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FINE STRUCTURES OF CORPUS PARACLOACALIS VASCULARIS IN COCKS*

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The corpus paracloacalis vascularis in cocks was observed under scanning (SEM) and transmission electron microscopes (TEM). Under the SEM it was clearly demonstrated that the organs consisted of the capsule, trabeculae, capillary cords and lymphatic spaces. The capillary cords were arranged in anastomosing thick columns or sheets partitioned by lymphatic spaces under the SEM. The fine structures of the lymphatic spaces perfectly corresponded with the ordinary lymphatic capillaries under the TEM. The blood capillaries in the capillary cords consisted of a layer of endothelial cells and comparatively numerous pericytes, but some characteristic features were noted; the endothelial cells were surrounded by a thicker, denser basement membrane and included numerous dilated rough-surfaced endoplasmic reticulums and unusual large pinocytotic vesicles, 300~500 m μ in size, which were often opened on the inner and outer surfaces of the endothelium.

INTRODUCTION

In male chickens, the corpus paracloacalis vascularis is one of the important accessory reproductive organs as well as the phallus and lymph folds concerning with copulation and ejaculation (NISHIYAMA, 1955). Histological structures of the organs have been briefly described by LAKE (1971), LIEBE (1914), LUCAS & STETTENHEIM (1965) and NISHIYAMA (1955). Recently the writers (KUDO et al., 1975) reported the histological findings of the organ and reexamined the nomenclatures of the histological components. On the other hand, there is no information, to the writers' knowledge, of the ultrastructure of the organ. In the present paper, the fine structures of the organ are described with special reference to their functions.

MATERIALS AND METHODS

The corpus paracloacalis vascularis was obtained from eleven male chickens

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(4 White Leghorn and 7 White Cornish: Vantress), 33 days to 14 months old.

For the SEM, the organs were fixed by perfusion in 2.5% glutaraldehyde and then preserved in the same solution for 2 hours or more. The fixed organs were sliced with razor blades, dehydrated by graded acetone and dried in the air. In addition, four corrosion specimens of the capillary pattern of the organs were obtained by injection of Technovit 4143 C according to the Kikkawa's method (1965). The dried and corrosion specimens were coated with carbon and gold in a vacuum evaporator and then examined under a JSM-S1 scanning electron microscope using a beam accelerating voltage of 10 kV.

For the TEM, small pieces of the remained organs were postfixed in 1% osmium tetroxide and embedded in Epon 812 in the routine way. They were cut on a Porter Blum MT-1 ultramicrotome using glass knives. The sections were stained with uranyl acetate and lead citrate, and examined under a JEM-7 transmission electron microscope.

RESULTS

By observing the sliced-surfaces of the corpus paracloacalis vascularis under the SEM, the capsule, trabeculae, capillary cords and a plexus of sinus-like lymphatic capillaries or lymphatic spaces are clearly distinguished (fig. 1), as reported under an optic microscope by KUDO et al. (1975). The organs consist mainly of the capillary cords and trabeculae, among which are lymphatic spaces. The lymphatic spaces are divided into two parts, peripheral lymphatic spaces located under the capsule and internal lymphatic spaces which are present in the parenchyma (fig. 1).

Trabeculae have one to two arterioles and venules in variable sizes (fig. 2). Under the SEM, small columns, or flattened sheet-like trabeculae, through which blood vessels supply to the capillary cords, are often found in the lymphatic spaces (fig. 3). The surfaces of the trabeculae are immediately coated with the endothelium of the lymphatic spaces (fig. 13).

Three-dimensional capillary cords appear to be arranged in anastomosing thick columns or sheets partitioned by lymphatic spaces. On the cut surfaces of the cords, numerous profiles of blood capillaries are observed, but there are rare arterioles and venules (figs. 1~3). In some capillaries, erythrocytes, which are typically ellipsoid in form, are found. Corrosion specimens clearly show that an arteriole in the trabeculae enters into the capillary cord and divides into numerous capillaries forming a complex network (fig. 4). Some parts of the capillaries are dilated on the course, especially near the surface of the lymphatic spaces (fig. 5). Under the TEM, the capillaries in the cords consist of a layer of endothelial cells and comparatively numerous pericytes, as is described

