

Estrous Cycle In Domestic Animals And Factor Affecting Estrous Cycle

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Key Points

- Estrous Cycle: The cycle consists of proestrus, estrus, metestrus and diestrus, each associated with characteristic hormonal, reproductive and behavioural changes.
- Species Variation: Domestic animals are classified as polyestrous, seasonally polyestrous or monoestrous according to the frequency and seasonality of their estrous cycles.
- Factors Affecting Reproduction: Nutrition, photoperiod, heat stress, age, physical exertion, transportation, disease, uterine pathology, endocrine disturbances and male presence can significantly influence estrous cyclicity and fertility.

Abstract

The estrous cycle is a recurring physiological and hormonal process that prepares female domestic animals for ovulation, fertilization and pregnancy. It consists of four major phases—proestrus, estrus, metestrus and diestrus—with each phase characterised by distinct ovarian, reproductive tract and behavioural changes. Based on their cyclic patterns, domestic animals may be classified as polyestrous, seasonally polyestrous or monoestrous. The regulation and expression of the estrous cycle are influenced by several factors, including nutrition and body condition, photoperiod, temperature, age, physical exertion, transportation, systemic diseases, uterine pathology, endocrine disturbances and the presence of males. Understanding these factors is essential for effective reproductive management, early identification of reproductive disorders and improved fertility in farm and companion animals.

INTRODUCTION:

Reproduction is a fundamental biological process essential for the perpetuation of species, and the estrous cycle serves as the cornerstone of reproductive physiology in female domestic animals. The estrous cycle is defined as the recurring series of physiological and hormonal changes that prepare the female reproductive tract for ovulation, fertilization and potential pregnancy. In domestic animals such as cattle, buffalo, sheep, goat, swine, mare, bitch, and queen, the estrous cycle exhibits species-specific variations in duration, cyclicity, and behavioural manifestations. The cycle is broadly divided into four phase, proestrus, estrus, metestrus and diestrus each governed by a complex interplay of hypothalamic, pituitary, and ovarian hormones including GnRH, FSH, LH, estrogen, and progesterone. A comprehensive understanding of both the normal estrous physiology and the factors that modulate it is indispensable for veterinarians, livestock producers and reproductive biologists aiming to optimize fertility and address reproductive disorders. The present article aims to provide a detailed overview of the estrous cycle in various domestic animals and to critically examine the diverse factors that influence its regulation and expression.

Proestrus:

- Proestrus is an ill-defined period during which the Graafian follicle is growing under the influence of FSH and producing increasing amounts of estradiol.
- There are increases in the growth of cells and cilia lining the oviduct
- Increases in the vascularity of the uterine mucosa
- Increases in the thickness and vascularity of the vaginal epithelium, with cornification occurring in some species, such as the dog and cat.
- In the dog, the increased endometrial vascularity is characterized by proestrous vaginal bleeding. In the bitch and sow the vulva becomes definitely edematous and swollen.
- There is a gradual relaxation of the cervix and an increased secretion of viscid, slimy mucus from the goblet cells of the cervix, anterior vagina and uterine glands
- The corpus luteum is undergoing rapid vacuolization, degeneration and decrease in size.
- The marked increase in growth of the epithelial tissues, increase activity of the musculature of the reproductive tract, increased secretion of mucus, increased vascularity of the endometrium and vaginal mucosa is spoken of as the building-up period. It is produced by the secretion of increasing amounts of estradiol (Roberts, 2004)
- Late in this phase of the cycle the female animal usually exhibits interest in the male.

Estrus:

- Estrus is the fairly well-defined period characterized by sexual desire and the acceptance of the male by the female domestic animal.
- This period begins with the time of the first acceptance and ends with the last acceptance of the male. During this period the female will usually seek out and accept the male.

- The Graafian follicle is large and mature. Estradiol from the maturing Graafian follicle produces changes in the tubular genital tract.
- The oviducts are tonic, the epithelium mature and the cilia are active; contraction of the oviducts is occurring; and the fimbriated end of the oviduct is assuming a close affinity to the Graafian follicle. Increased amounts of oviduct fluid is being secreted.
- The uterus is erect, turgid and in some species, edematous. The blood supply to the uterus is increased; the mucosa is growing rapidly and mucus is secreted.
- The vaginal and cervical mucus is greatly increased. The mucosa is pink and congested, due to the increased vascularity.
- The cervix is relaxed and slightly edematous.
- The mucosa of the vagina is greatly thickened with many cornified epithelial cells being desquamated in certain species, such as the dog and cat. The vulva is relaxed and edematous in all species, but most noticeably in the bitch and sow.
- Strings of mucus may hang from the vulva in the cow.
- Toward the end of this period there may be an increase in leucocytes migrating into the uterine lumen. In most species the rupture of the mature follicle or ovulation occurs toward the end of this period of estrum, but it is only roughly correlated with the end of estrum.
- In the cow, ovulation occurs about 12 hours after the end of estrum. In certain species that do not ovulate spontaneously, such as the car, rabbit and ferret, ovulation does not occur until coitus and/or mounting takes place; hence in the cat estrum may be prolonged in the absence of a male to 7 to 10 days (Roberts, 2004).
- The acceptance of the male during estrum is due to the effect of estradiol on the central nervous system, producing the characteristic behavior patterns of receptivity in the various female animals.

