

### ESTROUS CYCLE IN RAT

The sexual cycle in vertebrates are extremely variable. In mammal usually the female only receive the male during a relatively brief period of oestrous (estrous) or heat. Ovulation is normally spontaneous and occurs during estrous. But animals, such as rabbit, ferret & mink are induced ovulators, where the stimulation of coitus acting through the hypothalamus & hypophyseal pathways is required for ovulation. Laboratory rats, mice, hamsters, guinea-pigs are polyestrous species that repeat their cycle throughout the year, without much variation unless interrupted by pregnancy or pseudopregnancy.

Since, the rat is used so extensively for the study of reproductive processes, its system will be described as exemplifying a simple estrous cycle.

#### The estrous cycle in rat

It is completed in four to five days, although the timing of the cycle may be influenced by exteroceptive factors such as light, temperature, nutritional status & social relationships. In species having such short cycles, the ovaries contain follicles in various stages of formation, as well as corpora lutea of several past estrous cycles.

The cycle in rat is roughly divisible into 4 stages.

1. Estrous or Heat
2. Metestrous
3. Diestrous
4. Proestrous

#### Estrus:

- a. This is the period of heat & copulation is permitted only at this time.
- b. This condition last for 9 – 15 hrs. & is characterized by a high rate of running activity.
- c. Under the influence of FSH a dozen or more ovarian follicles grow rapidly. Estrous is thus a period of heightened estrogen secretion.
- d. Behavioral changes include quivering of ears & lordosis or arching the back in response to handling or to approaches by the male.
- e. The uteri undergo progressive enlargement & become distended owing to the accumulation of luminal fluid. Congestion of uterus is maximum.
- f. Many mitoses occur in the vaginal mucosa, as new cells accumulate the superficial layers become squamous & cornified (superficial layers are fully keratinized).
- g. The later cells are exfoliated into the vaginal lumen, and their presence in vaginal smear is indicative of estrous.
- h. During late estrous there are cheesy masses of cornified cells with degenerate nuclei present in the vaginal lumen, but few if any leucocytes are found during estrous.
- i. Ovulation occurs during estrous & is preceded by histological changes in the follicle suggestive of early leuteinization.
- j. Much of the luminal fluid in the uteri is lost before ovulation.
- k. Large amount of mucous are secreted from the cervix during this period.

#### Metestrus/ progestational/ post estrus/ luteal phase:

- a. This occurs shortly after ovulation & is intermediate between estrus & diestrus.
- b. The period lasts for 10-14 hrs. & mating is usually not permitted.
- c. The ovaries contain corpora lutea & small follicles, and the uteri have diminished in vascularity & contractility.
- d. Endometrium increases in thickness.

- e. The events are under the influence of progesterone, hence known as progestational phase.
- f. Many leucocytes appear in the vaginal lumen along with a few cornified cells.

**DIESTRUS/ ANESTRUS:**

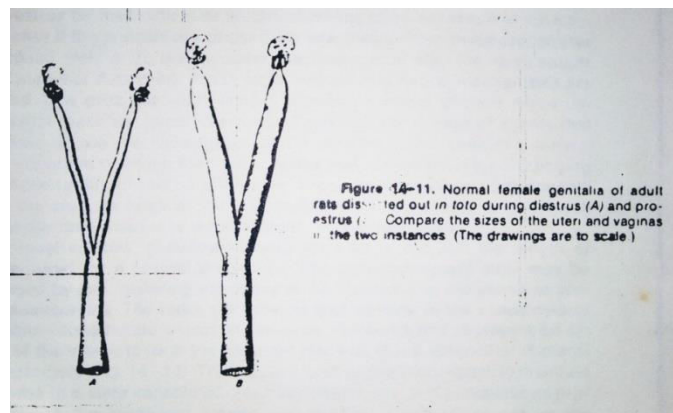
- a. This lasts for 60-70hrs. in rats. In monoestrus animals it lasts upto the next mating season & known as anestrus. In polyestrus animals the resting interval is short, upto the next cycle is called diestrus.
- b. The functional regression of corpora lutea occurs.
- c. The uteri are small, anemic & only slightly contractile.
- d. The vaginal mucosa is thin, and leucocytes migrate through it, giving vaginal smear consisting almost entirely of these cells.

**PROESTRUS/ FOLLICULAR PHASE:**

- a. This heralds the next heat & is characterized by functional involution of the corpora lutea & pre-ovulatory swelling of the follicles.
- b. It lasts for about 12 hrs.
- c. The uteri are again becoming distended with fluid & they become highly contractile. Uteri & vagina become congested & secrete a clear sanguinous fluid. Vaginal epithelium proliferates which is caused by estrogens secreted by the maturing follicles.
- d. Vaginal smear is dominated by nucleated ( non cornified) epithelial cells which may be detached singly or in sheets broken off from the proliferating vaginal epithelium secreted by the maturing follicles.

**Interruption of the cycle:**

In case pregnancy occurs the cycles are interrupted for the duration of gestation, which lasts for 20-22 days in rat. The animals come into estrus at the end of pregnancy but the cycles are again delayed until the termination of lactation.



### **Pseudopregnancy:**

This may be induced in many laboratory mammals by procedures that prolong the secretory function of the corpora lutea of ovulation, thus holding in abeyance the onset of the next estrus. Pseudopregnancy in rats & mice may be induced by stimulating the cervix of the estrus animals with glass rod & other mechanical means, electrical stimulation or by mating with a sterile male. The corpora lutea remain functional during this time, and the endometrial changes simulate those of normal pregnancy. Except for the fact that there are no developing young in the uteri, the endocrine balance is very similar to true pregnancy.

### **Endocrine Regulation of the Estrus Cycle:**

1. According to modern concepts, a feedback mechanism operates whereby the pituitary release of FSH and LH is controlled by the levels of estrogen and progesterone in the circulation.
2. It is not known what factors are originally responsible for the activation of pituitary-ovarian axis, but it has been postulated that very low levels of estrogens, coming from the immature follicles or extragonadal sources, may stimulate the pituitary to augment its release of FSH.
3. Significant production of estrogen by the follicle apparently requires both FSH and LH.
4. When the level of estrogen in the blood becomes high, indicating that the ovarian follicles are full-grown, it acts to prevent a greater release of FSH by the hypophysis and to promote an augmented release of LH.
5. Under the influence of rising titers of LH, preovulatory swelling ensues and definite lutein changes occur in the walls of the mature follicles. The preovulatory follicle undoubtedly secretes some progesterone as well as large quantities of estrogens.
6. Ovulation occurs while LH is in ascendancy and there is an immediate fall in the circulating estrogens after ovulation. The ruptured follicles become transformed into a corpus luteum, which become functional under influence of prolactin.
7. The discharge of LH from the anterior lobe seems to be inhibited by rising titers of progesterone.
8. The corpora lutea remain functional for only a short period unless pregnancy or pseudopregnancy supervenes.
9. Changes in the ovaries must be regarded as resulting from the interaction of the gonadotrophins and changes in the sex accessories as consequences of the interaction of the various ovarian hormones..
10. The uteri of the rat become quite small and anemic during diestrus indicating that while the corpora lutea persists they secrete progesterone only for a brief time in the reproductive cycle. When pregnancy or pseudopregnancy follows a period of estrus, the corpora lutea remain functional much longer, probably owing to the action of prolactin.
11. The progestational uteri, conditioned by estrogen plus progesterone are equally sensitive to implanting blastocysts or the endometrial trauma.

