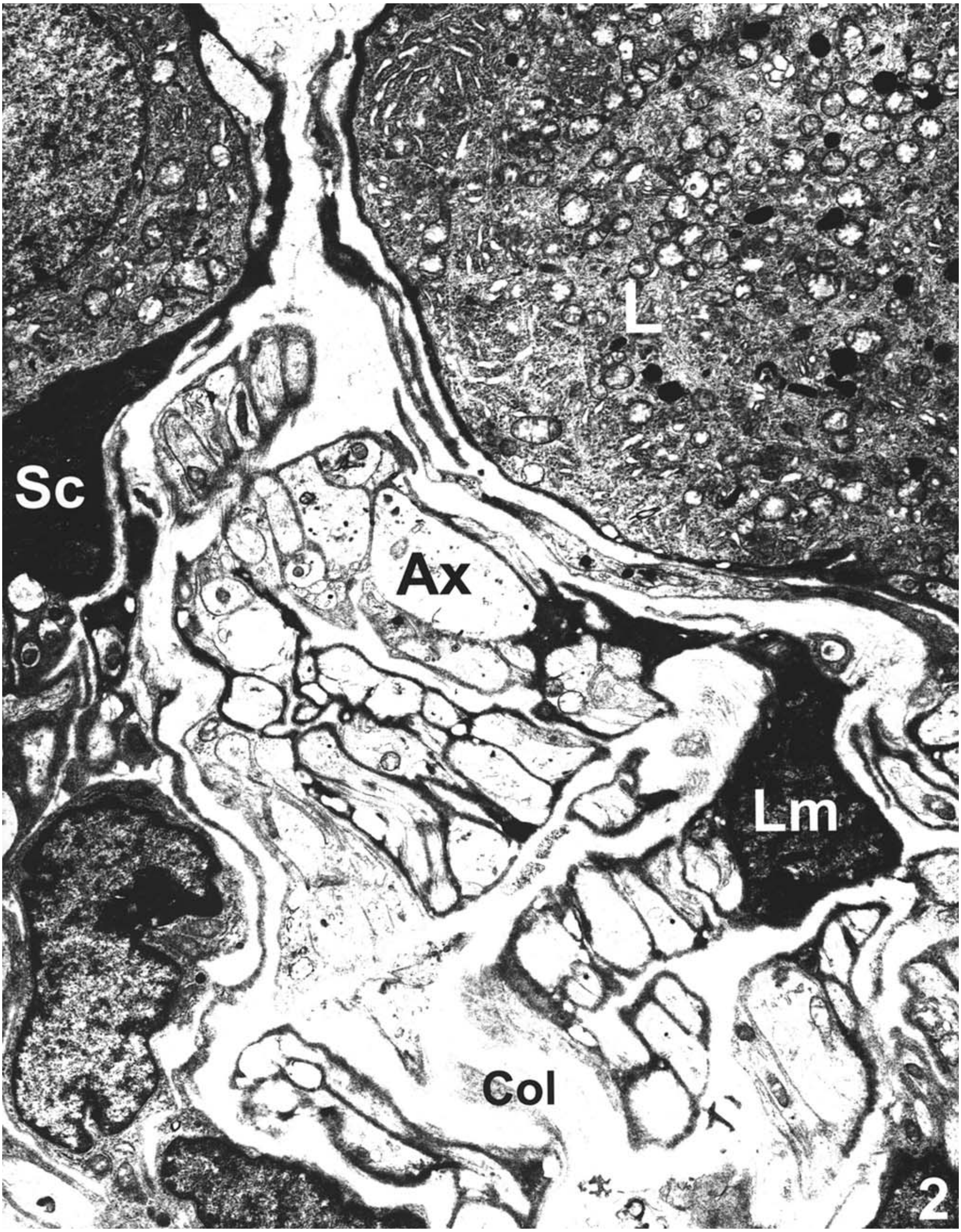


**Figure 2.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 7300. Ax — axon, Col — collagenous fibres, L — light cell, Lm — lemmocyte, Sc — satellite cell.


