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Gene H. Deutscher
University of Nebraska-Lincoln, gdeutscher@inebraska.com

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Reproductive Tract Anatomy and Physiology of the Bull[1]

Understanding the anatomy and physiology of the bull's reproductive tract is beneficial for proper management.

Gene H. Deutscher, District Extension Specialist (Livestock)

Good reproductive performance of a bull is necessary to obtain a high percent calf crop. A bull must be fertile and capable of servicing a large number of cows during a short breeding season for optimum production. Understanding the anatomy and physiology of the bull's reproductive tract is beneficial for proper management. A basic knowledge of the reproductive system will also help the producer to understand fertility examinations, reproductive problems and breeding impairments.

Anatomy and Physiology

The reproductive tract of the bull consists of the testicles and secondary sex organs which transport the spermatozoa from the testicle and eventually deposit them in the female reproductive tract. These organs are the *epididymis*, *vas deferens* and *penis*, and three accessory sex glands--the *seminal vesicles*, *prostate* and *Cowpers gland*. This basic anatomy is illustrated in *Figure 1*.

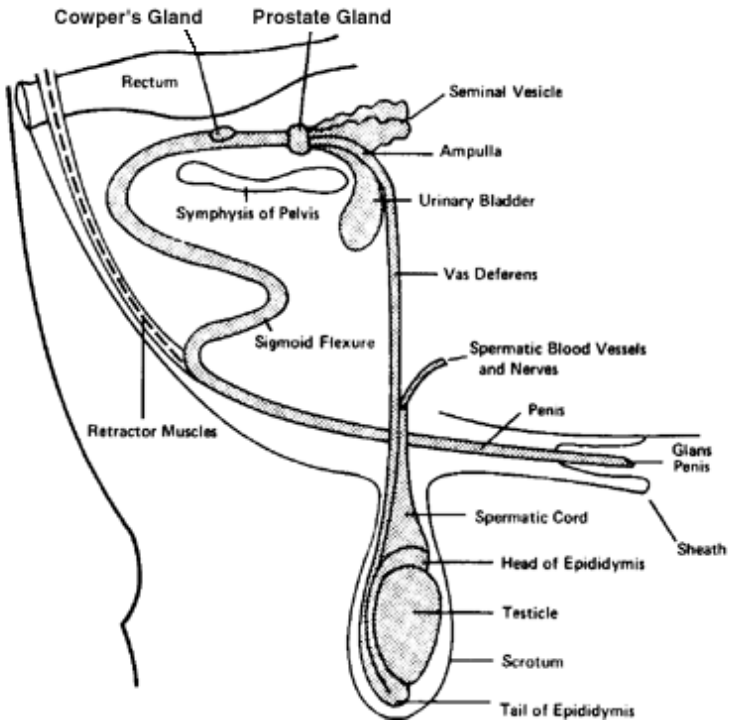

Figure 1. Diagrammatic drawing of the reproductive tract of the bull.

The testicle has two very vital functions: (1) producing the *spermatozoa*, and (2) producing the specific male hormone, *testosterone*. The testicles are located outside of the body cavity in the scrotum. This is essential for normal sperm formation which occurs only at a temperature several degrees below normal body temperature. However, very cold temperatures can also damage the testicle. The scrotum, therefore, helps to protect the testicle against both extremes of temperature. This is done by means of a temperature sensitive layer of muscle (cremaster muscle) located in the walls of the scrotum, which relaxes when hot and contracts when cold. Relaxation increases the relative length of the scrotum, thus moving the testicles away from body heat. In cold weather just the reverse happens -- the scrotum shortens and the testicles are held close to the warm body.

One or both testicles occasionally fail to descend into the scrotum during embryological development, and are retained in the body cavity. Such males are referred to as *cryptorchids*. Since body heat can destroy sperm producing ability, no sperm are produced by the retained testicle. If one of the testicles descends into the scrotum, it will function normally and usually produces enough sperm so that the male will be of near normal fertility. However, since this condition appears to have a hereditary basis, such males should not be used for breeding. If both testicles are retained, the male will be sterile.

Hormone production is usually near normal in the cryptorchid testicle and the male develops and behaves like a normal male. If this retained testicle is not removed at the time of castration, the male will develop the secondary sex characters of an uncastrated male. This operation is not as simple, nor as safe, as removing testicles that are in the scrotum. Therefore, it is recommended to select against this trait by culling cryptorchid males.

In addition to cryptorchidism, there are other circumstances which may cause sterility by raising the temperature of the testicle. These include excessive fat deposits in the scrotum; several days of very high fever; and exposing the males for extended periods to very high environmental temperatures. If the male was producing sperm prior to exposure to such conditions, and the period of exposure was not too prolonged, the resulting sterility is generally only temporary (6 to 10 weeks) and, if the conditions are

corrected, normal fertility will eventually return.

The testicle contains many long, tiny, coiled tubes, the *seminiferous tubules*, within which the sperm are formed and mature. Scattered throughout the loose connective tissue surrounding the seminiferous tubules are many highly specialized cells, the *interstitial cells of Leydig*, that produce the male hormone.

