

Male Reproductive System

ANS 215

Physiology and Anatomy of Domesticated Animals

I. Introduction

- A. Reproductive functions of the male include the formation of sperm and deposition of sperm into the female reproductive tract
- B. This process is assisted by hormones and the autonomic nervous system
- C. Production of sperm is continuous once puberty is established but rate of sperm formation can vary with daylength
- D. Sexual behavior leading to deposition of sperm into the female is also affected by daylength in some species.

II. Anatomy of the Male Reproductive Tract

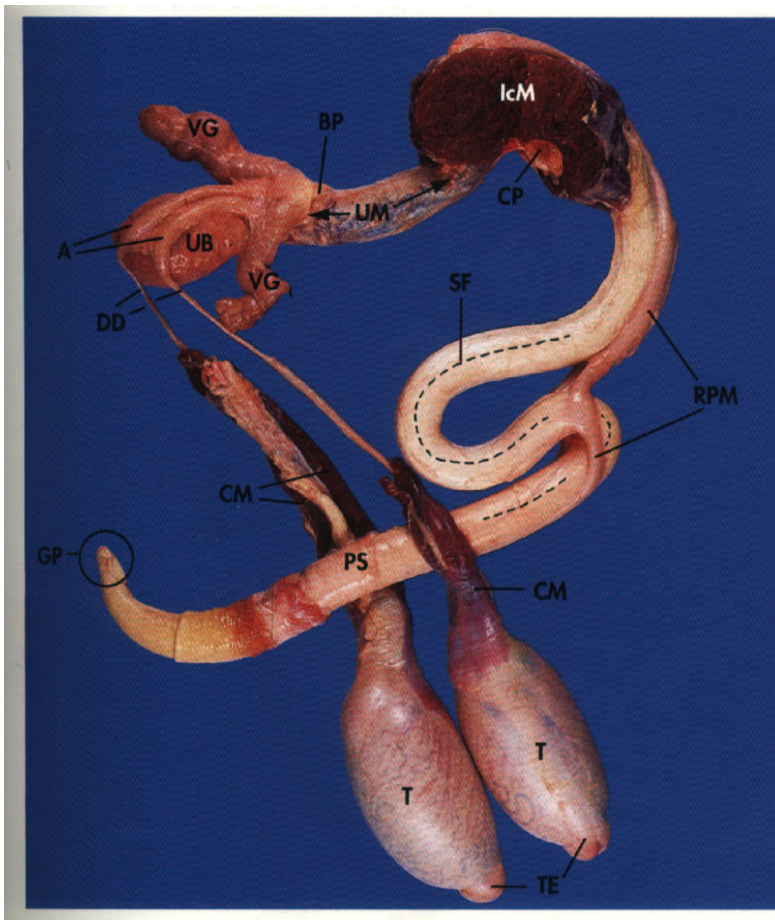


Figure 3-2.

Top Panel

Schematic illustration of a sagittal view of the bull reproductive tract (modified from Ellenberger and Baum, 1943, *Handbuch der vergleichenden Anatomie der Haustiere*, 18th Edition. Zietzschmann, Ackerknecht and Grau, eds. Permission from Springer-Verlag, New York).

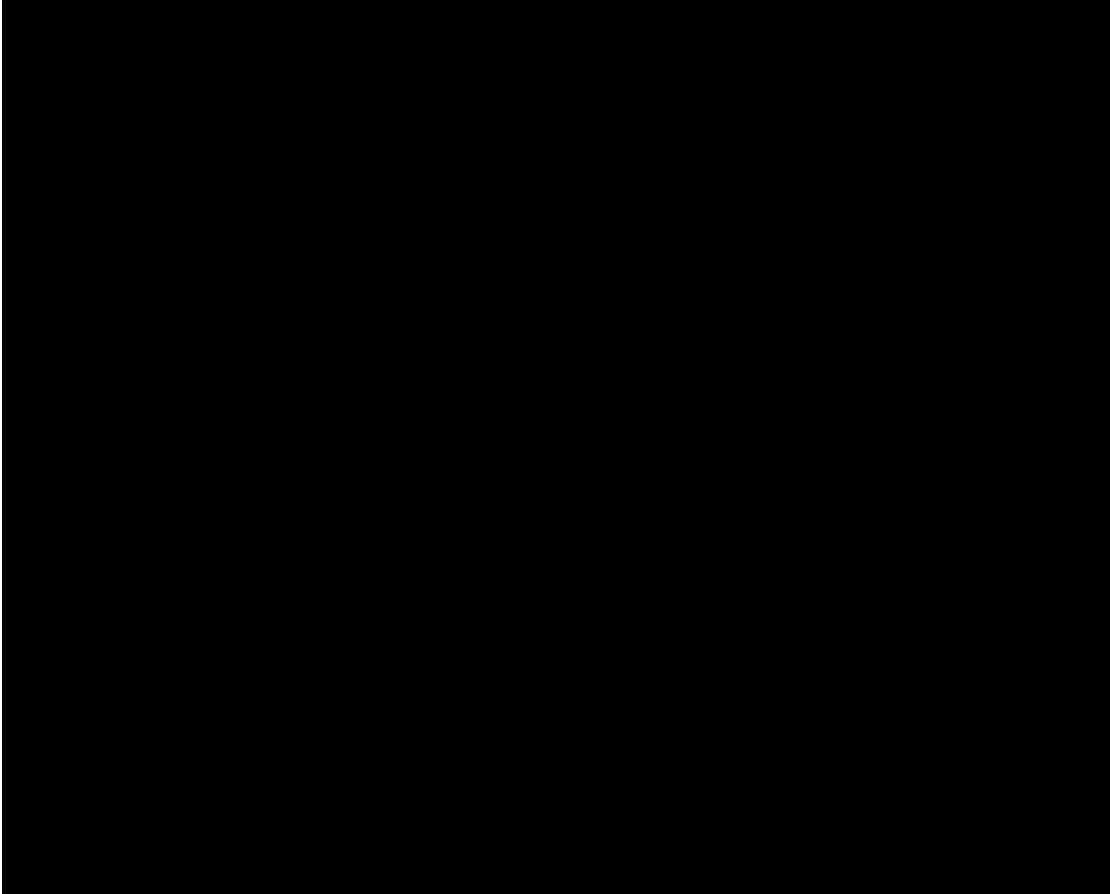
Bottom Panel

Sagittal view of an excised reproductive tract from the bull.

