Experimental Cell Research 27

THE SERTOLI CELL AS A "BRIDGE CELL" BETWEEN THE BASAL MEMBRANE AND THE GERMINAL CELLS

Histochemical and Electron Microscope Observations

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Using light [3, 5] and electron microscopy [2], various authors have considered the Sertoli cells as sustentacular and/or nurse cells for the spermatids and spermatozoa. However, the relationship between the Sertoli cell and the rest of the germinal cells has not been taken into account.

Normal adult rat, guinea pig and human testes obtained by biopsy were fixed in cold buffered formaldehyde or frozen for histochemical studies, and fixed in potassium permanganate 3 per cent or Caulfield's solutions (animal and plant tissues) for electron microscopy. Periodic acid-Schiff reaction (PAS), lipid and several hydrolytic and oxydative enzyme tests were applied to frozen sections. Material for electron microscopy was dehydrated with ethanol followed by butyl alcohol and embedded in methyl-butyl metacrylate.

Results.—The lower part of the body of Sertoli cells appeared directly attached to the basal membrane of the seminiferous tubules. Expanded from the lateral and apical portions, fine cytoplasmic branches spread in different directions interposed among germinal cells. In the human testis some branches could be observed between two spermatogonia reaching the characteristic infoldings of the basal membrane described by others [1]. In these sites the branches showed clusters of mitochondria which differ from those contained in the rest of the Sertoli cell cytoplasm, judging by their size and density of the matrix. The upper and lateral sides of the spermatogonial cells were covered by the Sertoli cell expansions, having a direct relation with the basement membrane through their lower side.

In contrast, the rest of the germinal cells and the residual bodies were all included in the body of the Sertoli cell, their cytoplasms being separated only by the plasmic membranes. No direct contacts among germinal cells were seen, as the cytoplasmic branches of Sertoli cells, sometimes as narrow as 200 Å, were interposed among them (Fig. 1). Sertoli cells were PAS positive, including their branches, which simulated bands of intercellular cement (Fig. 3) when they were wide enough to reach the resolution power of the light microscope. However, electron microscopy could in no case demonstrate free intercellular spaces or the presence of cementing substances.

Spermatids had large mitochondria located near the plasmic membrane, in the vicinity of the Sertoli cell cytoplasmic branches; they had a matrix with low electronic density and long extended crestae (Fig. 2).

Histochemical techniques showed positive reactions in the Sertoli cells for lipids, glycogen, leucyl-aminopeptidase, alkaline phosphatases, amylophosphorylase, glucose-

Fig. 1.—Electron micrograph of guinea pig testis. Several spermatids separated by cytoplasmatic branches of a Sertoli cell can be seen. There are no intercellular spaces. ×12,000.

