HISTOLOGICAL AND HISTOCHEMICAL STUDIES ON THE SPINAL GANGLIA IN THE RABBIT

THESIS

Submitted For The Degree of
Master In

(HISTOLOGY)

BY

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1979

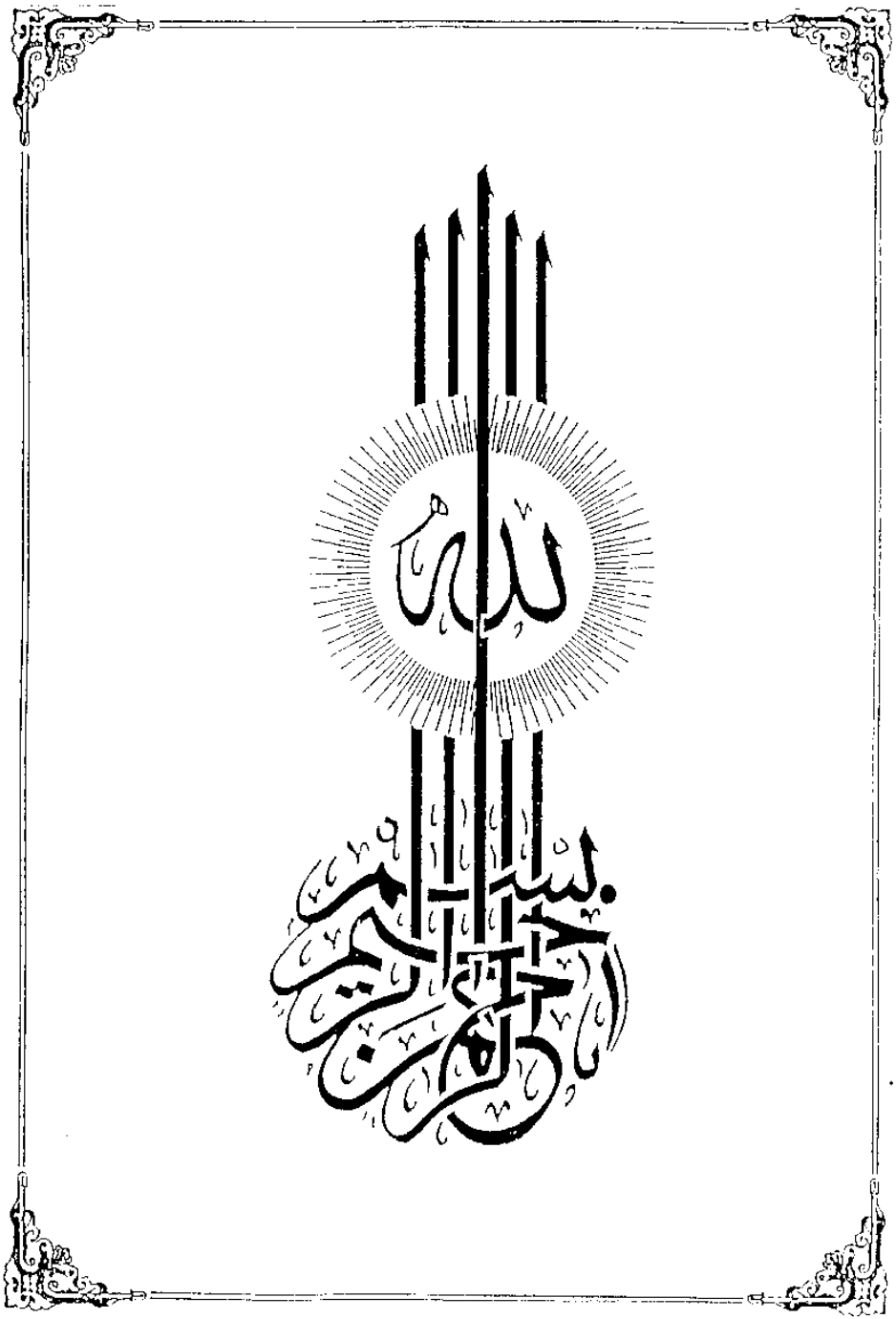
ACKNOWLEDGEMENT

I would like to thank my Professor Dr. Abd-El Latif Saleh, Chairman of Histology Department, Ain Shams University, for his kindness, fatherly attitude and for giving me the full facilities for a proper research work.

