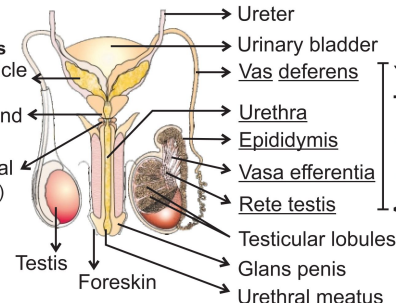


# Human Reproduction

## 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** (1 pair): Seminal vesicle, Prostate gland (one), Bulbourethral gland (1 pair)
- Accessory ducts**: Ureter, Urinary bladder, Vas deferens, Urethra, Epididymis, Vasa efferentia, Rete testis, Testicular lobules, Glans penis, Urethral meatus, Foreskin, Testis


### External genitalia of Male/Penis:

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

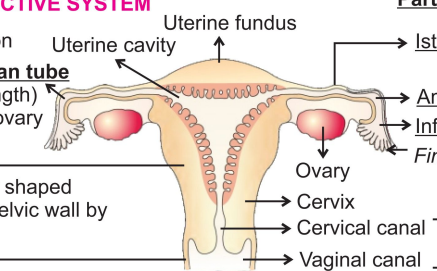
## 4 PRIMARY SEX ORGANS

Parameters	Male	Female	
Organ	Testis	Ovary	
Number	2	2	
Shape	Oval	Almond	
Location	Outside abdominal cavity in a pouch called <b>scrotum</b>	Lower abdomen, one 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 <b>testicular</b> hormones like androgens	Ova formation, synthesise steroidal <b>ovarian</b> hormones like estrogen and progesterone	
Compartments	250 testicular lobules <ul style="list-style-type: none"><li>1-3 coiled seminiferous tubules/lobule</li><li><b>Cells lining the seminiferous tubules</b><ol style="list-style-type: none"><li>Male germ cells/spermatogonia</li><li>Sertoli cells</li></ol></li></ul>	Peripheral <b>cortex</b> and inner <b>medulla</b> zones in ovarian stroma have follicles in various developing stages	

Labia minora	Paired folds of skin
Clitoris	Tiny finger like structure at the urethral opening
Hymen	<ul style="list-style-type: none"><li>Membrane at the opening of the vagina</li><li>Can be torn</li><li>May or may not be present</li></ul> <b>indicator of virginity</b>



## 3 FEMALE REPRODUCTIVE SYSTEM

- Location** : Pelvic region
  - 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**: Cervix, Cervical canal, Vaginal canal
- Uterine wall consists of three layers:**
- Endometrium** – Lines lumen, glandular and undergoes cyclic changes during menstruation
  - Myometrium** – Thick layer of smooth muscles that show strong contractions during delivery
  - Perimetrium** – External thin membrane

### External Genitalia of Female:

Parts	Features
<b>Mons pubis</b>	Cushion of fatty tissue covered by skin and pubic hair
<b>Labia majora</b>	Fleshy folds of tissue that extend down mons pubis and surround the vaginal opening
<b>Labia minora</b>	Paired folds of tissue under the labia majora
<b>Clitoris</b>	Tiny finger like structure which lies at the upper junction of labia minora above the urethral opening
<b>Hymen</b>	<ul style="list-style-type: none"> <li>Membrane that partially covers the opening of vagina</li> <li>Can be torn while - sudden jolt/fall, horse riding, cycling, insertion of vaginal tampon.</li> <li>May or may not be torn during the first coitus so its presence or absence is <u>not reliable</u> indicator of virginity or sexual experience.</li> </ul>

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

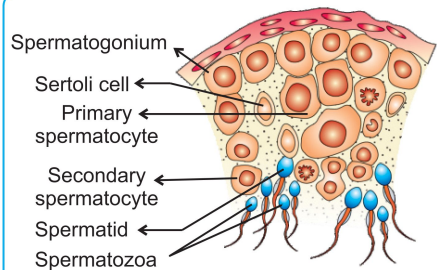
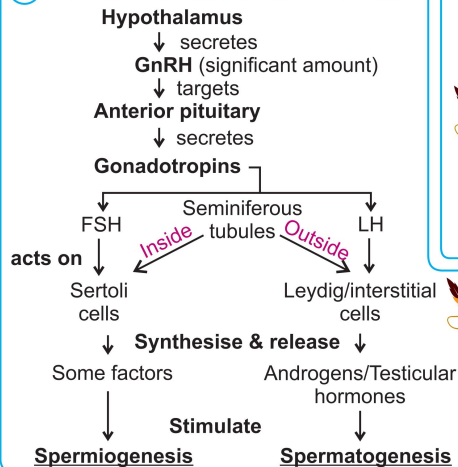