in textbooks (fig. 8). In the cytoplasm of the endothelial cells, a small Golgi complex, centrioles, mitochondria, lysosome-like dense bodies, and intracellular filaments are observed (fig. 9). In addition, there are numerous, dilated rough-surfaced endoplasmic reticulums and large vesicles, 300~500 m μ in size, with fine granular materials, in addition to a small number of ordinary pinocytotic vesicles. It is noted that the large vesicles often open on the inner and outer surfaces of the endothelial cells (figs. 10, 14 & 15); they seem to be a kind of pinocytotic vesicles. Endothelial cells and pericytes are surrounded by a layer of basement membrane which is thicker and denser than that of neighbouring arterioles or venules (figs. 10 & 11). Rare pores with diaphragm are found in the endothelial cells (fig. 9).

In the intercapillary connective tissue space, there are fibrocytes, collagenous fibers, and numerous bundles and endings of unmyelinated nerves. Most of the unmyelinated nerves have swellings packed mainly with agranular vesicles about 500 Å in size and a small number of cored vesicles about 1,000 Å in size (fig. 12).

Lymphatic spaces: The wall of the lymphatic spaces immediately covers the trabeculae and capillary cords. Under the SEM, the surface of the wall is irregularly folded and in some places, a number of small flatly oval convexes are observed to correspond with each endothelial cell (figs. 3 & 7). Reticular fiber-like strands are rarely observed crossing between the capillary cords (fig. 6). Junctions of the lymphatic endothelium are loose or lack, and sometimes small gaps are observed between the neighbouring endothelial cells (figs. 13~15). No basement membrane is clearly found, but anchoring filaments are found connecting with the basal surface of the endothelium (fig. 13). Organelles in the cytoplasm are similar to those of the endothelial cells of the blood capillary in the cords, but neither dilated endoplasmic reticulum nor large-sized pinocytotic vesicles are found (fig. 15).

DISCUSSION

The corpus paraoacalis vascularis in cocks consisted of several histological components; the capsule, trabecula, capillary cord and the lymphatic space, as described by KUDO et al. (1975). It seems that lymphoid tissues are not one of the constant components of the organ, contrary to the Nishiyama's finding (1955). The present ultrastructural observation of the organ shows that the parenchyma of the organ mainly consists of the capillary cords, among which a plexus of the lymphatic spaces is present. The cords and the lymphatic spaces seem to be in a close relationship each other topographically. The capillary networks in the cords are the most characteristic components of the organ; the endothelial cells are surrounded by a thick, dense basement mem-

brane. In their cytoplasm, dilated rough-surfaced endoplasmic reticulums and large-sized pinocytotic vesicles are observed.

The anatomy and function of the corpus paracloacalis vascularis, Nishiyama's vascular body, has been extensively studied by KNIGHT (1970), NISHIYAMA (1955) and NISHIYAMA & OGAWA (1961). Erection of the phallus and temporary swelling of the lymph folds is caused by lymph-like fluid which is formed from blood flowing in the lymphatic spaces of a pair of vascular bodies, though LAKE (1957 & 1971) emphasized that additional vascular tissue in the wall of the cloaca engorges with blood during erection. In addition, NISHIYAMA (1955) described that the lymph which flows into the lymph folds is expelled from here and the expelled lymph composes the main part of transparent fluid or accessory reproductive fluid which is added to the semen ejaculated from the ductus deferens during sexual excitement.

The capillary cords have a multilayered barrier through which lymph fluid is filtrated; it consists of capillary endothelium, basement membrane, connective tissue space and lymphatic endothelium. The filtration of lymph fluid through the endothelium of blood capillaries is thought to take place largely by means of peculiar, large-sized pinocytotic vesicles, probably through a process of active transport, although KNIGHT (1970) suggested from the acid and alkaline phosphatase test of the organ that the blood filtrate crosses the capillary wall into the lymphatic spaces by simple diffusion. A thick, dense basement membrane may limit the sizes of filtrating molecules. Nervous controls will need to take part in the filtration, because the ultrastructural studies of this organ have shown a high density of unmyelinated axons, most of which, so far as observing, have swellings packed with agranular vesicles about 500 Å in size and granular vesicles about 1,000 Å in size. COOK & KING (1970) identified three basic types of axonal enlargements containing mainly agranular or granular, or both agranular and granular vesicles in the avian bronchial muscles. Most of the axonal enlargements observed in the corpus paracloacalis vascularis may belong to the first type according to their report. Although there is no exact proof in chickens, these synaptic vesicles seem to be parasympathetic according to AKESTER (1970).