**Figure 3.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 3600. D — dark cell, L — light cell.

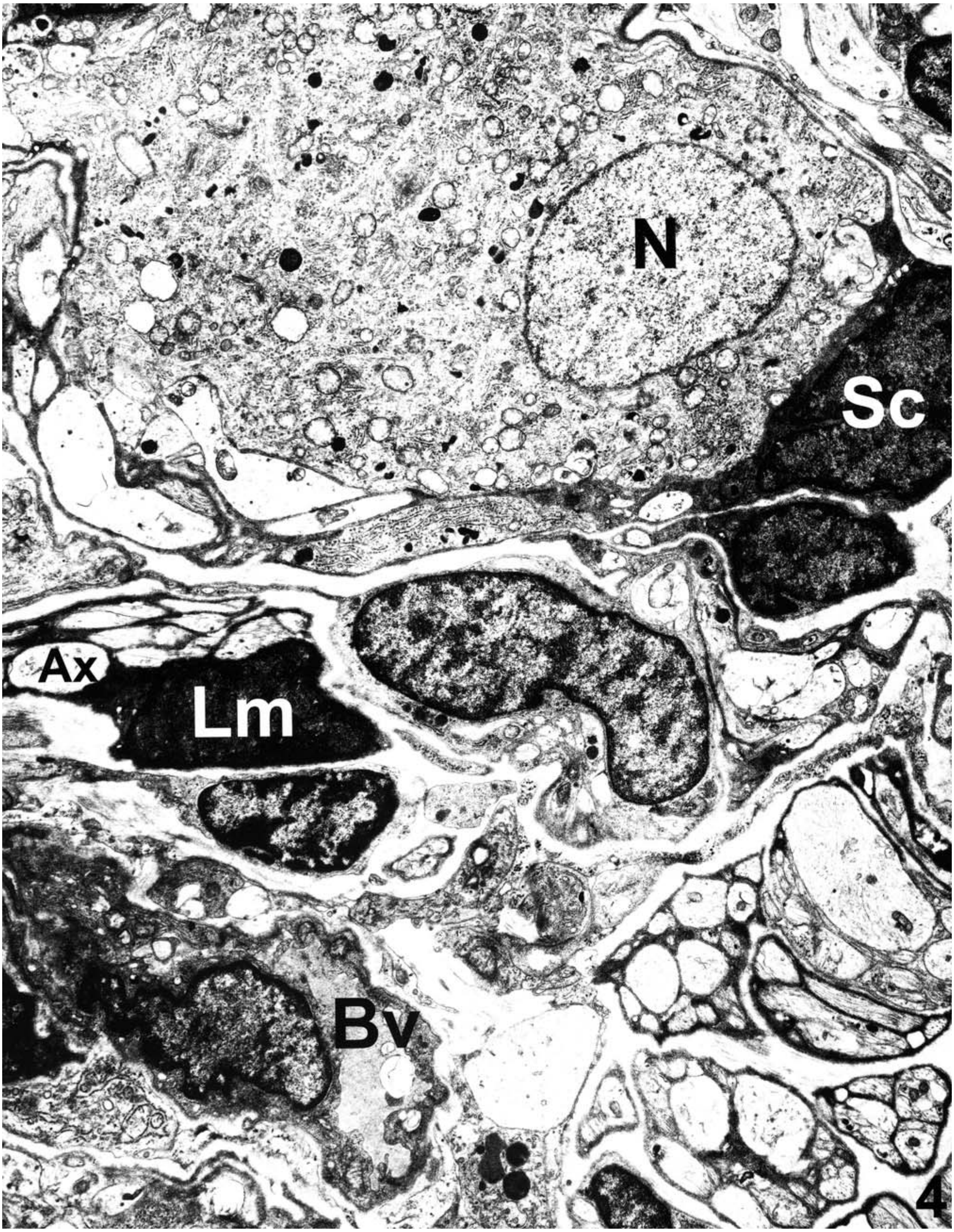


**Figure 4.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 5950. Ax — axon, Bv — blood vessel, Lm — lemmocyte, N — nucleus, Sc — satellite cell.

