Babcock Institute for International Dairy Research and Development

University of Wisconsin-Madison

Dairy Essentials

8) THE REPRODUCTIVE FUNCTION OF DAIRY CATTLE

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OVERVIEW OF THE COW'S REPRODUCTIVE TRACT

The reproductive tract of a cow is located beneath the rectum—the last segment of the large intestine (Figure 1). Most parts of the reproductive tract can be examined indirectly when an arm is extended into the rectum (rectal palpation):

- The cervix can be manipulated during artificial insemination;
- The follicles or corpus luteum may be identified on the ovaries;
- The presence of a growing embryo in the uterus can be detected.

The uterus, oviducts and ovaries are suspended in the body cavity by a broad ligament. The position of this ligament permits the uterus to accommodate a growing fetus.

Vagina

The vagina is a flattened tube, normally of about 30 cm long. It is the site of semen deposition during natural service. The vagina serves as a passageway for the instruments used for artificial insemination and for the emergence of the calf at the time of birth.

Cervix

The cervix is a strong muscle about 10 cm in length and 2.5 to 5 cm in diameter. It is pierced in its center by a narrow canal (Figure 1). The canal is usually closed (and sealed during pregnancy) except during heats and at birth. The cervix is a very effective "control gate" that prevents any foreign material from invading the uterus and, in effect, isolates it from the outside world.

Uterus

The uterus is the part of the reproductive tract where the developing calf is carried. In a non-pregnant cow, the body of the uterus is less than five centimeters long, and has left and right horns that curve like those of a ram (Figure 1). The uterus is a muscular organ capable of enormous expansion to accommodate a growing calf. By the end of a pregnancy, the uterus contains a calf of 35 to 40 kg, 20 to 30 kg of fluid, and five kg of placental tissue (afterbirth). After calving, it takes about 40 days for the

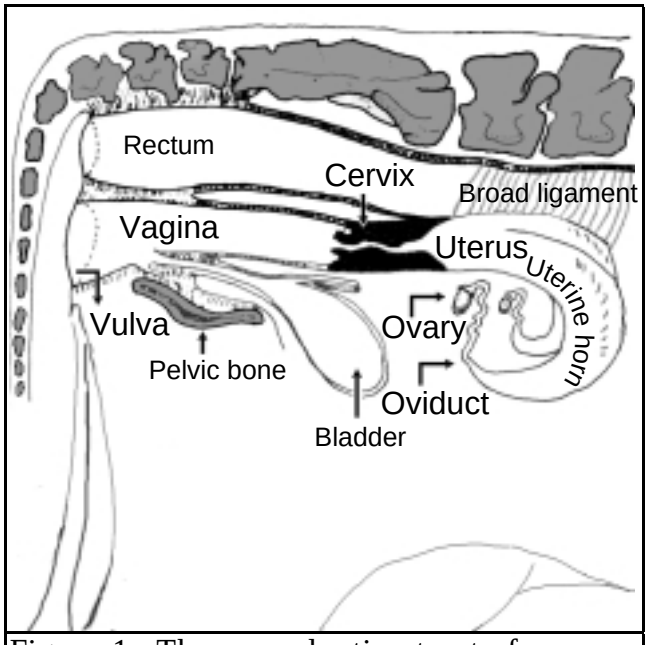

Figure 1: The reproductive tract of a cow

uterus and other parts of the reproductive tract to regain their non-pregnant size (this process is called involution).

Oviducts

The oviducts are the two convoluted tubes that join each of the uterine horns to one of the cow's two ovaries; they are more than 20 cm in length and only 0.6 cm in diameter. The end of each oviduct opens into a funnel-shaped structure (infundibulum); this structure collects the egg that is ejected from the ovary during heat. Fertilization, or the union of the egg and a spermatozoon, occurs in the oviduct. The embryo stays in the oviduct for three or four days before moving into the uterus. This period of time is necessary for the uterus to prepare itself to receive a growing embryo.

Ovaries

In a non-pregnant cow, the ovaries are oval (shaped like an egg), about four to six cm in length and two to four cm in diameter. The major functions of the ovaries are to:

- Produce a mature egg or ovum every 21 days when the cow has a normal estrous cycle;
- Secrete hormones that:
  - —Control the growth of an egg within the ovary;
  - —Change the cow's behavior during estrus;
  - —Prepare the reproductive tract for possible pregnancy.