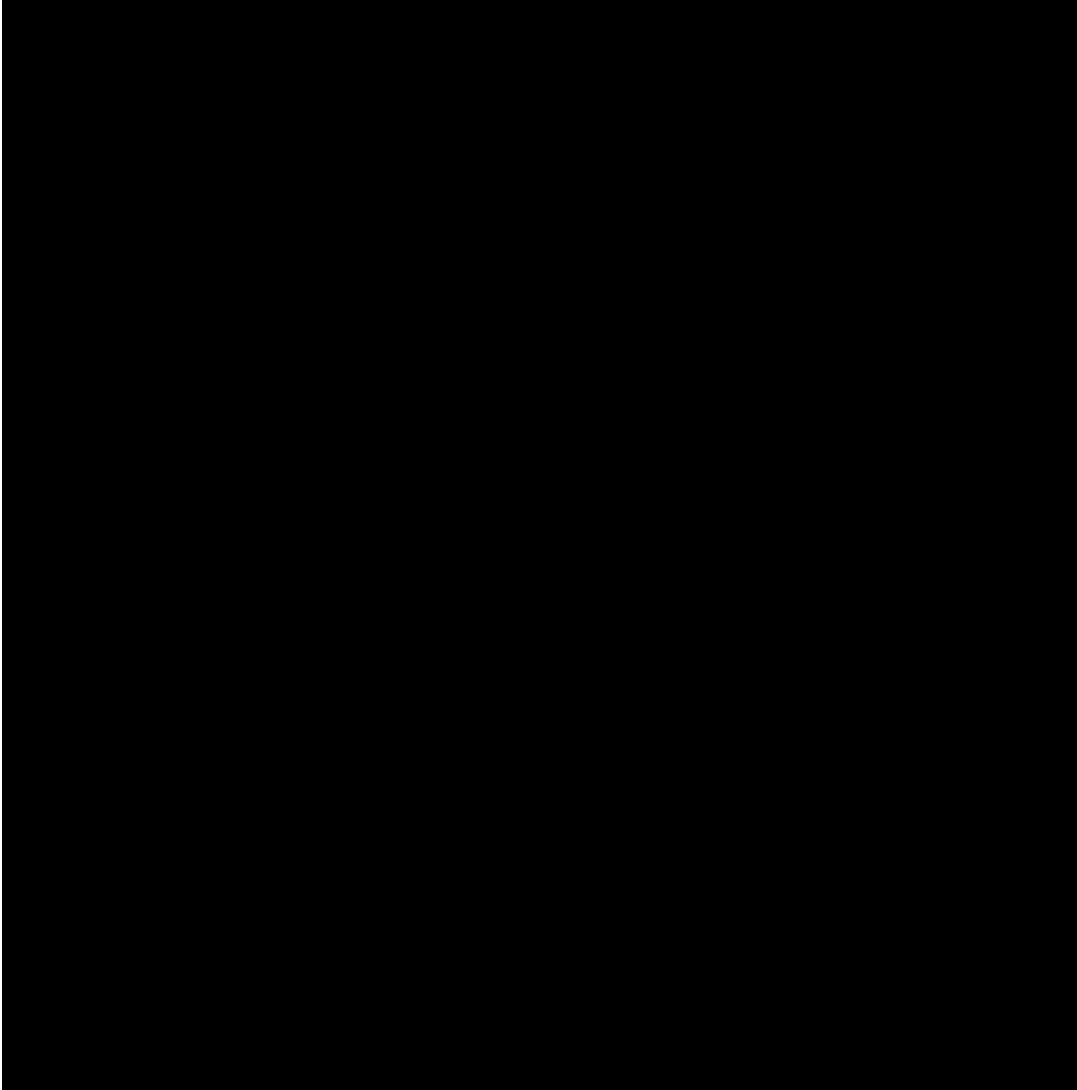
A = Ampulla; BP = Body of Prostate; CM = Cremaster Muscle; CP = Crus Penis; DD = Ductus Deferens; GP = Glans Penis; IcM = Ischiocavernosus Muscle; PS = Penile Shaft; RPM = Retractor Penis Muscle; SF = Sigmoid Flexure; TE = Tail of Epididymis; T = Testis; UM = Urethralis Muscle; UB = Urinary Bladder; VG = Vesicular Gland.

A. Testis

- i. Two testes produce spermatozoa and testosterone



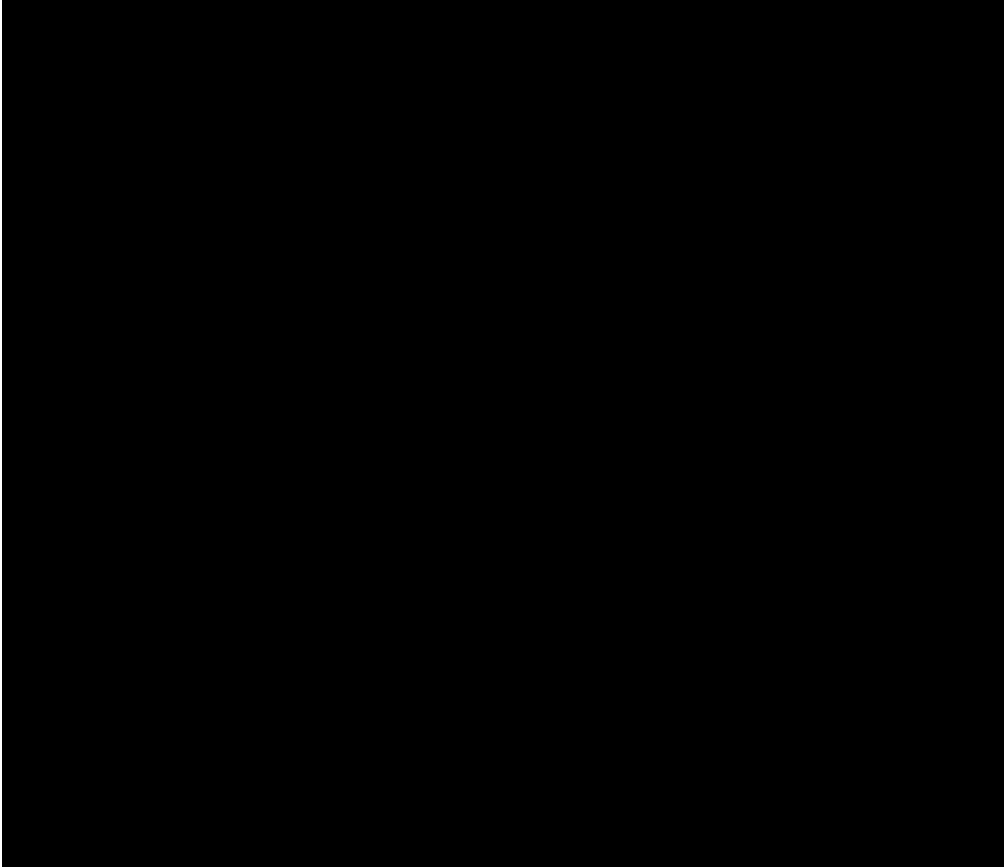
- B. Site of spermatogenesis is the seminiferous tubule.
 - i. Convoluted and occupy greatest portion of each testicle
- C. Outer covering of the testicle is the tunica albuginea
- D. Connective tissue extensions from the tunica albuginea provide support for the seminiferous tubule.