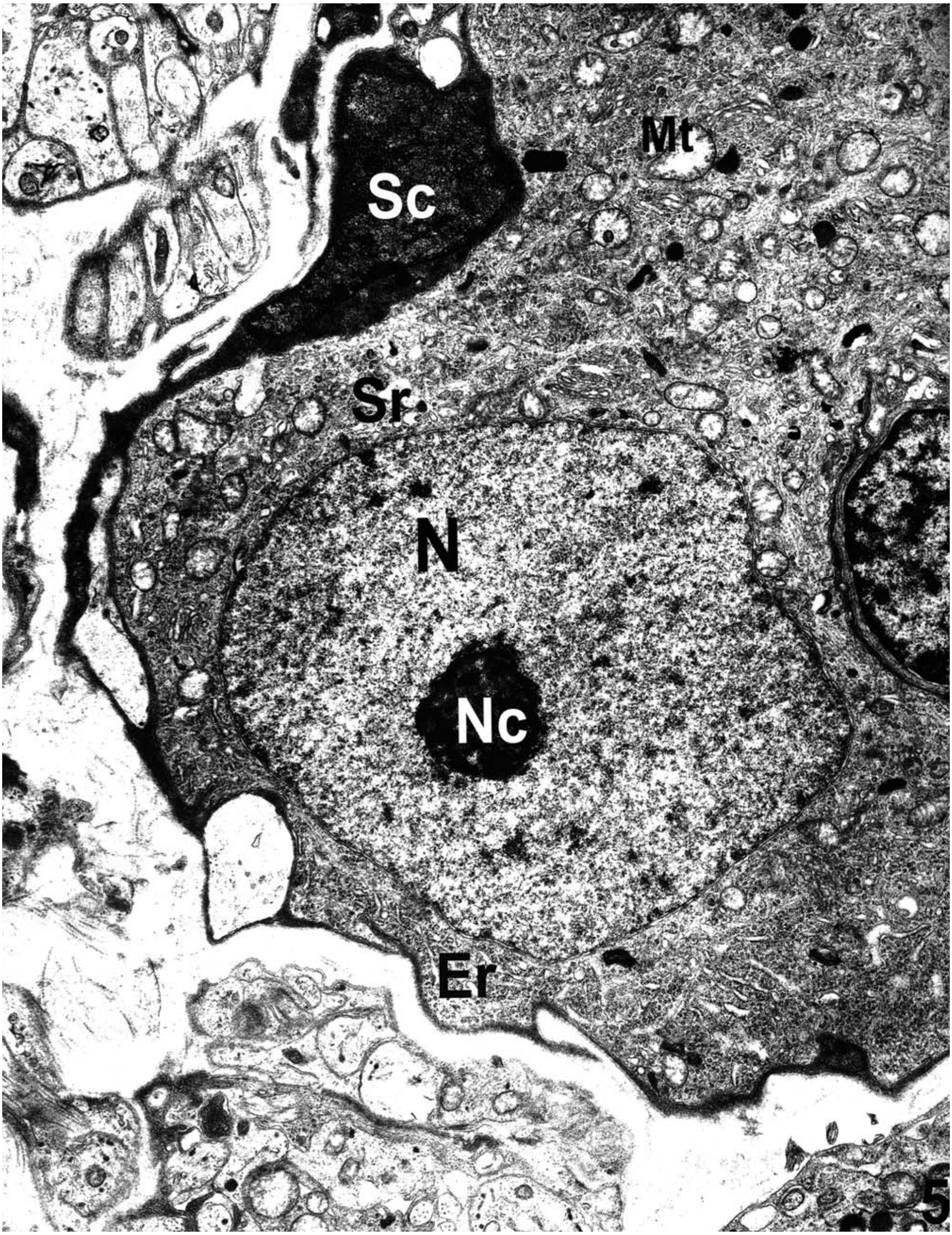


**Figure 5.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 8400. Er — rough endoplasmic reticulum, Mt — mitochondrium, N — nucleus, Nc — nucleolus, Sc — satellite cell, Sr — smooth endoplasmic reticulum.

