THE MORPHOLOGY OF THE MAMMALIAN SEMINIFEROUS TUBULE, REPRINTED FROM THE AMERICAN JOURNAL OF ANATOMY, VOL. 24, NO. 3, SEPTEMBER, 1918, PP. 337-393

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649224470

The morphology of the mammalian seminiferous tubule, reprinted from the American Journal of Anatomy, Vol. 24, No. 3, September, 1918, pp. 337-393 by George Morris Curtis

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

www.triestepublishing.com

GEORGE MORRIS CURTIS

THE MORPHOLOGY OF THE MAMMALIAN SEMINIFEROUS TUBULE, REPRINTED FROM THE AMERICAN JOURNAL OF ANATOMY, VOL. 24, NO. 3, SEPTEMBER, 1918, PP. 337-393

Trieste

THE MORPHOLOGY OF THE MAMMALIAN SEMINIFEROUS TUBULE

BY

GEORGE MORRIS CURTIS

Department of Anatomy, University of Michigan

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the University of Michigan

REPRINTED FROM
THE AMERICAN JOURNAL OF ANATOMY, VOL. 24, NO. 3,
SEPTEMBER, 1918, PHILADELPHIA

AUTHOR'S ABSTRACT OF THIS PAPER ISSUED BY THE BIBLIOGRAPHIC SERVICE, JULY 19

Reprinted from THE AMERICAN JOURNAL OF ANATOMY, Vol. 24, No. 3, September, 1918

THE MORPHOLOGY OF THE MAMMALIAN SEMINIFEROUS TUBULE

GEORGE MORRIS CURTIS

Department of Anatomy, Vanderbilt University Medical School

TWENTY-FOUR FIGURES

CONTENTS

1. INTRODUCTION

That there exists an interdependence of structure and function in organs is now fully recognized. In the testis, for example, the structure of the spermatogenic cells lining the seminiferous tubules indicates the functional activity of the gland in the production of spermatozoa. Consequently, in considering the morphology of the seminiferous tubule, two phases of the problem call for consideration, one dealing mainly with the purely morphologic aspects, the other with function as expressed by structural differentiation. Under the former phase it is our purpose to consider such questions as the course, size, and relations of the tubules; under the latter, problems of spermatogenesis, particularly the functional activity of the entire tubule, as expressed in the spermatogenic wave.

The problem, as originally suggested by Dr. Huber, was essentially to isolate complete seminiferous tubules from serial sections of mammalian testes, reconstruct them, and study their form and function.

In previous work on both phases of the problem, to be considered more fully in connection with the literature, variations of the teasing method have been most commonly employed. Use has also been made of injection methods, serial sections, or, by Bremer ('11), the Born wax-plate procedure. In considering more particularly the spermatogenic function of the tubule, segments have been teased out on a slide, crushed under a cover-glass, or cut into smaller pieces, oriented, and sectioned.

In this work complete serial sections have been employed as suggested above. In addition to tubules reconstructed graphically and in wax, others have been isolated by teasing, Huber and Curtis ('13). A list of the eleven tubules isolated for study has already been given by Curtis, ('15).

The portion of this paper dealing with the albino mouse seminiferous tubule was reported at the Cleveland meeting of the American Association of Anatomists, 1912–13, the teased preparations were demonstrated at Philadelphia, 1913–14, while the part dealing with spermatogenesis was presented at St. Louis, 1914–15.

2. LITERATURE

The earlier history of our knowledge concerning the structure and function of the testis has been excellently summarized by Stieda ('77). Reference should be made to this work for a critical survey of the earlier literature. The later literature is considered under two headings, in accord with the two phases of the problem.

a. The seminiferous tubule

J. Müller ('30) first described the existence of blind ends in the course of the seminiferous tubules of the squirrel. He figures a testis, with tunica albuginea removed, showing four of these structures. Apparently no critical study of these was made, and it is possible that they represent the ends of tubules broken during dissection. This is stated since the position of the blind ends is peripheral, where injury would be most likely to occur in removing the tunica albuginea. The testis figured presents no lobules, as do the dog or rabbit testes, and resembles the mouse testis in the arrangement of its tubules.

Lauth's original work ('30) I have been unable to obtain. As quoted by Mihalkovics ('73), Sappey ('89), and others, he found that the tubules originate in a peripheral 'reseau.' After teasing out fresh human tubules, he thought that if blind ends were present they were rare, as he found but one which proved to be a closed tip. Sappey ('89), who finds blind ends common, in citing this case of Lauth's thinks that more were not found because they were deep in the peripheral lobules, 1 to 3 mm. under the tunica albuginea.

