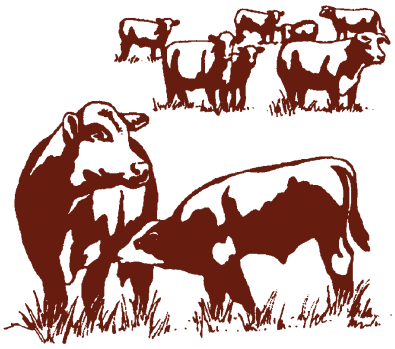

Beef Cattle Handbook

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Reproductive Tract Anatomy and Physiology of the Cow

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Anatomy

A diagrammatic sketch of the reproductive tract of the cow is presented in Figure 1. The female reproductive tract of various farm animals have similar parts to those shown for the cow, but with major differences in the shape of the uterus.

The *ovary* is the primary reproductive organ of the female and has two important functions: (1) production of the female reproductive cell, the *egg* or *ovum* and (2) production of two hormones, *estrogen and progesterone*. Each of the two ovaries of the cow are oval to bean-shaped organs 1 - 1½ inches long, located in the abdominal cavity.

The secondary sex organs are, in effect, a series of tubes which receive the semen of the male, transport the sperm to the egg so it can be fertilized, nourish the fertilized egg (*embryo*), and expel the offspring. These organs include the *vagina, cervix, uterus, uterine horns,* and *oviducts* (also called *Fallopian tubes*) which have a funnel shaped opening called the *infundibulum.*

The ovary produces the egg by a process called *oogenesis*. In contrast to spermatogenesis in the bull, which is continuous, oogenesis is cyclic. This cycle, (called the *estrual cycle*), is of a characteristic length, depending on the species, and consists of a definite sequence of events, both of a physiological and a

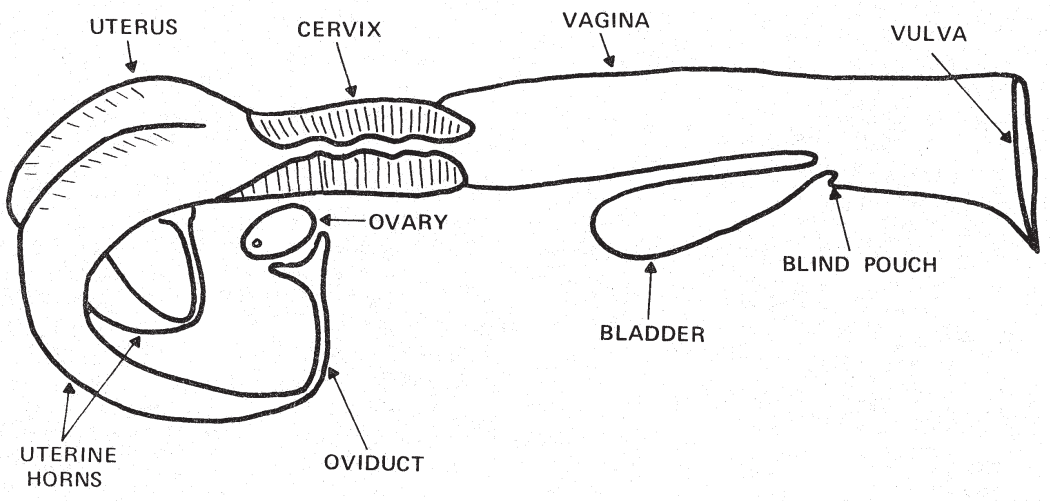

Figure 1. Diagrammatic Sketch of the Reproductive Tract of the Cow.

behavioral nature.

The ovary contains several thousand tiny structures, called *primary follicles*, which consist of a germ cell surrounded by a layer of cells. This germ cell has the potential to mature into an egg if the follicle completes development. However, most of the primary follicles never complete development. Rather they die, are absorbed by the ovary and replaced by newly formed primary follicles.

The relatively few primary follicles which complete development do so through a series of developmental phases. Many layers of cells are added to the single layer of cells surrounding the egg in the primary follicle, and a central cavity forms. As the follicle and the cavity grow larger, the egg is attached by a stalk of cells to the back side of the follicle opposite the site of ovulation. As the follicle continues to grow rapidly, the side opposite the egg bulges from the surface of the ovary and becomes very thin. This follicle is then mature and called a *Graafian follicle*. At ovulation, the thin portion ruptures to release the contents of the follicle, including the egg.

Following ovulation, the cells that developed within the follicle differentiate to form the *corpus luteum*. The corpus luteum has the very important function of producing progesterone.

The released egg is caught by the infundibulum and moves into the oviduct where fertilization occurs if viable sperm are present. The egg remains capable of fertilization for only a few hours; thus, it is very important that fertile sperm be present near the time of ovulation. The egg moves through the oviduct into the uterus within the next 3 - 4 days. If it is fertilized, it begins embryological development in the uterus. If it is not fertilized, it degenerates and disappears.