There are many hundreds of individual seminiferous tubules in the testicle. These unite with one another until eventually some dozen tubules pass out of the testicle into the head of the epididymis.

The epididymis is a compact, flat, elongated structure closely attached to one side of the testicle. In it the dozen or so *vasa efferentia* from the testicle combine into a single tubule some 130 to 160 feet in length, which is packed into the relatively short epididymis. This tubule eventually emerges from the tail of the epididymis as a single straight tubule (the *vas deferens*) and passes as part of the spermatic cord through the inguinal ring into the body cavity.

It requires 45 to 50 days for sperm to form in the seminiferous tubules and move through the epididymis where they mature for ejaculation. About one week of this time is spent in the epididymis, a period of time that appears to be necessary for the sperm cells to mature into fertile sperm. The sperm in the testicle are much more sensitive to damage from heat than are those that have already been formed and are stored in the epididymis. This may result in a slight delay between the time a male is exposed to some unfavorable condition and the time his fertility is reduced. However, this period of reduced fertility may then last for the 45 to 50 days required to produce a new sperm cell. This may explain why a male may settle females for a week or so after recovering from a high fever and then go through an infertile period of several weeks.

The epididymis is a single tube which serves as an outlet for all the sperm produced in the testicle and any blockage of this tube is a serious matter. Sometimes there is a temporary blockage due to swelling following an injury or infection (*epididymitis*) as shown in *Figure 2*. However, this swelling or infection occasionally results in the formation of scar tissue in the tubule, permanently blocking it and preventing the passage of sperm.

In addition to the vas deferens the spermatic cord includes the blood vessels and nerves supplying the testicle and the supporting muscles and the connective tissue. Males may be sterilized by an operation called a vasectomy in which the vas deferens are cut so that sperm cannot pass to the outside of the body. If only the vas deferens is cut, the testicle continues to function normally, producing both sperm and male hormone. However, if the blood vessels of the spermatic cord are cut or blocked, shutting off the blood supply, the testicle will stop functioning and waste away.

One of the weak spots of the male anatomy is the *inguinal ring*, the opening through which the spermatic cord passes into the body cavity. If it enlarges, usually as a result of an injury, a loop of the intestine can pass into the scrotum, resulting in a scrotal hernia. Since predisposition to injury at this point appears to have a hereditary basis, males with scrotal hernias should not be used for breeding even though they may be of normal fertility.

The two vas deferens eventually unite into a single tube (the *urethra*) which is the channel passing through the penis. The urethra serves as the common passage way for the excretory products of the two male tracts--semen of the reproductive tract and urine of the urinary tract.

Two of the accessory glands are found in the general region where the vas deferens unite to become the urethra. These glands produce the secretions that make up most of the liquid portion of the semen. In addition, the secretions activate the sperm to become motile.

The largest of these, and the one producing the largest fraction of the seminal fluid, is the *seminal vesicles*. They consist of two lobes about 4 to 5 inches long, each connected to the urethra by a duct. Another accessory gland in this region is the prostate gland, which is located at the neck of the urinary bladder where it empties into the urethra. The *prostate* is poorly developed in the bull and does not produce a very large volume of secretion.

The third accessory gland, the *Cowper's glands*, are small, firm glands located on either side of the urethra. It is believed that one of the chief functions of their secretion is to cleanse the urethra of any residue of urine which might be harmful to spermatozoa. The clear secretion that often drips from the penis during sexual excitement prior to service is largely produced by these glands.

One of the accessory glands may occasionally become infected, resulting in semen samples that are yellow and cloudy and which contain many pus cells. It is not uncommon in bulls for the seminal vesicles to be so affected (*seminal vesiculitus*).

The sigmoid flexure is an anatomical structure that provides the means by which the penis is held inside the body and sheath except during time of service. Strong retractor muscles serve to hold the penis in the "S" shaped configuration. Occasionally these muscles are too weak to function properly and a portion of the penis and sheath lining protrude at all times. This exposes the male to the danger of mechanical injury, particularly in rough, brushy country, or on ranges where there is considerable cactus and prickly pear.

The penis is the organ of insemination. In all domestic animals it consists of two cylindrical bodies called the *corpora cavernosa penis*. The spaces of the corpora cavernosa become filled with blood during sexual excitement, resulting in erection of the organ. The end of the penis is the glans penis. The glans penis is richly supplied with nerves and is the source of the sensations associated with copulation. Impairments of the glans penis may exist (*Figure 2*) and should be corrected during a fertility exam.

Semen

Semen consists of the spermatozoa and a liquid composed largely of the secretions of the accessory glands. The volume of semen and the number of sperm ejaculated by different bulls varies considerably. However, most bulls will ejaculate 3 to 5cc of semen containing about 1 billion sperm per cc, or 3 to 5 billion sperm per ejaculate.

Once sexual maturity is reached in farm animals, sperm production is continuous throughout the remainder of their reproductive life. During periods of sexual rest old sperm in the epididymis die, degenerate and are absorbed. For this reason, the first sample collected after a long period of sexual inactivity may appear to have a high percentage of dead and abnormal sperm. Therefore, semen evaluation of a bull should not be made on one collection alone.

