

FEMALE REPRODUCTIVE SYSTEM

PUBRTY IN FEMALES:

Puberty is the age when animal attains the ability to release the gametes, and manifest complete sexual behavioral sequences. Puberty age is very important for the successful livestock farming. Animals attain puberty earlier are more productivity.

Factors affecting Puberty in Females:

1. Genetic makeup of the animal:

Exotic breeds attain puberty in earlier as compared to local breeds. Exotic Dairy breeds attain puberty in 12-15 months, Exotic beef breeds attain puberty in 15-18 months. Local breeds attain puberty at the age of 18-24 months. Inbreeding will prolong the onset of puberty whereas the cross breeding in buffalo, but selective breeding should be done.

2. Nutrition: In weak animals, puberty is delayed. On balanced diet, age of puberty attained earlier. When the animal gains 55-60% of adult body weight, then animal attains puberty.

3. Season of birth: example 2 sheep's, A&B are born in January and April respectively. The time required for the sheep to attain puberty is 6 month , sheep A cannot attain puberty in June because, in June the sheep do not come in heat while the sheep B in born in April will attain puberty in September, which is the season of breeding for the sheep.

4. Temperature: In summer the temperature is very high, due to heat stress growth rate is low and puberty is delayed

5. Management: When males and females are kept together then puberty comes earlier and vice verse. It is due to visualization.

Hormonal Change during puberty:

3 hormones are important in this respect.

- Estradiol
- FSH
- LH

Estradiol:

Its secretion starts quite early in the fetal life in bovines I.e. at 60th day of gestation. In sheep this age is 30-50 days. Its source is interstitial tissue present in the ovary in fetal life, this source becomes ineffective after birth. After birth Estradiol is produced due to FSH, LH.

FSH, LH:

Their secretion starts after 1^{1/2} -2 months of gestation in cows. Their secretion stops before 2 months of delivery in cow in 1 month (or just before parturition) in sheep.

After parturition FSH & LH are secreted in low level for 3 months in cattle, 1 month in sheep & 6-7 years in humans. This period of low level of FSH & LH is called period of infancy. Then animal enters into Prepubertal period where level of FSH & LH starts increasing. There are 2 reasons behind increasing of FSH & LH.

- i. Steroids have -ve effect on hypothalamus in period of infancy which is reversed.
 - ii. The response of receptors towards GnRH on pituitary is low in period of infancy which is also increased.
- 2 weeks of lamb has 1 per 6 hours pulse frequency while that of 8 week lamb the pulse frequency is 5 per 6 hours.

AGE OF PUBERTY IN DIFFERENT ANIMAL

Animal Species	Age of puberty (months)
Exotic cattle	12-18
Zebu cattle	18-24
Buffalo	24-30
Sheep	04-08
Goat	04-08
Mare	12-24
Bitch (small)	06-08
Bitch (large)	08-12
Sow	06-10
Cat	06-12

FOLLICULOGENESIS/ OOGENESIS

Oogenesis is a pattern of growth of G.F. in the fetal life before sexual difference. Gonads are made up of sex cords. Sex cords are made up of germinal cells and somatic cells .

In males sex cords develop into seminiferous tubules of testes and in case of females the sex cords disappear and each of sex cord vanishes and each germinal cell divides by mitosis & changes into primary oocyte. Each primary oocyte becomes surrounded by a single layer of somatic cells . This follicle is called **primordial follicle**.

These primordial follicles develop in the first half of the fetal life and the numbers which are established during the fetal life are available for the entire life of the female . fetus of cows of about 110 days of age has about 2,700,000 follicles. Only these are available for the entire life . At birth the ovary of cow has 100,000 to 150,000 follicles. At puberty only