The body of the uterus of the cow, as well as that of the ewe and sow, is short and poorly developed while the uterine horns are relatively long and well developed. The embryo develops in the uterine horns in these species. In the mare the uterine horns are poorly developed and embryological development occurs in the body of the uterus. Wherever it occurs, the fetus develops within a layer of membranes, called the *placenta*, through which nourishment from the mother diffuses, since there is no direct blood connection between fetus and mother.

The cervix is, in effect, the neck of the uterus. It has thick walls and a small opening that is difficult to penetrate in the cow because of overlapping or interlocking folds. It serves as a passageway for sperm deposited in the vagina and for the fetus at the time of birth. During pregnancy it is usually filled with a thick secretion which serves as a plug to protect the uterus from infection entering from the vagina.

The vagina serves as the receptacle for the male penis during service. In the cow, the semen is deposited in the vagina near the cervix, although in some other species the cervix may be penetrated. The urinary bladder opens to the exterior through the urethra which opens into the vagina. This region of the cow's vagina is restricted in size because of sphincter muscles associated with the urethral opening. The region posterior to the external urethral orifice is called the *vestibule* and is a common passage way for both the urinary and the reproductive systems. The external opening of the vagina is called the vulva.

Hormonal Regulation of the Female Reproductive Tract

Normal reproduction in the female depends upon hormones, which are specific chemical substances produced by specialized glands, called *endocrine glands*. These secretions pass into the body fluids (blood and lymph) and are transported to various parts of the body where they exert several specific effects.

The female hormone, *estrogen*, is produced by the Graafian follicle. A second hormone of the ovary is *progesterone* produced by the corpus luteum. Each has an important role in the female reproductive process.

Estrogen has varied effects:

(1) responsible for the development and functioning of the secondary sex organs, (2) responsible for the onset of heat, *estrus*, the period of sexual receptivity, (3) affects rate and type of growth, especially the deposition of fat, and (4) primes or prepares the prepuberal heifer and post-partum cow for onset of sexual activity.

Progesterone is the hormone of pregnancy. It suppresses the further development of follicles and secretion of estrogen. While progesterone is being produced, the female does not come into heat. Progesterone is necessary for preparing the uterus to receive the fertilized egg and maintains the proper uterine environment for the maintenance of pregnancy.

Estrogen and progesterone are not completely separate in their effects since both are necessary for complete development of important organs. The deveopment of the uterus is initiated by estrogen and completed by progesterone. The fertilized egg will not implant and survive in the uterus unless that tissue has been properly prepared by the action of estrogen, and then of progesterone. Estrogen causes rhythmic contractions of the uterus. Progesterone, on the other hand, has a quieting effect on the uterus, so there are no contractions which might disturb pregnancy.

Complete development of the mammary gland is also dependent upon both hormones. Estrogen promotes the growth of the duct system and progesterone is necessary for the development of the clusters of milk-secreting alveoli on the ducts.

Thus, it can be seen that, in general estrogen makes things happen and progesterone calms them down.

As in the male, the production of the hormones of the ovary is under the direct influence of the *gonadotrophic hormones* of the anterior pituitary gland, located at the base of the brain. The names follicle stimulating hormones (FSH) and *luteinizing hormone* (LH) were given because of the effects of these hormones on the female. FSH stimulates the growth, development and function of the follicle, while LH causes the rupture of the follicle and development of the corpus luteum.

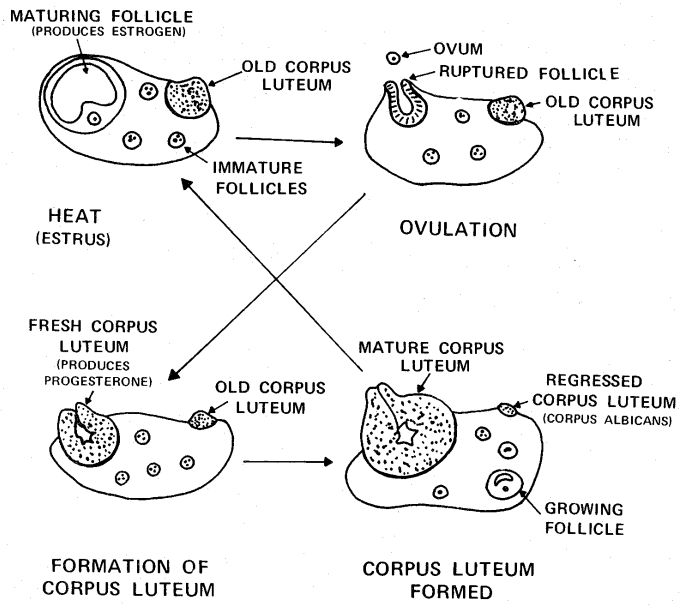

Figure 2. The Sequence of Events in a Typical 21-day Estrous Cycle in Which Pregnancy Does Not Occur

The Estrual Cycle

The reproductive cycle of the cow consists of a series of events which occur in a definite order over a period of days. The estrual cycle in the cow averages 21-days (range is 17 - 24) and is concerned with preparing the reproductive tract for *estrus* or *heat* (the period of sexual receptivity) and *ovulation* (the release of the egg). Figure 2 outlines the sequence of events and hormones involved for a typical 21-day cycle in which pregnancy does not occur.

