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Reproductive Organs
and Hormones of the Bull

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This publication is designed as a teaching aid for the intensified cattle reproduction schools conducted by the Indiana Cooperative Extension Service. It is also included in the Beef and Dairy Production Handbooks for County Extension Workers. The purpose of these publications is to help producers more clearly understand the structure, functions and abnormalities of the reproductive organs of cattle.

Introduction

If a cow fails to conceive after one or a series of services, or she aborts or loses a calf at birth, a loss is created. This loss results from having fewer salable calves or prospective herd replacements, selling non-pregnant but otherwise productive cows for slaughter prices, non-uniform calf crops, and higher labor requirements per cow. In dairy herds, the largest loss is in reduced milk production because of a longer calving interval.

Low reproductive efficiency may be the fault of either the bull, cow, or overall management. Sterility applies to an animal that cannot reproduce; infertility applies to the animal that is neither normally fertile nor totally sterile.

The primary purpose of the bull's reproductive organs is to produce and transport the male reproduction cells or sperm to the female's reproductive tract. Other secondary functions of the various parts of the bull's tract are to: (1) manufacture fluids which are necessary to carry and nourish the sperm, and (2) produce certain chemical substances (hormones) which are necessary for normal development and maintenance of a bull.

Organs of the bull

The reproductive or genital system of the bull (shown in Figure 1) is composed of the scrotum, testes, duct system, accessory glands, penis, and sheath.

The scrotum is a sac or pouch in which the testes are suspended below the body cavity. The scrotum has two functions: (1) provides protection for the testes, and (2) regulates the temperature of the testes. The scrotum maintains the temperature of the testes between 6 and 10 degrees Fahrenheit below the body temperature. It does this by relaxation or contraction of the scrotal muscles. For instance, in cold weather, these muscles contract and pull the testes closer to the body for added warmth.

The testes or testicles are paired oval structures suspended within the scrotum with the aid of the cremaster muscles. Inside each testis, sperms are produced in thousands of microscopic tubules (spermiferous tubules). The cells which line these small tubules divide and form immature sperm which are
The tail of each epididymis joins a vas deferens, which carries the sperm upward to a point near the urinary bladder. Near the top of the testes the vas deferens combine with blood vessels and nerves which provide nourishment and nervous control of the testes. These vessels and nerves compose the spermatic cord. This cord is severed or crushed (depending on the method used) in castration. However, since the blood vessels, nerves, and vas deferens are capable of regeneration (re-growing their connections), using a knife in castration is the best method.

As the spermatic cord extends toward the backbone of the bull, the vas deferens separate from the blood and nerve supply. Along the top and rear of the bladder the vas deferens unite. The walls thicken and become more muscular. The thicker part of the tube is called the ampulla.

Two vesicular glands are located in the same area as the ampulla. These glands secrete fluids which carry several substances necessary to keep sperm alive. The vesicular gland secretions make up about 50 percent of the volume of bull semen.

The urethra serves as a passageway for both semen and urine and extends from the bladder through the penis. The vesicular glands and the vas deferens open into the urethra at approximately the same location.

The prostate gland surrounds the urethra between the vesicular and the bulbourethral glands and secretes a thick fluid directly into the urethra.

The bulbourethral glands are paired, round bodies about the size of walnuts located above the urethra. The two openings of the bulbourethral glands are situated so that their secretions flush the urethra partially free of urine before ejaculation. These secretions are the preliminary fluids which appear before actual ejaculation.

Figure 1. Diagram of the bull’s reproductive system

moved to larger tubules at the core of each testis. Special cells in the testes also produce the primary male hormone, testosterone, which is secreted into the bloodstream and circulated throughout the body. The tubules at the core of each testis conduct the immature sperm upward to the top of the testis where they enter the head of the epididymis. There are three sections of each epididymis: the head, body, and tail. If an epididymis from an adult bull was straightened out, it would be more than 120 feet in length.

In the epididymis, fluids are absorbed from the sperm suspension and the sperm go through further stages of development. Sperm are stored in the tail of the epididymis until ejaculation. About 7 or 8 weeks are required from the time a sperm begins formation in the testes until it is mature.
As the urethra passes downward, it is S-shaped when the penis is not erect. The S-shaped portion is called the sigmoid flexure. It is in this area that "stones" or calculi may accumulate and interfere with normal urination.

The retractor penis muscle connects the lower portion of the sigmoid flexure to the lower side of the rectum. This muscle serves to retract the penis and keep it in the sheath during relaxation.

The urethra continues beyond the sigmoid flexure through the penis, which is the terminal outlet for both semen and urine. The glans penis has many nerve endings, and is the most sensitive part of the penis. The sheath in the bull is long and narrow and serves to protect the penis during relaxation.

Onset of sexual maturity

Sexual maturity, or puberty, is the time in the animal's life when it normally becomes capable of reproduction. Bulls usually reach puberty at from 8 to 12 months of age, depending on breed and nutritional level. However, bulls should not be used for extensive breeding until at least 20 months of age.

From birth to puberty the bull's reproductive tract goes through a period of growth and development. This growth is brought about chiefly by hormones, which are chemical substances manufactured by glands located in different parts of the body. These hormones are usually secreted into the bloodstream and carried with the blood to other glands and tissue. Once the hormones reach a particular gland or tissue, they change the activity or growth of that gland or tissue.

