Activity L

1. How do you detect when a cow, sheep or goat is on standing heat?

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.1.1.1.1. Ovulation

Ovulation is the process by which the ovum (egg) is released from the ovary. Among farm mammals, the cow and mare usually ovulate just one ovum per estrus period, although multiple births sometimes do occur because of the ovulation of two or more ova. It is also possible for two or more offspring to develop from a single ovum. Multiple births are common among sheep and goats. Ewes may ovulate from one to five ova during a single estrus period. In swine, gilts[1] may ovulate from 10 to 12 ova, and sows 15 to 20 or more. In cattle when there is a twin birth of a male and female these animals are sterile and are called Freemartins.

The number of ova developing into young at birth depends to a certain extent on the amount of space and nutrients available to them in the uterus and on other factors, some of which are unknown. Production of more than the usual number of ova may be induced in females by the administration of gonadotropins[2] containing FSH, during proestrus, when follicles normally develop.

Ther are three types of ovulation:

- Superovulation
- Spontaneous and
- Induced

Production of more than the usual number of ova is known as *superovulation*.

Ovulation among different species is often referred to as being *spontaneous* or induced. The cow, ewe, mare, and sow ovulate spontaneously, that is, when follicles develop and the ova mature. Ovulation occurs naturally without the influence of some external force.

In the female rabbit, however, ovulation does not occur without copulation, and this type of ovulation is referred to as *induced ovulation*. Copulation in the rabbit sends a neural (via the nervous system to the brain) impulse to the hypothalamus that causes the

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[1] Young female pig.

[2] Of any substance acting as a stimulant upon the gonads (ovary).

anterior pituitary gland to release LH. This hormone causes ovulation. If copulation does not occur, the mature follicles eventually regress and another crop of follicles develop in the ovary. Thus, at least in the active mating season in the mature female rabbit, there are overlapping crops of follicles and ripened ova present in the ovary if copulation and pregnancy do not occur.

.1.1.1.2. Fertilization

Fertilization is the union of male and female *gametes* (sex cells) to form a new individual. The unfertilized egg and each sperm have the haploid[3] number of chromosomes. Fertilization in farm mammals usually occurs in the upper one-half of the oviduct. This means that spermatozoa have a considerable distance to travel from their point of deposition in the female reproductive tract at the time of mating, to the site of fertilization. In some species of mammal, spermatozoa arrive at the site of fertilization in the oviducts, 15 to 20 minutes after mating. Since the rate of travel of sperm from their own motion appears to be only 3 to 4 mm per minute, another force must be responsible for their rapid transport within the female reproductive tract. *Contractions* are probably the most important force responsible for this increase in sperm motility.

Freshly ejaculated spermatozoa from some species must undergo change within the female reproductive tract before they are capable of fertilizing the ovum. This process is referred to as *sperm capacitation*. Although many millions of spermatozoa are usually introduced into the reproductive tract of the female at mating, only a few (1000 or less) actually reach the site of fertilization. This number is sufficient, however, since only one viable sperm is required to fertilize each ovum.

Microscopic studies of the union of the sperm and egg in prepared solutions outside the body (*in vitro*[4] technique), have led to the belief that the sperm and egg meet by chance alone. However, inseminations of the female with a mixture of semen from two of more males indicate that sperm from some males are more likely to fertilize the ovum than are the sperm from other males.

The ovum possesses a cumulus mass of cells, *cumulus oophorus*, when it reaches the site of fertilization. The spermatozoon penetrates this mass of cells by means of its own motility and possibly by means of an enzyme it contains, *hyaluronidase*, which dissolves the *cumulus oophorus*. After penetrating the cumulus

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[3] Having half the number of chromosomes characteristic of the fertilized cell.

[4] *Latin* within glass: said of experiments carried on in test tubes or outside of the living organisms.

mass, the sperm also must penetrate the *zona pellucida*. Many sperm may enter the *zona pellucida* but normally only one penetrates the vitelline[5] membrane to set up a "fertilization block" that prevents the entrance of other sperm. The fertilization block appears to diminish in its efectiveness under certain conditions. One of these conditions is delayed copulation leading to fertilization of aged ova. In such instances, more than one sperm may penetrate the vitelline membrane, leading to the condition known as *polyspermy* (poly meaning "many"). This would lead to the condition known as *polyploidy*,[6] and the developing embryo would possess more than the *2n* number of chromosomes. Polyploidy among larger mammals may be a cause of some embryonic death loss. Possibly, but very rarely in farm mammals, some triploid individuals (possessing the *3n* number or chromosomes) survive to birth.