Day 0: The cow is in estrus (standing heat). Near the end of the standing heat, the mature *Graafian follicle* ovulates (ruptures) in response to a surge of LH released by the pituitary gland.

Day 1-2: The cells that formerly lined the follicle change and become the lutein cells of the corpus luteum. This change in cell form is caused by hormonal action, primarily the action of LH.

Day 2-5: The corpus luteum grows rapidly in both size and function. At this stage, numerous follicles may be seen on the ovary but by day 5 they have begun to regress.

Days 5-16: The corpus luteum continues to develop and reaches its maximum growth and function at about day 12. It secretes the hormone progesterone which inhibits (blocks) LH release by the pituitary gland. During this period, the ovaries are relatively inactive except for the functional corpus luteum. No follicles reach maturity and/or ovulate because of the existence of the high levels of progesterone.

Days 16-18: The corpus luteum regresses rapidly due to some luteum activity of the uterus (prostaglandin).

Days 18-19: The corpus luteum is almost nonfunctional and this releases the blocking action of progesterone. Of the several follicles that commence growth, one becomes more prominent by a surge in rapid growth and activity. As the Graafian follicle grows, it secretes increasing amounts of estrogen. The remainder of the follicles regress.

Days 19-20: With the increase in estrogen release by the Graafian follicle and a corresponding decrease in progesterone by the regressing corpus luteum, estrus or heat will occur (cycle has now returned to day 0). The high estrogen level in the blood triggers a release of LH near the end of heat. Following this surge in blood levels of LH, the mature follicle ruptures to release the egg and the cellular tissue left behind becomes *luteinized* in response to the stimulation of a hormonal complex to form a new corpus luteum (cycle has now returned to day 1-2). Progesterone again becomes the dominant hormone.

It must be appreciated that the timing given for the preceding events is only approximate, and would differ for different cycle lengths.

Also, the discussion of events occurring during the estrous cycle was based on a full cycle in which pregnancy does not occur. If the egg is fertilized and begins development in the uterus, the corpus luteum does not regress but continues to function by secreting progesterone. No follicles develop to maturity and heat does not occur. Progesterone keeps the uterus quiet and thus provides the most favorable conditions for the developing fetus.

Any condition that prolongs the period of time that blood levels of progesterone remain high (such as implanting, injecting or feeding progestin materials for estrus synchronization) will have the same effect as does pregnancy. Occasionally, the corpus luteum does not regress normally even though the animal does not become pregnant. This requires the diagnosis and treatment of a veterinarian.

Occasionally, abnormally short estrous cycles (7 - 11 days) occur and this condition appears to be caused by, either no corpus luteum being formed, or if one is formed, it is nonfunctional as progesterone levels remain low.

Most animal species, including all farm livestock, are *spontaneous ovulators*, which means ovulation occurs at a certain time during the estrous cycle whether mating occurs or not. Females from some species are *induced ovulators* and ovulation occurs only following the stimulus of mating. Included in this group are the rabbit, cat, and mink. In these species it has been established that ovulation is the result of LH secretion in response to nerve impulses resulting from the mating act. Thus, both hormonal and nerve pathways are important factors in the reproductive process.

There are wide differences between the species of mammals in the various characteristics of the estrual cycle. Some species have only one heat period each year and are called *monoestrous.* The cow is in a group that exhibit heat more than one time per year and is called *polyestrous.* There is considerable variation in the

latter group, however, from those having estrus continuously throughout the year to those that have only a few cycles during a restricted season. Most wild animals and sheep among the domestic animals are said to be *seasonal breeders*. The non-breeding period is called anestrus.

Species that are considered to be continuous breeders (such as the cow) are not without periods of anestrus during which the estrous cycles stop. For example, anestrus is commonly observed in cows, especially young cows, when nursing calves and subsisting on low planes of nutrition.

Estrus is not always accompanied by ovulation, nor ovulation by estrus. Heat without ovulation (*anovulatory heat*) will not result in pregnancy even though the female is bred. Ovulation without the external signs of heat (*quiet or silent heats*) is not uncommon in cows, especially the first few weeks after calving. Such females will not accept service .

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