In the immature bull the hormonal action is less complex than in the heifer. The pituitary gland, located at the base of the brain, produces hormones which stimulate the onset of sexual maturity. The pituitary consists of two parts: the anterior lobe and the posterior lobe. The posterior lobe is believed to play a minor role in development of the bull's reproductive system. However, development and maintenance of reproductive glands and organs, development and maintenance of masculine appearance, involved with FSH and LH in spermatogenesis, sexual behavior, faster, more efficient weight gains, leaner carcasses, increased rate of metabolism.

Figure 2. Main functions of (FSH), (LH) and testosterone
the anterior lobe produces two substances: (1) follicle stimulating hormone (FSH), and (2) luteinizing hormone (LH), which are very important. FSH is found in high concentrations in the developing bull fetus and stimulates growth of the testes and spermatogenesis (sperm production). As puberty approaches the LH concentration increases, further stimulating sperm production and release. LH also stimulates certain cells in the testes to produce a third hormone, testosterone. Testosterone passes directly into the blood stream and is carried throughout the body. These three substances (FSH, LH, and testosterone) continue to be produced in the mature bull. Figure 2 gives a sketch of the generally accepted functions of these three hormones.

Sperm

Figure 3 shows a microscopic view (magnified about 2000 times) of bull sperm. In the bull approximately 5 billion sperm are ejaculated at each service. Mature bulls may produce upwards of 70 billion sperm each week.

Figure 3. Bull sperm at approximately 2000 magnification

A sperm consists of two parts, the head and the tail. The bull's genetic contribution (genes) is carried in the head. Although the tail may help to propel the sperm it is questionable if the tail is necessary for fertilization of the egg.

Although 5 billion sperm may be ejaculated at one service, normally only one sperm unites with an egg to form the new individual. The rest of the sperm are wasted. One advantage of artificial insemination is that 300 to 1000 cows may be inseminated artificially with the sperm contained in one ejaculation.

Ejaculation of semen

In the bull the penis is rigid even when non-erect. The erection is due partly to the temporary inability of blood to drain freely from the penis. However, most of the actual length of the erect penis is due to a straightening of the sigmoid flexure.

During the courtship or teasing period, the sperm are transported from the tail of the epididymis. At the same time, contractions of the secondary glands (vesicular, prostate, and bulbo-urethral) force their fluids into the urethral cavity where the fluids are mixed with the sperm. The resulting mixture of sperm and fluids (semen) is then propelled to the outside through the penis by muscular contractions of the reproductive tract.

Semen testing

There have been many different tests performed on semen samples in an effort to estimate the fertility of bulls. These include percent of sperm that are alive, degree of motility, percent of sperm of abnormal size or shape, concentration of sperm in the semen and chemical tests involving the activity of the sperm.

None of these tests can reliably rank bulls according to their actual fertility. However, some of the measures, such as sperm concentration, motility score, and percent alive, if used correctly, can identify bulls which are completely sterile or of very low fertility.
Collection of semen

There are two primary methods of collecting semen for testing or artificial insemination: (1) artificial vagina, allowing a bull to mount a cow, steer, or dummy, and diverting the ejaculated semen into a collection device; and (2) electrical stimulation, inserting a special electrode into the rectum, stimulating certain parts of the reproductive tract, and collecting the semen.

The most desirable method is the artificial vagina, because of the more representative semen sample that is obtained. The electro-ejaculation method is usually used on young, inexperienced bulls or on bulls which are not able to mount a cow.

Inherited abnormalities and weaknesses

Hereditary abnormalities are conditions passed genetically from parent to offspring. Some of these are detectable at birth, while others cannot be known until maturity.

Cryptorchidism is a condition in which one or both testes remain in the abdominal cavity. The testis or testes remaining in the body cavity usually do not produce sperm because of the high body heat. Cryptorchidism, if bilateral, results in sterility, and if unilateral (monorchidism), results in a reduced sperm count and a fair degree of fertility.

Scrotal hernia is a condition first noticed as an enlargement near the upper part of the scrotum. This enlargement is caused by the intestines and related structures passing through the body wall and into the scrotal area. When a bull with a scrotal hernia mounts a cow, a portion of the intestines may pass into the scrotum. The increased heat and pressure from the hernia interferes with normal breeding and can lower the bull’s fertility or even cause sterility.

There are several abnormalities of the penis and sheath which seem to be genetically conditioned. Some abnormalities found in beef bulls include the inability to retract the penis, the protrusion of the penis beyond the sheath, and an abnormally curved penis.

Other abnormalities may also cause infertility or sterility. For instance, small parts or complete sections of the duct system may be missing or incorrectly formed, thereby preventing normal production or passage of the semen.

Generally, longevity and the degree of fertility are not believed to be highly heritable. However, there are lines of breeding which tend to be of lower fertility than other lines.

Structural soundness of feet and legs is highly important in a herd bull and cow herd. Many structural weaknesses are also inherited. An unsound herd bull is a poor investment. A thorough physical examination and a semen test by a veterinarian before the purchase or sale of a bull, and annually thereafter, helps eliminate some of the reproductive problems with bulls.