Fig. : Sectional view of seminiferous tubules

### 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

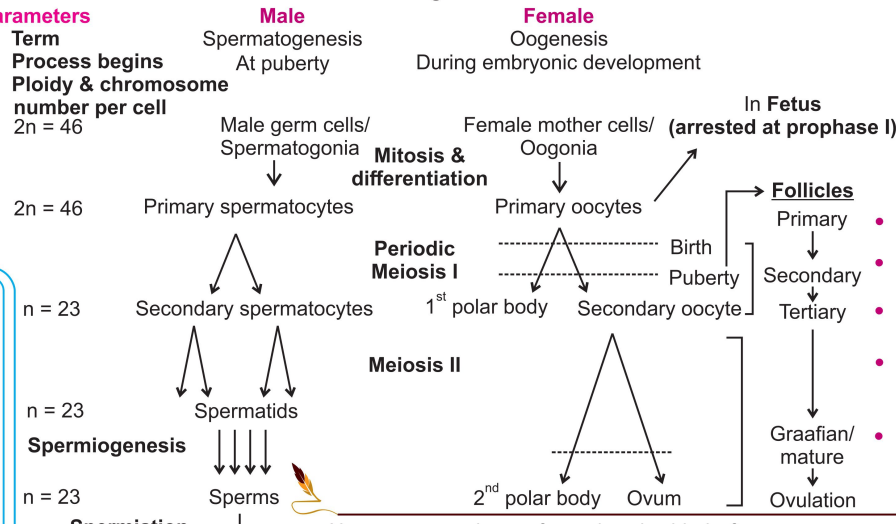


### Parameters

- **Term**
- **Process begins**
- **Ploidy & chromosome number per cell**  
 $2n = 46$

### 5 GAMETOGENESIS

#### Process of gamete formation



\* $2n$  = diploid  
\* $n$  = haploid

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

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

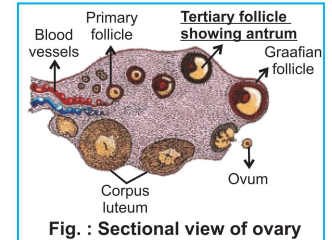


Fig. : Sectional view of ovary

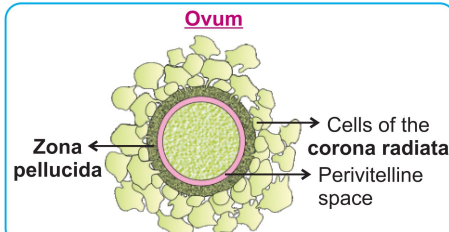
### Characteristics

- Single layer of granulosa cells
- More layers of granulosa cells and a **new theca layer**
- Completion of meiosis I (*Reduction division*)
- Fluid filled cavity **antrum** and theca layers are organised into external and internal layers
- Secondary oocyte forms **acellular zona pellucida** around it

- 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

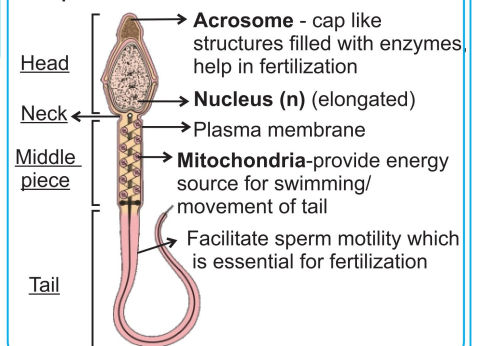
- During the embryonic development, a couple of million gamete mother cells (oogonia) are formed within each fetal ovary