- E. Cell types in the seminiferous tubule include:
- i. Germ cells and developing spermatocytes
 - ii. Leydig cells
 - 1. Produce testosterone
 - iii. Sertoli cells
 - 1. Act as nurse cells for developing sperm
 - a. Processes from Sertoli cells surround spermatids and spermatocytes and provide nutritional support for all stages of spermatogenesis.
 - b. Also called sustentacular (supporting) cells
 - c. Sertoli cells have their base at the periphery of the seminiferous tubule and extend toward the center.
 - d. The basal junction (tight junction) with adjacent Sertoli cells forms a blood-testis barrier that permits control of the environment within the tubule.
 - e. Sertoli cells divide the seminiferous tubules into two compartments.

i. Basal compartment- communicates with interstitial fluid and provides space for germinal epithelial cells.

ii. Adluminal compartment- space between Sertoli cells that communicates centrally with the lumen of the tubule



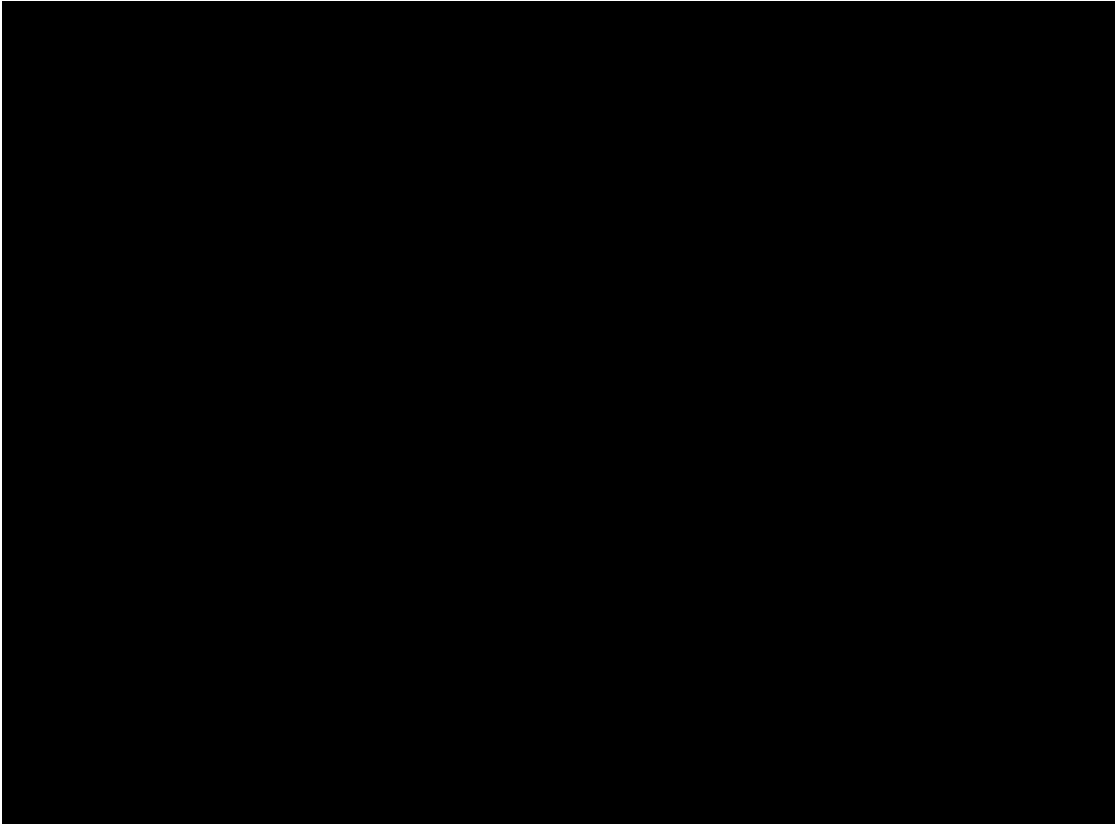
iii. Division of the germinal epithelial cell (spermatogonium) provides a replacement cell and another cell which moves through the Sertoli cell junction to enter the adluminal compartment.

iv. In the adluminal compartment the stages of spermatogenesis occur.

v. The Sertoli cells secrete a fluid into the adluminal compartment which favors the ongoing process of spermatogenesis.

