HUMAN REPRODUCTION

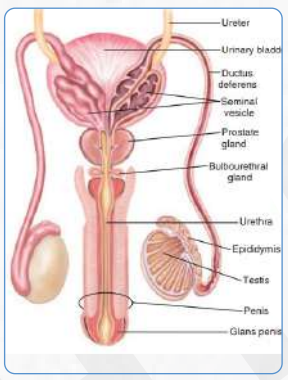
1 INTRODUCTION

- Humans are sexually reproducing viviparous organisms
- Reproductive system is composed of
  - **Primary sex organs** - Site for gamete formation
  - **External genitalia** - Involved In copulation
- Accessory ducts, Accessory glands → Facilitate transport of gametes

2 THE MALE REPRODUCTIVE SYSTEM

- Location: Pelvic region
- **Seminal plasma** from these contains fructose, calcium, enzymes
- Its secretions **lubricate the penis**
- Vas deferens receives a duct from seminal vesicle and opens into the urethra as the **Ejaculatory duct**

Accessory glands
- Seminal vesicle (1 pair)
- Prostate gland (one)
- Bulbourethral gland (1 pair)



External genitalia of Male/Penis

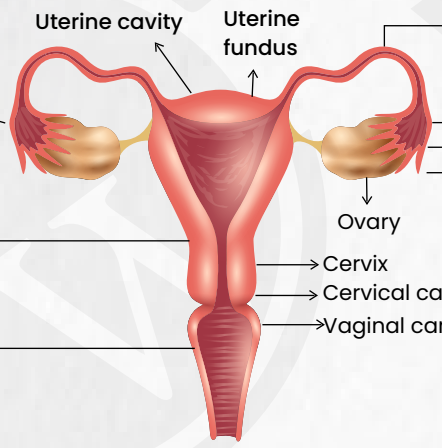
Parts	Features
Urethra	Originates from the urinary bladder and extends through the penis
Special tissues	Help in erection of penis to facilitate insemination
Glans penis	Enlarged end of penis covered by loose fold of skin called foreskin

3 FEMALE REPRODUCTIVE SYSTEM

- Location: Pelvic region

Accessory ducts

- **Oviduct/fallopian tube**
  - 10-12 cm (length)
  - Extend from ovary to uterus
- **Uterus/womb**
  - Inverted pear shaped
  - Attached to pelvic wall by ligaments
- **Vagina**



Parts of Fallopian tube
- Isthmus → Last part of oviduct, Narrow lumen, Joins the uterus
- Ampulla - Wider part
- Infundibulum - Funnel shaped
- Fimbriae - Finger like projections that collect ovum after ovulation

Birth canal = Cervical canal + Vaginal canal

- Uterine wall consists of three layers:
- **Endometrium** - Lines lumen, glandular a undergoes cyclic changes during menstruation
- **Myometrium** - Thick layer of smooth muscles that show strong contractions during delivery
- **Perimetrium** - External thin membrane

Parts	Features
Mons pubis	Cushion of fatty tissue covered by skin and pubic hair
Labia majora	Fleshy folds of tissue that extend down mons pubis and surround the vaginal opening
Labia minora	Paired folds of tissue under the labia majora
Clitoris	Tiny finger like structure which lies at the upper junction of labia minora above the urethral opening
Hymen	• Membrane that partially covers the opening of vagina • Can be torn while-sudden jolt/fall, horse riding, cycling, insertion of vaginal tampon • May or may not be torn during the first coitus so its presence or absence is not reliable indicator of virginity or sexual experience.