### 8 STRUCTURE OF GAMETES



### Sperm

#### Main parts



## 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

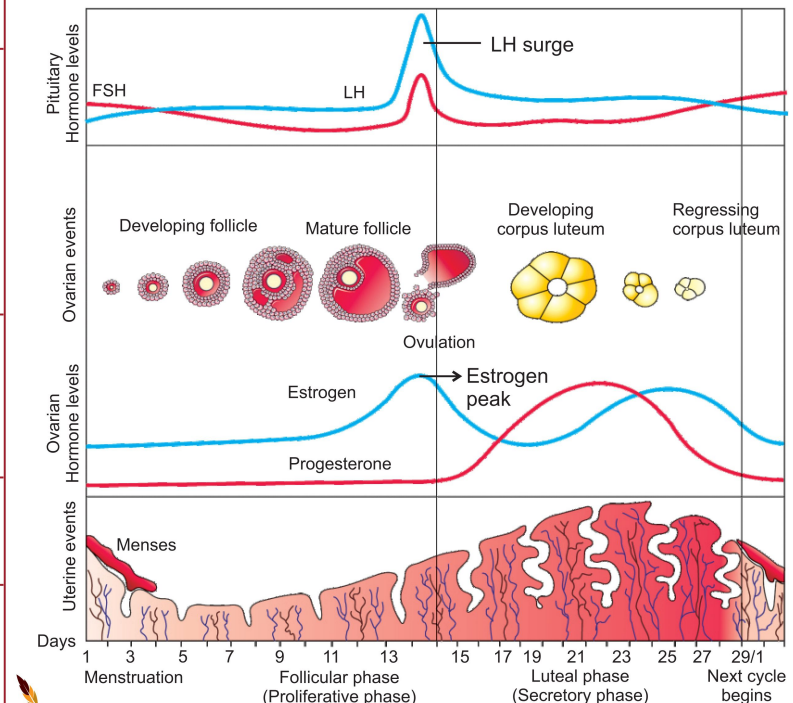
### Menstrual Cycle

- 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
<b>Menstrual</b>	3-5 days	Drastic decline in progesterone	Corpus luteum degenerates	<ul style="list-style-type: none"> <li>• Breakdown of endometrial lining and its blood vessels which forms liquid that comes out through vagina constituting <b>menstrual flow</b></li> </ul>
<b>Follicular or Proliferative phase</b>	Variable	Gradual increase in FSH and LH that stimulate secretion of estrogen from follicles	Primary follicle gradually matures to Graafian follicle	<ul style="list-style-type: none"> <li>• Endometrium regenerates through proliferation</li> </ul>
<b>Ovulation</b>	14 <sup>th</sup> day (Middle of cycle)	FSH and LH at peak, ( <b>LH surge</b> )	Rupture of Graafian follicle and release of only one ovum/ cycle	<ul style="list-style-type: none"> <li>• Proliferation of endometrium continues</li> </ul>
<b>Luteal or Secretory</b>	<b>Fixed (14 days)</b>	Secretion of progesterone and estrogen	Remnants of the Graafian follicle transforms into corpus luteum	<ul style="list-style-type: none"> <li>• Endometrium is maintained</li> <li>• If ovum remains unfertilized, endometrium is sloughed off, marking a new cycle</li> </ul>

### Menstrual Hygiene

1. Maintenance of hygiene and sanitation during menstruation is very important
2. Take bath and clean yourself regularly use sanitary napkins/home made pads
3. Change sanitary pads after every 4-5 hrs.
4. Dispose of used sanitary napkins properly by wrapping it in used paper.
5. 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



# Human Reproduction

## 1 INTRODUCTION

- Sequence of reproductive events occurring in humans include:

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

## 3 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**

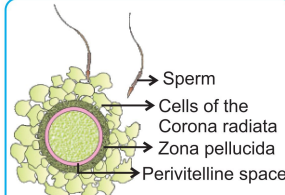
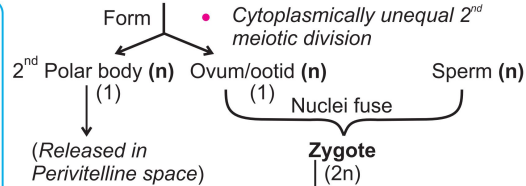


Fig. : Ovum surrounded by few sperms

Inducing completion of Meiosis II of secondary oocyte



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

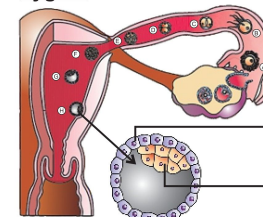
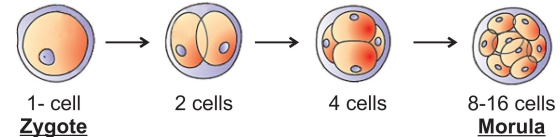
## 4 SEX OF A BABY IS DETERMINED BY THE FATHER

Parameters	Female	Male
Chromosome pattern	XX	XY
Gametes formed	X	X, Y
Fusion of gametes	XX (Female)	XY (Male)

- 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

## 5 DEVELOPMENT OF THE ZYGOTE

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



**Blastocyst**  
Implants in uterus

**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

After attachment, uterine cells divide rapidly and cover the blastocyst.  
Embedding of blastocyst in endometrium is called **Implantation**  
Leads to ↓ **Pregnancy**

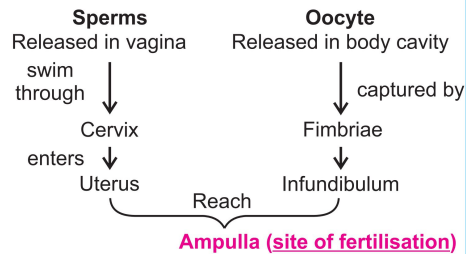
The inner cell mass contains certain cells called **stem cells** which have the potency to give rise to all the tissues and organs.