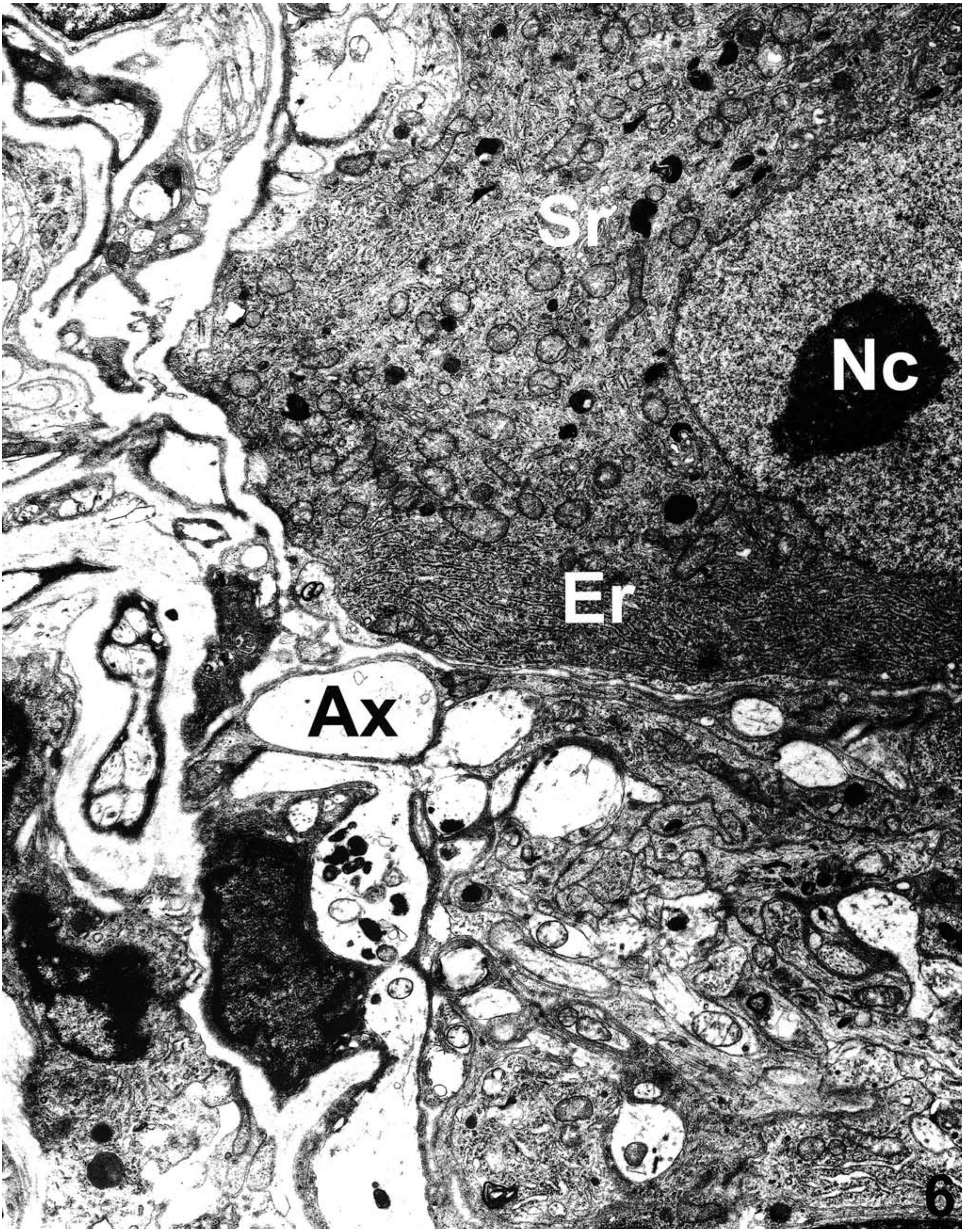


**Figure 6.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 8400. Ax — axon, Er — rough endoplasmic reticulum, Nc — nucleolus, Sr — smooth endoplasmic reticulum.