.1.1.1.3. Pregnancy and Parturition

The period of ***pregnancy*** (gestation) is the time in which the female carries her developing young within the uterus. The gestation period ranges from 110 to 115 days in the sow, 140 to 150 days in the ewe, 272 to 292 days in the cow, and 335 to 345 days in the mare as shown in *Table 2-2*.

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[5] Pertaining to the yolk of an egg or that portion of the contents or substance of the ovum which is used for the nourishment and formation of the embryo.

[6] Having more than two basic chromosome sets in the body cells.

Table ***Error! No text of specified style in document.****-1. Reproductive Data for the Cow, Horse, Pig, Sheep, Dog, Cat, Rabbit, Rat, Mouse, and Man*

Description	Cow	Horse	Pig	Tropical Sheep and Goats	Dog
Puberty	10 - 15 mo.	15 - 20 mo.	5 - 7 mo.	7 mo.	6 - 8 mo.
Age of first Breeding	12 - 15 mo.	2 - 3 yrs.	8 - 10 mo.	12 - 18 mo.	12 - 15 mo.
Length of oestrus cycle	17 - 25 (21) days	21 ± 5 days	18 - 24 days	16.5 days	7 - 8 mo. (?)
Duration of Heat (oestrus/estrus)	12 - 28 (18) hrs.	6 ± 4 days	2 - 3 days	30 - 36 hrs.	7 - 9 days
Time of Ovulation	10 - 15 (12) hrs during heat	1 - 2 days before heat	36 - 40 hrs. after onset of heat	24 - 30 hrs. after onset of heat	1 - 3 days after beginning of heat
Physical Signs	will stand to be mounted	urinates regularly and exhibits vulva contractions (“winking”)	stands still if pressure is applied to the back		red exudate (drippings) from the vulva for about 2 wks.
Optimal Time Service	6 - 18 (12) hrs.	2 days before end	2nd day	8 - 48 hrs. after onset	11 days after dripping begins then 2 - 3 days later
Breed after Parturition	40 - 60 days	30 ± days	4 - 9 days after weaning	4 - 12 wks. post-partum	several months (≅ 4 mths.)
Gestation	283 ± 5 days	338 ± 9 days	114 ± 4 days	145 ± 2 days	58 - 63 days
Litter Size	1	1	8 - 12	1.9 [Range 1 to 4]	7 - 12

mo. – months hrs. - hours

Description	Cat	Rabbit	Rat	Mouse	Man
Puberty	7 - 12 mo.	5 - 8 mo.	36 - 42 days	35 ± 5 days	15.5 ± 2.2 yrs
Age of first breeding	-	-	-	-	18
Length of oestrus cycle	15 - 21 days	16 days	4 - 5 days	4 - 6 days	28.3 ± 5.4 days
Duration of Heat (oestrus/estrus)	4 days	-	13 - 14 hrs. begins 7 p.m.	a few hours	Menst. 5 days
Time of Ovulation	24 - 30 hrs. after mating	spontaneous ovulation 10 hrs. after mating	8 - 11 hrs. after beginning of heat	midnight to 2 - 3 hrs.	14 days
Physical Signs	-	-	-	-	-
Optimal Time Service	-	-	near ovulation	oestrus	10 - 17 days
Breed after Parturition	4 - 6 weeks	4 - 6 weeks post-partum (?)	21 days	24 hrs.	2 - 3 months
Gestation	63 days	30 - 32 days	22 days	18 - 20 days	266 ± 9 days
Litter Size	3.9	4 - 8	6 - 9	6	1 - 2

While the fertilized ovum is moving through the oviduct to the uterus, it survives on yolk and uterine secretions (uterine milk) until contact is made between the maternal and fetal membranes known as *implantation*. After implantation, the developing young obtain nourishment from the mother. Implantation is a gradual process in farm mammals. Present evidence suggests that implantation occurs 10 to 18 days after fertilization in the ewe, 12 to 24 days after in the sow, 20 to 32 days after in the cow, and 35 to 60 days after in the mare.