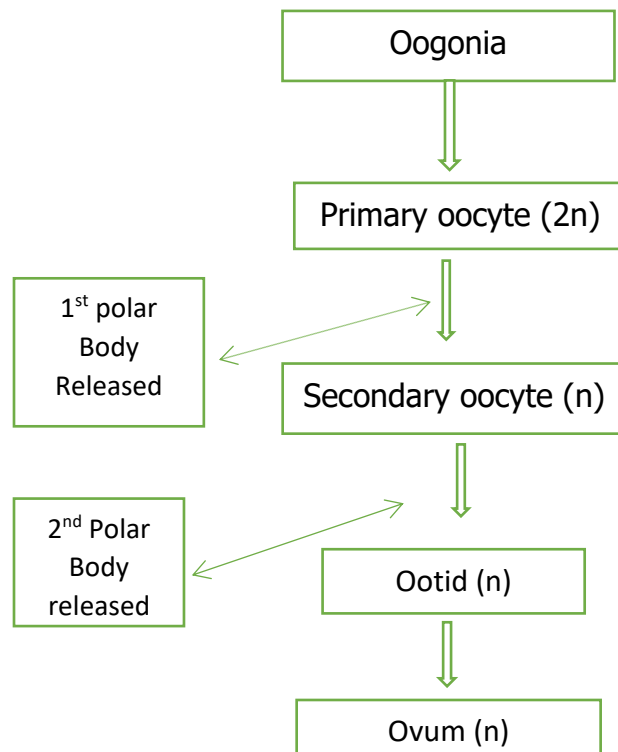
50,000 to 70,000 primordial follicles are present. The cow at the age of 14-15 years has 20,000 or less primordial follicles . Buffalo has 80,000 primordial follicles at birth and at puberty only 39,000 follicle are present.

This primordial follicle carries ' $2n$ ' no of chromosome . These somatic cells surrounding the follicle are called granulosa cells. Around oocyte a thick layer of glyco-protein is deposited by them. This layer is called **zona pellucida** and now the follicle is called **primary follicle**.

The no. of layers of somatic cells surrounding the primary follicle increase by mitosis but still the oocyte remains in the center this follicles is called **secondary follicles**.

These granulosa cells starts secreting follicular fluid or liquor folliculi, as a result cavities appear but oocyte is still in center. Now this follicle is called **tertiary follicle**.

Later because of continuous secretion of fluid oocyte is pushed towards one side. The theca externa & theca interna development of antrum , the growth is regulated by FSH , LH oocyte is embedded in a bunch of cells called **cumulus oophorus**.



The development of follicle from primordial follicle up to secondary follicle is dependent upon some intravarian factor, but after development of antrum, the growth of follicle is regulated by FSH, LH.

Antrum of the follicle only appears after birth, not during fetal life. Ovulation of follicle only occurs at puberty because of surge release of LH at that time. The development of secondary follicle from primary follicle is prohibited by OMI - factor (oocyte maturation factor) secreted by granulosa cells in the ovary.

At ovulation, preovulatory surge release of LH will suppress the OMI - FACTOR as a result primary oocyte will change into secondary oocyte in almost all the animals.

In dog & foxes at ovulation, oocyte will be at primary oocyte stage.

Heat period has duration of almost 18 - 24 hours. Ovulation occurs after 10-14 hours after the end of heat. Meiosis II only occurs during fertilization when sperm enters into oocyte.

What is Polar Body ?

In male no polar body is formed 2 polar bodies are formed. Polar body has small cytoplasm but has full no. Of chromosomes. This is done so that oocyte or zygotes gets the maximum nutrition. These polar bodies die out.

ESTRUS CYCLE

DEFINITION:

It refers to the cyclic occurrence of physical and hormonal events associated with folliculogenesis, ovulation, luteinization and luteolysis in adult female animal.

DIVISION OF ESTRUS CYCLE

Estrus cycle divided into 4 phases

1. Proestrus

2. Estrus
3. Metestrus
4. Diestrus

According to another concept, estrus cycle is divided into two phases.

- 1) Follicular phase (pro-estrus + Estrus)
- 2) Luteal phase (met- estrus + Diestrus)

HORMONAL CHANGES (e.g in bovine)

- ◆ Estradiol level is high while the progesterone level is low during estrus.
- ◆ Progesterone level is high at diestrus (day-9 → 6-10 ng/ ml).
- ◆ Progesterone level goes decreasing at day -16 .
- ◆ During follicular phase, level of estrogen is 5-15 pg/ml.
- ◆ During luteal phase, the level of estrogen is 2-5pg/ml.

HORMONES	BASAL OR TONIC LEVEL	PEAK OR PRE -OVULATORY LEVEL
FSH	50-70 ng/ml	160 ng/ml
LH	2-6 ng/ml	25 ng/ml

EXTERNAL HEAT SIGNS:

1. Decrease in feed intake by the female animal .
2. Decrease in milk yield (up to 25%).
3. Milk retention in the udder
4. Restlessness of animal
5. Increase in body temperature (0.1°C)

6. Bulling cow behavior
7. Stands to be mount (very potent sign)
8. Sniffing of hind quarter of the other animals.

It is also known as Flaming Response .