At the present time, however, the writers have no evidence regarding an actual relation between the function and the ultrastructure of the corpus paracloacalis vascularis. Further ultrastructural experiments using some tracers are necessary to clarify whether peculiar large pinocytotic vesicles actually take part in active transport during sexual excitement or not, and whether or not this process is influenced by nervous stimulation.

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EXPLANATION OF PLATES

PLATE I

Fig. 1 Low magnification of cut surface of the corpus paracloacalis vascularis under the SEM

The organ is surrounded by a capsule (Cap). The parenchyma consists mainly of capillary cords (CC) and a small number of trabeculae (T). There is a plexus of lymphatic spaces among the capillary cords and trabeculae (internal lymphatic spaces; IS), and under the capsule (peripheral lymphatic spaces; PS).

Fig. 2 In the trabecula (T), an arteriole and a venule are found. Capillary cords (CC) are packed with numerous capillaries. Note internal lymphatic space (IS) around trabecula.

Fig. 3 A trabecula crosses in the internal lymphatic spaces (IS) to connect with a capillary cord (CC). Numerous oval convexes are found on the surface of the lymphatic spaces.

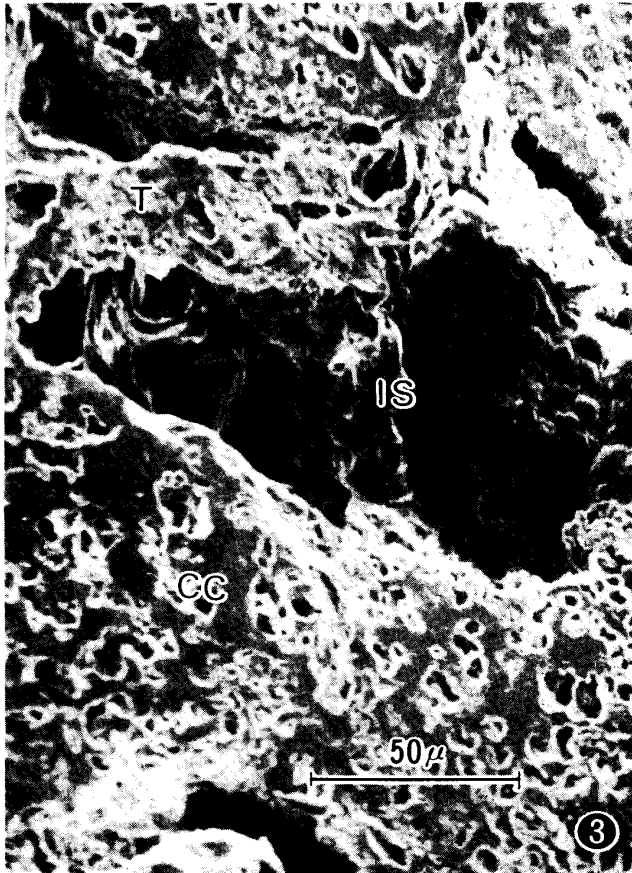
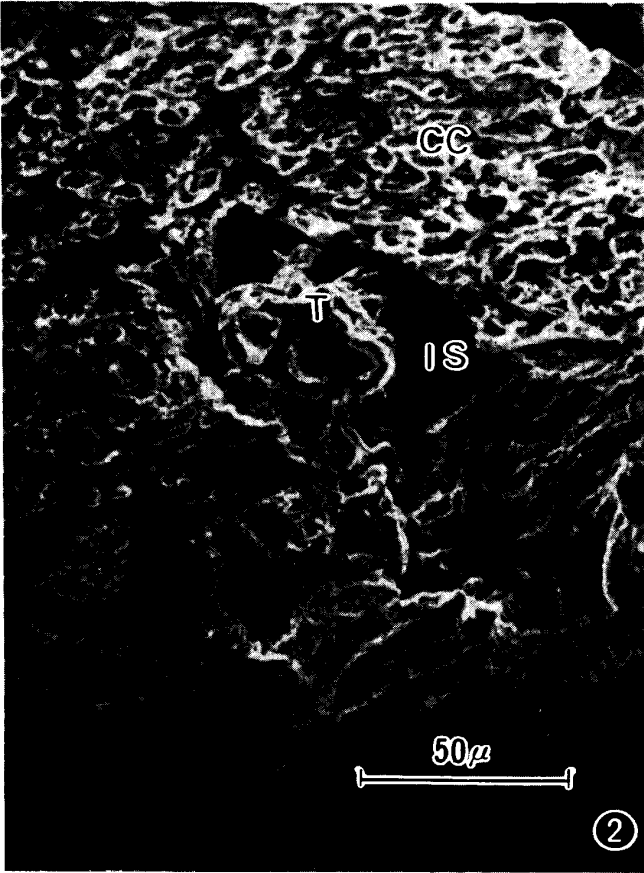
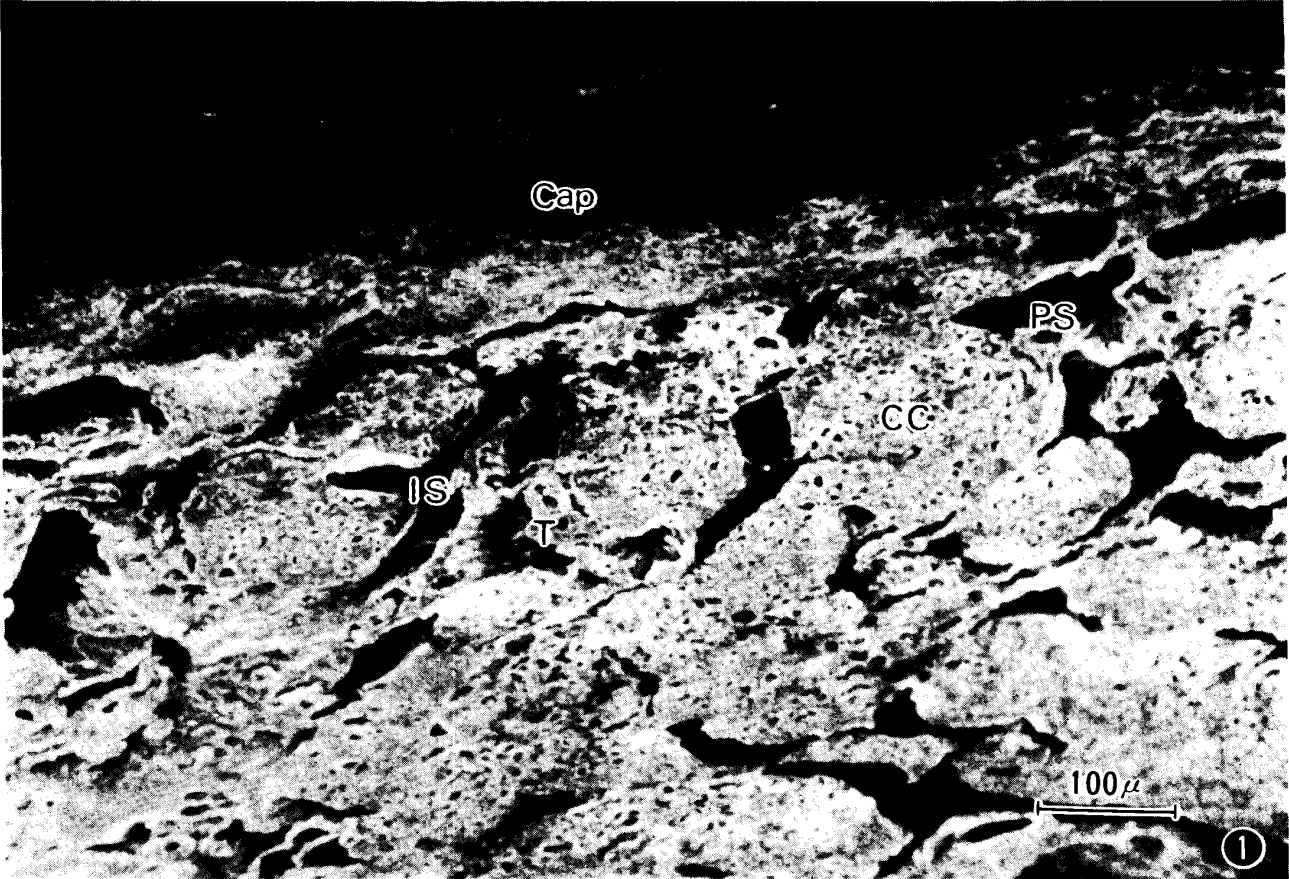