Germ layers

- Outer – Ectoderm
  - Middle – Mesoderm
  - Inner – Endoderm
- These together give rise to all tissues/organ in adults.

## 2 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**

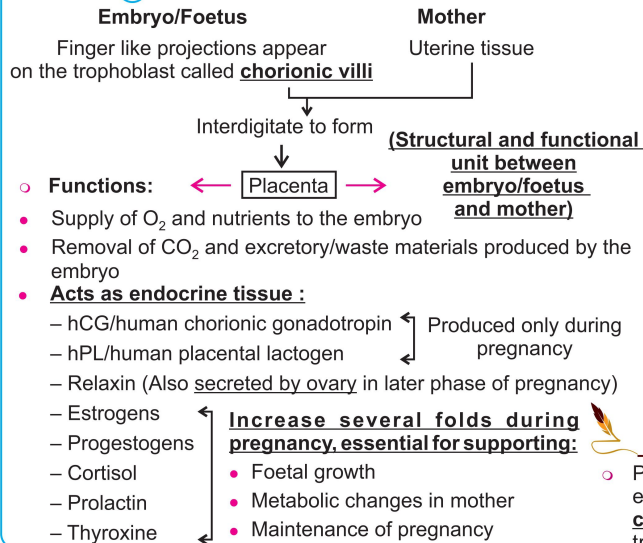


**Ampulla (site of fertilisation)**  
↓  
Fusion of gametes/**syngamy/Fertilization**  
(vital event of sexual reproduction)

- 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



## 6 CHANGES AFTER IMPLANTATION



## 7 GESTATION PERIOD

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

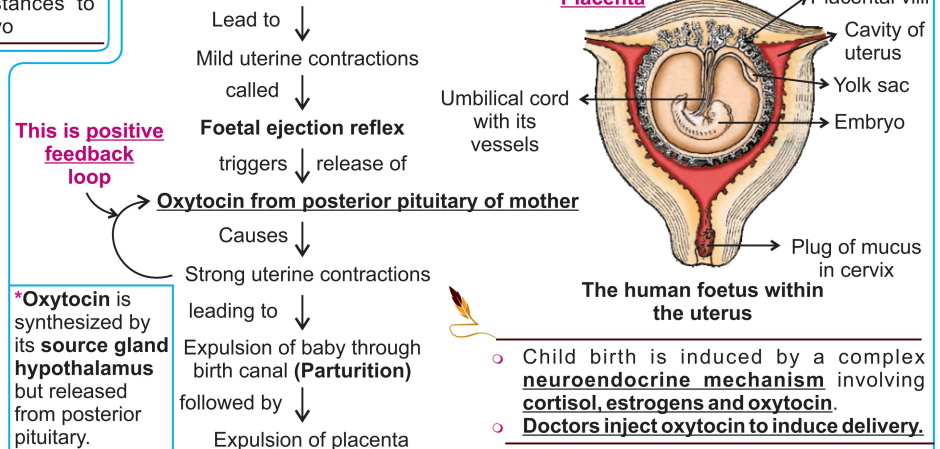
Major events during gestation period in humans:

Trimester	Month	Week	Event
1 <sup>st</sup>	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
2 <sup>nd</sup>	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
3 <sup>rd</sup>	IX (end)	36	Foetus is fully developed and is ready for delivery

## 8 PARTURITION

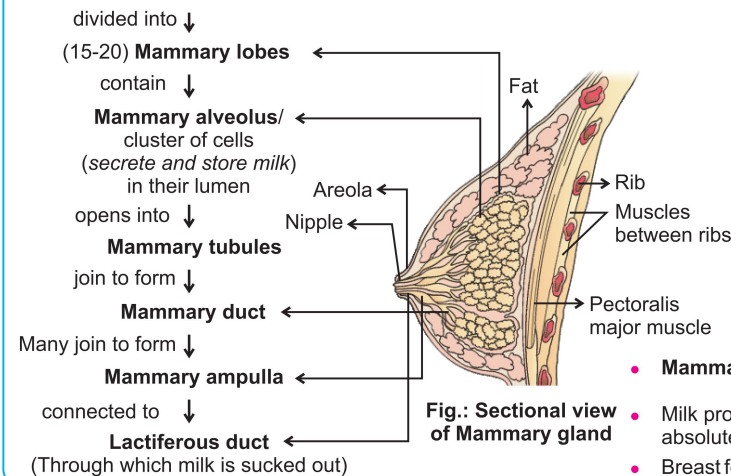
- Defined as delivery of the foetus (Child birth)

- Signals for parturition originate from **Fully developed foetus** and **Placenta**



## 9 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**



- 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 new born babies.
- Breast feeding during the initial period of infant growth is recommended by doctors for bringing up a healthy baby