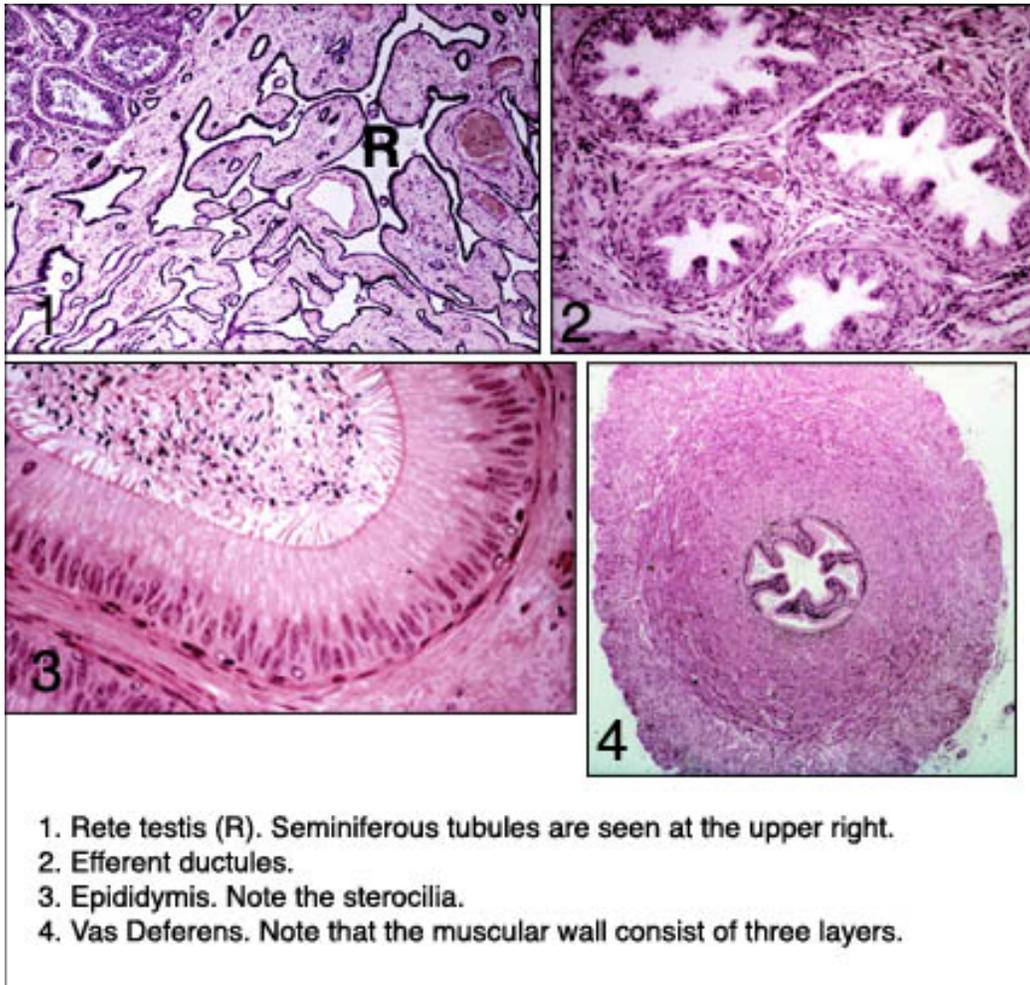


Male Ducts



The male ducts consist of a complex system of tubules that link each testis to the urethra, through which the exocrine secretion, semen, is conducted to the exterior during ejaculation. The duct system consists of the tubuli recti (straight tubules), rete testis, ductus efferentes, ductus epididymis, ductus deferens, ejaculatory ducts, and prostatic, membranous, and penile urethra.

Tubuli Recti

Near the apex of each testicular lobule, the seminiferous tubules join to form short, straight tubules called the tubuli recti. The lining epithelium has no germ cells and consists only of Sertoli cells. This simple columnar epithelium lies on a thin basal lamina and is surrounded by loose connective tissue. The lumina of the tubuli recti are continuous with a network of anastomosing channels in the mediastinum, the rete testis.

Rete Testis

The rete testis is lined by simple cuboidal epithelium in which each of the component cells bears short microvilli and a single cilium on the apical surface. The epithelium lies on a delicate basal lamina. A dense bed of vascular connective tissue surrounds the channels of the rete testis.

Ductuli Efferentes

In men, 10 to 15 ductuli efferentes emerge from the mediastinum on the posterosuperior surface of the testis and unite the channels of the rete testis with the ductus epididymis. The efferent ductules follow a convoluted course and, with their supporting tissue, make up the initial segment of the head of the epididymis. The luminal border of the efferent ductules shows a characteristic irregular contour due to the presence of alternating groups of tall and short columnar cells. Ciliated and nonciliated cells are present. Each contains the organelles normally associated with epithelia as well as supranuclear granules that are lysosomal in nature. The nonciliated cells show numerous microvilli on their apical surfaces and are thought to absorb much of the testicular fluid that is present in this part of the ductal system. Cilia on the other cell type beat toward the epididymis and help move the nonmotile sperm and testicular fluid in that direction. The epithelium lies on a basal lamina and is bounded by a layer of circularly arranged smooth muscle that thickens toward the duct of the epididymis. Cilia are not found beyond the ductuli efferentes, and the movement of sperm through the remainder of the duct system depends on the contractions of the muscular wall and fluid flow.