I also like to pay a special tribute to my Prof. Dr. Ahmed Said El-Morsy for his masterly teaching, that created my love to histology trustful help and sincerely effort to realise a successeful work.

Also I wish to express my deepest thanks and gratitude to Dr. Samia Riad for her encouragement advice and effort to teach me the histological procedures.

To all my professors and collegues in the histology Department. I should pay much gratitude and respect.



C O N T E N T S

INTRODUCTION

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Despite the intensive studies devored to the structure of spinal ganglia, there are still many points to be studied. Most workers have dealt with the subject from different aspects.

Unfortunately, the correlations between the different findings are either incomplete or unsatisfactory.

The aim of this work is to carry histological, cytological and histochemical studies of ganglia at different levels. A trial will be done to correlate the results obtained.

REVIEW OF LITERATURE

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The posterior root ganglia has been extensively investigated by the light and electron microscopes. The nature of the stucture of Golgi apparatus was described by Bensley (1910) noticed that the Golgi apparatus of the spinal ganglionic nerve cells was in the form of a reticulum.

Bensley and Gersh (1933) observed that the Nissl substance was not uniformly distributed throughout the nerve cell but was segregated in granules and composite masses made up of fine granules. Baker (1944) stated that the Golgi apparatus of the nerve cell was formed of dense lipoidal materials associated with secretory granules which may be readily silvered and thus similate a net.

Later on Thomas (1948) stated that the Golgi apparatus of ganglionic cells most probably was a technical artefact produced by the conjoining of closely adjacent mitochondria and associated vesicular bodies. Gatenby (1949) noted that the Golgi apparatus where composed of a canalicular reticulum associated with granular bodies. Palade and Claude (1949) noted that

the Golgi apparatus were formed by fusion of diffused lipoid granules during fixation.

Barr and Bertram (1949) studied the differences in chromosomal content of ganglionic nerve cells. They noticed the presence of an intranuclear body, which appeared as a small satellite to the large nucleolus. It was better developed in female than in male cells. Further details concerning this, interesting sex difference were described by Barr et al. (1950). They used the term "Nucleolar satellite" for this sex influenced body. It was about 1 M in diameter. This body could be clearly demonstrated in all types of nerve cells including spinal ganglia of the female cat. On the other hand, it was seldom seen distinctly in the male cells. They also found that the nuclear satellite was formed of desoxyribose nucleic acid (DNA), unlike the nucleolus which was formed of ribonucleic acid (RNA).

Palade (1952) studied the E/M structure of mitochondria in varieties of rat cells including the spinal ganglionic cells. Each mitochondria was found to be formed of:

1. A membrane 7 to 8 M thick.
2. A system of internal ridges (Cristae mitochondriales) that protruded from the inside surface of the membrane

towards the interior of the organelle. These ridges were disposed in series within which they appeared to be parallel to one another and more or less regularily spaced.

3. A mitochondrial matrix that, except for occasional granules, appeared structurless

Beams et al. (1952) studied the spinal ganglion cell of albino rat with light and electron microscopes. They observed that the ganglionic nerve cells were variable both, in size (from 25 to 60 M) and in staining reaction. The smaller cells were found to be more chromophilic than the larger ones. They appeared as unipolar cells with relatively large rounded or oval vesicular nuclei containing deeply stained nucleoli. The chromatin material appeared in the form of fine granules dispersed throughout the nuclei. The mitochondria were in the form of granules and short rods distributed evenly throughout the cytoplasm between the Nissl bodies and appeared in the region of the axon hillock. They also studied the neurofibrillae in silver preparations of ganglionic cells. They appeared in the form of a network. The E/M revealed them as groups of small filaments of about 700°A in diameter. They described the Nissl bodies as irregularly shaped bodies distributed

throughout the cell except in the axon hillock. The Golgi material was associated with the mitochondria or neurofibrillae.

Adamstone and Taylor (1952) used fresh frozen sections of spinal ganglia to study the Golgi apparatus. Frozen Sections were used to ensure rapid uniform fixation and to eliminate as far as possible the structural changes in the cell due to shrinkage and post mortem changes. They observed that the silver impregrated Golgi network was the combined result of silvering of many minute granules in the cell followed by further silvering of the cytoplasmic strands with which these granules were associated. They suggested that these granules are the mitochondria. Adamstone (1952) used a modified Da Fano Cajal's technique to study the golgi apparatus in ganglionic nerve cells. The Golgi net was found to be composed of two components.