Metestrum or postestrum:

- Metestrum or postestrum is a poorly defined period following estrum during which the corpus luteum grows rapidly from the granulosa cells of the ruptured follicle under the influence of the luteinizing hormone of the anterior pituitary. Metestrum is largely under the influence of progesterone produced by the corpus luteum. "Apparent anestrus"
- In the cow, during the early part of metestrum the epithelium over the caruncles of the uterus is very hyperemic and some capillary hemorrhage occurs. This is called postestrua or metestrua bleeding or "menstruation."
- This is not similar to true menstruation in primates which occurs at the time of progesterone withdrawal and is associated with a loss of the superficial layers of the endometrium.
- In cattle postestrua bleeding is associated with estrogen withdrawal.
- The mucous secretion decreases and the glands of the endometrium grow rapidly.

- Toward the middle to the end of metestrus the uterus becomes rather soft and pliable, due to a relaxation of the uterine muscle.
- In cow, sheep, sow and mare, the length of metestrus is about equal to the time it takes for the ova to reach the uterus or about 3 to 4 days.

Diestrum:

- Diestrus is the longest period of the estrous cycle in domestic animals including the cow, sheep, goat, sow and mare.
- The corpus luteum is mature and the effects of progesterone on the reproductive tract are marked.
- The endometrium becomes thicker and the glands hypertrophy. The cervix is constricted and the vaginal mucus is scanty and sticky.
- The mucus membrane of the vagina is pale. The uterine muscle is relaxed. Late in this period the corpus luteum begins to show regress.
- The endometrium and its glands atrophy or regress in size. Beginning of development of primary and secondary follicles and finally proestrus occurs.
- In certain species that are not polyestrous, anestrus may occur

Anestrus:

- Anestrus, when referred to in connection with the physiological estrous cycle, is usually characterized by quiescent, functionless ovaries and reproductive tract.
- During anestrus the uterus is small and flaccid and the vaginal mucus is scanty and sticky. The vaginal mucosa is pale and the cervix is pale and tightly closed. Some follicular activity of the ovaries may develop but a mature follicle and ovulation seldom occur during the anestrus period. Physiological anestrus observed in mares during winter month (**winter anestrus**), Ewe during late spring and summer
- **Lactational anestrus:** In swine, dogs and cats much of the lactation period is usually characterised by lack of estrus, termed lactational anestrus

The relative lengths of these various periods of the estrous cycle in domestic animals are approximately as

Species	Estrus	Metestrus	Diestrus	Proestrus
Cow	12 to 24 hrs	3 to 5 days	13 days	3 days
Mare	4 to 7 days	3 to 5 days	6 to 10 days	3 days
Sow	2 to 4 days	3 to 4 days	9 to 13 days	3 days
Ewe	1 to 2 days	3 to 5 days	7 to 10 days	2 days
Bitch	9 days	-	62-65 days if pregnant 70-90 days if non-pregnant	9 days

Animals divided into three classes according to their estrous cycles.

Based on how frequently they experience estrus (heat) throughout the year.

- **Polyestrous (Continuous Breeders):** These animals cycle continuously throughout the year until they become pregnant. They do not have a specific breeding season.
 - *Examples:* Cow, buffalo, pigs
- **Seasonally Polyestrous:** These animals experience multiple estrous cycles, but only during a specific season of the year when environmental conditions (like daylight length and temperature) are optimal for reproduction.
 - **Long-day breeders:** They cycle as the days get longer (spring and summer). *Examples:* Horses and ferrets.
 - **Short-day breeders:** They cycle as the days get shorter (fall and winter). *Examples:* Sheep, goats and deer.
- **Monoestrous:** These animals have only one (or sometimes two) estrous cycle(s) per year.
 - *Examples:* Dogs (typically cycle 1–2 times a year), wolves, foxes.