9. Intermittent urination
10. Vulva would be swollen and hyperemic.
11. Mucosa of the vagina will be wet and also hyperemic.
12. Mucus discharge from vulva.

INTERNAL HEAT SIGNS:

- 1) TONE IN uterus (it seems to be a erected)
- 2) Presence of mucus predominantly
- 3) Fully matured G.F and regressing C.L on the ovary.

DURATION OF ESTRUS CYCLE AND ESTRUS PERIOD

SPECIES	ESTRUS (DAYS)	CYCLE ESTRUS ESTRUS	PERIOD/
COW	21 (18-24)	24 HOURS	
MARE	21 (20-23)	6 DAYS	
SHEEP	17(15-20)	30 HOURS (24-36)	
GOAT	21	36 HOURS (30-40)	
BITCH	180	9 DAYS	

CAT	21 (14-28)	3-10 DAYS
CAMEL	10-24	3-10 DAYS
SOW	19-20	2-3 DAYS

BREEDING SEASON:

Breeding season is that period of year during which female shows the optimum breeding activity e.g. autumn breeder like sheep & spring breeder like mare.

There are two types of breeders:

CONTINUOUS BREEDERS:

THE species which show breeding activity through out the year

Those species which show breeding activity during particular period of year . seasonal breeder are divided into two types.

1. Mono-estrus/ mono-cyclic:

Those species which shows breeding activity only once during their season e.g. bitch.

2. Poly-estrus/ Poly- cyclic :

Those species which shows breeding activity many time during their breeding season e.g sheep, goat, mare cat camel.

- **Continuous breeder are breeding are always poly estrus**

Bitch:

- Bitch shows its breeding activity twice in a year, First time in spring and then spring and then in autumn .
- The estrus cycle length is average 6 month . after ovulation in bitch corpus luteum disappears after 60 days.

- Proestrus -9 days
- Estrus -9 days
- An estrus - 3 months
- Met estrus -2 months

Since the time of C.L persistence is quite longer in the bitch, we sometime consider that bitch is pregnant because the belly swell even the pregnancy has not occurred. The phenomenon is called pseudo pregnancy.

SHEEP/ GOAT:

Sheep and goat are short day breeders. The estrus cycle length in sheep is 17 days while in goat is 21 days. Pregnancy occurs in autumn and spring. UK the sheep comes in heat in autumn while near equator there is no proper period.

MARE:

Mare is long day breeder, breeding season starts in February and ends in August.

CAMEL:

Camel is long day breeder. The breeding seasons starts from December & end in April .

CAT:

Cat is long day breeder and maximum activity is shown in summer and spring.

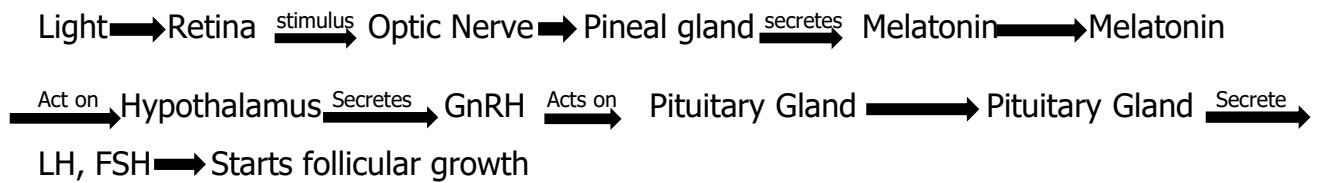
BUFFALO:

It is a long day breeder. The seasons starts from September & ends with December.