Semen evaluation is being practiced more and more. However, it should be realized that its primary value lies in detecting males that have very definite semen deficiencies such as no sperm, a very low number of sperm cells, poor motility, large number of abnormal sperm (*Figure 2*), a large percentage of dead sperm arid the presence of large amounts of pus. Males producing semen of this sort will usually be sterile or of low fertility. However, there is a wide range of semen quality in males of normal fertility, and it is difficult to predict the level of fertility in a male that does not have grossly deficient semen.

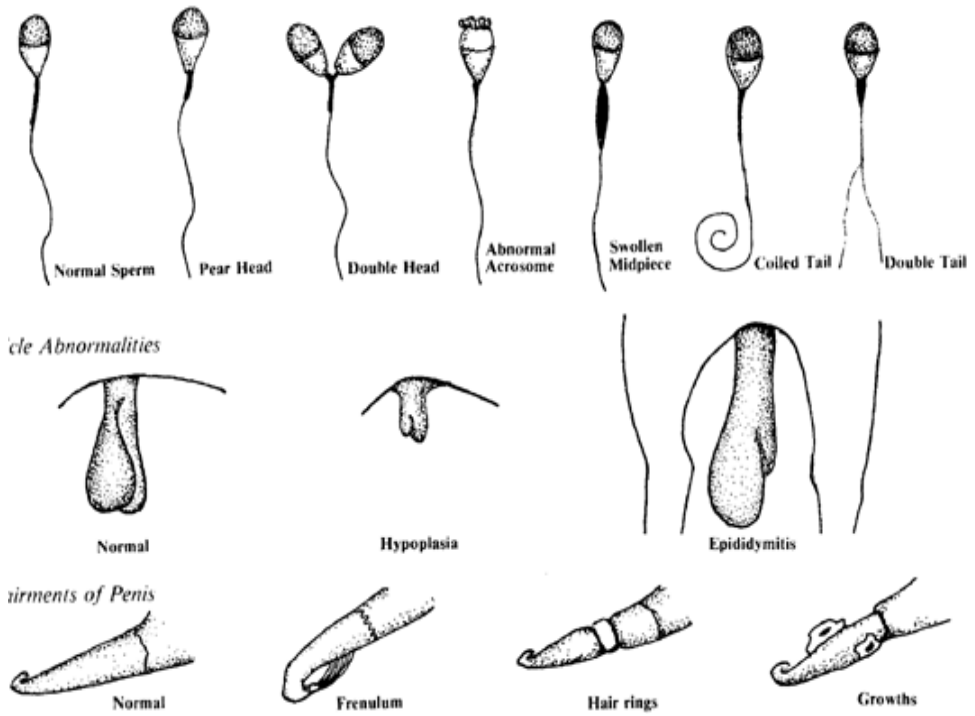

Figure 2. Diagrammatic sketches of some abnormalities and impairments of sperm cells, testicle and penis.

Hormonal Regulation of the Male Reproductive System

The normal functioning of the male in reproduction is largely controlled by hormones. Produced by a specialized gland called an endocrine gland, a hormone is a specific chemical substance which passes into the body fluids (blood and lymph) and is transported to various parts of the body where it produces some specific effect.

The testicle functions as an endocrine gland because of the production of the male hormone, *testosterone*, by the interstitial cells. Testosterone has several major effects:

1. It is largely responsible for the development and maintenance of the male reproductive tract.
2. It causes the development and maintenance of the secondary sex characteristics associated with "masculinity," such as the crest and heavily muscled shoulders of the bull, the spur and comb of the rooster, the tusks of the boar, and the growth of the beard and change of voice in man.
3. It is a major factor in normal sex drive and behavior of the male.
4. It increases muscular and skeletal growth.
5. It is essential for normal sperm formation.

The testicle is, in turn, under the influence of hormones produced by other glands in the body. The primary hormones regulating the testicle are the *gonadotropic hormones* produced by the anterior lobe of the pituitary gland. The pituitary gland is a small gland located under the brain at the base of the skull. The pituitary hormones regulating reproduction in both the male and the female (by stimulating the testes or ovaries) are called gonadotropic hormones.

Not only is the hormonal production by the testicle regulated by hormones released by the anterior pituitary but the reverse is also true. The level of testosterone in the blood regulates the secretion of the

gonadotropic hormones by means of a feedback mechanism.

Purified preparations of gonadotropic hormones or preparations with a similar physiological action are available for use by veterinarians. They can be useful in treating some cases of reproductive failures, *but only if the problem is caused by a deficiency of that hormone*.

Because of the feedback mechanism controlling hormone release, normal functioning depends on a proper balance of the hormones and too much can be just as undesirable as too little. The use of hormone therapy should not be routinely carried out, and should be done only by qualified persons, with the expectation that they may not be of benefit.

[1]Adapted from Great Plains Beef Handbook Fact Sheet GPE-8450 by E. J. Turman and T. D. Rich, Oklahoma State University.

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