Lereboullet ('51) found blind ends in the course of the rabbit seminiferous tubules. He thought that the lobules present were composed of two tubules, which united near the apex of the lobule. Lereboullet also insisted on the difference in size between tubuli contorti and tubuli recti, which was later generalized by Mihalkovics ('73) and confirmed by Stieda ('77).

Kölliker ('54) figures the tubules as ending blindly. According to Mihalkovics ('73), Beale, and Henle, whose works are inaccessible to me, found blind ends in the course of the tubules. St. George ('73), after teasing, describes and figures blind ends in the testis of a child.

Mihalkovics ('73) made studies on the testes of eleven mammals, teasing out human and dog tubules. In the human testis he describes and figures (fig. 1) a few small ampullae, .07 to .15 mm. in length, joining the tubule by a narrow neck, but finds no blind ends or side processes. In the dog he finds that the tubules form a closed network. Dichotomous branchings are present near the apices of the lobules, the end branches of which anastomose and do not leave the lobule. He could not determine the number of tubules in a lobule. In summarizing he states (p. 252) that: "Die gewundene Samenkanälchen bilden ein Netz unter mehrfacher dichotomischer Theilung. Die aus der Theilung entstandenen Endäste hängen unter sich durch Schlingen zusammen. An den Samenkanälchen des Menschenhodens findet man in der Rindenschicht kleine knospenähnliche Ausbuchtungen der Wand."

Krause ('76) holds that the tubules present blind ends. Stieda ('77) used human and other mammalian testes, and found one or two tightly coiled tubules in each lobule. These became straight near the apices of the lobules and joined tubuli recti, one of which is described as present for each lobule. He states (p. 23) that "An der Basis des Kegels haben die einzelnen Kanälchen blinde Anfänge, Theilungen kommen vor, doch äusserst selten."

Hyrtl ('89), who used methods of injection, states that the seminiferous tubules do not end blindly as is customary for tubular glands, "sondern gehen an ihren peripherischen Enden bogenförmig in einander über."

Sappey ('89) has studied the human seminiferous tubules most thoroughly by teasing methods, using macerated and unmacerated material. He insists on the presence of blind ends and describes the occurrence of ampullae. Three forms of anastomoses were recognized: 1) From one lobule to another, as described by Lauth. These are very numerous and unite the lobules at their periphery. 2) From one tubule to another in the same lobule. These become more numerous toward the periphery of the gland, and may acquire an exceptional length. 3) From one point in a tubule to another point in the same tubule. This type forms rings, such as are shown in Bremer's ('11) and Huber's ('16) figures. Sappey thinks that in traversing the side paths afforded by these ring anastomoses, the spermatozoa would have more time to develop.

v. Ebner ('02) figures blind ends as present in the human testis. Eberth ('04), while figuring blind ends, fails to find them in teasing unstained human tubules. He corroborates Sappey in describing and figuring ampullae.

Bremer ('11) has carefully modeled a series of tubules from the testes of human embryos and fetuses ranging from 22.8 mm. to seven months of age. These are most instructive in presenting the early morphogenesis of the human seminiferous tubule. He shows that the tubules form, at first, a complete network, apparently regular in its arrangement, with blind ends at the periphery and mediastinum, and with numerous cross anastomoses forming rings. He describes a partial destruction of this network, during development, resulting in the loss of certain of the cross connections. Regarding the fate of these he states, "in the later stages, when the cords have become more established, the loose ends are not usually retracted or absorbed, but remain as short knobs or as long branches with blind ends." From his studies he concludes that, "Testis tubules may be single, ending blindly, may branch, or may anastomose."

Huber and Curtis ('13) found no blind ends in five completely teased rabbit tubules. Huber ('16) has shown that ring anastomoses are frequent in the bird testis, and points out the similarity between the bird tubules and those of a cryptorchid of the rabbit, which he teased.

b. The spermatogenic wave

The earlier history of our knowledge of spermatogenesis has been considered by Waldeyer ('06). Without going into the extensive literature of this subject, it may be well to mention some of the observations, cited by Waldeyer, which became a basis for the studies on the spermatogenic wave. Kölliker ('41–'54) showed that the wall of an active seminiferous tubule consists of several layers of cells, which differ in form and degree of development. He found the youngest cells lying along the membrana propria, the oldest lining the lumen. Sertoli ('65) recognized and differentiated the sustentacular cells. Henle ('66) described the two types of cells occurring within the tubules and pointed out the difficulty of obtaining a complete series to demonstrate the cytogenesis of the spermatozoon.

v. Ebner ('71) described eight different phases of the picture of spermatogenesis, which appeared in the various cross-sections of rat seminiferous tubules. These were readily recognized. To