4 PRIMARY SEX ORGANS

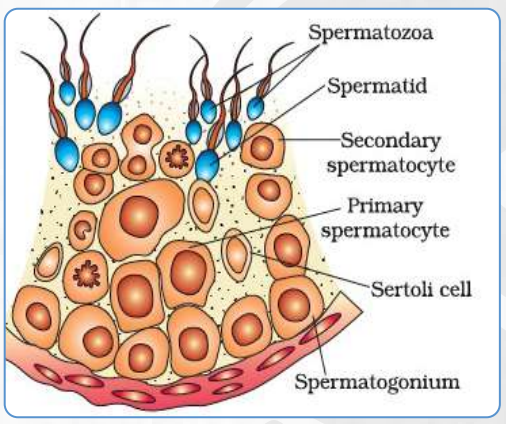
Parameters	Male	Female
Organ	Testis	Ovary
Number	2	2
Shape	Oval	Almond shaped
Location	Outside abdominal cavity in s pouch called **scrotum**	Lower abdomen one on on each side
Dimensions	Length 4-5 cm, Width 2-3 cm	Length 2 to 4 cm
Covering	Dense connective tissue (outermost)	Thin epithelium (outermost)
Functions	Sperm formation; synthesise steroidal **testicular** hormones like androgens	Ova formation; synthesise steroidal **ovarian** hormones like estrogen and progesterone
Compartments	250 testicular lobules; 1-3 coiled seminiferous tubules/lobule	Peripheral cortex and Inner medulla zones in ovarian stroma have follicles in various developing stages

• **Cells lining the seminiferous tubules**	**Functions**
1. Male germ cells/spermatogonia	Sperm formation
2. Sertoli cells	Provide nutrition to the germ cells

- Scrotum helps in maintaining the temperature 2 to 2.5°C lower than body temperature, necessary for **spermatogenesis.**
- Interstitial spaces outside the seminiferous tubules contain **immunocompetent** cells and **Leydig cells**
- Ovary is connected to pelvic wall and uterus by **ligaments.**

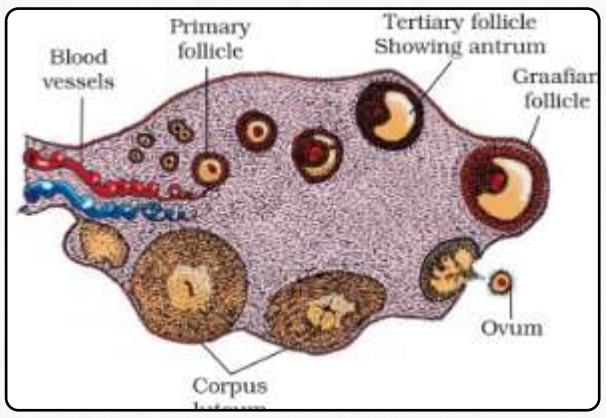
5 GAMETOGENESIS

- **Process of gamete formation**



Parameters	Male	Female
• **Term**	Spermatogenesis	Oogenesis
• **Process begins**	At puberty	During embryonic development
• **Ploidy & number of chromosomes**		
2n = 46	Male germ cells/ Spermatogonia	Female mother cells/ Oogonia
	Mitosis & differentiation	**In** Fetus (arrested at prophase I)
2n = 46	Primary spermatocytes	Primary oocytes
	Periodic Meiosis I	Birth, Puberty
n = 23	Secondary spermatocytes	1st polar body, Secondary oocyte
	Meiosis II	
n = 23	Spermatids	2nd polar body, Ovum
	Spermiogenesis	
n = 23	Sperms	
	Spermiation	
	Released from seminiferous tubules	

Follicies
Primary
(Single layer of granulosa cells)
Secondary
(More layers of granulosa cells and a new theca layer)
Tertiary
(Fluid filled cavity **antrum** and theca layers are organised into external and internal layers Secondary oocyte forms **acellular zona pellucida** a round it)
Graafian mature
(No more oogonia are formed and added after birth)
Ovulation



- No more oogonia are formed and added after birth
- A large number of follicles degenerate from birth to puberty so only **60,000-80,000 primary follicles are left in each ovary at puberty.**
- **Meiosis** in oogenesis results in unequal sized **cells** and the secondary oocyte retains bulk of the nutrient rich cytoplasm of the primary oocyte,
- Fate of polar body is not certain
- During the embryonic development, a couple of million gamete mother cells (oogonia) are formed within each fetal ovary

Spermiogenesis is transformation of spermatids to sperms and sperms head embedded in Sertoli cells

6 SEMEN

- Secretions of epididymis and vas deferens are essential for maturation and motility of sperms
- **Male ejaculates** about 200-300 million sperms during a coitus.
- **For normal fertility:**
  - 60% sperms must have normal shape and size
  - **40% of 60% sperms must show vigorous motility**