B. Epididymis

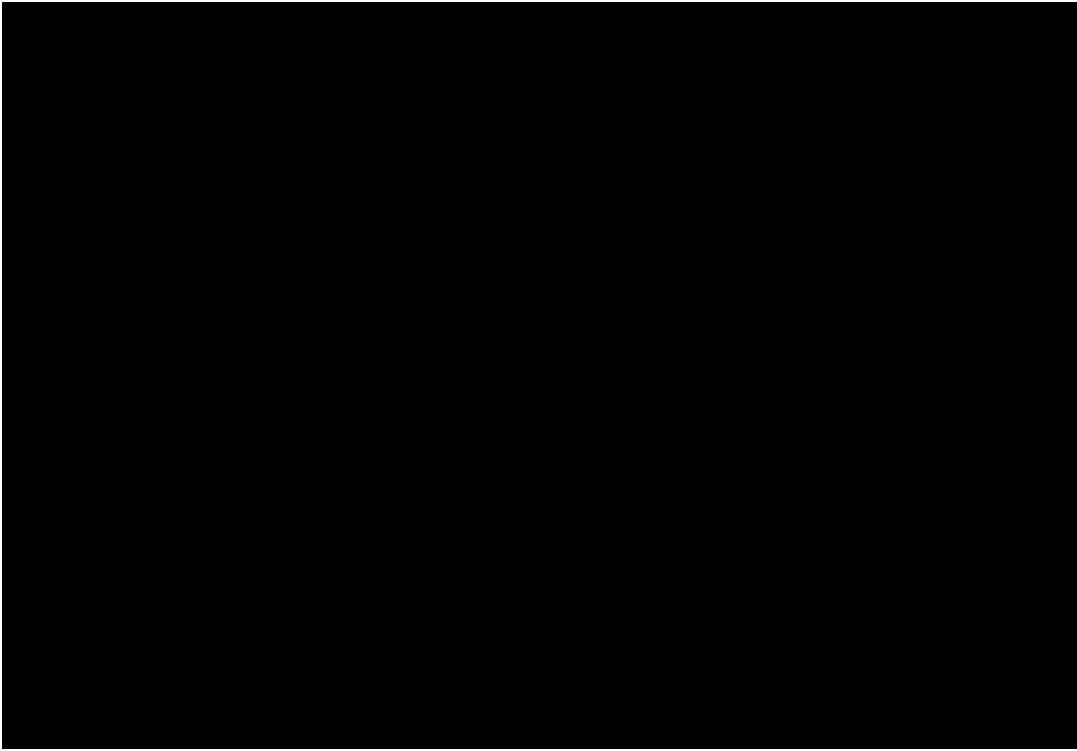
- a. Collection and storage location for the testis and site of maturation of sperm.
- b. Begins at the pole of the testis in which blood vessels and nerves enter; also known as the head
- c. The head of the epididymis receives sperm and adluminal fluid through efferent ducts from the rete testis
 - i. Rete testis-intratesticular network of straight tubules that receives content from the convoluted seminiferous tubules.



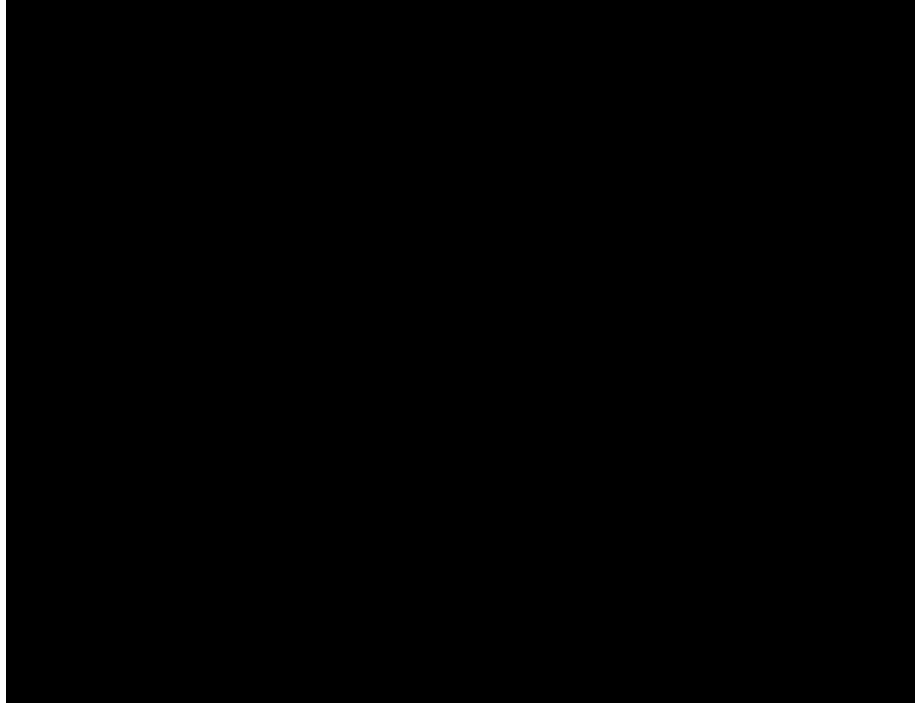
- d. Head of epididymis continues along one side of testis as body
- e. Storage in the epididymis allows the spermatozoa to undergo maturation and to gain motility
- f. Spermatozoa move to the epididymis by the flow of fluid into the lumen of the seminiferous tubules from the adluminal spaces.
- g. Reabsorption of much of the seminiferous tubular fluid occurs in the head of the epididymis.

C. Ductus Deferens (vas deferens)

- a. Continuation of the duct system from the tail of the epididymis to the pelvic urethra
- b. As the vas deferens leaves the testis toward the abdomen it is enclosed along with the testicular artery, vein, nerve, lymphatic vessels and internal cremaster muscle within the visceral layer of the tunica vaginalis (also known as the spermatic cord)



- c. After the spermatic cord passes through the internal and external Inguinal rings the vas deferens separates from the spermatic cord to proceed to the pelvic urethra
- d. The vas deferens terminates with an enlarged glandular area Known as the ampulla