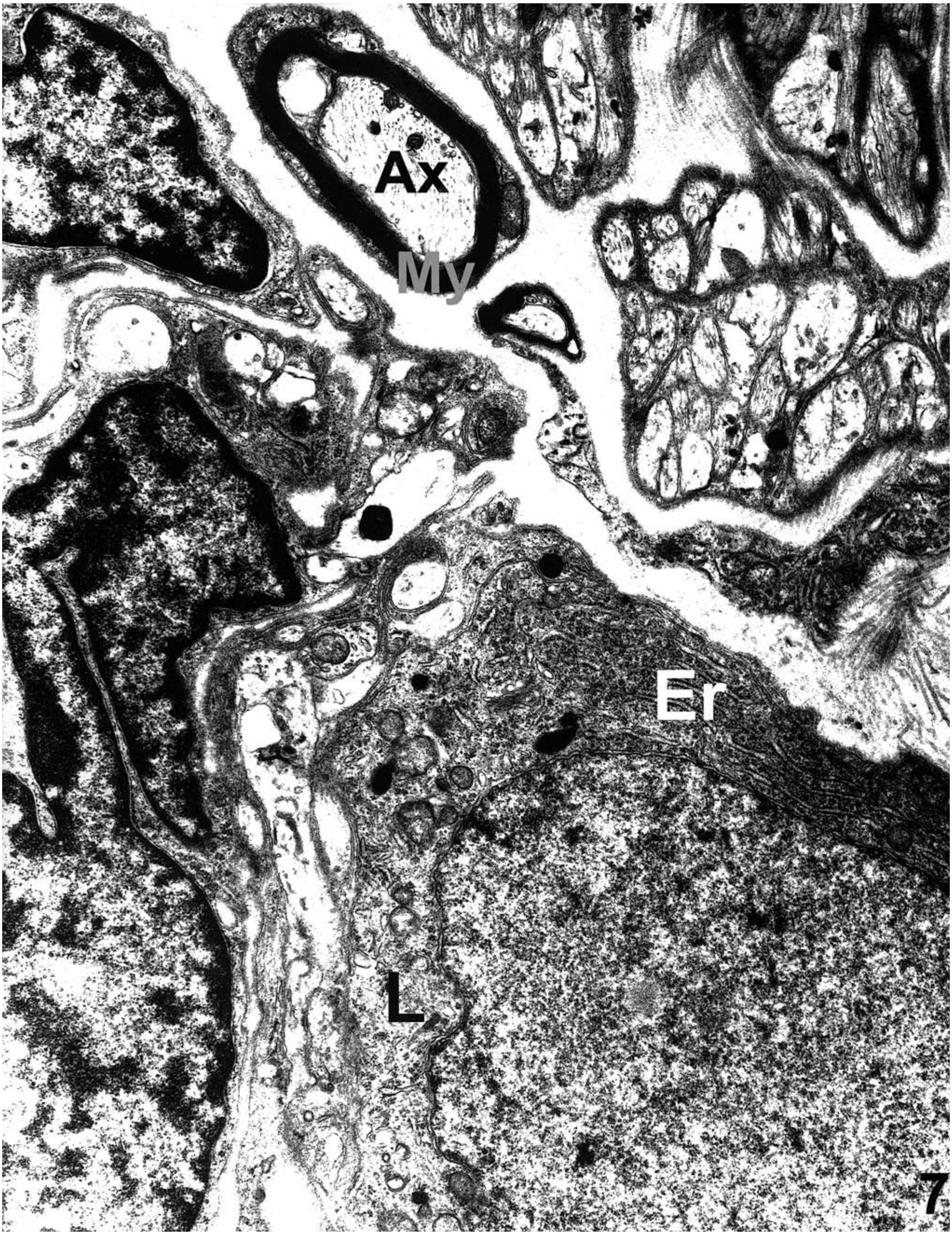


**Figure 7.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 15500. Ax — axon, Er — rough endoplasmic reticulum, L — light cell, My — myelin sheath.