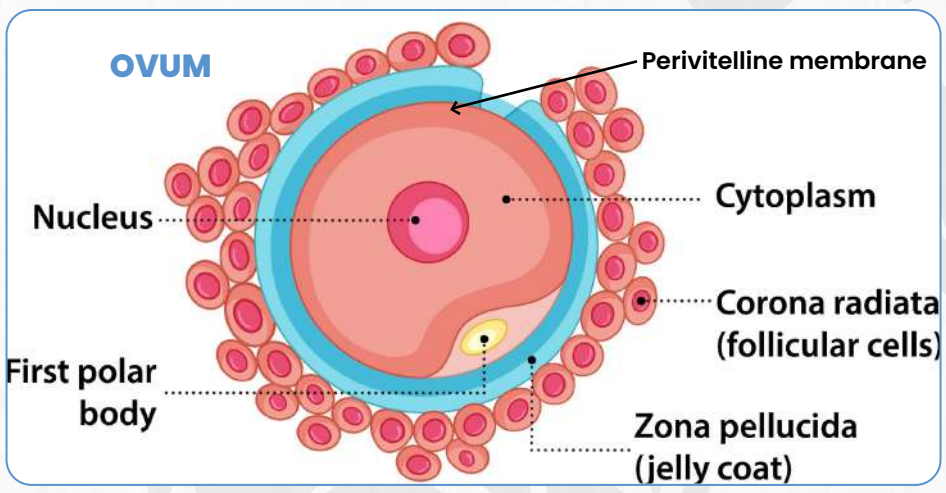
7 HORMONAL REGULATION IN MALES

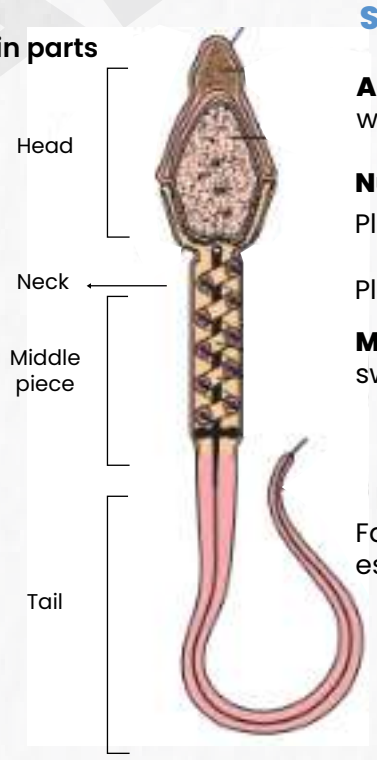
Hypothalamus
↓ secretes
GnRH (significant amount)
↓ targets
Anterior pituitary
↓ secretes
Gonadotropins

FSH		LH
↓ acts on	Seminiferous tubules (inside ↙ / outside ↘)	↓
Sertoli cells		Leydig/interstitial cells
↓ Synthesise & release		↓
Some factors		Androgens/Testicular hormones
↓ Stimulate		↓
Spermiogenesis		**Spermatogenesis**

The function of male sex accessory ducts and glands are maintained by the testicular hormones (androgens)

8 STRUCTURE OF GAMETES





SPERM

Acrosome- cap like structures filled with enzymes help in fertilization

Nucleus (n) (elongated)