PLATE II

- Fig. 4 Corrosion specimens under the SEM
The capillary cord (CC) is occupied with a network of blood capillaries divided from an arteriole (A).
- Fig. 5 Some parts of the capillaries (C) are dilated near the surface of lymphatic spaces.
- Fig. 6 Rare reticular fiber-like strand (RF) crosses between capillary cords in the internal lymphatic space (IS).
- Fig. 7 In this figure, the surface of lymphatic space is irregularly folded and an irregular pore is observed on it (arrow). There is a small trabecula (T) crossing in the internal lymphatic space (IS).

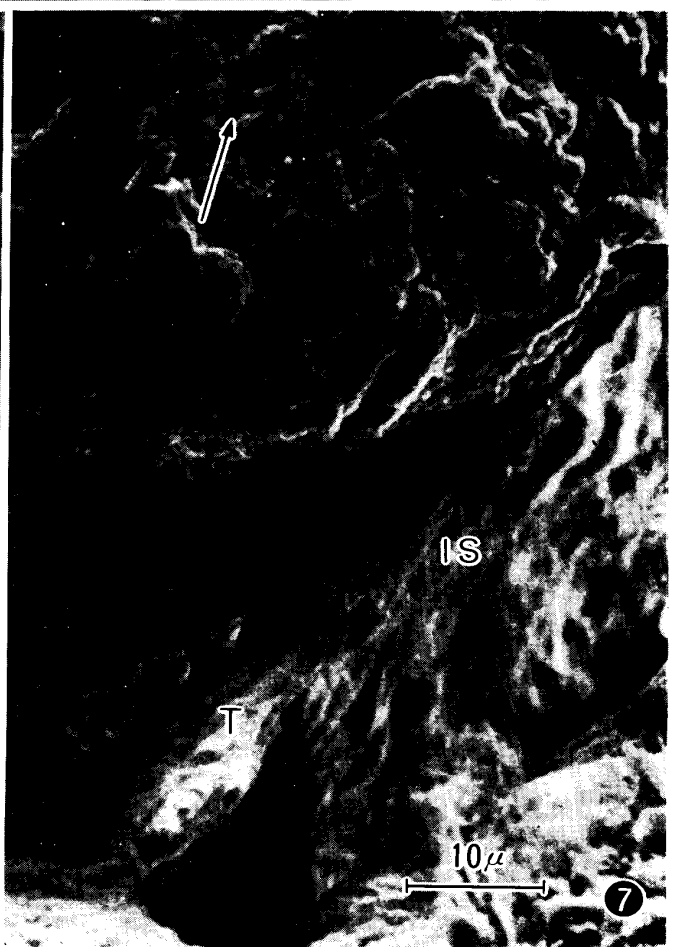
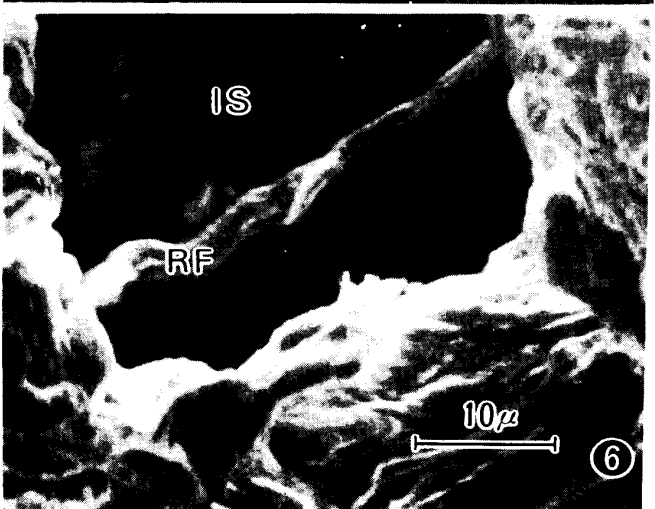
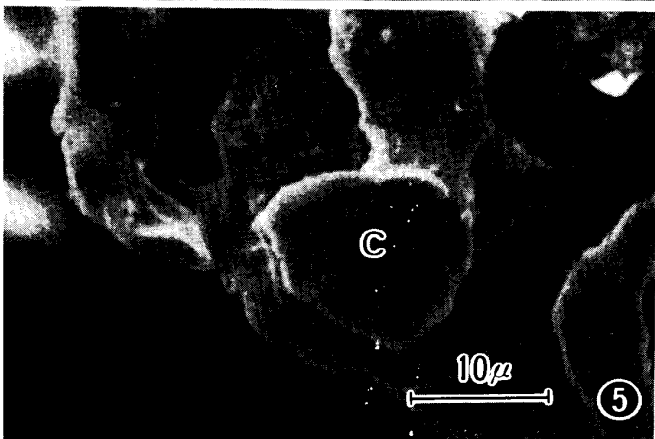