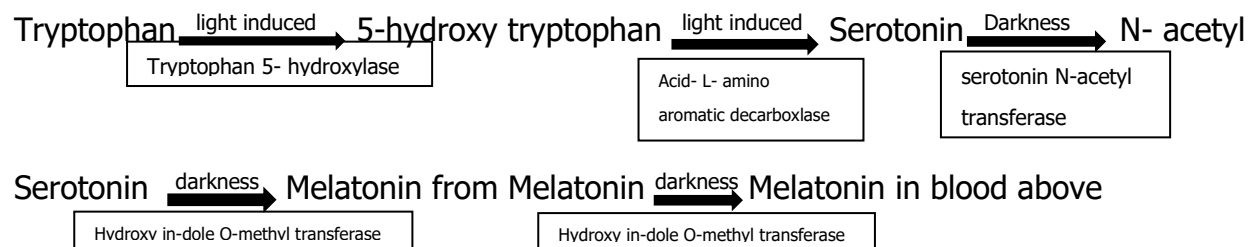
FACTORS AFFECTING BREEDING SEASONS:

- ✧ Photoperiod
- ✧ Temperature
- ✧ High altitudes

✧ Food supply



◆ Tryptophan is a precursor of melatonin. The mechanism involved in the conversion of tryptophan into melatonin is as follows



Relations it darkness is needed is evident that as well as light period is also very important in determining the length of breeding seasons.

OVULATION:

It is the physiological process in which one or more Graffian follicles rupture and release the oocyte along with cumulus cells.

Cattle , buffalo ---1 follicle , Sheep & goat --- 1-2 and bitch --- 8-10.

SITE OF OVULATION:

- In buffalo , cattle, sheep and goat ovulation can occur at any place of ovary except attached border, as follicle can develop at any site.
- In mare ovulation only occurs at the ovulation fossa. Why???
- Because in ovary of bovine and other mammalian species, cortex is the outer portion which contains numerous developing follicles while the inner portion , medulla

contains only blood vessels. But in case of mare , cortex is situated inside and medulla is outer portion but at the site of ovulation fossa this cortex is only exposed to.

- In camels ovulation alternates b/w the ovaries (in one cycle , if it right ovary then at next cycle left ovary will be subjected).

INDUCED OVULATORS:

There are some species which require certain nervous stimuli for ovulation ; these species are called induced ovulators, this process is called induced ovulation e.g. camel ,cat & milk. In these species , ovulation only occurs after mating.

Spontaneous Ovulation:

Those species which do not require any stimuli for ovulation are called spontaneous ovulation e.g. cattle ,sheep, goat, dog, etc.

MECHANISM OF OVULATION:

The ovulation phenomenon is carried out by the following three aspects :

Increased Internal pressure within follicle.

Contraction in smooth muscle of the wall of follicle.

Enzymatic digestion or thinning of follicular wall.

PRE - OVULATORY LH SURGE:

FOR ovulation preovulatory LH surge is required ,In induced ovulators the LH surge occurs only after mating and if there is no mating the follicle is regressed.

Blockage of LH surge:

Preovulatory LH surge is blocked by high level of progesterone .

Stimulation of LH SURGE:

It is stimulated by high level of Estradiol.

During mid cycle follicles grows and on 10th -11th day there is mature fully grown Graffian follicle but it does not ovulate as at that time fully develop C.L will produce high P₄ which block LH surge.

In cattle preovulatory LH surge about 6 hours after start of estrus and duration of LH surge is 7 hours ,& ovulation occurs about 25 hours after LH surge. Peak level of LH in blood in cattle is 25 ng/ml , while basal level is 2-6ng/ml.

ROLE OF PRE - OVULATORY LH SURGE:

1. It changes the metabolic activity of the granulosa cells of follicle which in turn change the composition of fluid changes, so it result into suppression of oocyte maturation inhibition (OMI).
2. It induces cytoplasmic maturation of oocyte ; as a result oocyte attains ability to from female pro- nucleus just before ovulation .
3. LH surge increased blood flow towards the dominant follicle.
4. It Also induced the secretion of PGF_{2a}. PGF_{2a} will imparts the following effects;
 - I. It causes the contraction of smooth muscles in the theca externa of follicle.
 - II. It stimulates the fibroblastic activity in the theca cells to release the enzymes which cause the thinning of wall of follicle ovulation.

TIME OF OVULATION

SPECIES	TIME OF OVULATION
BUFFALO& CATTLE	12-15 Hrs after the ends of heat (heat period =18-24 hrs)
MARE	1-2 days before the end of heat (heat period =24-48 hrs)

SHEEP&GOAT	just before the end of heat (heat period =36-38 hrs)
BITCH	1-3 days after start of heat (heat period =9 days approx.)
CAMEL, CAT	24-36 hrs after mating (coitus)

FERTILAZATION

Fertilization is a physiological process in which the male and female gametes each having haploid (n) no .of chromosomes fuse to form zygote.