Plasma membrane

Plasma membrane

Mitochondria-provide energy source for swimming/movement of tail

Facilitate sperm motility which is essential for fertilization

9 HORMONAL REGULATION IN FEMALES AND MENSTRUAL CYCLE

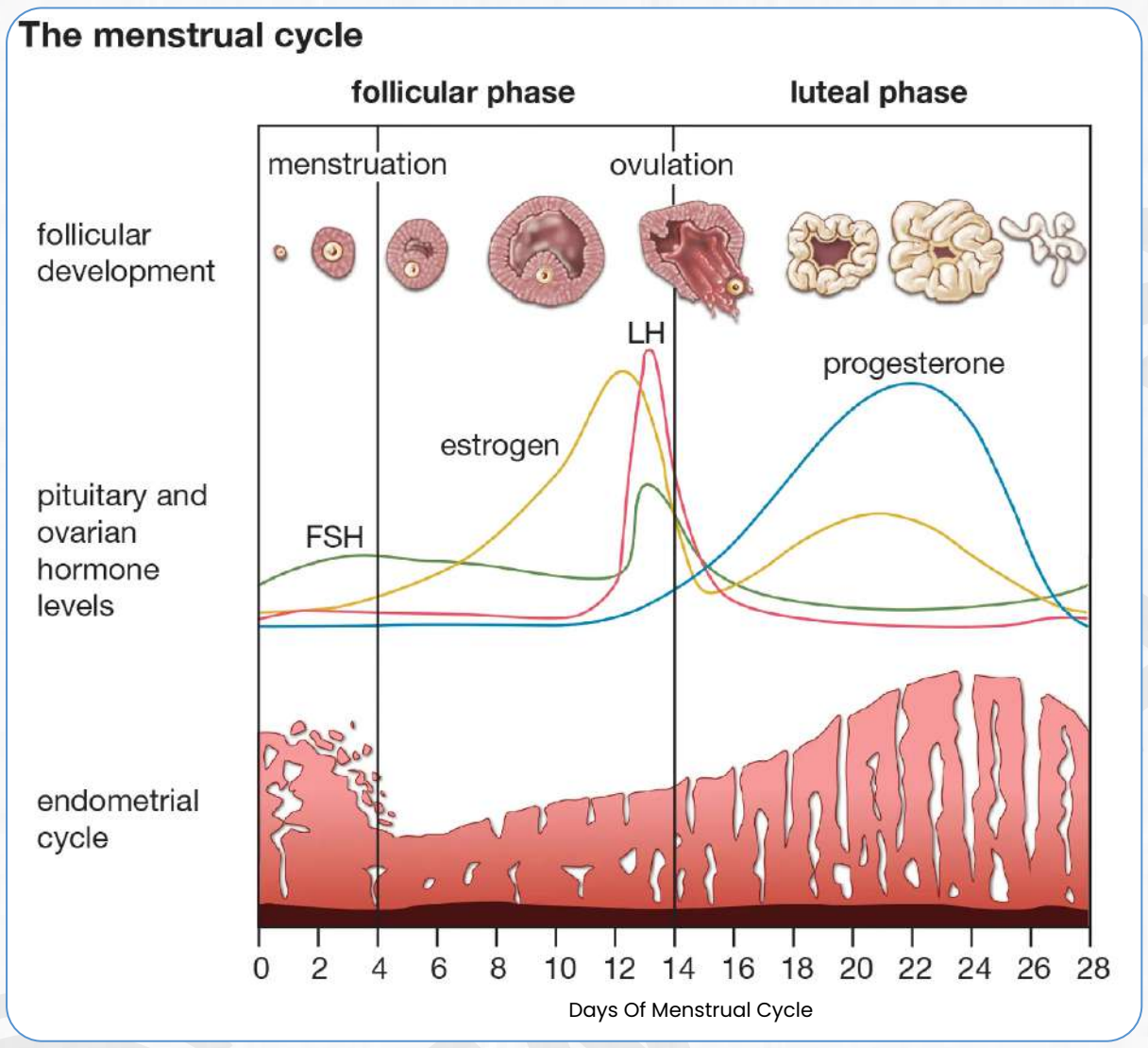
- The cycle of events starting from one menstruation till the next one is termed **menstrual cycle**
- **Characteristic** of female primates
  - Monkeys
  - Apes
  - Humans
- **Begins** at puberty - **menarche**
- **Ceases** at 50 years - **menopause**

Reproductive phase

- **Cycle occurs if ovum remains unfertilized**
- **Lack of cycle** may be an indication of Pregnancy, stress, poor health etc
- Average duration in humans = 28/29 days

Menstrual Hygiene

- Maintenance of hygiene and sanitation during menstruation isvery important
- Take bath and clean yourself regularly use sanitary napkins/home made pads
- Change sanitary pads after every 4-5 hrs.
- Dispose of used sanitary napkins properly by wrapping it in used paper.
- After handling the napkin wash hands with soap



• **If ovum gets fertilized, endometrium is maintained by progesterone** necessary for implantation and other events of pregnancy.
• During pregnancy all events of menstrual cycle stop

Menstrual Cycle

• Changes in the ovary and the uterus are induced by changes in the levels of pituitary and ovarian hormones