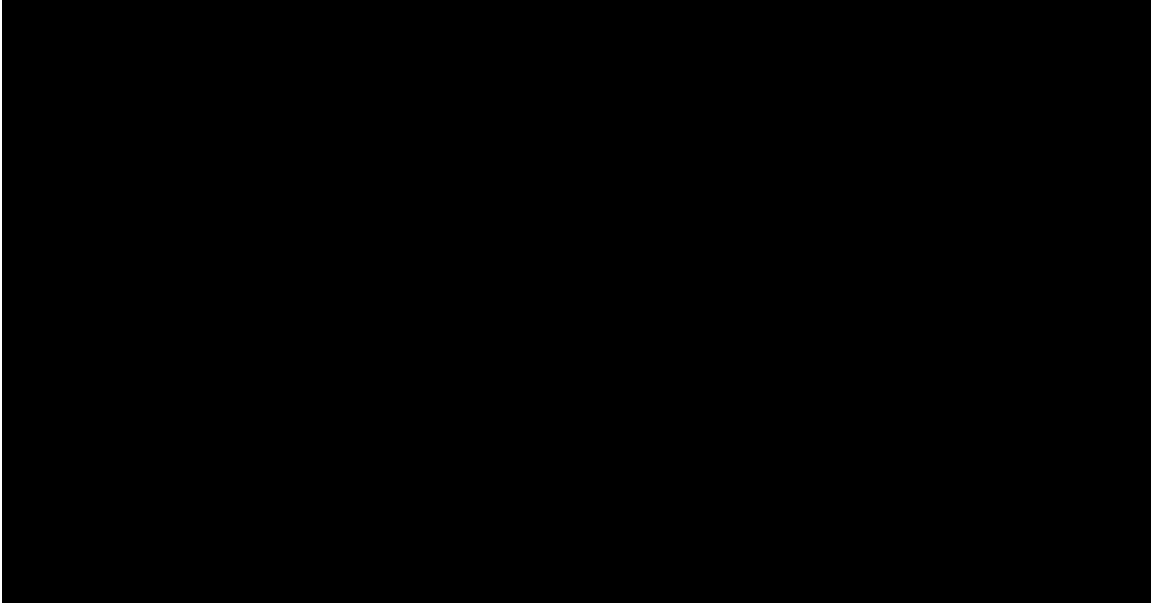
D. Scrotum

- a. Cutaneous sac containing the testes
- b. Contains a subcutaneous layer of smooth muscle fibers known as the tunica dartos
 - i. Relaxes or contracts depending on environmental temperature
- c. Scrotum is lined with the parietal layer of the tunica vaginalis

E. Tunica Vaginalis

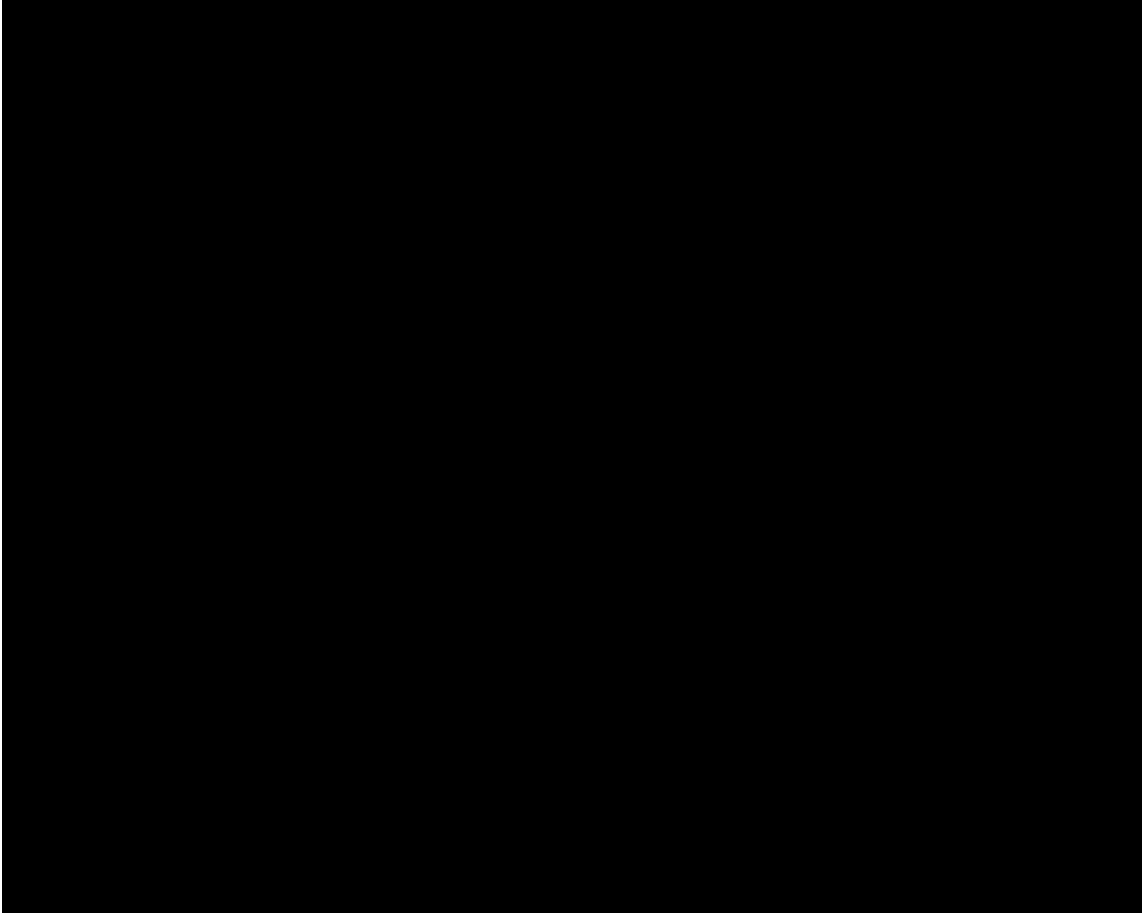
- a. During embryonic development the testis is intra-abdominal but is outside the peritoneum.
- b. The testis is connected to the scrotum by a fibrous connection known as the gubernaculum testis.
- c. As development and growth progress the gubernaculum testis pulls the testis through the inguinal rings into the scrotum through a double walled tube of peritoneum, the vaginal process, which preceded the descent of the testis.
- d. The testis, epididymis, vas deferens, internal cremaster muscle and testicular vessels are enveloped by the inner tube of the peritoneum known as the tunica vaginalis.
- e. The outer tube of peritoneum is known as the tunica vaginalis communis (parietal tunic) and it lines the scrotum.
- f. The testis and epididymis that are enveloped within the visceral tunic completely fill the scrotal cavity lined by the parietal tunic so that only a narrow space remains between the two tunics (vaginal cavity).
- g. The vaginal cavity is continuous with the abdominal cavity at the vaginal ring (inguinal ring).

- h. If the vaginal ring is too large loops of small intestine may enter the vaginal cavity (inguinal hernia).
- i. Cryptorchid testis are those that fail to descend



F. Accessory Sex Glands and Semen

- a. Accessory sex glands provide secretions that empty into the pelvic urethra near their origin.
- b. They vary in size and shape among species and can be absent in some
- c. Comprised of:
 - i. Ampullae of vas deferens
 - ii. Seminal vesicles
 - 1. empty into the pelvic urethra
 - iii. Prostate gland
 - 1. encircles urethra
 - 2. Enlargement can block urine flow
 - iv. Cowpers glands (bulbourethral glands)
 - 1. Most caudal of accessory sex glands
- d. At the time of ejaculation the accessory gland secretions (collectively known as seminal plasma) are mixed with sperm to form semen.
- e. Components of seminal plasma include fructose, prostaglandins, Electrolytes, vitamins



G. Penis

- a. Male organ of copulation through which urine and semen pass by way of the penile urethra
- b. Variations in penile structure include a sigmoid flexure in the bull, ram and boar and the bulbus glandis at the caudal part of the glans in the dog.