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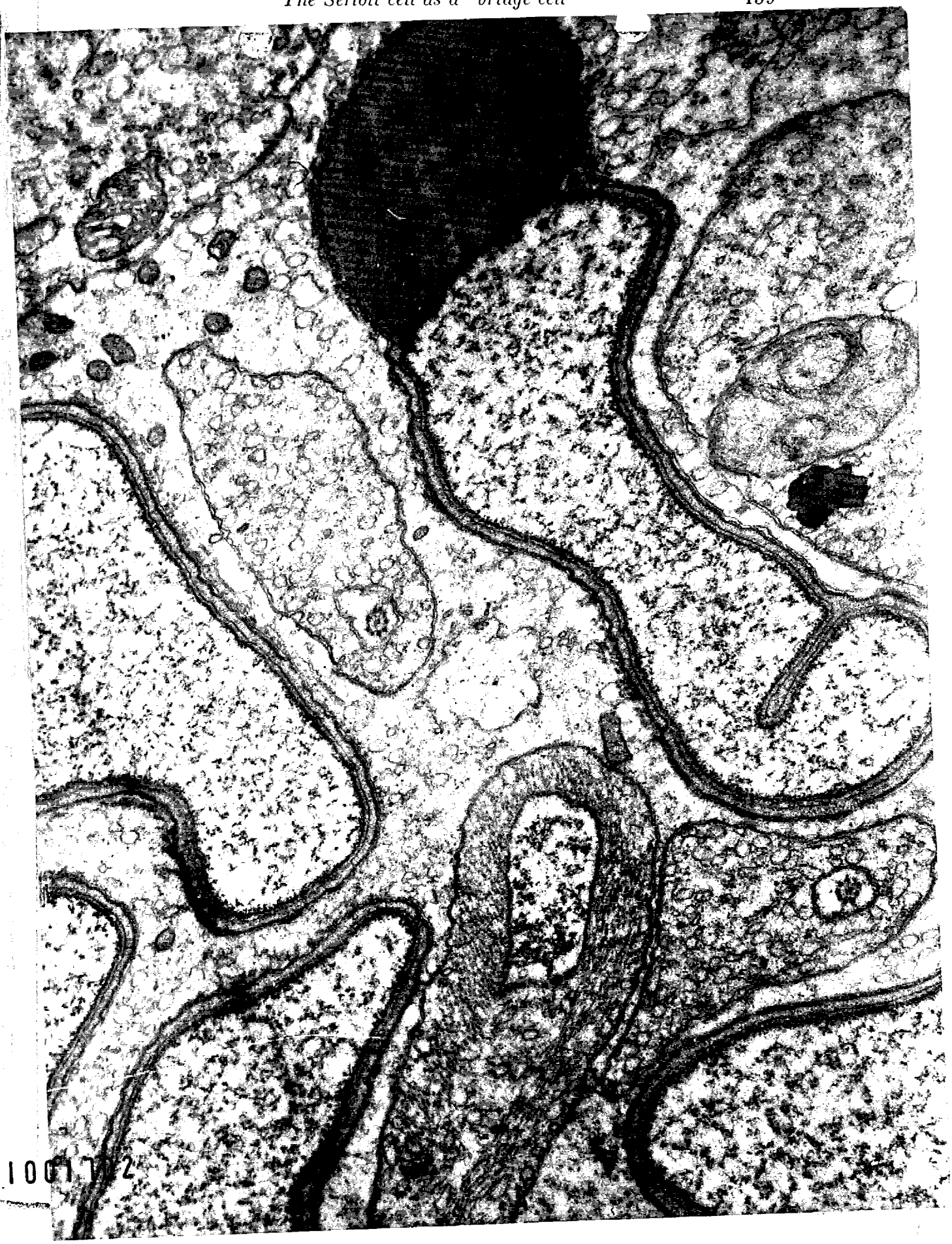

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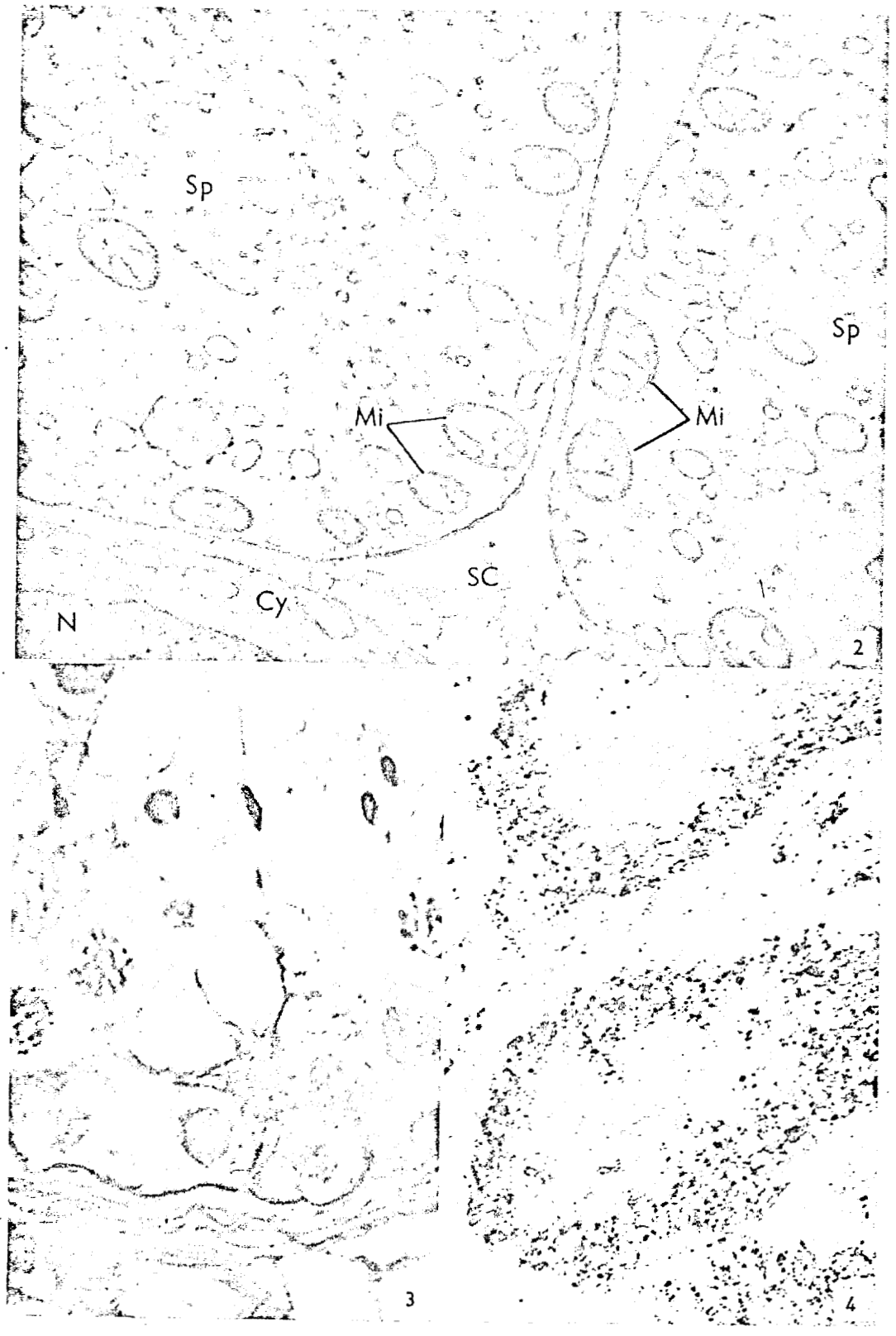