Phase	Duration	Hormones & their effects	Events in ovary	Events in uterus
Menstrual	3-5 days	Drastic decline in progesterone	Corpus luteum degenerates	• Breakdown of endometrial lining and its blood vessels which forms liquid that comes out through vagina constituting menstrual flow
Follicular or Proliferative phase	Variable	Gradual increase in FSH & LH that stimulate secretion of estrogen from follicles	Primary follicle gradually matures to Graafian follicle	• Endometrium regenerates through proliferation
Ovulation	14 day (Middle of cycle)	FSH and LH at peak, (LH surge)	Rupture of Graafian. follicle and release of only one ovum/ cycle	• Proliferation of endometrium continues
Luteal or Secretory	Fixed (14 days)	Secretion of progesterone and estrogen	Remnants of the Graafian follicle transforms into corpus luteum	• Endometrium is maintained • If ovum remains unfertilized, endometrium is sloughed off, marking a new cycle

10 SEQUENCE OF REPRODUCTIVE EVENTS OCURING IN HUMANS INCLUDE:

Gametogenesis → Insemination → Fertilization → Implantation → Gestation → Parturition/Birth

11 PATH FOLLOWED BY GAMETES IN FEMALE REPRODUCTIVE TRACT

- During coitus, semen is released from male reproductive tract by the penis into the female reproductive tract i.e., the vagina by process termed Insemination
- **Sperms** → Released in vagina → swim through → Cervix → enters → Uterus
- **Oocyte** → Released in body cavity → Captured by → Fimbriae → Infundibulum → Reach towards ampulla
- **Ampulla (site of fertilisation)** → Fusion of gametes/**syngamy/Fertilization** (vital event of sexual reproduction)
- Fertilization can only occur if the ovum and sperms are transported simultaneously to the ampullary region. This is the reason why not all copulations leads to fertilization and pregnancy

12 CHANGES IN GAMETES DURING FERTILIZATION

- Secretions of **Acrosome part of sperm**
  ↓ allow
  Entry of sperm into cytoplasm of oocyte through zona pellucida and plasma membrane
- Changes in zona pellucida prevent entry of additional sperms and **ensures that only one sperm can fertilise an ovum** Inducing completion of Meiosis II of secondary oocyte

Form 2nd Polar body (n) (1)
Cytoplasmically unequal 2nd meiotic division → egg/ovum
→ (1) (Released in Perivitelline space)

Ovum/ootid (n) (1) → Nuclei fuse ← Sperm (n)
Nuclei fuse → Zygote (2n)

- **Characteristics :**
  - Vital link that ensures continuity of species between organism of one generation and the next.
  - Sex of a child is decided at this stage

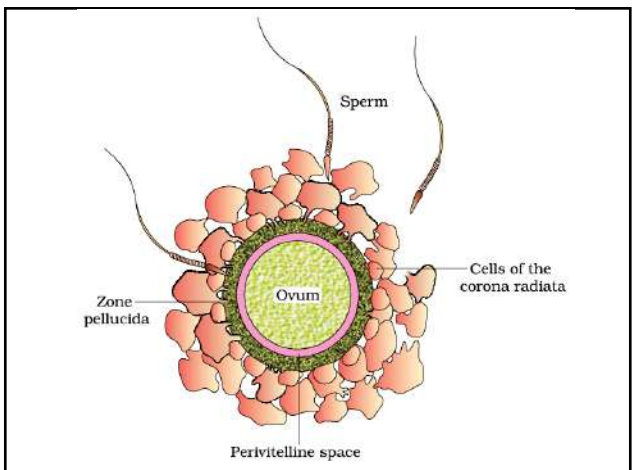
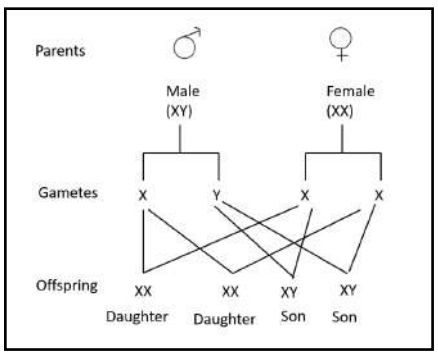