Several types of abnormal implantations or pregnancies have been observed in humans and may occur in other animals. These types of abnormal implantations include ovarian, tubal, and abnormal pregnancies. The young are seldom, if ever, carried to full term in such pregnancies.

Early in pregnancy, the young develop certain membranes to provide for their protection and nourishment. These are known as ***fetal (extra-embryonic) membranes***.

The ***amnion*** is the innermost membrane that surrounds the fetus. It is filled with a fluid known as amniotic fluid, within which the developing fetus is suspended.

The outer layer of fetal membranes is called the ***chorion***, and it makes contact with the maternal uterine tissues. In ruminants, the chorion attachment to the uterus is of a cotyledonary type, in which contact is made only at certain points on the uterus rather than over its entire surface area. The placental attachment in the mare and sow is of a diffuse type in which contact with the uterus is made over most of the surface area of the chorion.

The outer portion of the ***allantois***[7] is fused with the chorion, and the inner layer with the amnion, forming a sac or space filled with allantoic fluid.[8]

The ***placenta*** is formed by the fusion of the chorion and the uterine mucosa. It has several important functions:

- Transmission of nutrients from mother to young
- Transmission of wastes from young to mother
- Protection of young from shock and adhesions by means of amnioic fluid
- Prevention of the transmission of bacteria and other large molecular substances from mother to young, and
- Secretion of certain hormones

[7] A membranous saclike appendage, for effecting oxygenation and other changes in the blood, developed from the hinder part of the ailmentary tract in the embryos of mammals, birds, and reptiles.

[8] Contains a tissue-forming crystalline substance $C_4H_6N_4O_3$ that occurs in the allantoic excretion of cows and in the urine of most mammals.

The placental barrier in domestic mammals prevents large molecules such as antibodies and some of the fat-soluble vitamins (*e.g.*, vitamin A) from passing in large amounts from mother to young.

Unfortunately, some viruses are small enough to penetrate the placental barrier. They may cause defects in the young if they reach the fetus in the stage of pregnancy when certain body parts are being developed. The developing young are particularly susceptible to viral infection because they have not produced antibodies of their own and have received few, if any, from their mother.

Each developing embryo usually has its own set of membranes, although those of two individuals may fuse, resulting in their having a common blood supply. Twins in cattle, and probably in other species, have common membranes and a common blood supply. Having common membranes and a common blood supply is reported to cause the *freemartin*[9] condition in a heifer born twin with a bull calf. A heifer born twin with a bull is freemartin about 90 percent of the time. The reproductive system of the freemartin female does not develop normally and she is sterile. A scientific explanation of this phenomenon has not been elucidated. This condition usually does not occur very frequently and is very rare in other species of farm mammals.

In the sow, where many young are nourished within the uterus during the same pregnancy, the young are spaced at definite intervals within the uterine horns. If the young are too close together or if the uterus is crowded, some of the developing young fail to survive to birth. Another phenomenon also occurs in the sow to help ensure that there is approximately an equal number of young in both uterine horns: if one ovary produces only one ovum and the other ovary 12, some fertilized ova from the side where many ova were produced will move across to the uterine horn on the opposite side where only one ovum was produced. This mechanism tends to distribute the young evenly within the two uterine horns and is known as *intrauterine migration*.

Even though the gestation period varies greatly in length among species, all young in female farm mammals are born at about the same degree of development or maturity. However, this is not true of all animal species. For example, baby opossums are born about 12 days after the ova are fertilized. They have no fetal membranes at birth. They find their way, in some way, into the pouch of their mother after birth, fasten their mouths to one of the nipples and remain attached to that nipple until they are fully developed. The female opossum normally ovulates 45 to 50 ova and gives birth to 25 or more young, but there are only 12 to 13 nipples available in the pouch, so that no more than this number of young survive.

[9] A female calf twinned with a male calf and generally barren.