One of two structures predominates at the surface of an ovary: either a follicle containing a maturing egg, or a corpus luteum (yellow body) which grows from what remains of a follicle after the egg has been expelled (ovulation).

Egg or Ovum

In contrast to all other cells in the body, each egg contains only one copy of the genetic information contained in the chromosomes. Eggs are found in the ovary before birth, but maturation of the eggs begins with sexual maturity at puberty (12 to 14 month of age) and the onset of heat cycles.

THE HEAT CYCLE

The heat cycle is the interval (21 days average length) between two heats (Figure 2). A heat, or estrus, lasts six to 30 hours and is the period of sexual receptivity (Day 1 of a cycle).

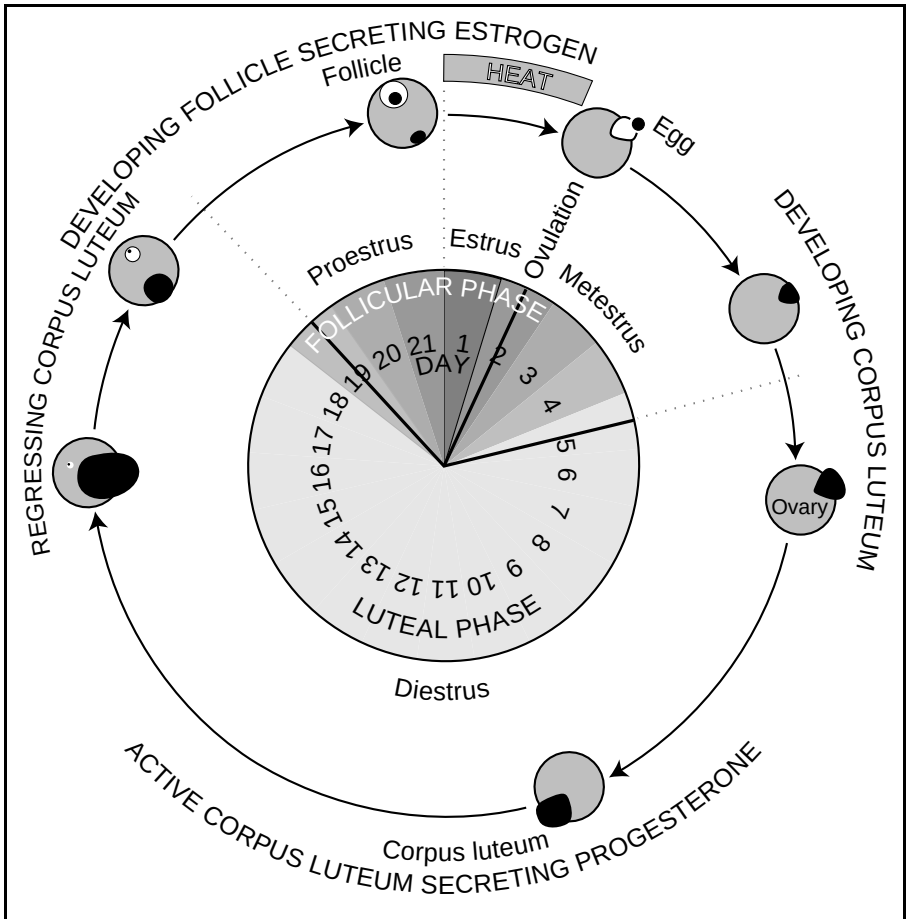

Figure 2: The estrous cycle

Follicular phase

Toward the end of a heat cycle when an egg reaches maturity, it is enveloped in a series of coating cells and is surrounded by nutritive substances. The entire structure is called a follicle and it secretes estrogen, a hormone that changes the behavior of the cow in heat. It is only during a heat that a cow allows herself to be mounted by a bull or other cows. During heat, the egg and the follicle reach the final stages of maturation.

At ovulation (12 hours after the end of signs of heat), the follicle "explodes," the egg is propelled into the oviduct and the remaining cells on the ovary begin to form a new structure called a corpus luteum. The corpus luteum secretes a hormone called progesterone that prevents the complete growth of follicles and is necessary to maintain pregnancy.

Corpus luteal phase

The complete development of a corpus luteum takes about three days (Days 2 to 5 of a cycle). Although some follicles start to grow on Day 1 of the cycle, the progesterone secreted by an active corpus luteum prevents them from maturing and they degenerate. On Days 16 to 18 of a cycle, if the uterus has not detected the presence of an embryo, it will send a hormonal signal (prostaglandins) that causes the corpus luteum to regress. This regression removes the inhibition of the final phases of follicular growth and allows a dominant follicle to complete its maturation. This leads to a new heat and the beginning of a new cycle.