1. A net - like cytoplasmic reticulum.
2. A series of minute, black silvered granules closely applied to the surface of the net. These granules were supposed to be mitochondria.

Dawson et al. (1955) in their E/M study on the spinal ganglia of rabbit, observed that the Nissl substance was in the form of aggregates in the light cells and dispersed fine granules in dark cells. The aggregates did not appear as uniform density. They showed darker areas where the granules were packed together. In the some year Hess (1955) in his E/M study on young ganglionic nerve cells, termed the Nissl bodies as Ergastoplasm. When the examined those substances under low magnifications, they appeared as a densely packed masses of small granules. With higher magnifications, some of the granules could be resolved as very fine tubular filaments surrounded with granules. This was an appearance similar to the endoplasmic reticulum. However, the granules appeared more numerous than those of the Ergastoplasm present in other cells. At higher magnifications the granules were seen to have smaller denser granules in and around them. Yielding a punctate appearance. He also described the mitochondria as small, thin, and elongated organelle with cristae or folds. The mitochondrial folds did not cross its entire width. The senile ganglioncic nerve cells showed swollen mitochondria with unrecognizable folds. The matrix material was essentially lacked or very dilute.

Giacobini and Zajicek (1956) found that the esterase estimated in single spinal ganglion cell was on acetyl cholinesterase (specific or true cholinesterase) which was the enzyme claimed to be connected with the mechanism of the transmission of nerve impulse.

Rosenbulth (1962) described some electron microacopic differences between the toad and mammalian spinal ganglia. The toad ganglia contained a striking number of heterogenous inclusion bodies which resemble lysosomes. They also exhibited stellate lipid inclusions. Islands of granules which were larger than ribosomes and not associated with endoplasmic reticulum were observed. He suggested that these islands may be glycogen granules. The Nissl bodies were consisting of endoplasmic reticulum, which appeared vesicular rather than cisternal, and ribosomes most of which were not attached to the endoplasmic reticulum.

Hiraoka and Breemen (1963) studied the E/M structure of nucleolus and nuclear envelope of spinal ganglion cells of rat and salamander. The nucleus of rat spinal ganglion cells was enclosed in a double membrane envelope. The outer membrane was mostly agranular. Both the inner and outer membranes were perforated by pores that exhibited a regular distribution. Their studies

showed that the structure features of the nucleolus of the rat spinal ganglion cell were in the form of:

a) Dense aggregates.

b) Light particular aggregates.

c) Small light vacuoloids.

d) Large light vacuoloids.

e) An adjacent groups of dense granules.

The nucleus of the salamander spinal ganglion cell contained a less differentiated nucleolus consisting of one to several dense aggregates surrounded by less compact particles. The nucleus was found to be irregular in shape with deep membranous folds and invaginations. Nuclear pores could also be demonstrated.

Beaver et al. (1965) observed the presence of light and dark neurons in the human trigeminal ganglia. The cell bodies of the neurons tended to occur in groups or clusters. A pigment resembling lipofuscin could be seen in the cytoplasm. It varied in amount from cell to cell. It was also present occasionally in some schawnn and salellite cells.

Novikoff (1966) in his studies on dorsal root ganglia of rat, noticed that an unspecific cholinesterase activity appeared as brown deposit in the

unmyelinated fibers and sheath cells surrounding the perikarya. Acetyl cholinesterase activity was revealed in the perikaryon cytoplasm and at the axoplasmic surface of myelinated fibres. He observed that the cholinesterase activity was seen in all perikarya, but at greatly different levels.

Pineda et al. (1967) described the mitochondria of nerve cells as, elongated organelles with dense matrix. The Golgi apparatus was formed of numerous clusters of smooth membranes. Each cluster was composed of several pairs of lamellae or chains of vesicles. The rough endoplasmic reticulum was not uniformly dispersed throughout the cyotplasm but was principally clustered into Nissl bodies, separated by bundle of microtubules and fine neuro filaments. Few glycogen like granules could be identified in the neuronal cytoplasm as well as in the axon. Some restricted areas of cytoplasm displayed accumulations of dense inclusions. In the same year Bunge et al. (1967) observed the presence of light and dark ganglionic cells in tissue culture. He suggested that this difference in the staining reaction was due to the amount of cytoplasmic neurofilaments.