Fig. : Ovum surrounded by few sperms

13 SEX OF A BABY IS DETERMINED BY THE FATHER

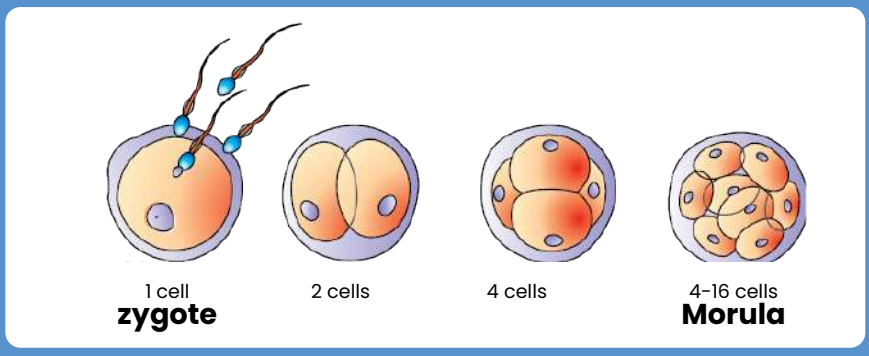
Parameters : Chromosome pattern Gametes formed Fusion of gametes

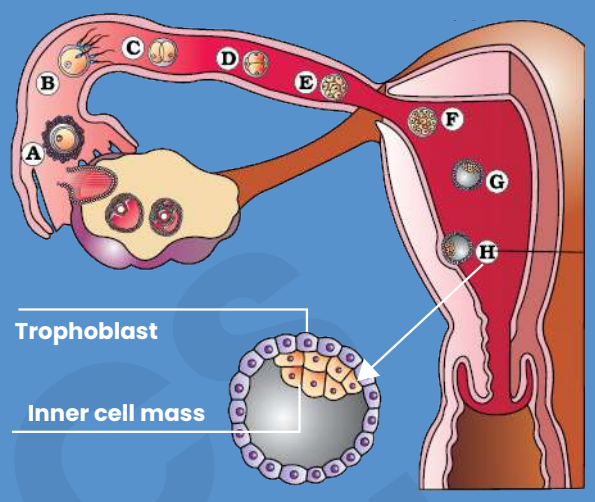


- 50% male gametes carry X chromosome and 50% carry Y chromosome
- Zygote would carry either XX or XY depending on whether the sperm carrying X or Y fertilizes the ovum

14 DEVELOPMENT OF THE ZYGOTE

- Every sexually reproducing organism, including human beings begin life as a single cell i.e., the zygote.
- During embryogenesis, zygote undergo cell divisions and cell differentiation
- The process of development of embryo from zygote is called embryogenesis.
- Cleavage starts as zygote moves through isthmus to the uterus
- Daughters formed after cleavage are called Blastomeres





Trophoblast – Outer layer of blastomeres attaches to endometrium

Inner cell mass – Inner group of cells attached to trophoblast ⟶ Differentiates into embryo with three germ layers

Blastocyst Implants in uterus
The inner cell mass contains certain cells called stem cells which have the potency to give rise to all the tissues and organs.

After attachment, uterine cells divide rapidly and cover the blastocyst. Embedding of blastocyst in endometrium is called

Implantation Leads to ⟶ **Pregnancy**

Germ layers
- Outer – Ectoderm
- Middle – Mesoderm
- Inner – Endoderm

These together give rise to all tissues/organ in adults.

15 CHANGES AFTER IMPLANTATION

Embryo/Foetus
Finger like projections appear on the trophoblast called chorionic villi

Mother
Uterine tissue

Interdigitate to form

Placenta **(Structural and functional unit between embryo/foetus and mother)**

- **Functions:**
  - Supply of O_2 and nutrients to the embryo
  - Removal of CO_2 and excretory/waste materials produced by the embryo
- **Acts as endocrine tissue :**
  - hCG/human chorionic gonadotropin
  - hPL/human placental lactogen

  → **Produced only during pregnancy**
  - Relaxin (Also secreted by ovary in later phase of pregnancy)
  - Estrogens
  - Progestogens
  - Cortisol
  - Prolactin
  - Thyroxine

Increase several folds during pregnancy, essential for supporting:
- Foetal growth
- Metabolic changes in mother
- Maintenance of pregnancy

•Placenta is connected to the embryo through an umbilical cord which helps in the transport of substances to and from the embryo

16 GESTATION PERIOD

- Average duration of pregnancy in
- Dog ~ 63 days
- Cat ~ 63 days
- Elephant ~ 18-22 months
- Human ~ 9 months