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6-phosphatase, succinic dehydrogenase and cytochrome oxidase. These reactions were weaker or negative in the germinal cells.

Discussion.—Our results showed that there are no intercellular spaces among the cells of the animal and human seminiferous tubules, the Sertoli cells being located among germinal cells. This histological pattern could be observed using different fixatives, such as potassium permanganate 3 per cent (hypertonic), Caulfield's solution for animal tissues (isotonic) and Caulfield's solution for plant tissues (hypotonic). It is thus evident that any transfer between intertubular vessels and germinal cells must take place not only through the connective structures of the tubular wall but also through the cytoplasm of Sertoli cells. In this sense Sertoli cells would act as "bridge cells", their cytoplasm extending from the basal membrane to the germinal cells; an exception could be the spermatogonia which also have a direct contact with the basal membrane.

The high enzymatic activity exhibited by Sertoli cells may be related to an intense metabolic activity of these cells, which may function as an active transporting system. Current studies in our laboratory are demonstrating that injected homologous rat albumen labeled with ^{131}I leaves the circulation in the intertubular spaces and rapidly moves into the seminiferous tubules, diffusing through the cytoplasm of Sertoli cells [8]. These findings are being checked using different serum fractions labeled with fluorescent dyes and ferritin. A similar role as intercellular spaces transporting water and metabolites was ascribed to the glial cells in the central nervous tissue [4, 6] and to the Müller cells in the retina [7].

As Sertoli cells reach maturity at pubertal ages, simultaneously with the beginning of the spermatogenesis, an obvious regulation by the pituitary must be admitted. Concerning the hypothetic role of the Sertoli cells as nurse cells, the question arises as to whether the gonadotropins act simultaneously upon germinal and Sertoli cells or whether a primary effect on Sertoli cells is present.

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Fig. 2.—Electron micrograph of human testis. A Sertoli cell among two spermatids and one spermatocyte. Note localization of mitochondria. ×24,000.

Fig. 3.—Micrograph of human testis. PAS reaction. A Sertoli cell with branches located among germinal cells. ×1000.

Fig. 4.—Micrograph of human testis. Cytochrome oxidase reaction. Note positive reaction in basal cells (Sertoli cells) and negative in the other ones. ×240.

Ac, acrosome; *N*, nucleus; *Ph*, phlagellum; *Mi*, mitochondria; *Sp*, spermatid; *Cy*, spermatocyte; *SC*, Sertoli cell.

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