Ductus Epididymidis

The efferent ductules gradually unite to form a single ductus epididymidis that measures 5 to 7m long. This highly coiled duct and its associated vascular connective tissue form the rest of the head, body, and tail of the epididymis. The epithelial lining is pseudostratified columnar and consists of principal and basal cells. Principal cells are the most numerous and are very tall (80 μm) in the proximal segment but gradually decrease in height distally to measure only 40 μm near the junction with the ductus deferens. Long, branched microvilli, inappropriately called stereocilia, extend from the apical surfaces of the principal cells. Like microvilli found elsewhere, they contain an axial bundle of actin microfilaments. The actin microfilaments extend from the stereocilia into the terminal web region of the principal cells. A very large Golgi complex takes up a supranuclear position in the cell, and the basal region is filled by an abundance of endoplasmic reticulum. Lysosomes, multivesicular bodies, and numerous coated vesicles also are present. One of the functions of the principal cell is absorption; together, the proximal portion of the ductus epididymidis and the ductuli efferentes absorb over 90% of the fluid produced by the seminiferous epithelium. Principal cells also phagocytose degenerate spermatozoa and residual bodies. Principal cells of the epididymal epithelium secrete Ubiquitin, a highly conserved protein molecule. It forms covalently linked polyubiquitin chains on structures within the epididymal fluid, such as defective sperm and debris, during epididymal transit. These identified targets are recognized for endocytosis and removed from the epididymal fluid by the principal cells of the epididymal epithelium. The epithelium lining of the mid and distal regions of the ductus epididymis also secrete glycoproteins, sialic acid and other factors that are believed to play a role in sperm maturation. Basal cells are small, round cells that lie on the basal lamina, interposed between the principal cells. They have a lightly

staining cytoplasm with few organelles. Scattered intraepithelial lymphocytes often are present in the epithelium of the ductus epididymidis. The epididymal epithelium lies on a basal lamina and is surrounded by a thin lamina propria and a thin layer of circularly arranged smooth muscle cells. Near the ductus deferens, the muscle layer thickens and becomes three-layered (inner longitudinal, middle circular, outer longitudinal); it is continuous with that of the ductus deferens. The regional differences reflect differences in the mobility of the ductus epididymidis. Proximally, the duct shows spontaneous peristaltic contractions that slowly move spermatozoa through the epididymis; distally, the peristaltic contractions are reduced, and this region serves to store sperm. Spermatozoa become physiologically mature as they pass through the epididymis. Those entering the proximal part of the duct mostly are incapable of fertilization and swim in a weak, random fashion. Spermatozoa from the distal portion are capable of fertilizing ova and show strong, unidirectional motility. How the ductus epididymidis contributes to the maturation of spermatozoa is unknown. Transit time through the epididymis is about 3 weeks for humans.

Ductus Deferens

The ductus deferens unites the ductus epididymidis and the prostatic urethra. It is characterized by a wall consisting of a mucosa, a thick muscularis, and an adventitia. It is often referred to as the most muscular tube in the body. The mucosa is thrown into longitudinal folds that project into the lumen and is lined by a pseudostratified columnar epithelium resting on a thin basal lamina. The principal cells of the epithelium bear stereocilia on the luminal surface. The surrounding lamina propria is dense and contains numerous elastic fibers. The muscularis is the dominant feature of the ductus deferens and consists of three layers of smooth muscle cells arranged longitudinally in the inner and outer layers and circularly in the middle layer. The muscularis is surrounded by the loose connective tissue of the adventitia, which blends with neighboring structures and anchors the ductus deferens in place. Powerful contractions of the muscular wall propel sperm from the distal ductus epididymidis and rapidly transport them through the ductus deferens during ejaculation. Near its termination, the ductus deferens dilates to form the ampulla. The lumen expands and the mucosa is folded, creating a labyrinth of pocket-like recesses. The lining epithelium is pseudostratified columnar. The muscular coat of the ampulla is thinner and the layers are less distinct than in other parts of the ductus deferens. Nearly all the smooth muscle in the muscularis of the ductus deferens is phasic smooth muscle characterized by distinct action potentials and rapid contraction. Nearly every smooth muscle cell is innervated (multiunit innervation) by the autonomic nervous system. This accounts for the rapid, forceful, pulse-like contractions of the ductus deferens during ejaculation.

Ejaculatory Duct

A short, narrow region of the ductus deferens extends beyond the ampulla and joins the duct of the seminal vesicle. This combined duct forms the ejaculatory duct, which empties into the prostatic urethra. It is about 1 cm long and is lined by a pseudostratified or stratified columnar epithelium. The mucosa forms out pockets that are similar to, but not as well developed as, those in the ampulla. The remainder of the wall of the ejaculatory duct consists only of fibrous connective tissue.

Prostatic Urethra

The ejaculatory duct penetrates the prostate and opens into the prostatic part of the urethra. The prostatic urethra is lined by a thin transitional epithelium and bears a dome-shaped elevation, the colliculus seminalis, on its posterior wall. A small blind diverticulum called the prostatic utricle lies on the summit of the colliculus and represents a remnant of the Müllerian duct in the male. The two ejaculatory ducts, one draining each testis, empty into the prostatic urethra on either side of the prostatic utricle. The numerous glands of the surrounding prostate also empty into this part of the urethra.

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