Major events during gestation period in humans:

Trimester	Month	Week	Event
1st	I	4	Heart is formed, sign of growing foetus noticed by listening to the heart sounds through stethoscope
	II	8	Foetus develops limbs and digits
	III (end)	12	Most of major organ systems are formed including external genital organs
2nd	V	20	First movement of foetus, Appearance of hair on head
	VI(end)	24	Body is covered with fine hair, Eyelids separate, Eyelashes are formed
3rd	IX (end)	36	Foetus is fully developed and is ready for delivery

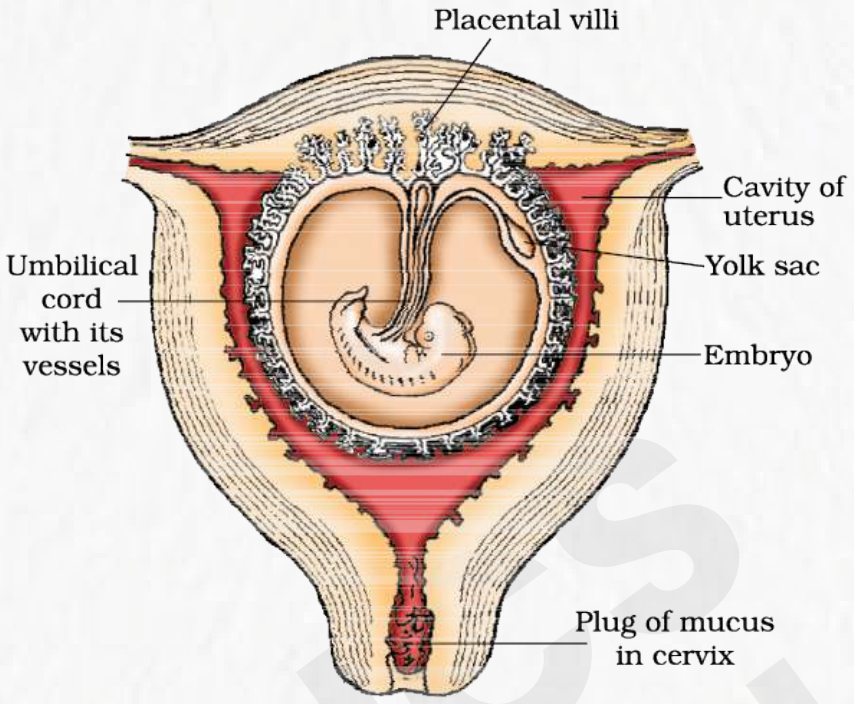
17 PARTURITION

- Defined as delivery of the foetus (Child birth)
- Signals for parturition originate from → Fully developed foetus, Placenta
  - Lead to
  - Mild uterine contractions
  - called
  - **Foetal ejection reflex**
  - triggers | release of
  - **Oxytocin from posterior pituitary of mother** → **This is positive feedback loop**
  - Causes
  - Strong uterine contractions
  - leading to
  - Expulsion of baby through birth canal **(Parturition)**
  - followed by
  - Expulsion of placenta

- Oxytocin is synthesized by its **source gland hypothalamus** but released from posterior pituitary.

- Child birth is induced by a complex neuroendocrine mechanism involving cortisol, estrogens and oxytocin.

Fully developed foetus
Placenta



The human foetus within the uterus

18 MAMMARY GLANDS AND LACTATION

- Functional mammary gland is characteristic of all female mammals
- Paired structures (Breasts) that contain variable amount of fat and

Glandular tissue
→ **(15-20) Mammary lobes**
→ Contain
→ **Mammary alveolus**
cluster of cells
(secrete and store milk) in their lumen
→ opens into
→ **Mammary tubules**
→ join to form
→ **Mammary duct**
→ Many join to form
→ **Mammary ampulla**
→ connected to
→ **Lactiferous duct**
(Through which milk is sucked out)

Fig.: Sectional view of Mammary gland

- **Mammary glands**
  - Undergo differentiation during pregnancy
  - Secrete milk after child birth that helps mother in feeding new born by process called lactation.

- Milk produced during initial few days of lactation is called colostrum which contains several antibodies, absolutely essential to develop resistance for the newt born babies.
- Breast feeding during the initial period of infant growth is recommended by doctors for bringing up a healthy baby