Parturition is the act of giving birth to young by the mother. It is preceded by certain activities in females of some species. Female of most species lose their appetite and usually try to find a secluded area where they will have privacy during the birth process. Sows will often build a nest before giving birth to young. The ligaments and muscles around the pelvic region of most females (especially the cow and mare) relax, and usually milk is present 24 to 48 hours before the young are born.

Parturition in farm mammals is initiated by the fetal anterior pituitary gland. The role of the fetal anterior pituitary gland was first demonstrated to be involved in parturition in cattle with prolonged gestation. Pregnancy in these cattle was generally prolonged from 3 to 4 weeks, resulting in birth weights of calves varying between 110 to 163 lb. In such instances the calves were dismembered or delivered by cesarean operation. It was later shown that experimental destruction of the pituitary gland caused prolonged gestation. Animals without a pituitary gland, however, would deliver their young if they were administered ACTH (*adrenocorticotropic hormone*[10]*).* Therefore, ACTH produced by the fetal anterior pituitary gland appears to be the hormone that initiates the process of parturition. The same phenomenon has also been demonstrated in sheep.

Other hormones involved in parturition are:

- Estrogen
- Progesterone
- Prostagliandin ($PFG_2\alpha$)
- Oxytocin
- Relaxin
- Glucocorticoids

As you hopefully remember, ***estrogen*** is found in the ovarian fluids and exercises a specific and critical influence on the sexual cycle.

Progesterone is a hormone from the corpus luteum. It is active in preparing the uterus for reception of the fertilized ovum.

$PFG_2\alpha$ is released to destroy the corpus luteum. This is necessary since high levels of progesterone inhibit uterine contraction.

Oxytocin is a hormone of the posterior lobe of the pituitary gland, believed to facilitate uterine contractions during childbirth.

Relaxin is

[10] Stimulate the cortex of the adrenal glands.

Glucocorticoids are

After progesterone levels are reduced, oxytocin, and PFG stimulate uterine contraction.

Estrogen sensitizes the uterus to oxytocin, and relaxin causes relaxation of the birth canal.

Females should be observed very carefully at parturition to see if the birth process is progressing properly. This is especially important in your young females producing their first offspring.

Normal Presentation of Young

The normal presentation of the young in cattle, horses and sheep is front feet first, with the outstretched head resting on the feet. In swine, both head and hind feet first presentations are normal. Figure 2-7 presents a description of the Normal Presentation of Singles and Twins in cattle. Please refer to module 3: Unit 1, Section 3.1.7 for presentation in sheep.

Abnormal Presentation of Young

Various abnormal presentations are encountered among animals. These include one or both legs folded back, the neck bent backward, or a posterior presentation (except in swine, where the young are normally born hind feet first).

NOTE: Posterior presentations in cattle are of particular importance because when the connection of the umbilical cord with the uterus is severed, fetal blood flow from the mother ceases and the young has no oxygen supply. Unless delivered promptly, the calf may perish from lack of oxygen.

Figure 2-8 gives the different types of abnormal presentations (dystokias) in the female bovine. Figure 2-9 gives the description of how to attach a chain or rope to the leg of a calf to assist in extraction of an abnormal presentation.