PLATE III

Fig. 8 The capillary cord under the TEM

In this capillary cord, there are a number of blood capillaries. The capillaries consist of a layer of endothelial cell (E) and pericytes (P). Comparatively numerous unmyelinated nerves (N) are found in the intercapillary connective tissue space.

Fig. 9 High magnification of a blood capillary

The endothelial cell (E) is surrounded by a thick, dense basement membrane (BM) and has a small Golgi complex (G), mitochondria, and dilated rough-surfaced endoplasmic reticulum (rER). Note a pore with diaphragm (arrow).

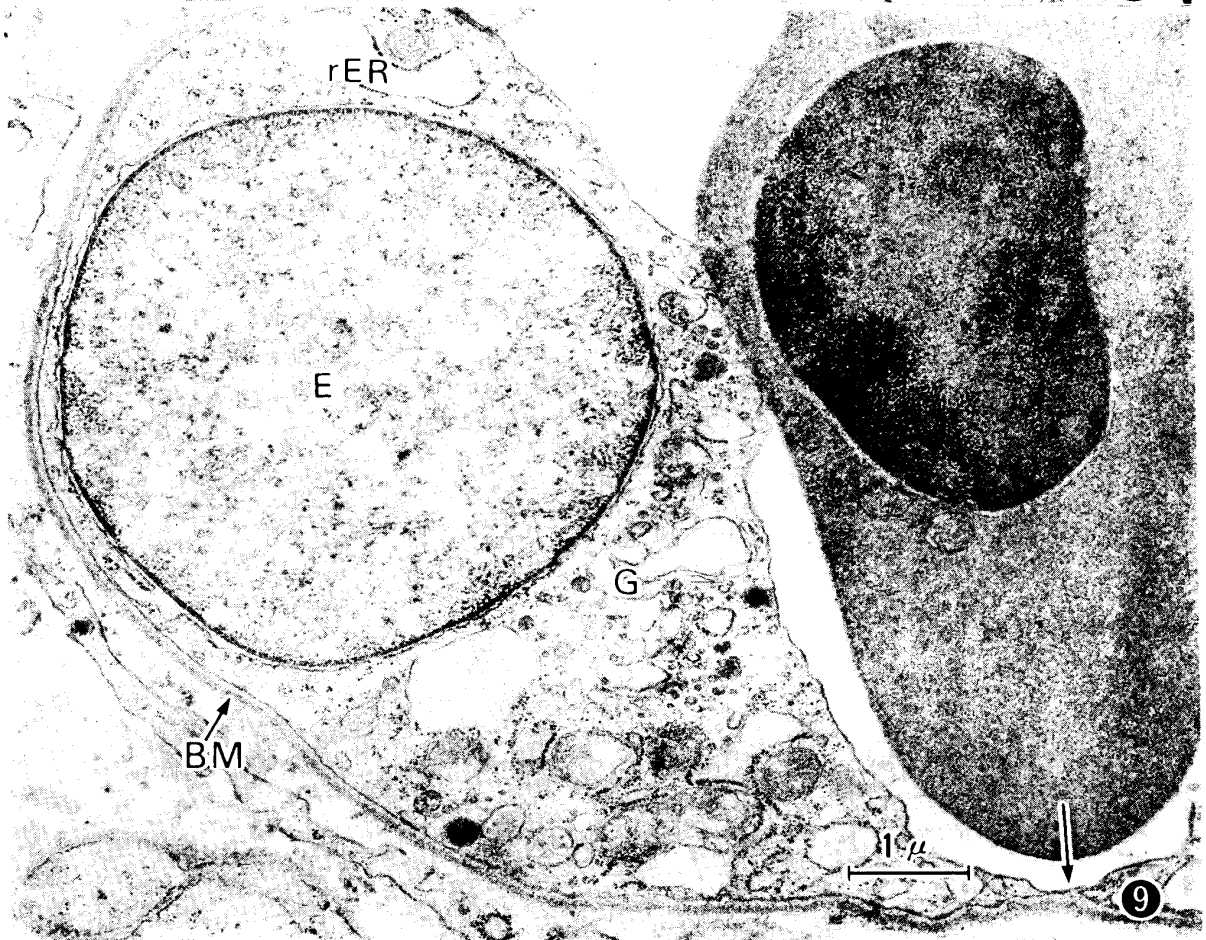


PLATE IV

- Fig. 10 In this endothelial cell (E), dilated rough-surfaced endoplasmic reticulum (rER) and large-sized pinocytotic vesicles (Pi) containing fine granular materials are noted. A vesicle opens on the outer surface of the endothelium (arrow). Note a thick, dense basement membrane (BM).
- Fig. 11 This arteriole is shown here for comparison with a capillary shown in figure 10. The endothelial cells (E) have numerous pinocytotic vesicles in ordinary size, but not large-sized pinocytotic vesicles.