Site of Fertilization:

Site of fertilization is lower part of ampula of fallopian tube.

Bull ejaculate semen in vagina, if A.I is used, then the semen is ejected in the body of uterus, which rush for the fertilization in fallopian tube. Almost 100 -1000 sperms are present after 8 -12 hours of ejaculation.

MECHANISM OF FERTILIZATION

Oocyte is surrounded by a thick layer of glycoprotein called zona pellucida and a single layer of cells called corona radiate. Many layers of follicular cells surrounds the oocyte which collectively known as cumulus oophorus.

As a result of ovulation, zona pellucida, cumulus oophorus and corona radiata cells become luteal cells.

Steps involved in Fertilization

1. Penetration of sperm through cumulus & corona cells
2. Attachment & penetration of sperm through the zona pellucida
3. Fusion of male and female pronuclei

1. Penetration of sperm through cumulus & corona cells

Sperm has acrosome, acrosome has 3 major enzymes involved in fertilization.

- i. Hyaluronidase
- ii. Corona Penetrating Enzyme
- iii. Acrosine

When sperm are deposited in female tract, there is sperm capacitation and acrosomal reaction occur which, activates these enzymes. Cumulus oophorus cells are bound together by hyaluronic acid which are digested by hyaluronidase as a result the cumuli cells disperse and sperms become able to enter. The corona penetrating enzyme helps the sperm to pass through corona cells.

2. Attachment & penetration of sperm through the zona pellucida

Now the sperm attaches to zona pellucida. Zona carries receptors for sperm attachment and these receptors are species specific. After attachment acrosine makes a hole in the zona pellucida so that sperm can enter in it. After attachment sperm enters in it within 5-15 minutes. Sperm motility also play major role in the penetration through zona.

At this time the secondary meiotic division (Meiosis II) is completed & secondary oocyte is changed into ootid and second polar body is released into perivitelline space (1st polar body is released just before ovulation).

3. Fusion of Male and Female pro-nuclei:

Then sperm enters in the peri-vitelline space as the tail diminishes and head assumes the round shape just like other somatic cells and is now called as **male pro-nucleus** and now female ovum is called female pronucleus. Then membrane of both nuclei dissolve and they combine to form a single nucleus called as zygote.

When one sperm enters oocyte, later the entry of further sperm is prohibited. If more than one sperm enters in the oocyte due to any abnormality as is called polyspermy and the individual formed will be polyploid. Such zygotes are lethal and cannot develop into adults. In mammals the chance of polyspermy is 1-2 %. It may increase due to aging of oocyte, delayed mating or A.I.

Since polyspermy is lethal, nature has made some blocks in oocyte, called ...

Blocks to Polyspermy

- i. **Zona reaction.** When one sperm passes through zona pellucida, some chemical changes occur in zona so subsequent sperms do not enter in zona.
- ii. **Vitelline Block.** When sperm passes through vitelline membrane, some specific cortical granules release which bring changes in its composition and their secretion does not permit other sperms to enter. Thus, Granules change the chemical composition of vitelline membrane.

As a result of fertilization, the zygote is formed which then divides into two daughter cells called **blastomeres**. It occurs by a specific division called as cleavage. Cleavage is a cell division like mitosis in which there is an increased in number of cells without parallel increase in cell mass. These two blastomeres have unique property to develop into an independent individual, if they get separated. The twins originated from same zygote are called **identical twins or monozygotic twins**. They have exactlu same genetic makeup and other features.

In sheep, goat, swine etc many follicles grow and ovulate and each individual originate from new zygote called **fraternal twins or dizygotic twins**. The property of blastomeres to develop into a seperate individual persists upto 8 cell stage, after this ability is lost. Then 8 cells change into 16 cells.

8 cells ➡ 16 cells ➡ 32 cells

This all division is still occuring within the zona pellucida. The embryo having 8-16 cells is called **morula** and in cattle this stage is reached 3 -5 days in most of the mammals. But in dog and cat it stays for 7 -8 day. Then the zygote enters in the uterus at morula stage.

After morula stage the blastomeres (cells) secrete a fluid which accumulates in center and cells are pushed into the periphery. The cavity formed is called as **blastocele** & embryo at this stage is called as blastocyst. It is reached about at 7 -8 days after fertilization in cattle.