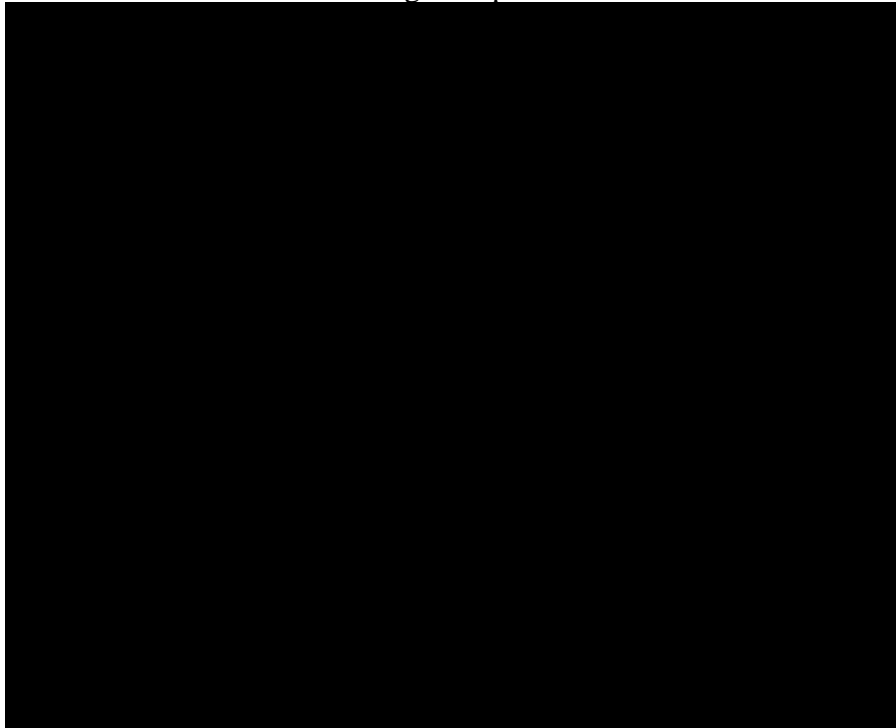
H. Prepuce

- a. Invaginated fold of skin that surround the free extremity of the penis

I. Muscles of Male Genitalia

- a. External cremaster muscle
 - i. Formed by the caudal fibers of the internal abdominal oblique muscle.
 - ii. Passes through the inguinal canal and attaches to the outside parietal layer of the tunica vaginalis.
 - iii. The muscle regulates testis temperature by controlling distance from body wall.
 - iv.
- b. Internal cremaster muscle

- i. Smooth muscle fibers that help to hold spermatic cord structures together.
- c. Urethralis
 - i. Pelvic continuation from the smooth muscle wall of the urinary bladder.
 - ii. Peristaltic action of this muscle assists in the transport of urine or semen through the pelvic urethra



- iii. Continues the action of the urethralis in emptying the urethra
- e. Ischiocavernosus muscles
 - i. Paired striated muscles that converge on the body of the penis from the origins on the lateral sides of the ischial arch
 - ii. When these muscles contract, they pull the penis upward against the floor of the pelvis
 - iii. Much of the venous drainage from the penis is obstructed because of the location of the veins on the dorsal surface of the penis and erection is thereby assisted
- f. Retractor penis muscles
 - i. Paired striated muscles that originate from the suspensory ligaments of the anus.
 - ii. Continue forward and converge caudal to the body of the penis.

- iii. After they join on the underside of the penis they continue forward to the glans penis
- iv. The retractor penis muscles pull the flaccid penis back into the prepuce.

J. Blood and Nerve Supply

- a. Blood to the testis is supplied by the testicular arteries.
- b. Testicular veins parallel the testicular arteries.
- c. Both artery and vein are enclosed within the spermatic cord.
- d. A short distance above the testicle, the testicular vein is convoluted (pampiniform plexus) and is in close association with the convoluted part of the testicular artery.
 - i. Blood entering the testis is cooled by the venous blood leaving the testis.