Factors affecting the estrous cycle:

1. Nutritive State (Nutrition and Body Condition)

- **Negative Energy Balance (NEB):** Common in high-producing dairy cows in early lactation. They burn more energy for making milk production leading to delayed first ovulation postpartum, silent heats and poor conception rates.
- **Flushing:** In sheep, goats, and pigs, increasing the energy plane (nutrition) 2–3 weeks before breeding ("flushing") increases the ovulation rate, leading to larger litters or higher twinning rates.
- **Body Condition Score (BCS):** Low BCS will experience delayed puberty, irregular cycles, or complete anestrus. Obesity also impair cyclicity and reduce fertility.

2. Seasonal Influences and Light (Photoperiod)

The amount of daylight regulates the pineal gland's secretion of melatonin, which directly influences the release of GnRH.

- **Short-Day Breeders (Sheep and Goats):** These animals cycle as the days get shorter (autumn and winter). During the long days of spring and summer, they enter seasonal anestrus (cycles stop) because melatonin secretion is suppressed.
- **Long-Day Breeders (Mares):** Mares cycle as days get longer (spring and summer). During the short days of winter, they enter seasonal anestrus. Artificial lighting is often used in barns to mimic long days and bring mares into heat early in the year.
- **Polyestrous (Cows and Pigs):** These animals cycle year-round. However, their cycle influenced by season due to secondary factors like changes in forage quality or temperature.

3. Temperature (Heat and Cold Stress)

While cold stress can reduce fertility indirectly by reducing feed intake, **heat stress** is a massive direct disruptor of the estrous cycle.

- High temperatures reduce the manifestation of estrus behavior (standing heat), decrease the quality of the oocyte (egg), and alter the uterine environment, leading to early embryonic death. Summer infertility is a major issue in cow and buffalo.

4. Age

- Young animals must reach a target body weight (usually **55-65% of mature weight**) before the HPG axis activates and cycles begin.

Senescence (Old Age): In older animals the estrous cycle may become irregular. Often have poorer oocyte quality, higher rates of early embryonic death and weaker behavioral signs of heat (silent estrus).

5. Character of Work (Physical Exertion)

This factor is almost exclusively relevant to **mares** (horses).

- High-performance mares (e.g., racehorses, heavy draft horses, or intense show horses) are subjected to rigorous physical training.
- **This heavy workload creates a massive energy drain and physical stress.** This can delay the onset of puberty, cause irregular estrous cycles, or induce complete anestrus during the heavy training season.

6. Transportation

Transportation causes physical and psychological stress, activating the hypothalamic-pituitary-adrenal (HPA) axis and releasing cortisol. High levels of cortisol suppress the release of GnRH and the LH (Luteinizing Hormone) surge. If animals are transported right before or during estrus, ovulation may fail to occur.

7. Systemic Diseases

- **General Infectious** diseases suppress the HPG axis, causing the animal to stop cycling until it recovers.
- **Metabolic Diseases:** In **dairy cows**, metabolic disorders like ketosis or milk fever (hypocalcemia) severely disrupt the estrous cycle, leading to delayed first ovulation and cystic ovaries. In **sows**, conditions like MMA (Mastitis-Metritis-Agalactia) post-farrowing will stop the return to estrus.

8. Pathology of the Uterus

The uterus plays an active role in regulating the length of the estrous cycle. If the uterus is diseased, the cycle is disrupted.

- **Endometritis (Uterine Infection):** Common in **cows** (postpartum metritis), **mares** (breeding-induced endometritis) and **sows**. If the uterus is inflamed, it cannot support an embryo. Furthermore, an infected uterus will often secrete Prostaglandin F_{2α} (PGF_{2α}). This hormone destroys the Corpus Luteum (CL), causing the animal to return to heat prematurely (short cycle) or irregularly.
- **Pyometra / Mucometra:** If the cervix closes (due to infection or anatomical issues), PGF_{2α} cannot be expelled. Without PGF_{2α}, the CL is not destroyed, and the animal remains in a state of permanent diestrus (anestrus). This is seen in older **cows** and **sows** (Cystic Endometrial Hyperplasia).

9. Endocrine Disturbances

Hormonal imbalances directly alter the estrous cycle.

- *Follicular cysts* secrete continuous estrogen, causing the cow to show constant, aggressive signs of heat (nymphomania).

- *Luteal cysts*: The cyst luteinizes and secretes progesterone. The cow shows no signs of heat (anestrus).
- **Persistent Corpus Luteum (PCL)** continues to pump out progesterone, preventing the animal from coming back into heat.
- **Anovulatory estrus**: Common in **mares** during the transition from **winter anestrus to the breeding season**. Follicles grow and produce estrogen, but the LH surge is insufficient to cause ovulation, leading to prolonged, erratic estrus behaviors.

10. Proximity of male

- The presence of male with the female in the anestrus season hasten the onset of estrus. This effect is brought out by gonadotrophic hormone mediated by visual, auditory and olfactory stimuli to the CNS.

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