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General principles of the structure of testes and epididymis in mammals

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Summary: The reproductive system is a system of organs that is very sensitive and responds to the slightest changes in the body. Therefore, these organs of this system, such as the testes and epididymis, are considered universal organs for experimental research. This article provides data from various sources on the structure of the testes and epididymis in humans and rats.

Key words: reproductive system, testes, epididymis

The testes are the main reproductive organs in men; its function is not only to produce male gametes, but also to synthesize and controlled release of the main androgen (testosterone) [14].
They are oval in shape, located in the scrotum and separated by the scrotal septum. The size of the testicles varies among mammals, but their structure is almost the same in humans and laboratory rodents. Experts compared the testes of several types of laboratory rats. And no differences were found in their histology or sperm count [19].
In rats, the testes are pinkish-white in color, soft-elastic consistency, and elliptical in shape. Moreover, the mass of the left testis is slightly greater than the mass of the right one [1].
There is a tunica albuginea, consisting of dense, unformed connective tissue. In mature rats (aged 3 to 5 months), the testes were covered with a clearly defined capsule consisting of tunica albuginea and choroid [9].
The bulk of the testis is formed by seminiferous convoluted tubules, round or ellipsoid in shape. The seminiferous tubules are special tubular structures in the testicles that continuously produce sperm throughout the male's life cycle [12].
There are two types of seminiferous tubules: “external” and “internal”. The outer and inner tubules form funnel-shaped and cone-shaped networks, respectively. The outer tubules are in contact with the tunica albuginea, but the inner tubules are not [12].
The seminiferous tubules are separated from each other by a thin membrane of interstitial connective tissue, under which there is a thick wall of spermatogenic epithelium at different stages of development. The areas of interstitium between the convoluted seminiferous tubules are evenly distributed, predominantly triangular in shape. In the center of the convoluted tubule there is a lumen where the formed sperm exit. Different tubules undergo different stages of spermatogenesis.
The tubular lining is made of connective tissue fibers. Outside the basement membrane there is a layer of loose connective tissue, in which there is a layer of myoid cells that have a scaly, semilunar and elongated shape. Myoid cells are located evenly along the entire contour of the convoluted seminiferous tubule. Inside the membrane itself, separated by a basement membrane, is the spermatogenic epithelium [1].
A study of the seminiferous epithelium revealed Sertoli cells (supporting cells) lying on the basement membrane of the seminiferous tubules. Sertoli cells were connected to each other by junctional Sertoli-to-Sertoli cell complexes [9].
Histological studies of the testes of white rats showed that the first outer layer of the spermatogenic epithelium in the convoluted seminiferous tubules consists of spermatogonia lying on the basal membrane with a dark optically dense nucleus and a narrow rim of cytoplasm.
Spermatocytes are located closer to the center of the tubule. These are large cells with a large nucleus and a wide rim of cytoplasm, and have a rounded shape.
The innermost layer of the convoluted tubule consists of spermatids, small cells with a light nucleus, lying in several rows. Early spermatids are round in shape with a spherical nucleus and are found in the middle layers of the spermatogenic epithelium. Late spermatids lie in the layer adjacent to the lumen of the tubule and have an elongated shape. Some late spermatids exhibit a flagellum [1].

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Spermatozoa in the lumen of the convoluted seminiferous tubule are located in groups of 6-8 along the entire contour of the lumen. The head of the sperm is hook-shaped [1,8].
Another study describes the composition of the spermatogenic epithelium by period. During the pubertal period, spermatogonia (type A and type B), primary (pachytene spermatocytes) and secondary spermatocytes, spermatids (round spermatids, Golgi phase, Cap phase, acrosome phase) and spermatozoa with residual bodies in the form and Leydig cells. During the postpubertal period, Wistar rats exhibit a basement membrane, spermatogonia (type A and type B), more spermatocytes, round spermatids and spermatids with Golgi phase, Cap phase and acrosomal phase, numerous spermatozoa with residual bodies. and Leydig cells [11].
In the interstitial tissue of the testes, consisting of loose connective tissue, blood vessels were identified, around which lie single, or more often in groups of 5-7 cells, large oval or polygonal Leydig cells with a large spherical nucleus. The total number of glandulocytes in one area of the interstitium reaches 10-12 pcs [1].
Numerous reviews have also been published covering various aspects of mammalian epididymal physiology [4,5], some of which focus on the structure and function of the human epididymis [16,17].
In laboratory rodents, the epididymis is divided into four segments: the initial segment, the head, the body and the tail of the epididymis. The proximal regions (initial segment and head) support sperm maturation, while the tail maintains sperm at rest and plays a role in sperm storage [3].
In humans there is no obvious initial segment, and the proximal region of the excretory duct is mainly formed by efferent ducts. These ducts form a complex histological structure, especially at the junction of the efferent ducts and the head of the epididymis. The efferent ducts have a specific cellular structure compared to the adjacent epididymal tubule [18].
The anatomy of the human epididymis reveals the presence of septa formed by connective tissue. They are oriented perpendicular to the organ. In mice and rats these septa are well organized; their number and location along the organ are the same. Using these septa, mouse and rat epididymis can be divided into 10 or 19 segments, respectively [10].
The human appendage is more complex [15], and although several reports show 5–10 segments, the exact number is unclear.
These septa have been proposed to play a role in differentiation and regulation of gene expression along the epididymis. How these segments coordinate with each other to ensure sperm contact with the appropriate luminal microenvironment is unknown [6].
After completion of testicular spermatogenesis, sperm are morphologically mature, but do not yet exhibit forward motility and are incapable of fertilization [16].
Although there is no consensus on the transit time of human sperm, it remains believed that the timing of sperm transit through the epididymis likely influences sperm maturation processes in humans [17]. The duration of maturation in mice is approximately 10 days [13].
Another author states that maturation lasts 1 or 2 weeks and exposes the immature sperm to a successively changing environment, promoting intense interaction with the secretions of the epididymal epithelium [2].
It is believed that epididymal smooth muscle cells are responsible for adequate sperm transport [7].
Thus, we can conclude that the structure of the testes and their appendages has been well studied, but changes in their structure under the influence of various factors require further research.

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