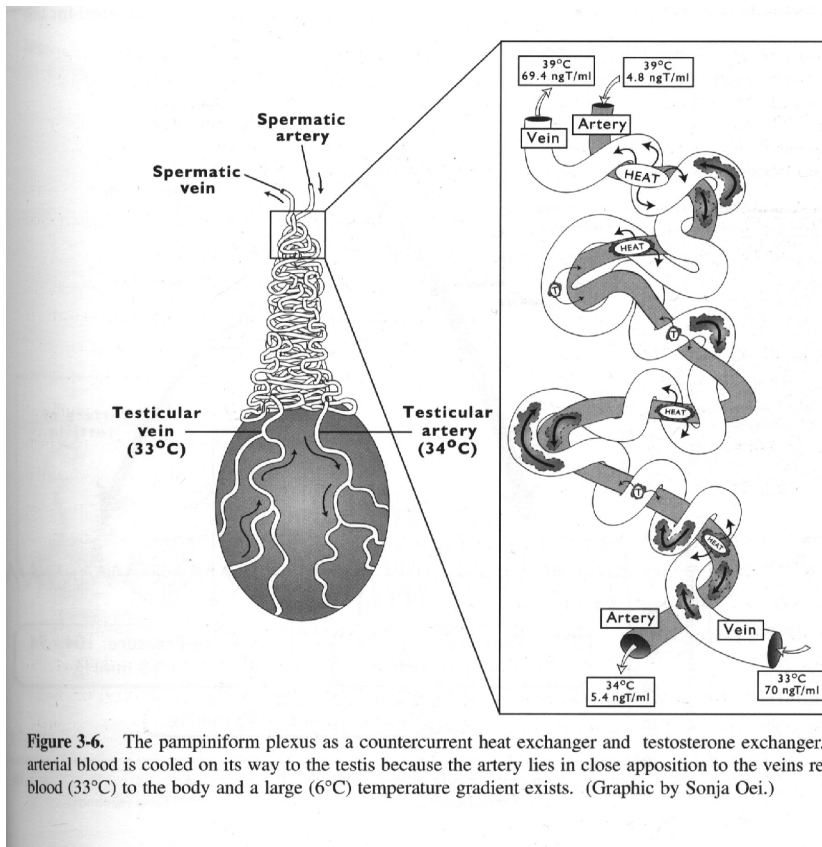
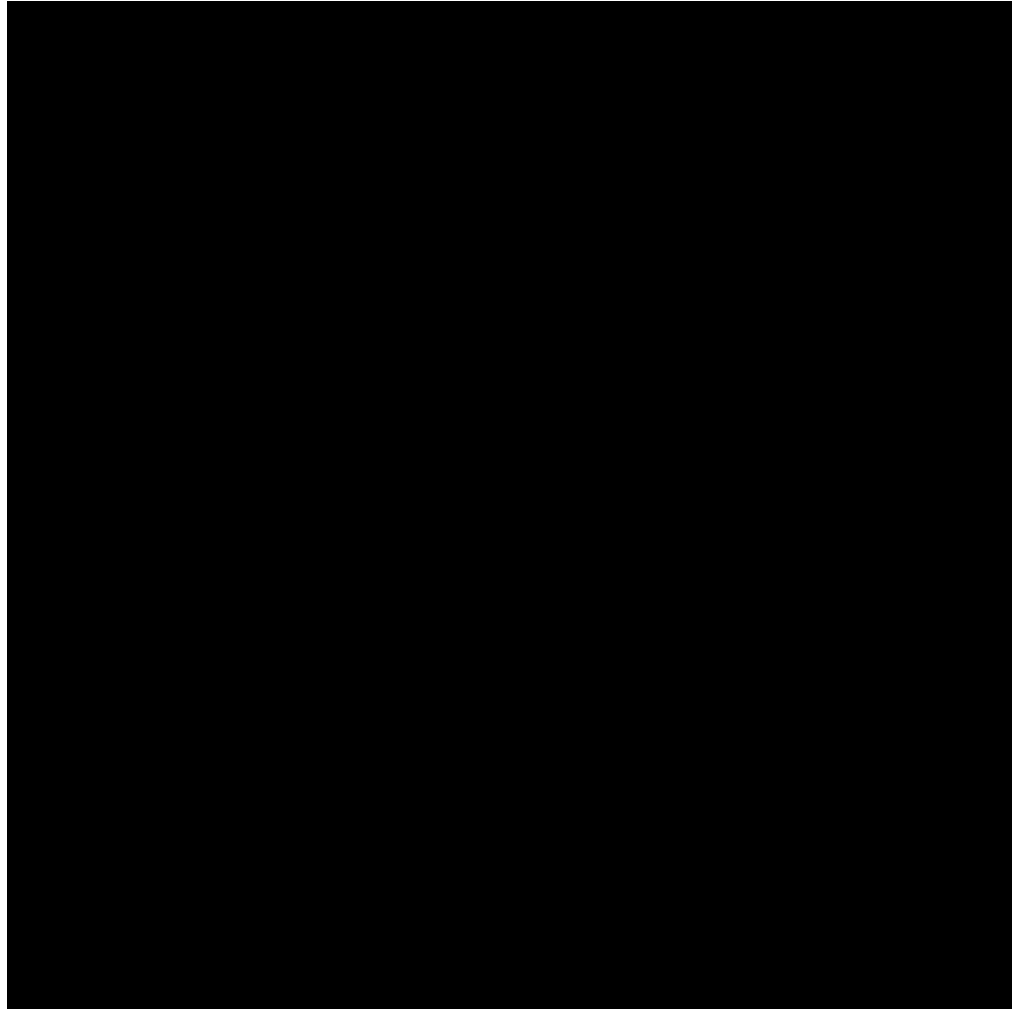


Figure 3-6. The pampiniform plexus as a counter-current heat exchanger and testosterone exchanger. Warm (39°C) arterial blood is cooled on its way to the testis because the artery lies in close apposition to the veins returning cooler blood (33°C) to the body and a large (6°C) temperature gradient exists. (Graphic by Sonja Oei.)

- e. In addition to autonomic nerve fibers to the testis, penis and Accessory glands, the penis is supplied by a spinal nerve, the pudendal nerve.
 - i. Sensory stimulation of the glans provides the afferent side For reflexes associated with erection and ejaculation.
 - ii. Reflex centers for erection and ejaculation are in the Lumbar region of the spinal cord.

III. Spermatogenesis

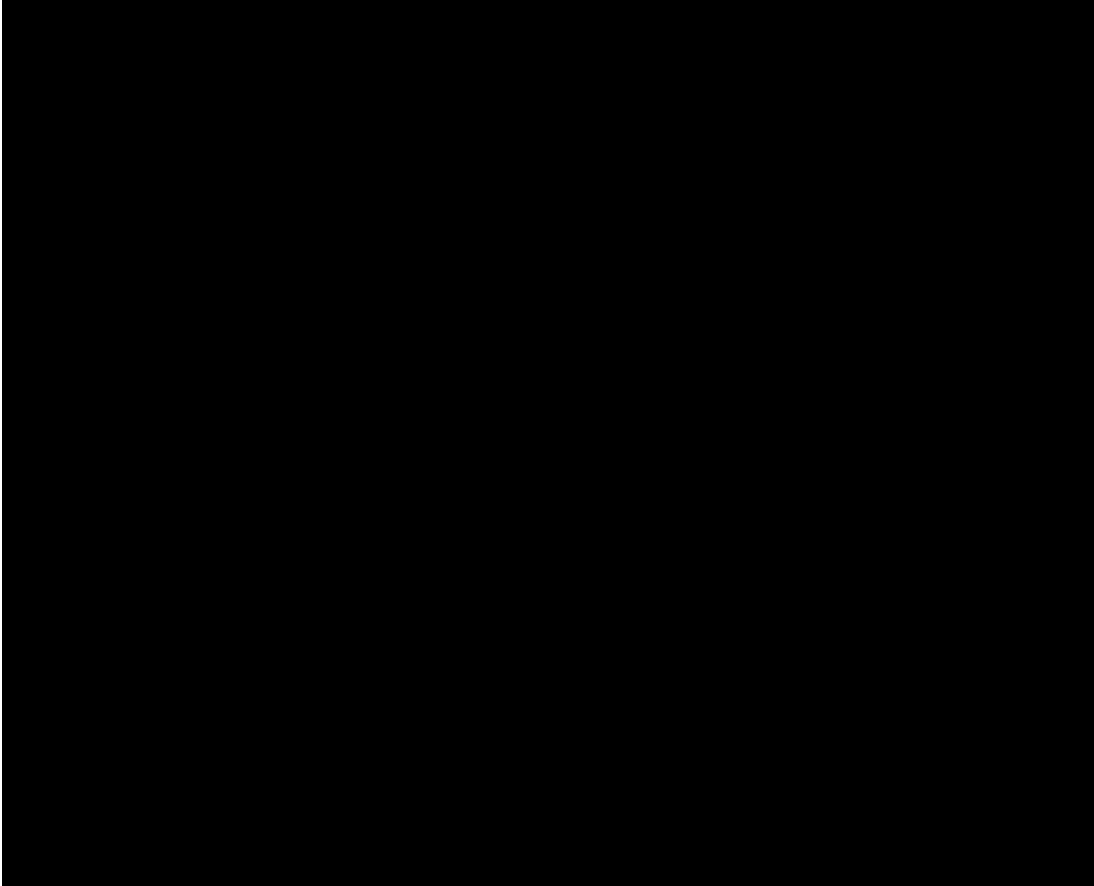
- A. Term refers to the entire process involved in the transformation of germinal epithelial cells (stem cells) to spermatozoa.
- B. Both mitosis (cell division in which each new cell retains a diploid, or $2n$, number of chromosomes) and meiosis (cell division in which each new cell has a haploid, n , number of chromosomes) occur in spermatogenesis. Spermatozoa are haploid