- Fig. 12 Unmyelinated axon (N) has enlargements packed with mainly agranular vesicles and a small number of dense cored vesicles.

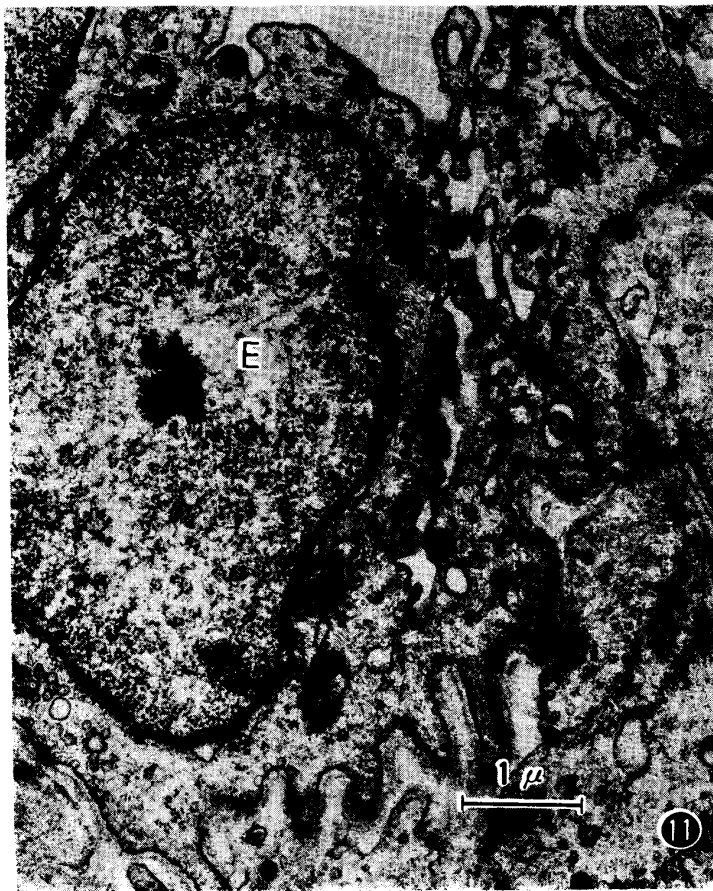


PLATE V

- Fig. 13 In this figure, the endothelium (LE) of the lymphatic space (LS) immediately covers trabecula. Junctions (J) between endothelial cells are absent or poorly developed. Anchoring filaments (Af) are observed, but not basement membrane around the endothelium. In the stroma of trabecula a fibrocyte (Fb) and collagenous fibers are found.
- Fig. 14 The lymphatic endothelium (LE) covering on the capillary cord has a junction, but no basement membrane. Blood capillary (E) in the cord is surrounded by a thick basement membrane. Note two large vesicles opening on the inner side of the endothelium (arrows).
- Fig. 15 In the outer side of this capillary cord, both endothelial cells (LE) of lymphatic space (LS) and blood capillary (E) are in contact with the intervention of a narrow, connective tissue space. A small gap is found in the lymphatic endothelium (double arrow). The endothelial cell of this blood capillary has large pinocytotic vesicles opening on the inner surface (arrows).