In the case of pregnancy, the uterus and the embryo send hormones that help maintain the corpus luteum throughout the entire pregnancy.

OVERVIEW OF THE BULL'S REPRODUCTIVE TRACT

The testes of the bull produce the male sexual cells or spermatozoa which, like the egg, contain only one copy of the genetic information necessary to constitute an individual. Although the male sexual organs (Figure 3) begin to produce hormones before birth, the production of spermatozoa begins only at puberty (seven to 12 months of age).

Scrotum

The scrotum is the sack located outside the abdominal cavity that contains the testes. By adjusting the distance between the testes and the body, the scrotum regulates the temperature of the testes. This is necessary because the formation of spermatozoa functions better at a temperature 2 to 4°C lower than normal body temperature.

Some bulls have only one testis in the scrotum. This descended testis will function properly, but the one that remains in the body cavity will not. This condition is inherited and these bulls should not be used so the propagation of this defect will be avoided.

Testes

The testes have two main functions:

- To produce viable, fertile spermatozoa;
- To produce male hormones.

Each testis is enveloped in its own compartment and each is a complete, independent unit. The testes are primarily made of small tubules (seminiferous tubules) where the production of spermatozoa takes place. Some specialized cells (called leydig cells

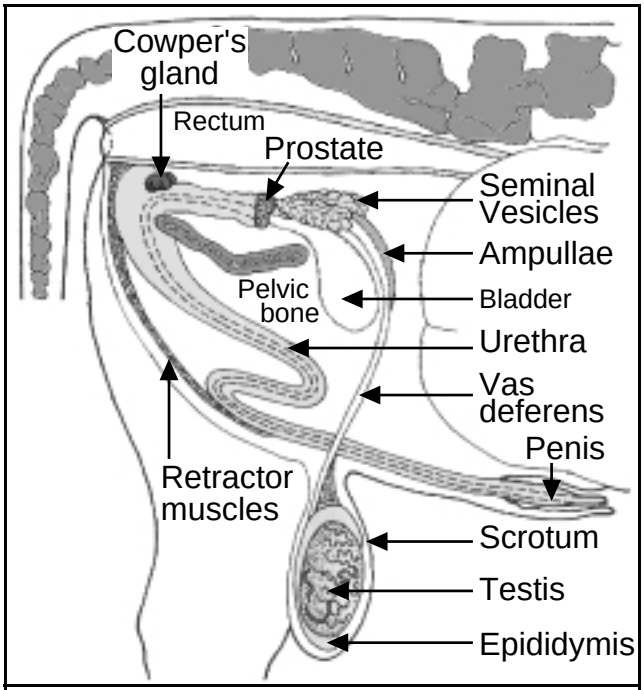

Figure 3: The reproductive tract of a bull

or interstitial cells) are dispersed throughout the tissues of the testes and produce testosterone, the predominant male hormone. This hormone is important:

- For the formation of normal spermatozoa;
- To determine the sex drive of the bull (libido);
- To maintain the normal activity of the secondary sex organs (prostate, seminal vesicles and Cowper's glands—Figure 3).

At the time of mating, before the sperm is ejaculated, the spermatozoa are mixed with secretions rich in nutritive substances from the secondary sex organs.

FORMATION OF THE SPERMATOZOA

It takes about 64 to 74 days for the formation of spermatozoa and 14 to 18 days for a sperm to travel through the epididymis (site of accumulation and final maturation of spermatozoa). Thus symptoms of bull infertility may occur two and a half to three months after the process of sperm formation has been impaired. In general, sperm formation increases with the weight and diameter of the testes. Thus larger and older bulls (that are likely to have larger testes) usually produce more sperm than smaller or younger bulls. The secretion of the accessory glands contributes, on average, up to 80% of the total volume of the ejaculated semen. A young bull coming into service produces as little as one or two ml of semen per ejaculation whereas a fully mature bull may produce 10 to 15 ml of semen per ejaculation. In general, when a bull serves a second, or even a third time in succession, the volume of ejaculate does not decrease, but the concentration of spermatozoa tends to decrease. Frequent ejaculations do not usually affect an adult bull's fertility, but a young bull should be used more carefully.