- C. Mitogenic divisions result in production of primary Spermatocytes
- D. Meiotic division results in production of spermatids
 - i. In the bull, 64 spermatids are formed from 1 type A spermatogonium
- E. Maturation of spermatids occurs while they are still in the adluminal Compartment
 - i. Involves a series of nuclear and cytoplasmic changes called

Spermiogenesis

- ii. During spermiogenesis the spermatid transforms from a non-Motile to a potentially motile cell with a flagellum.
- iii. During the final phase of spermiogenesis the spermatids are Released into the lumen of the seminiferous tubules as spermatozoa.



F. Epididymal Transport

- i. Fertilizing ability of the spermatozoa is attained progressively during the transport of sperm through the epididymis.
 - 1. unidirectional motility
 - 2. changes in nuclear chromatin
 - 3. changes in plasma membrane
 - 4.
- ii. Major site of sperm storage is the tail of the epididymis
 - 1. 70% of sperm outside of seminiferous tubules and rete testis are stored in tail of epididymis.
 - 2. 100% of fertile sperm are stored here.

G. Spermatogenic Wave

- i. Spermatogenesis requires 64 days in the bull.
- ii. To ensure a constant supply of sperm different parts of the seminiferous tubule have different stages of spermatogenesis.

iii. Daily production of spermatozoa is 6,000,000,000 in the bull.

H. Hormonal Control of Spermatogenesis

i. Leydig and Sertoli cells are responsible for hormone production within the testes.

ii. Luteinizing hormone (LH) controls production of testosterone from Leydig cells

1. Testosterone maintains spermatogenesis by supporting meiosis
2. Testosterone maintains secondary sexual characteristics and Libido
3. Boar taint comes from other androgens produced in the Boar which cause off-flavor in meat

iii. Androgen binding protein is produced by Sertoli cells

iv. Sertoli cells also produce inhibin and estrogen

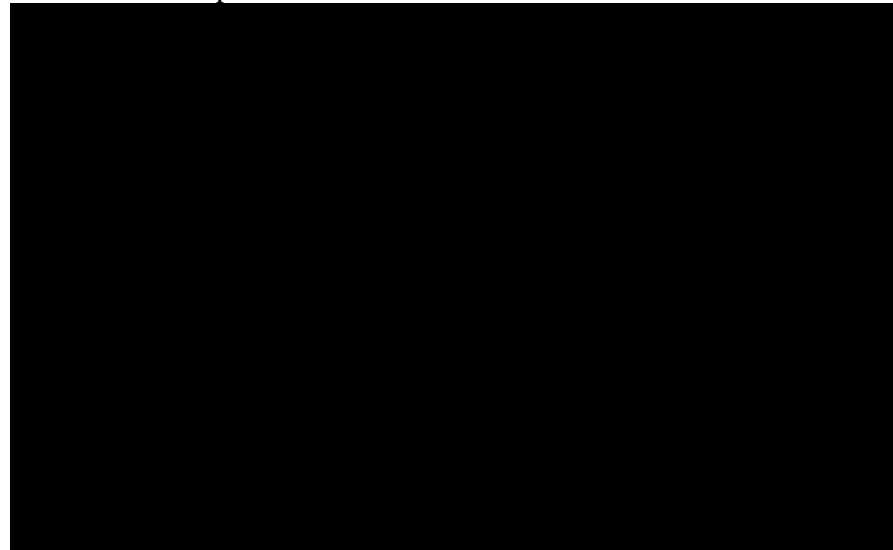
1. Inhibin inhibits FSHs secretion which is not required to maintain spermatogenesis

IV. Physical Considerations

A. Erection

i. Increase in turgidity of the penis

ii. Caused by an increase of blood pressure within the cavernous sinuses of the penis



iii. Complete erection of the glans penis in the horse is delayed until after introduction of the penis into the vagina of the mare due to compression of the prepuce and subsequent blockage of venous drainage

iv. Parasympathetic stimulation causes increase in blood flow Erection.

v. In animals with a sigmoid flexure, the filling of the cavernous sinuses, coupled with relaxation of the retractor penis muscles causes the flexure to be eliminated and the penis to be straightened.

B. Mounting and Intromission

- i. Mounting is the stance assumed by the male to bring the penis into apposition with the vulva of the female
- ii. Introduction of the penis into the vagina and its maintenance within the vagina during coitus is termed intromission.
- iii. Duration of intromission among species varies
 1. shortest for the bull and ram and longest for the boar

C. Emission and Ejaculation

- i. Emission precedes ejaculation
 1. Results from sympathetic innervation whereby sperm and fluids in the vas deferens and ampullae are emptied into the urethra along with accessory gland secretions
 2. Accomplished by peristaltic movement
- ii. Once emission has been accomplished, reflex peristalsis of the Urethral muscles forces contents of the urethra to the exterior. This is termed ejaculation.

V. Reproduction in the Bird

- A. Testis is located within the body cavity in the bird
- B. Internal structure of testis is similar to mammals
- C. There is no pampiniform plexus in the male bird
- D. Instead of an epididymis as arranged in mammals, the sperm are stored in the vas deferens