Figure 2-7. Normal Presentation of singles and twins in the female bovine

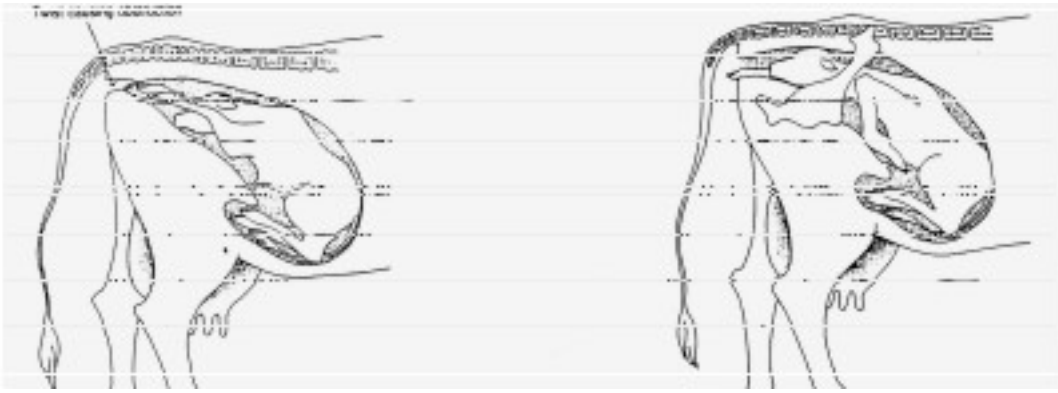

Figure 2-8. Abnormal Presentations (dystokias) in the female bovine

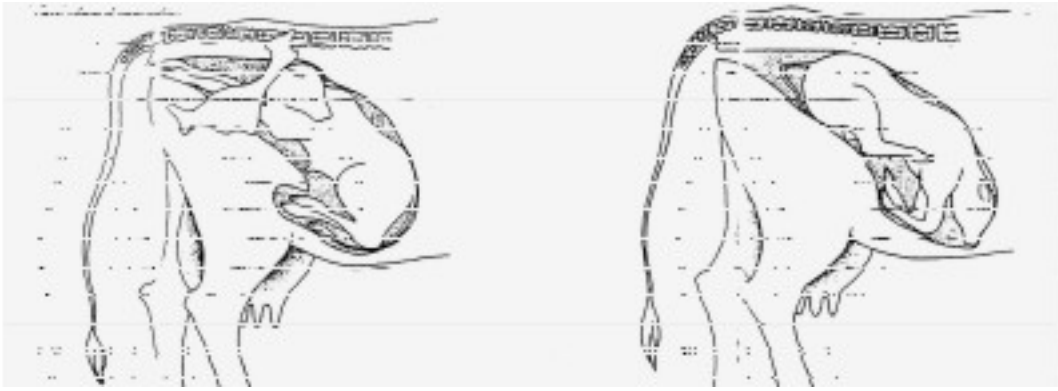

Figure 2-8. Abnormal Presentations (dystokias) in the female bovine

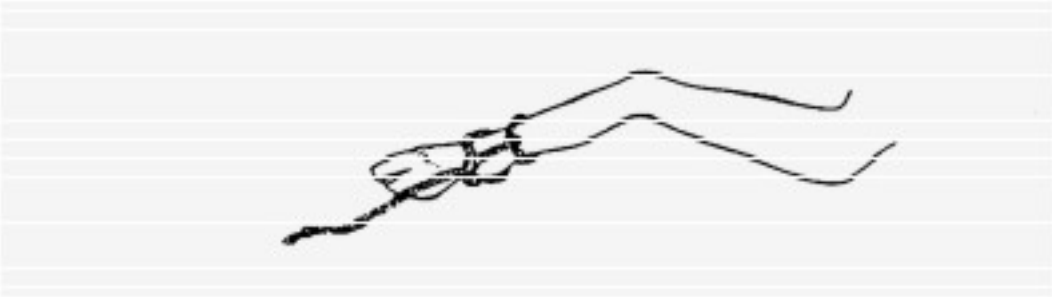

Figure 2-9. Attachment of calving chain or rope

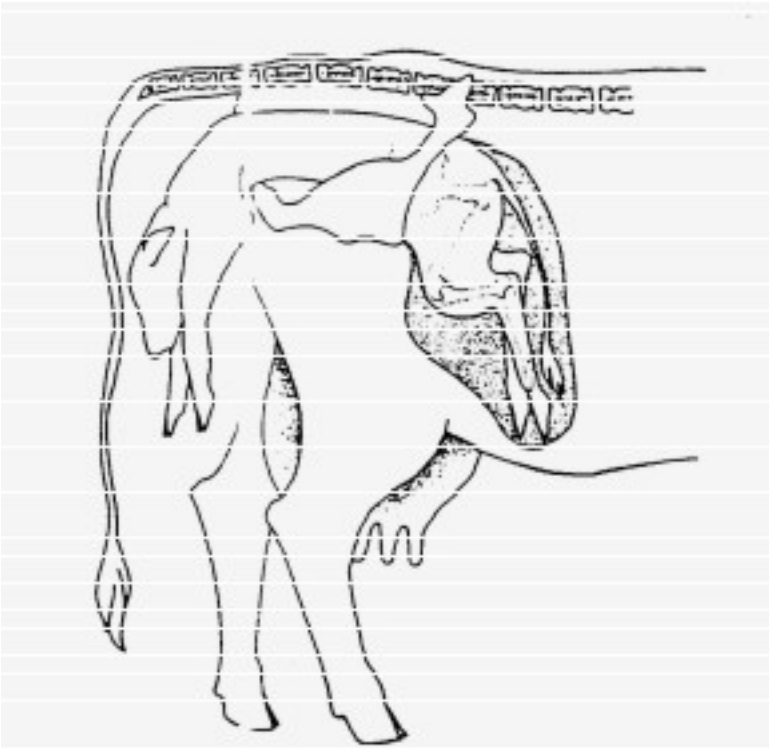

Figure 2-10. Hiplock

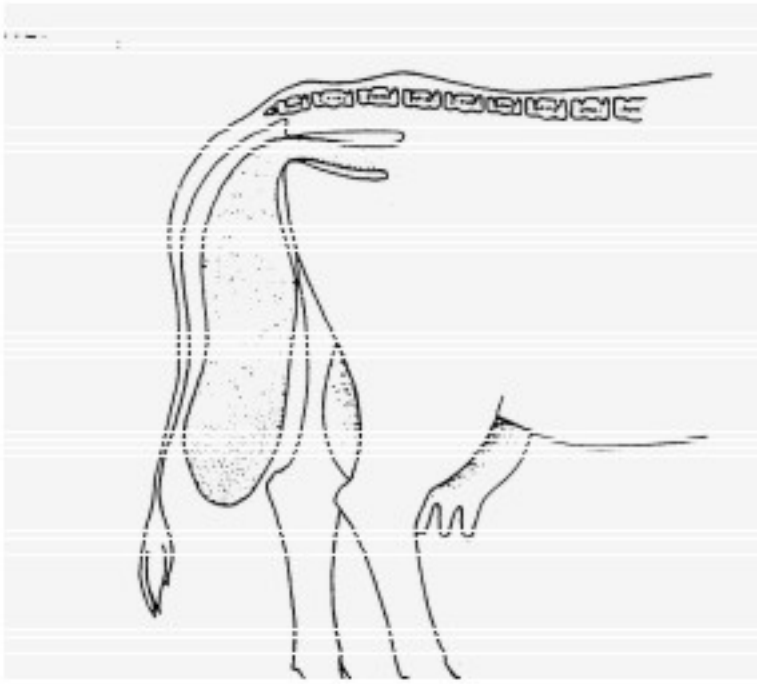

Figure 2-10. Uterine Prolapse

Do's & Don'ts!

Do study the Contents of Table 2-2 and understand how to use the information in the breeding of the farm animals you have under your control.

Highlights

Reproduction is controlled mainly by hormones. The female animal is the more important half in reproduction, but the male contributes equally with the female to the genetic makeup of the off-spring.

Conclusion

Now that you understand the marvelous process known as reproduction, do you not marvel at the wonder that is nature? Sit down and think of the whole physiological functions: from hormones to organs, from chromosomes to sperm to ovum, from puberty to pregnancy to birth. In your next unit, you will encounter the new wonder of lactation and process of how the mother manufactures food to nourish her young.

Worksheet -

Activity P

1. Draw a diagram of the male reproductive system and label the parts.
2. Draw the reproductive tract of the female and name the parts.
3. What are the primary sex organs in the male? In the female?

Activity E

1. Can a male have all the normal sex characteristics and still be sterile? Explain.
2. Define the following terms: FSH, LH, seminiferous tubule, oestrus, oestrous cycle, ovulation, fertilization, freemartin, gestation, parturition, follicle, progesterone, estrogens and cryptorchid.
3. Outline the funtions of LH and FSH in the female.
4. List functions of estrogens, progesterone and testosterone.
5. What is meant by sperm capacitation?
6. What is the normal length of the estrous cycle in the cow, sow, ewe, mare, and human female?

References

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Accompanying Reading

None

Suggested Reading

None

Evaluation Materials

None