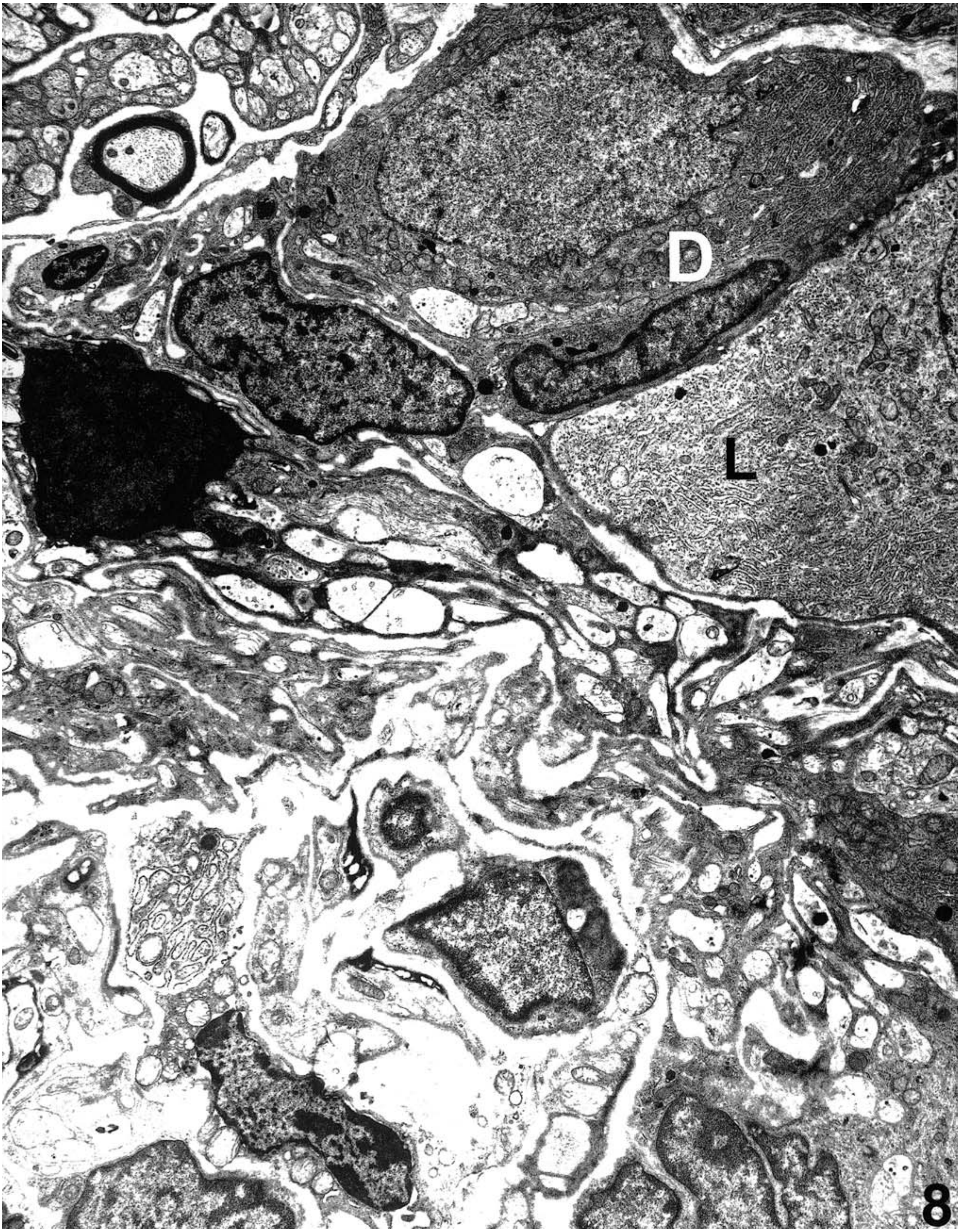


**Figure 8**. The hypogastric nerve of a human foetus at 23 weeks. Magn. × 5250. D — dark cell, L — light cell.


**Figure 9.** The hypogastric nerve of a human foetus at 23 weeks. Magn. × 66500. P — protosynapse, S — synaptic junction.


**Figure 10**. The hypogastric nerve of a human foetus at 23 weeks. Magn. × 58000. S — synaptic junction.

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